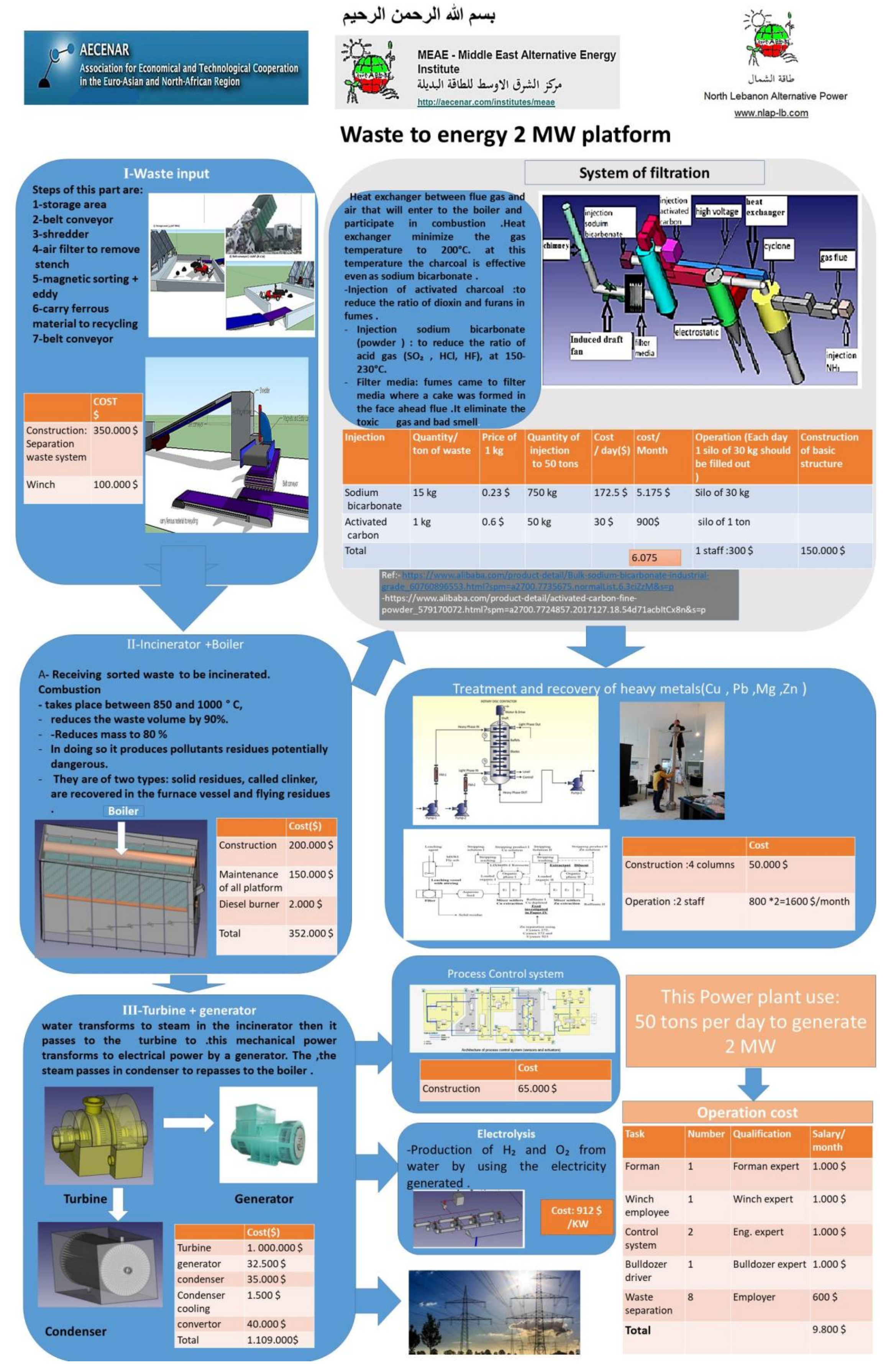
بسم الله الرحمن الرحيم

NLAP-2MW Incineration Power Plant – Final Report (2015 – 2020)

Planning, Design, Construction, Environment Impact Assessment



<u>Based on following reports:</u>

[TEMO-IPP 40MW CFD FHamed 2015]

[TEMO-IPP 40MW FEM BKerdi 2015]

[Turbine 1.5MW MZoebi 2016]

[NLAP-IPP 2MW Technical Manual]

[EIA Srar 2019]

[Presentation CCIAT March 2019], Conference Report

[Proposal BOT Meshha Akkar May 2019], [Proposal BOT Taran Dinniye May 2019]

FreeCAD Database

<u>Posters</u>

- 2 MW platform
- Norms
- Flue Gas Purification
- Heavy Metals Recycling
- 8 Columns
- Steam Header

Last update:

26 August 2020

Content in short

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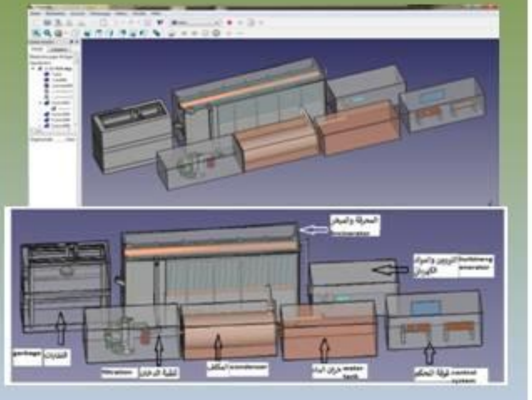
Project Management

1 Business Plan (الجدول الاقتصادي)

المنتوج ونظام التشغيل



المحطة تشغل 12 ساعة اي في غياب كهربة الدولة

الوضع القانوني في لبنان

- الانبعاثات يجب ان تخضع القوانين البيئية

Valeurs limites à respacter lors de l'incinération des ordures ménagères
الحدود القصوى المسموح بها لملوثات الهواء في الانبعاثات الناجمة عن حرق النفايات المنزلية

Capacité de l'incinérateur
طاقـة الاستيعاب

>3 tonnes /H اكثر من ٣ اطنان/ساعة		1-3tonnes/H من ١-٣ طن في الساعة		<1 tonne/H اقل من طن في الساعة			
Valeur maximale mg/m3	الحدود القصوى ملغ/ متر مكعب	Valeur maximale mg/m3	الحدود القصوى ملغ/ متر مكعب	Valeur maximale mg/m3	الحدود القصوى ملغ/ متر مكعب	Element	الملوث
30	٣٠	100	١٠٠	200	٢٠٠	Poussières totales	الجسيمات العالقة الكلية
5	٥	5	٥	-	-	Pb+Cr+Cu +Mn	رصاص+كروم+ نحاس+منغنيز
1	١	1	١	-	-	Ni+As	نيكل+زرنيخ
0,2	٠,٢	0,2	٠,٢	-	-	Cd+Hg	كادميوم وزئبق
50	٥٠	100	١٠٠	250	٢٥٠	Cl en HCl	كلور (كحامض هيدروكلوريك)
2	٢	4	٤	-	-	F en HF	فلور (كحامض هيدروفلوريك)
300	٣٠٠	300	٣٠٠	-	-	SO_2	ثاني اكسيد الكبريت

D: limits of emissions in Lebanon

- الكهرباء يمكن ان تباع عبر شبكة خاصة او مع اتفاق مع شركة الدولة

كلفة المحطة و تكاليف التشغيل والمدخول عن طريق بيع الكهرباء

كلفة المحطة (مدة التصنيع حتى التشغيل: 9 اشهر)	**3 Mio.$**

كلفة التشغيل سنوياً	
كلفة التشغيل (3 اشخاص في كل دوام، 3 دوامات = 9 اشخاص)	$150,000
تكاليف تصليح (سنويا)	$50,000
كلفة استخدام شبكة الكهرباء (ما يعادل 5% من الدخل عن طريق الكهرباء)	$50,000
0.25 Mio$	

الربح سنوا (مدخول ناقص تكاليف التشغيل والتصليح)	
سعر الkWh: 0.13 $	
المدخول سنوا 1500kW x 12 h x 330 d x 0.13 $	**1 Mio $**
كلفة التشغيل سنوياً	-0.25 Mio$
0.75 Mio.$	

2 NLAP 1.5 MW Demoplant & Marketing - Planning for 2019

AECENAR Finance Planning

Jan - Jun 2019			Jan	Feb	Mar	Apr	May	Jun
Staff cost (Personalkosten)	**Projekt**	**Responsible**						
MEAE-WEDC	NLAP-PCS_Platform (BPC, GUI)	Abdurrahman	$300	$300				$300
		MMJZ	$300	$300				$300
	Electrolysis, Hydrogen Storage, WEDC	Siham	$400					
	IAP-SAT Chem. Prop. Commisioning	Abdullah		250	250	250	250	250
		Samer	$250					
		Othman	$250					
	Heavy Metals Recycling Commisioning	Maysaa		$534				
	WEDC	Siham		$400				
	Fuel Burner Commisioning	Samer			$250			
		Othman			$250			
	Methan Liquification / Chem.Prop.	Mariam A.		$400	$400	$400	$400	$400
	15 MW / EU Standard: General Documents	Maysaa	$534		$534	$534	$534	$534
	WEDC	Siham			$400	$400	$400	$400
	Chemical Treatment / Deaerator Contruction	Samer					$250	
		Othman					$250	
	15 MW Turbine 14 bar, 195°C Gears Construction	N.N.						
	Generator - Trafo Block / Standards	Alaa (Trainee)						
	Building for 15 MW Power Plant	N.N. / Rami (Trainee)						
MEGBI	MEGBI-APP Automation	Abdurrahman			$300	$300		
		MMJZ			$300	$300		
ICS	TEMOLeb-Mintad Mechanics Construction	Samer		$250				
		Othman		$250				
	TEMOLeb-Commisioning	MMJZ					$300	
		Abdurrahman					$300	
IEP	IEP-MEPSA	Bilal	$150	$150	$150	$150	$150	$150
	IEP-MEPSA	Asia	$150	$150	$150	$150	$150	$150
IAP	IAP-SAT Electrical Prop	Mariam M.	$300	$300	$300	$300	$300	$300
	IAP-SAT Chem. Prop. Commisioning	Samer				$250		
		Othman				$250		
Administration External Relations		سمير ايوبي	$300	$300	$300	$300	$300	$300
Material								
WEDC			$2.000	$1.000	$1.000	$1.000	$1.000	$1.000
MEGBI-APP				$1.000	$500			
IAP-SAT/Chem. Prop.			$1.000	$1.000	$500	$500	$500	$500
Ground Ras Masqa/WEDC								
	Inner walls IAP, MEAE, Terasse		$600	$300				
	WEDC area		$1.000	$1.000				
AECENAR - Grundstueck, Bau -> verschoben nach 2020								
Rent Ras Masqa Facility				$5.000				
		sum	**$7.534**	**$12.884**	**$5.584**	**$5.084**	**$5.084**	**$4.584**
Some parameters:								
Financing should be reliable for the following 6 month							Total Jan-Jun 2019	
normally: salaries are 70% of total costs							**$40.754**	

FEM Investigation for 40 MW Incineration Power Plant

بسم الله الرحمن الرحيم

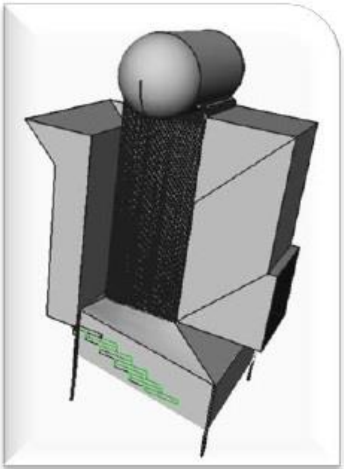
MEAE – Middle East Institute for Alternative Energy

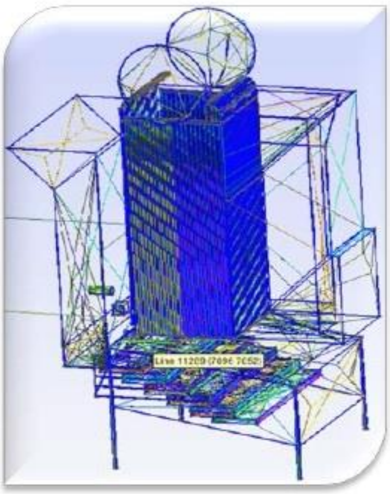
AECENAR
Association for Economical and Technological Cooperation in the Euro-Asian and North-African Region
www.aecenar.com

الجامعة اللبنانية
كلية العلوم

TECDA Research Center

Mechanical analysis of an upscaled version of the vaporizer of the incineration power plant TEMO-IPP





Master Thesis

Prepared by: Banan ELKERDI

بسم الله الرحمن الرحيم

عن أبي هُريرةَ رَضيَ اللهُ عنه قالَ قالَ رَسُولَ اللهِ صَلى اللهُ علَيْه وسَلَّمَ

إذَا مَاتَ ابنُ آدَمَ انقَطَعَ عمَلُهُ إلاَّ مِنْ ثَلاثٍ صَدَقَةٍ جَارِيَةٍ أو عِلْمٍ يُنْتَفَعُ بِهِ أووَلَدٍ صَالِحٍ يَدْعُو لَهُ.

-رواه مسلم-1631

اللَّهُمَّ انفعني بما علمتني وعلمني ما ينفعني وارزقني علما تنفعني به

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3 ACKNOWLEDGEMENTS

عن أبي هريرة، عن النبي صلى الله عليه وسلم قال: "**لا يشكر الله من لا يشكر الناس**". رواه ابو داود. ورواه الترمذي عن أحمد بن محمد، عن ابن المبارك، عن الربيع بن مسلم وقال: صحيح.

The prophet Muhammad (peace be upon him) said***: "Who doesn't thank a person (for something good), do not gives thank to God".***

First I want to thank Dr. Hamed Elkhatib, my professor at the Lebanese University for its support and assistance throughout the work. Also a big thanks to Dr. Abd El Fattah Khoder.

Then the great thanks go to my family , my father Khalid , Najat my mother and all my brothers and my sister.

Banan Elkerdi

Burj Akkar, Akkar/North Lebanon

18 October 2015

4 ABSTRACT

This thesis discusses the mechanical study of the incineration chamber and vaporizer (including climbing pipes) subjected to relatively high pressure, which may cause a relatively great mechanical stress leading to fatigue and damage and eventually break.

It is a study for upscaling the TEMO-IPP test plant in Ras Nhache, Batroun /Lebanon to a commercial 30 or 40 MW plant for a city like Tripoli/Lebanon.

The fracture mechanics and the study of fatigue phenomenon are relatively recent sciences that saw the bulk of their development in the 20th century. The issue of those fields of mechanics is the same: it is to predict the behavior of structures up to their ruin, as much as possible to avoid the dangers and high costs introduced by fatigue and breakage.

Theoretically, several methods exist to estimate the number of cycles before damage, in this study we use several software (Fallo, FALLIN, FALLPR, FALLSIN) specialized in the estimate that are combined together to predict the fewest estimated cycle .

Keywords: multiaxial fatigue, rupture, Rankine cycle, crack propagation, damage, free software, open source.

5 CHAPTER 0: INTRODUCTION

This thesis discusses the mechanical study of the incineration chamber and vaporizer (including climbing pipes) subjected to relatively high pressure, which may cause a relatively great mechanical stress leading to fatigue and damage and eventually break.

It is a study for upscaling the TEMO-IPP test plant in Ras Nhache, Batroun /Lebanon to a commercial 30 or 40 MW plant for a city like Tripoli/Lebanon, see Appendix 3.

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6 CHAPTER I: Basics

6.1 Stress

6.1.1 Introduction

Stress is a tensor quantity (neither a vector nor a scalar) that depends on the direction of applied load as well as on the plane it acts. Generally speaking, at a given plane there are both normal and shear stresses. However, there are planes within a structural component (that is being subjected to mechanical or thermal loads) that contain no shear stress. Such planes are called principal planes and the directions normal to those planes are called principal directions. The normal stresses (only stresses in those planes) are called principal stresses. For a general three-dimensional stress state there are always three principal planes along which the principal stresses act. In mathematical terms we can say that the problem of principal stresses is an eigenvalue problem, with the magnitudes of the principal stresses being the eigenvalues and their directions (normal to the planes on which they act) being the eigenvectors. Principal stress calculations form an essential activity for a general stress analysis problem.

6.1.2 1.1.2. Categorization of stresses

Stresses are generally characterized as (a) primary stress, (b) secondary stress, or (c) peak stress. In the following discussion, the primary stresses will be denoted by P, the secondary stress by Q and the peak stress by F. These nomenclatures also apply to the ASME Boiler and Pressure Vessel Code We will now define each of the three categories of stress.

6.1.2.1 a. Primary stress

Primary stress is any normal stress or a shear stress developed by the imposed loading which is necessary to satisfy equilibrium between external and internal loads. These stresses are not self-limiting. If primary stresses are increased such that yielding through net section occurs, subsequent increase in primary stress would be through strain hardening until failure or gross distortion occurs. Generally primary stresses result from an applied mechanical load, such as a pressure load. The concept of equilibrium is based on a monotonic load and a lower bound limit load. Primary stresses are those that can cause ductile rupture or a complete loss of load-carrying capability due to plastic collapse of the structure upon a single application of load. The purpose of the Code limits on primary stress is to prevent gross plastic deformation and to provide a nominal factor of safety on the ductile burst pressure.

Primary stresses are further divided into three types: general primary membrane (Pm), local primary membrane (PL), and primary bending (Pb).

6.1.2.2 *b. Secondary stress*

Secondary stress originates through the self-constraint of a structure. This must satisfy the imposed strain or displacement (continuity requirement) as opposed to being in equilibrium with the external load. Secondary stresses are self-limiting or self-equilibrating. The discontinuity conditions or thermal expansions are satisfied by local yielding and minor distortions. The major characteristic of the secondary stress is that it is a strain-controlled condition. Secondary stresses occur at structural discontinuities and can be caused by mechanical load or differential thermal expansion. The local stress concentrations are not considered for secondary stresses. There is no need for further dividing the secondary stress into membrane and bending categories. In terms of secondary stress we imply secondary membrane and bending in combination.

6.1.2.3 *c. Peak stress*

Peak stress is the highest stress in a region produced by a concentration (such as a notch or weld discontinuity) or by certain thermal stresses. Peak stresses do not cause significant distortion but may cause fatigue failure. Some examples of peak stresses include thermal stresses in a bimetallic interface, thermal shock stresses (or stresses due to rapid change in the temperature of the contained fluid), and stresses at a local structural discontinuity.

Within the context of local primary membrane stress, PL, as well as secondary stress, Q, the discontinuity effects need not be elaborated. The structural discontinuity can be either gross or local. Gross structural discontinuity is a region where a source of stress and strain intensification affects a relatively large portion of the structure and has a significant effect on the overall stress or strain pattern. Some of the examples are head-to shell and flange-to-shell junctions, nozzles, and junctions between shells of different diameters or thicknesses. Local structural discontinuity is a region where a source of stress or strain intensification affects a relatively small volume of material and does not have a significant effect on the overall stress or strain pattern or on the structure as a whole.

6.1.3 1.1.3. Stress intensity

Let us indicate the principal stresses by σ1, σ2, and σ3. Then we define the stress differences by:

$$S_{1,2} = \sigma_1 - \sigma_2;\ S_{2,3} = \sigma_2 - \sigma_3;\ S_{1,3} = \sigma_1 - \sigma_3;$$

The stress intensity, SI, is then the largest absolute value of the stress differences, or in other words:

$$SI = \max[|S_{1,2}|, |S_{2,3}|, |S_{1,3}|]$$

The computed stress intensity is then compared with the material allowable taking into consideration the nature of the loading. The material allowable is based on yield and ultimate strength of the material with an implied factor of safety. Within the context of pressure vessel design codes, the comparison of the allowable strength of the material is always done with respect to the stress intensities. This puts the comparison in terms of the appropriate failure theory either the maximum shear stress theory (Tresca criterion) or the maximum distortion energy theory (von Mises criterion).

6.1.4 1.1.4. Stress limits

The allowable stresses (or more correctly the stress intensities) in pressure vessel design codes such as the ASME Boiler and Pressure Vessel Code are not expressed in terms of the yield strength or the ultimate strength but instead as multiples of tabulated design value called the design stress intensity (denoted for example as Sm). This value is typically two-thirds of the yield strength of the material or for other cases one-third of the ultimate strength. Therefore we have a factor of safety of 1.5 or 3 in terms of yield strength or ultimate strength, respectively. It is the purpose of the design codes that these multiples of either the yield or the ultimate strength are never exceeded in design.

The pressure vessel design codes often make specific recommendations on the limits depending on the conditions (or situations) of design. One typical such classification is in terms of design, normal, and upset (levels A and B), emergency (level C), faulted (level D) and test loadings, and accordingly limits are set appropriately. These stress limits have been discussed in some detail in Chapter 3. As an example, for design conditions the limits for the general primary membrane stress intensity, Pm, the local primary membrane stress intensity, PL, and the combined membrane and bending stress intensity Pm (PL)+ Pb, are typically expressed as:

$$P_m \leq S_m$$

$$P_L \leq S_m$$

$$P_L + P_b \leq 1.5S_m$$

These limits are sometimes higher than the actual operating conditions. It is the intent of the design code that the limit on primary plus secondary stresses be applied to the actual operating conditions. For normal and upset conditions (sometimes indicated as levels A and B), the range of primary and secondary stresses, PL þ Pb þ Q is not allowed to exceed 3Sm, or

$$|PL + \ Pb + \ Q|_{range} \leq 3S_m$$

A word of caution is needed here. For example, a stress limit on some of the combination of stress categories such as Pm(PL) Pb, PL Q needs to be carefully understood. The confusion arises because of the tendency to denote the stress intensity in a particular category by the symbol of that category, for example P is the stress intensity for the primary bending stress category. However (PL Pb Q) is not the sum of the individual components of primary membrane, primary bending and secondary stress intensities. It is in fact the stress intensity evaluated from the principal stresses after the stresses from each category have been added together in the appropriate manner (that is not by adding the stress intensities). The primary plus secondary stress limits are intended to prevent excessive plastic deformation leading to incremental collapse, and to validate the application of elastic analysis when performing the fatigue evaluation. The limits ensure that the cycling of a load range results in elastic response of the material, also referred to as shakedown (when the ratcheting stops)[3].

6.1.5 1.2. Fatigue assessment of pressure vessels

6.1.6 1.2.1. Introduction

All structures and mechanical components that are cyclically loaded can fail by fatigue. With limited input data, constant amplitude fatigue analysis is used to make a simple and quick estimate of the likely fatigue performance or durability.

There are three primary methods for estimating the fatigue resistance of components and structures. **Stress-Life** analysis assumes that the stresses always remain elastic even at the stress concentrators. Most of the live is consumed nucleating small microcracks. This is typical for long life situations (millions of cycles) where the fatigue resistance is controlled by nominal stresses and material strength. **Strain-Life** is used for situations where plastic deformation occurs around the stress concentrations.

An example would be in a structure that has one major load cycle every day. Both stress-life and strain-life provide an estimate of how long it will take to form a crack about 1mm long. **Crack growth** analysis is then used to estimate how long it will take to grow a crack to final fracture. Fatigue of welds requires special considerations because of their complex shape and loading.

6.2 1.2.2. Stress-Life

The stress life method is the classical method for fatigue analysis of metals and has its origins in the work of Wöhler in 1850. Stresses in the structure or component are compared to the fatigue limit of the material. The basis of the method is the materials S-N curve which is obtained by testing small laboratory specimens until failure.

6.2.1.1 a. Material Properties

Historically, these tests have been conducted in rotating bending. Today, it is often common to find test data for axial loading as well.

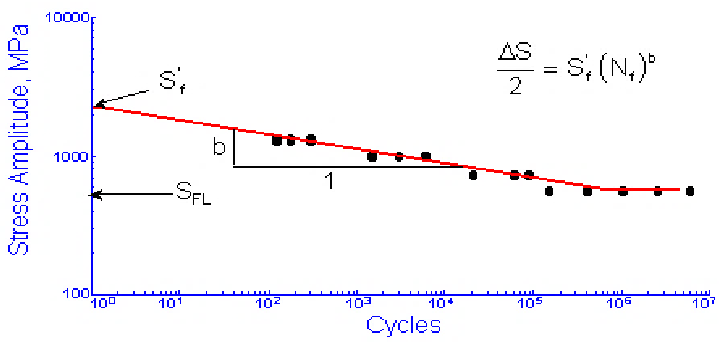


Figure 1

The fatigue limit, S_{FL}, is the stress below which failures do not occur in the laboratory. Wöhler called this a safe stress level for design. Today we know that failures will occur below the safe stress level but it will take a very large number of cycles, longer than the 10^6 or 10^7 cycles used in normal fatigue testing. The finite life portion of the curve is fit to a power function relating the stress amplitude, ΔS/2, and fatigue life in cycles, N_f. Some people use reversals, $2N_f$, instead of cycles for plotting fatigue data. There are 2 reversals in one cycle. The intercept at 1 cycle, S_f', and slope, b, are taken as material constants.

Many times the fatigue behavior of a material is unknown and must be estimated from the tensile properties. There is a strong correlation between fatigue strength and tensile strength [4].

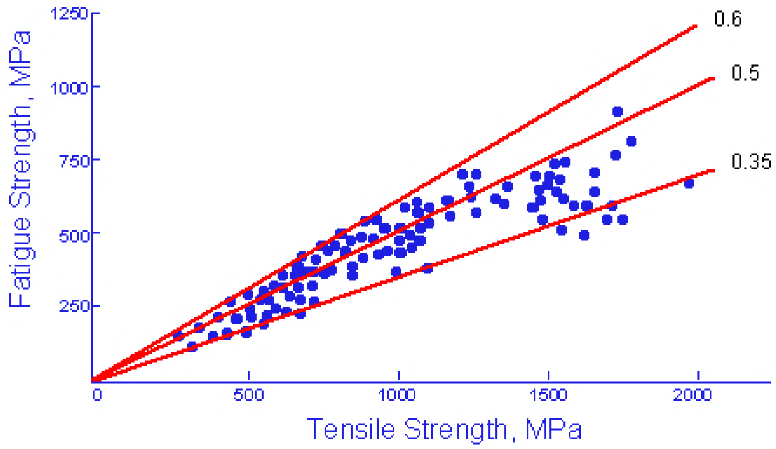


Figure 1

The fatigue limit is approximated as one half of the tensile strength.

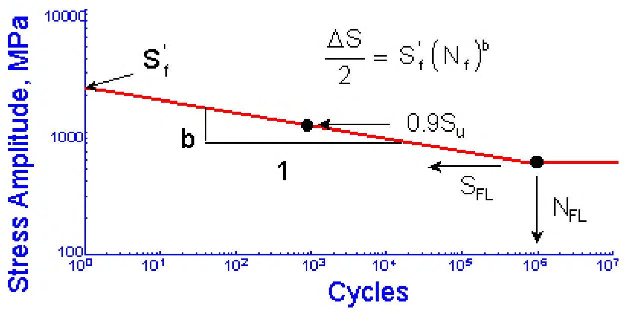
$$S_{FL} = 0.5 S_u$$

Many metal alloys are heat treatable and the hardness rather than the tensile strength are known. Another well-known approximation, with just as much scatter as shown above, is that the tensile strength, in English units of ksi, is approximately one half of the Brinell hardness, BHN. Combining these two approximations provides an estimate of the fatigue strength from the hardness.

$$S_{FL} = 0.25(BHN)$$

It has been observed that the fatigue strength at 1000 cycles is approximately 0.9 Su. This gives two points on the SN curve, both in terms of hardness that can be used to estimate the entire SN curve.

$$S_a = \frac{\Delta S}{2} = 1.62\, S_u (N_f)^{-0.085}$$



Four material parameters are used to describe the materials stress life curve, Sf', b, SFL and NFL, only three of which are independent. Leaving any one of the parameters blank will result in the fourth one being directly computed. If all four are entered, SFL will be ignored.

6.2.1.2 b.Modifying Factors

Materials, as they are tested, are always in a different condition (surface finish, residual stress, etc.) from the materials as they are actually used. An important part of the analysis is to "correct" the basic materials data to obtain an estimate of the fatigue limit of the material in the component or structure of interest. Fatigue cracks usually nucleate on the surface so that the condition of the surface plays a major role in the fatigue resistance of a component. Test specimens are polished to eliminate the effects of surface finish. The degree of surface damage depends not only on the processing but also on the strength of the material. Higher strength materials are more susceptible to surface damage. To account for this in the analysis the material fatigue limit is reduced by a surface finish factor, k_{SF}.

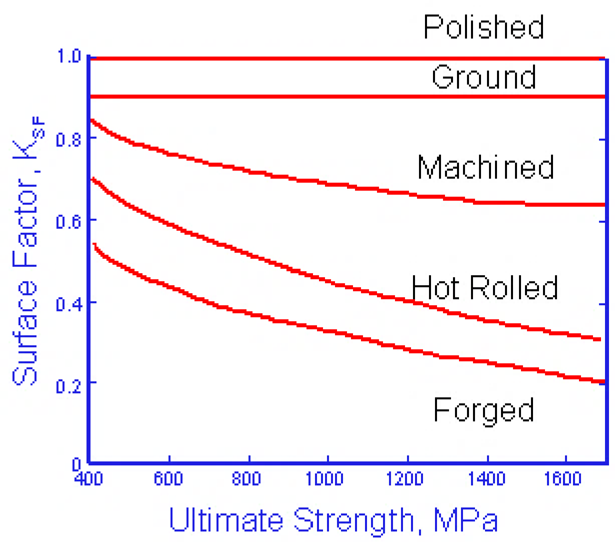


Figure 2

The original data for constructing this curve is shown below. The factors tend to provide conservative estimates for fatigue lives [5].

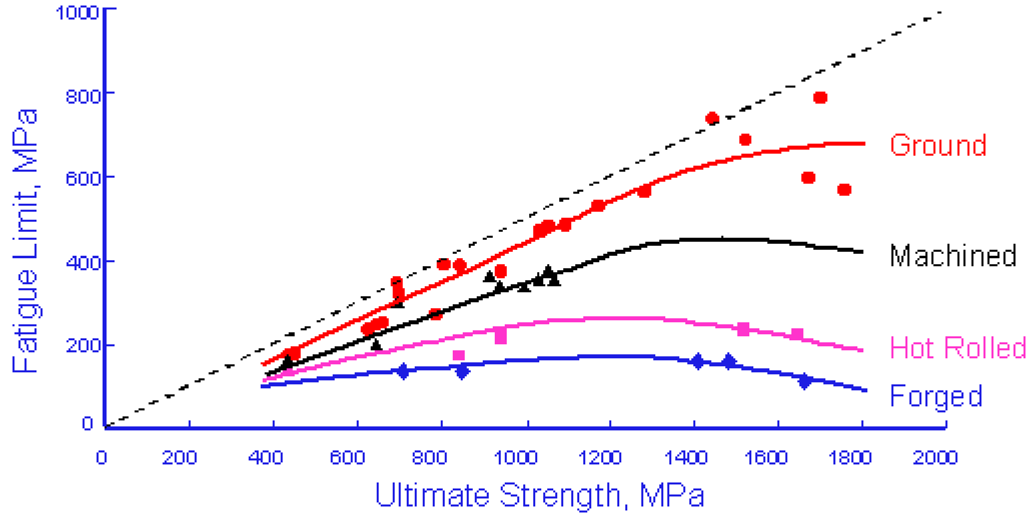


Figure 3

These data are fit to a simple power function to obtain an estimate of the surface factor for any hardness steel.

$$k_{SF} = \alpha S_u{}^{\beta}$$

Table 1:Ground

	A	β
Ground	1.58	-0.085
Machined	4.51	-0.265
Hot Rolled	57.7	-0.718
Forged	272	-0.995

Fatigue limits have historically been determined from small specimens, 6 mm in diameter, tested in rotating bending. High strength materials tested in tension tend to have lower fatigue limits. An empirical load factor, k_L, is introduced for other types of loading.

	kL
Tension, Su <= 1500 MPa	0.92
Tension, Su > 1500 MPa	1.0
Bending	1.0
Torsion	0.58

Table 2:Tension

Experiments show that smaller components tend to have higher fatigue limits than larger ones. This is accommodated in the analysis by introducing a size factor, k_{size}. Some people call this a gradient factor. One of the most widely used corrections is based on the diameter of a bar.

$$k_{size} = \left(\frac{d}{7.62}\right)^{-0.1133} \qquad 3 \leq d \leq 50$$

One of the problems associated with this simple approximation is what to do when the section is not round. This problem is overcome by defining an effective diameter. The volume of material subjected to 95% of the maximum stress in any shaped cross section is equated to a round bar of the same highly stressed volume. When these volumes are equated, the length canceled and the ratio becomes one of the relative areas. If we define the cross sectional area of a non-circular section subjected to 95% of the maximum stress as $A_{0.95}$, then the effective diameter is given by

$$d = \sqrt{\frac{A_{0.95}}{0.077}}$$

Once these correction factors are determined, the fatigue limit of the machine component in the condition that it is being used in can be evaluated from the standard test specimen.

$$S_{FL}(\text{component}) = S_{FL}(\text{material}) \cdot k_{SF} \cdot k_L \cdot k_{size}$$

These generalized empirical factors have the greatest confidence when applied to steel because they were all derived from on extensive database on steel accumulated from over 100 years of testing. The figures above have shown considerable scatter in the test data so that the factors must be regarded as approximate and are no substitute for actual test data for a critical application. That said, they do provide a good first approximation when no test data is available.

6.2.1.3 c.Stress Concentrations

Stress concentrations are one of the most important factors affecting the fatigue life of any component or structure. These stress concentrations may be intentional in the design or unintentional such as deep machining marks or other processing related flaws. It seems reasonable to directly compare the maximum stress at a stress concentration to the estimated fatigue limit for that component [6].

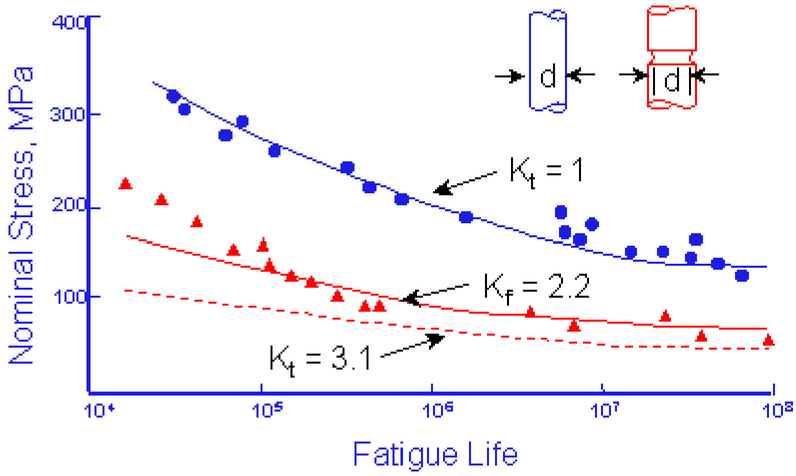


Figure 4

Test data for an unnotched bar, such as the one above pictured in blue, are plotted as blue circles. This geometry has a stress concentration factor, K_t, equal to 1. The red dashed line represents estimated data for a geometry that has a stress concentration factor of 3.1, such as the notched bar pictured in red. The presence of the notch reduces the allowable nominal stress amplitude at any fatigue life by a factor equal to K_t. Notice that all of the actual test data, red triangles, lie above this estimate. This is because the effective stress concentration in fatigue is less than that predicted by the stress concentration factor, K_t. This effective stress concentration factor is called the fatigue notch factor, K_f. The variation between K_f and K_t is dependant on the size of the notch and strength of the material. A material that is very sensitive to notches will have K_f equal to K_t. If the material is very insensitive to notches, K_f will be close to 1. A notch sensitivity factor, q, is introduced to quantify this sensitivity [7].

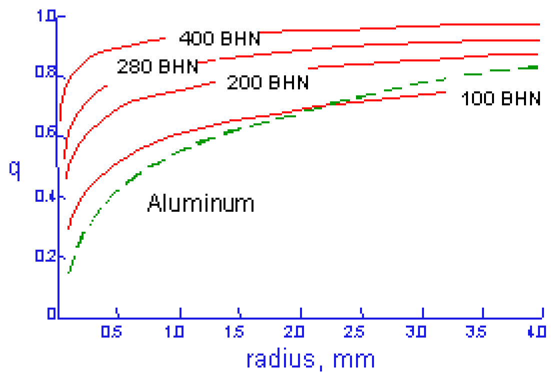


Figure 5

Smaller radii are less effective in fatigue than larger ones. Fatigue notch factors can be computed from K_t and q.

$$K_f = 1 + (K_t - 1)q$$

Peterson fit the available test data for steel and aluminum to obtain an expression for K_f in terms of ultimate strength, S_u, and notch radius, ρ in mm.

$$K_f = 1 + \frac{K_t - 1}{\frac{1 + 0.025\left(\frac{2070\,MPa}{S_u}\right)^{1.8}}{\rho}} \quad for steel$$

$$K_f = 1 + \frac{K_t - 1}{1 + \frac{0.5mm}{\rho}} \quad for aluminum$$

6.2.1.4 d. <u>Mean Stresses</u>

Tensile mean stresses are known to reduce the fatigue strength of a component. Compressive mean stresses increase the performance and are frequently used to increase the fatigue strength of a manufactured part. The most common method for accounting for mean stresses is the Goodman Diagram. It was first proposed in 1890. Goodman writes ".. whether the assumptions of the theory are justifiable or not.... We adopt it simply because it is the easiest to use, and for all practical purposes, represents Wöhlers data." The fatigue limit for zero mean stress is plotted on one axis and the ultimate strength on the other.

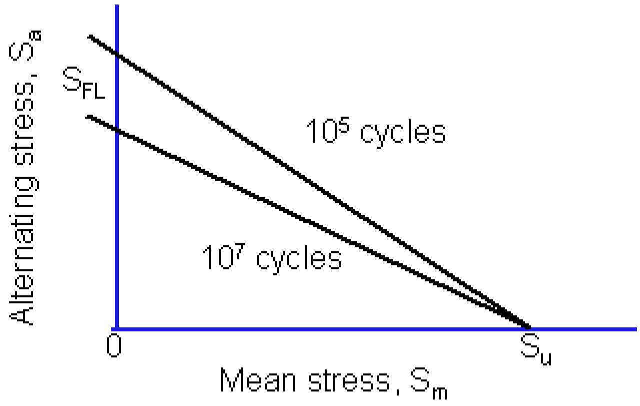


Figure 6

The diagram can be described by

$$\frac{S_a}{S_{FL}} + \frac{S_m}{S_u} = \frac{1}{n}$$

Stress concentration effects can be directly included in the Goodman diagram.

$$\frac{K_f\, S_a}{S_{FL}} + \frac{K_f\, S_m}{S_u} = \frac{1}{n}$$

For finite lives, an equivalent completely reversed stress, Seq, is computed and compared with the component SN curve.

$$S_{eq} = \frac{S_a}{1 - \dfrac{K_f \cdot S_m}{S_u}}$$

Here Kf is used to modify the mean stress but not the stress amplitude because stress concentration effects are already included in the component SN curve.

6.3 1.2.2 Formalism and classification of multiaxial fatigue criteria

A literature review has identified 37 criteria of fatigue. The set of criteria are divided into three distinct approaches that differ in their concept.

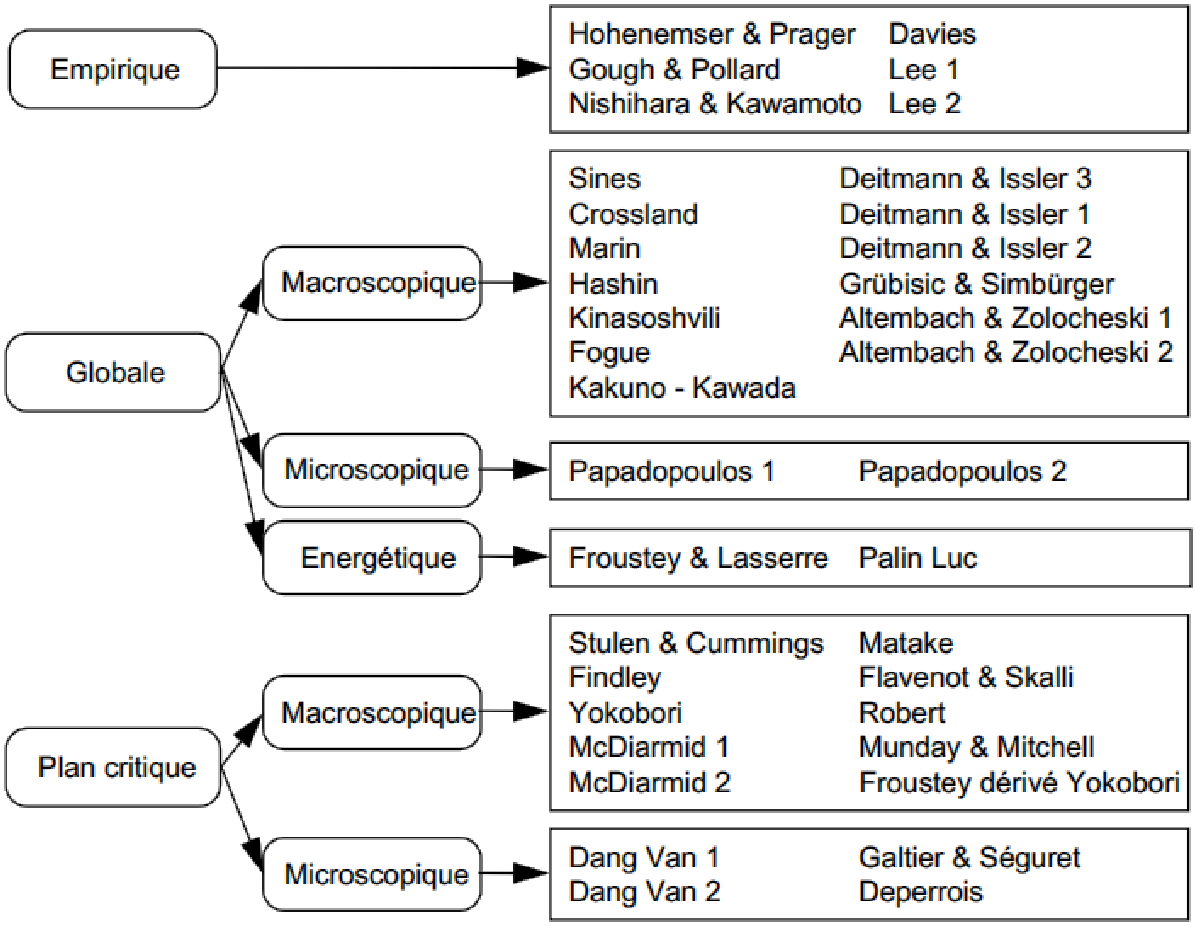
The first approach, called empirical, includes criteria the formalism derived from experimental results obtained for a type of multiaxial stress and equipment donated.

The second approach is called the comprehensive approach. It brings together the criteria which involve invariants of the stress tensor and its diverter. These amounts representing all the constraints in a scalar give the criteria implementing them is comprehensive. Certain criteria define quantities related to the set of possible physical planes passing through the point at which the study is fatigue then driving into a root mean in general. The latter provides as the criteria based on this principle a full appearance.

The third approach, critical type of plan, collates criteria the formalism is based on research of a critical physical. Damage to material fatigue at the point where the stress is known, is related to their action on the plane in question.

Of these three approaches, subgroups differentiate formalisms criteria. We distinguish the macroscopic criteria involving evaluated constraints on a macroscopic scale. The choice of the terms involved in defining constraints such criteria is justified by their author. Other criteria are based on the behavior of the material on a microscopic scale . They expressed though their microscopic Final formalism uses macroscopic

Figure 1 summarizes all the multiaxial fatigue criteria listed in literature and their classification .



6.3.1.1 The empirical approach criteria

Figure 7: multiaxial fatigue criteria and their classification

This category includes six criteria . They come from experimental results generally obtained for a type of multiaxial stress determined. It's about usually tension-torsion or bending - torsion , usually in phase. We found among these older models criteria , those of Hohenemser & Prager and Gough & Pollard that were developed in 1933 and 1935 respectively . The latest models proposed by Lee dating from 1980 [4,5] and 1989 [6,7].

The Hohenemser & Prager criterion

The Hohenemser & Prager criterion is the first criterion identified . Established in 1933, it was obtained from tension-torsion tests where the shear is variable and the normal stress σ_m traction is static;

$$E_{HP} = \left(\frac{\tau_a}{\tau_{-1}}\right)^2 + \frac{\sigma_m}{R_m}$$

6.3.1.2 The criterion Gough & Pollard

From many bending - torsion testing in phase , Gough & Pollard defined in 1935 two formulations that represent , in the reference related to the amplitudes of the normal bending stress and shear stress , ellipses . The first expression given below is for ductils materials

$$E_{GP} = \left(\frac{f_a}{f_{-1}}\right)^2 + \left(\frac{\tau_a}{\tau_{-1}}\right)^2$$

The second formulation involves the same quantities as before, but which is adapted to fragile materials. Fatigue function is as follows :

$$E_{GP} = \left(\frac{\tau_a}{\tau_{-1}}\right)^2 + \left(\frac{f_{-1}}{\tau_{-1}} - 1\right)\left(\frac{f_a}{f_{-1}}\right)^2 + \left(2 - \frac{f_{-1}}{\tau_{-1}}\right)\left(\frac{f_a}{f_{-1}}\right)$$

6.3.1.3 Davies criterion

Davies, in 1935, adopted a formulation similar to that of Hohenemser & Prager . It only models the evolution of the amplitude of the allowable shear according to a normal static stress σ_m but the opposite , i.e. it observes the amplitude of the allowable normal stress bending as a function of static shear stress m_τ . He built from his observations the following modeling:

$$E_{DA} = \left(\frac{f_a}{f_{-1}}\right)^2 + \frac{\tau_m}{\tau_u}$$

6.3.1.4 The criterion of Nishihara & Kawamoto

In 1941, Nishihara & Kawamoto offer two models from their experimental findings that are distinguished by the value of the ratio of the endurance limit symmetrical alternating bending endurance limit and symmetrical alternate twist . Both models are written:

$$E_{NK} = \left(\frac{\tau_a}{\tau_{-1}}\right)^2 + \left(\frac{f_a}{f_{-1}}\right)^2 \quad \text{si} \quad \frac{f_{-1}}{\tau_{-1}} \geq \sqrt{3}$$

$$E_{NK} = \left(\frac{\tau_a}{\tau_{-1}}\right)^2 + \frac{1}{2}\left(3 - \left(\frac{f_{-1}}{\tau_{-1}}\right)^2\right)\frac{f_a}{f_{-1}} + \frac{1}{2}\left(\left(\frac{f_{-1}}{\tau_{-1}}\right)^2 - 1\right)\left(\frac{f_a}{f_{-1}}\right)^2 \quad \text{si} \quad \frac{f_{-1}}{\tau_{-1}} \leq \sqrt{3}$$

6.3.1.5 The criterion of Lee 1

More recently, in 1980, Lee offers a way out of modeling bending -torsion testing out phase. It introduces α -dependent phase shift φ between the two loads and defined by $\alpha = 2\ (1 + \beta \sin \varphi\ )$ where β is a constant related to the materials . The criterion is given by the following relationship

$$E_{LEE\,1} = f_a\left[1 + \left(\frac{\tau_a f_{-1}}{f_a \tau_{-1}}\right)^{\alpha}\right]^{1/\alpha}$$

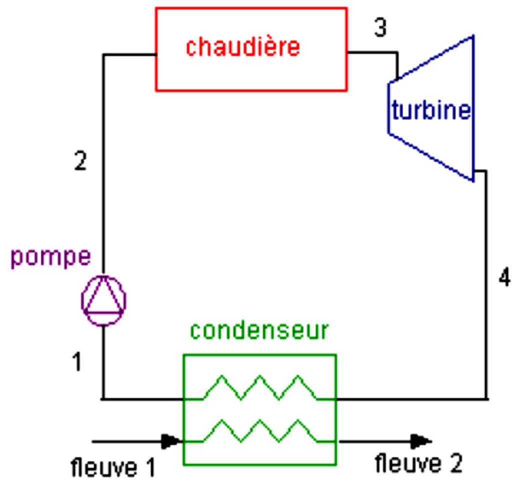
6.3.1.6 The criterion of Lee 2

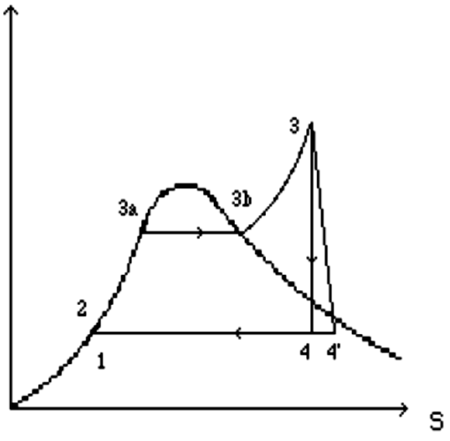
In 1989, Lee changed his first empirical criterion to add the influence of a average flexion. His last criterion involves an exponent n, between 1 and 2, is an empirical constant:

$$E_{LEE\,2} = \frac{E_{LEE1}}{\left[1 - \left(\frac{\sigma_m}{R_m}\right)^n\right]} = \frac{f_a\left[1 + \left(\frac{\tau_a\, f_{-1}}{f_a\, \tau_{-1}}\right)^{\alpha}\right]^{1/\alpha}}{\left[1 - \left(\frac{\sigma_m}{R_m}\right)^n\right]}$$

7 CHAPTER II: CONTRIBUTION

7.1 2.1. Analysis of Rankine cycle for the Tripoli-IPP 30 MW power plant





Cycle de Hirn

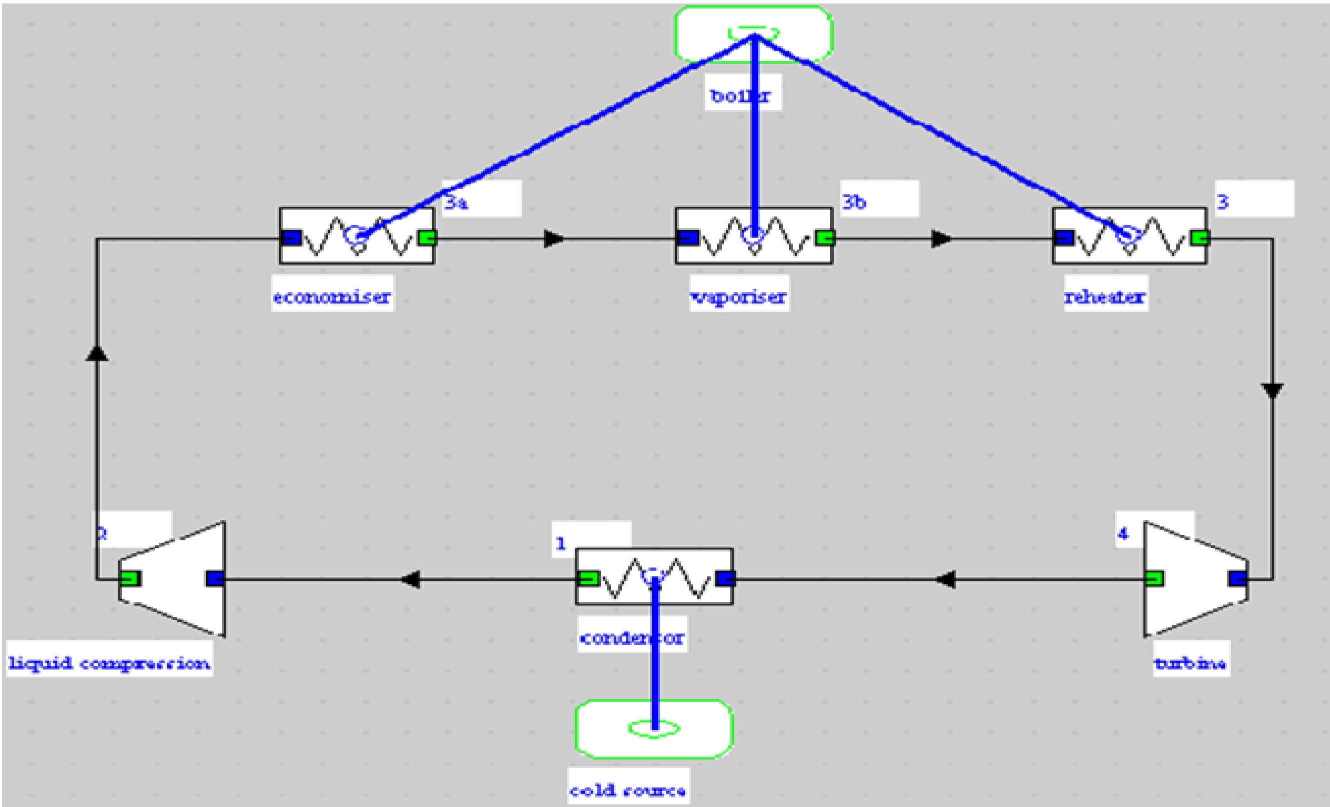


Figure 8: Rankine cycle modelisation in THERMOPTIM

In point 1, a 1 kg / s water flow is in the liquid state at a temperature of about 20 ° C, under low pressure (0.023 bars).

A Pump puts that water isentropicly with an efficiency equal to 1 to a pressure of 165 bar (Point 2).

The pressurized water is then heated at constant pressure in a flame boiler (waste).

The warm up has three stages:

-Heating the liquid in the economizer, 20 ° C to about 355 ° C, initial boiling point temperature165 bar: evolution (2-3a) on the entropy diagram

- Constant temperature 355 ° C vaporization in the vaporizer: evolution (3a -3b)

- Overheating of 355 ° C to 560 ° C in the superheater: evolution (3b -3).

The steam is then expanded in a turbine isentropicly with an efficiency of 0.85, until the

0,023 bar pressure change (3-4).

The liquid-vapor mixture is then condensed to the liquid state in a condenser exchanger between the ring and the cold source, for example water of a river. The cycle is closed.

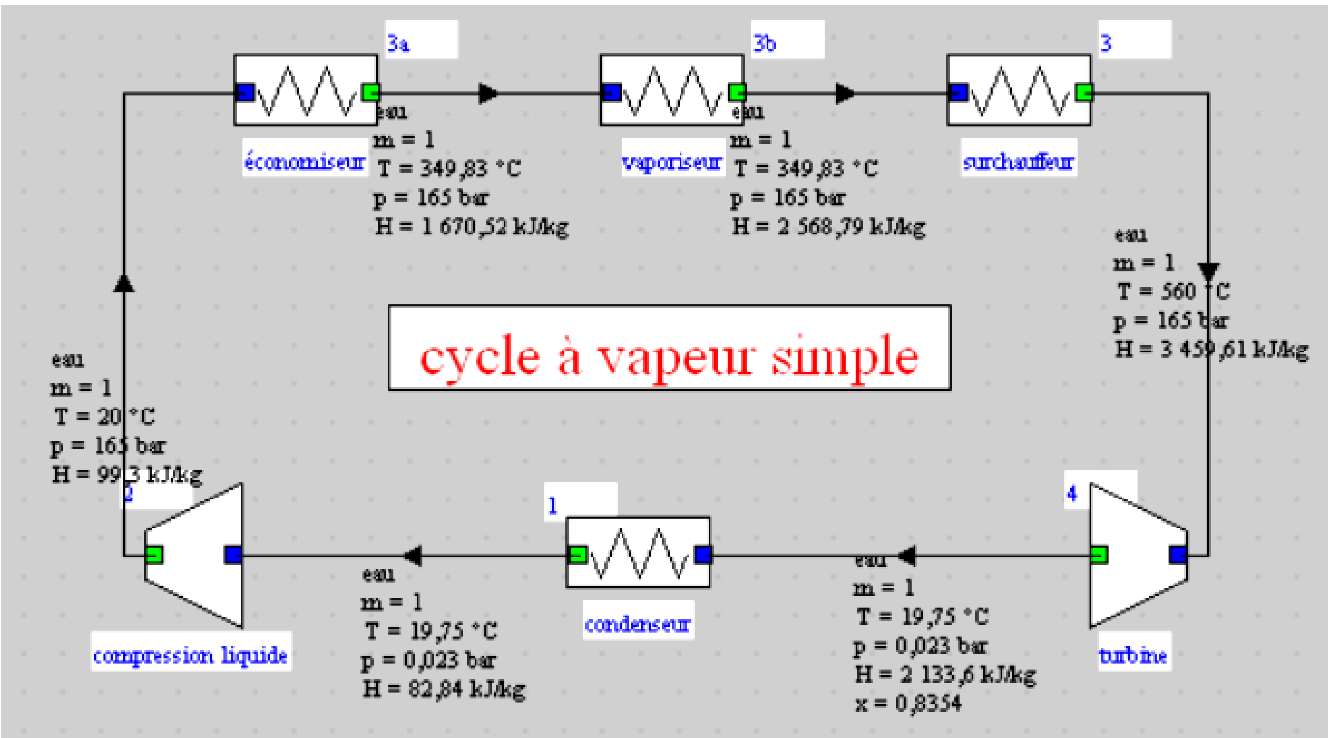


Figure 9: Values of temperature and pressure obtained by THERMOPTIM

nom du point	température T (°C)	pression P	enthalpie h	entropie s	volume v
1	19,74562	0,023	82,83661	0,292821	0,00100167
2	19,99591	165	99,29743	0,292809	0,000994375
3a	349,82707	165	1 670,51999	3,77803	0,00173903
3b	349,82707	165	2 568,79443	5,22016	0,00883163
3	560	165	3 459,61452	6,49548	0,0209757
4	19.74562	0.023	2 133.6008	7.29439	49.04255

Figure 10: Results obtained using THERMOPTIM

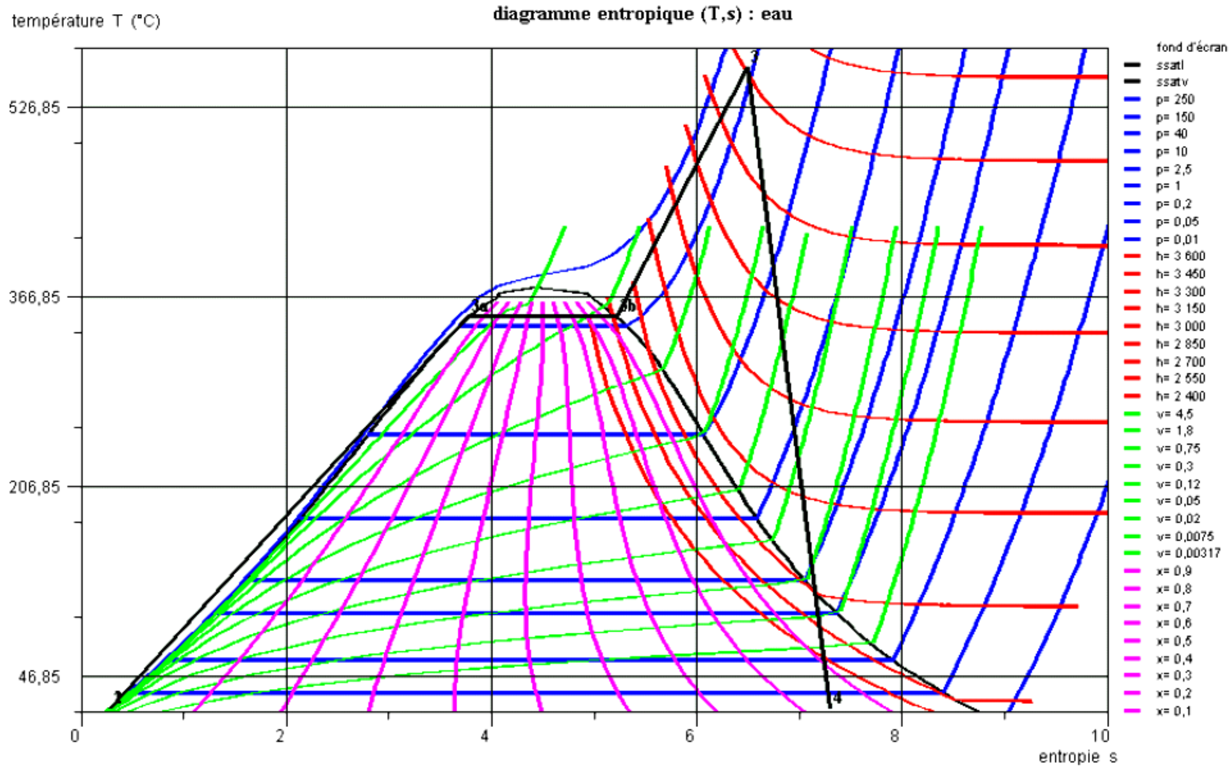


Figure 11: entropic diagram (T, S) obtained using THERMOPTIM

The Rankine cycle is important to calculate the thermal efficiency (30 %), while for a turbine that produces 30 MW of electricity we need a thermal power of 90 MW.

And according to the thermal power the value of the combustion chamber is dimensioned .

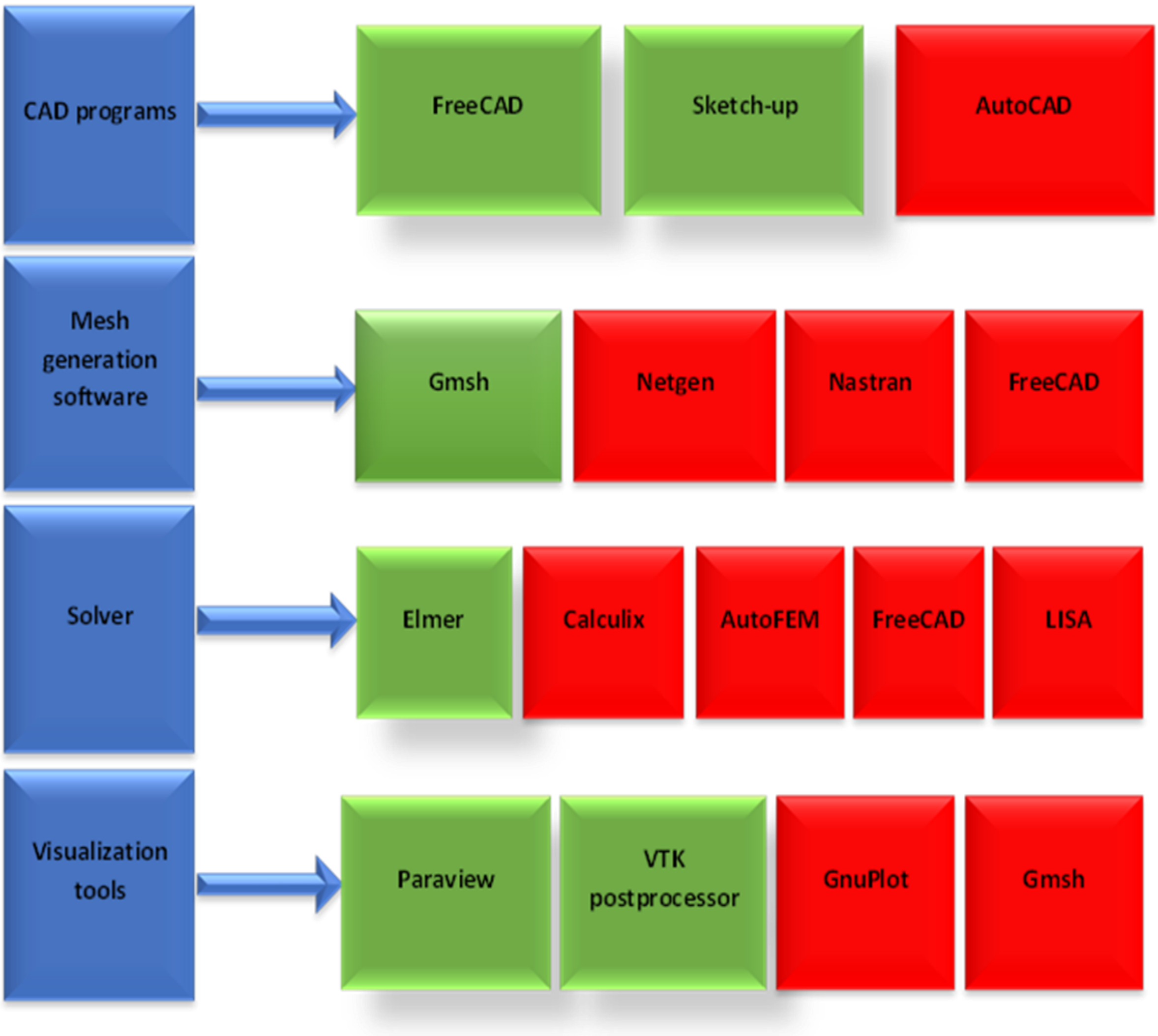
The volume of the combustion chamber adapted from a study [0].

The volume is 7,500 cu ft (212 cubic meters) spread over 4 m long , 4 m wide and 12 m high.

7.2 2.2. Software used for modeling and simulation

Many software packages are used in this study, and we adopted different strategies to achieve this work (concerning the design, the meshing, the solving and the visualization for results).

In the schematic shown below we describe this chain of tools used. The tools adopted in this thesis are colored in green and these colored in red were tried also during a long time in this master thesis but finally were not adopted , because they are not Free tools (without licence), and sometimes because there is so limited and can't support a big value of data.



7.3 2.3. Files format

One of the difficulties was the problem of transition from one tool to another.

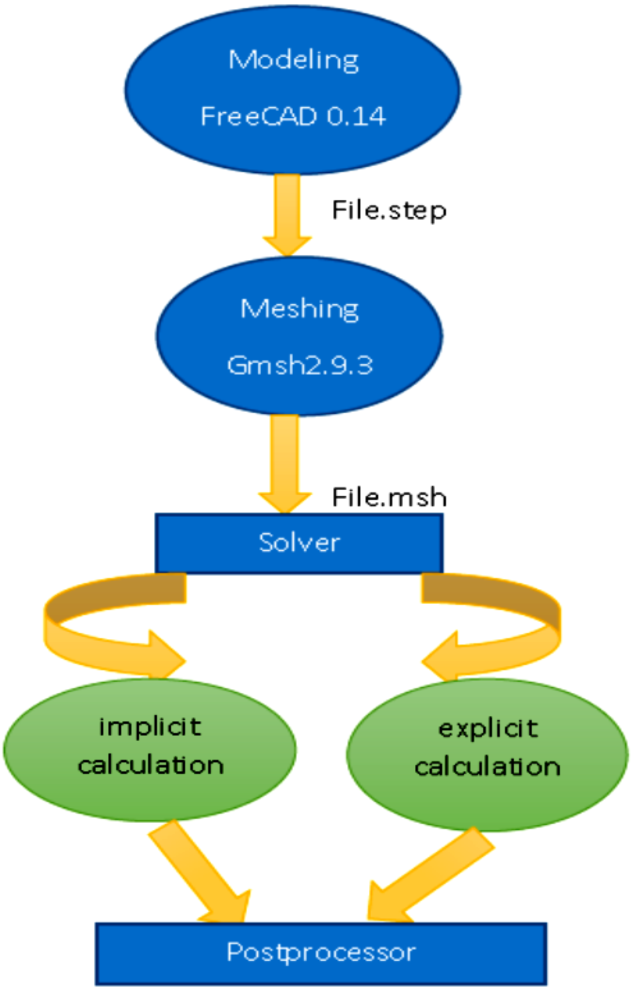


Figure 2.3.1

7.4 2.4. Designing CAD models for the vaporizer and for the drum

Several forms exist in the market, which are shown in the figure 2.4.1. We have adopted the simplest form to facilitate the industry process (Figure 2.4.2 and 2.4.3), especially manufacturing of boiler will be local.

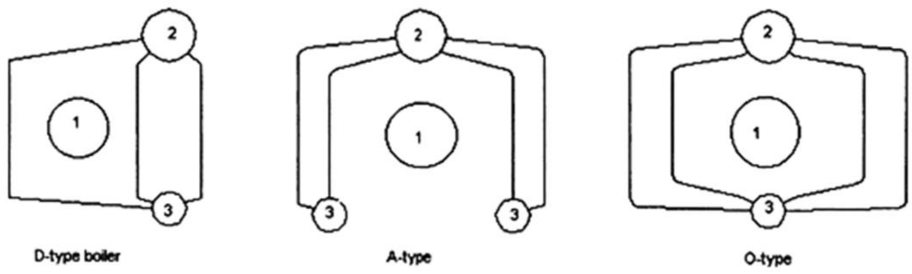


Figure 2.4.1: A-, D- and O-type boiler configurations.1.Burner; 2.Steam drum; 3.mud drum

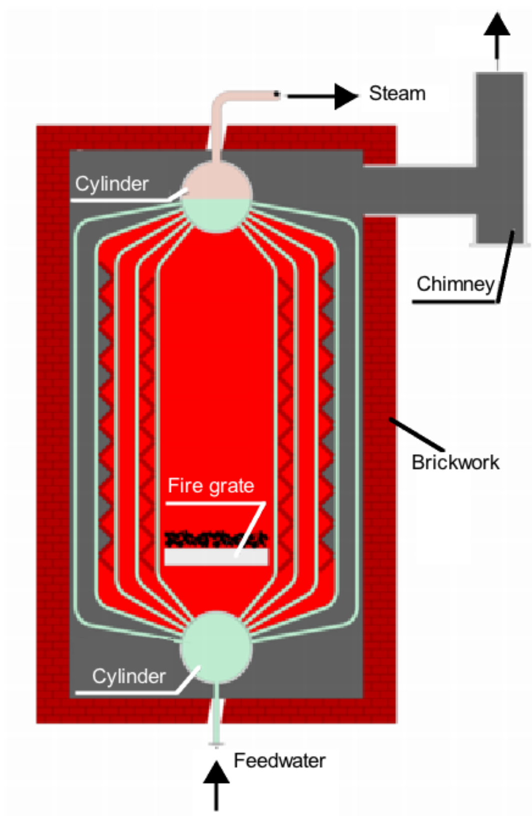


Figure 2.4.2: Schematic figure of boiler (wikiwand.com/en/Boiler),o-type

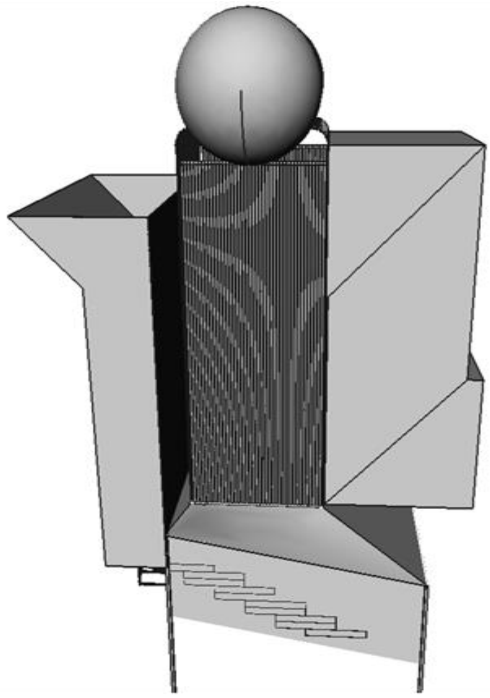


Figure 2.4.3: Boiler part of incineration plant in Free CAD, o-type

The volume of the combustion chamber (including vaporizer) is adapted from the study shown in [12]. The volume is 7500 cu ft. (212 meter cube) distributed on 4 m length, 4 m width and 12 m height.

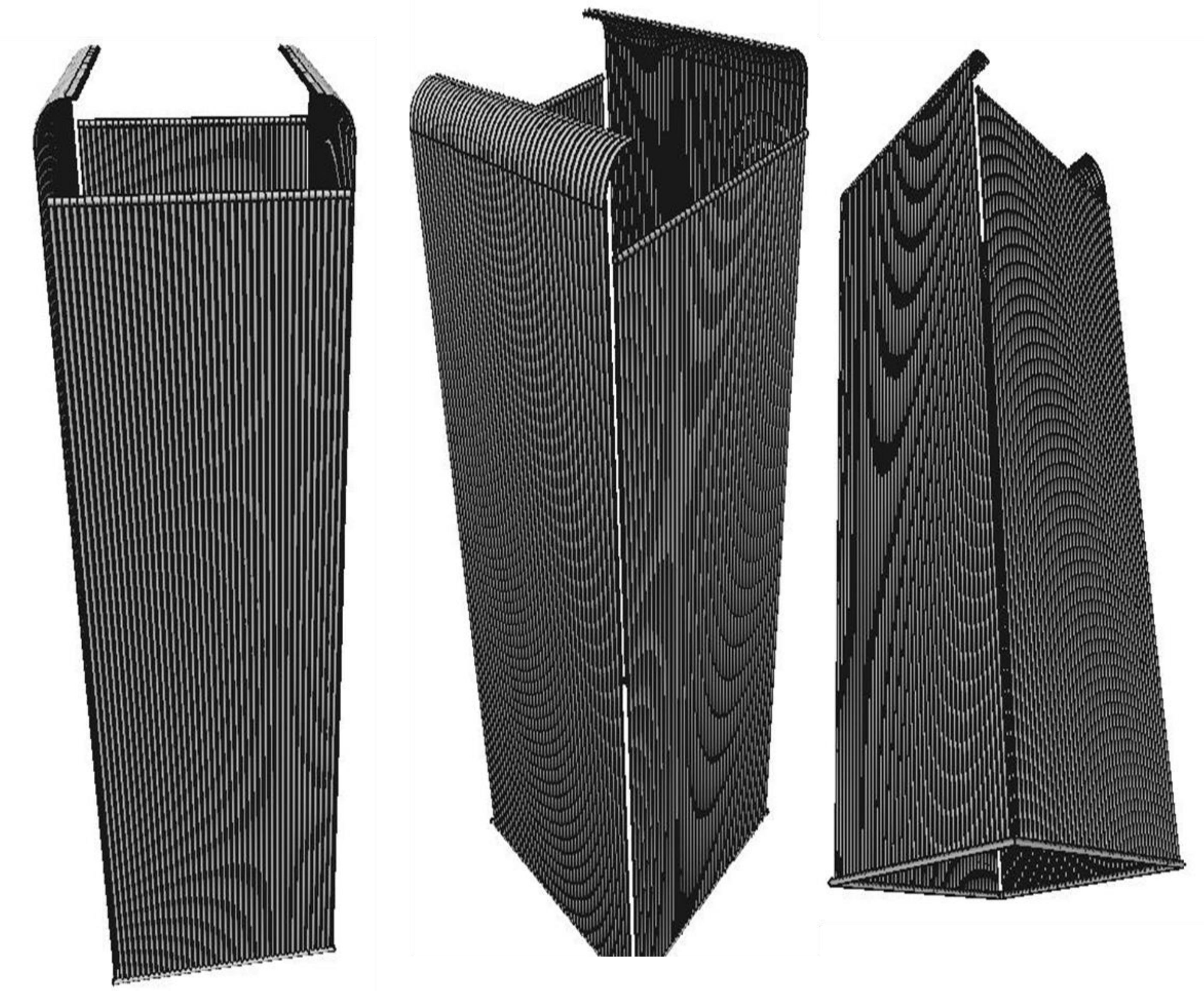


Figure 2.4.4: combustion chamber (including vaporizer) with climbing pipes

- The properties of drum:
  - Length: 32 ft. (10 m)
  - Diameter: 7 ft. (2.1 m)
  - Weight: 9200 pound (4173 kg)
  - Capacity: 6600 gallon (24 983 l)

  (all this information are obtained from Annex 5)

  - Thickness: 5 mm (this thickness is deduced from the browser in this site http://steelfinder.outokumpu.com/storage-tank/)
  - Material: Stainless steel 316L (physical properties of stainless steel 316L in Annex 6)

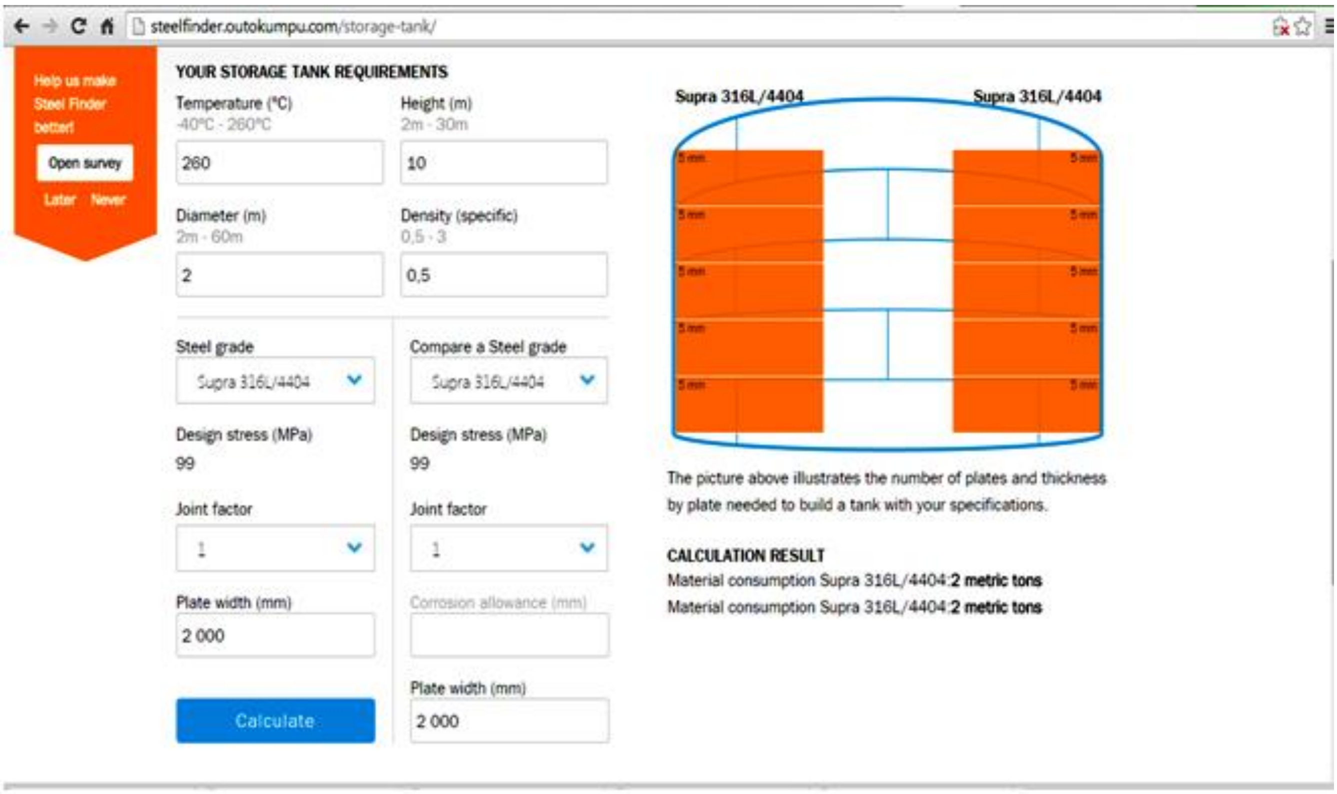


Figure 2.4.5: Calculation of thickness via browser (chosen material is steel 316L)

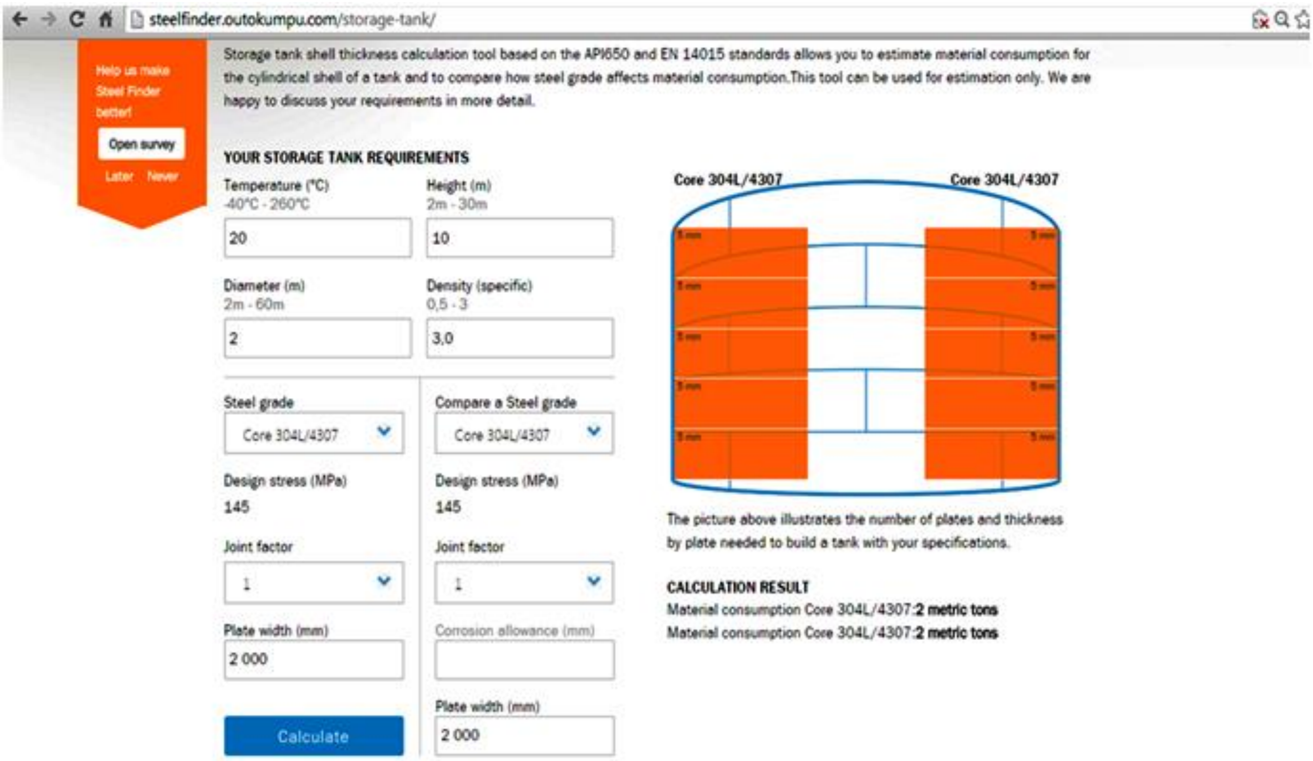


Figure 2.4.6: Calculation of thickness via browser (chosen material is steel 304L)

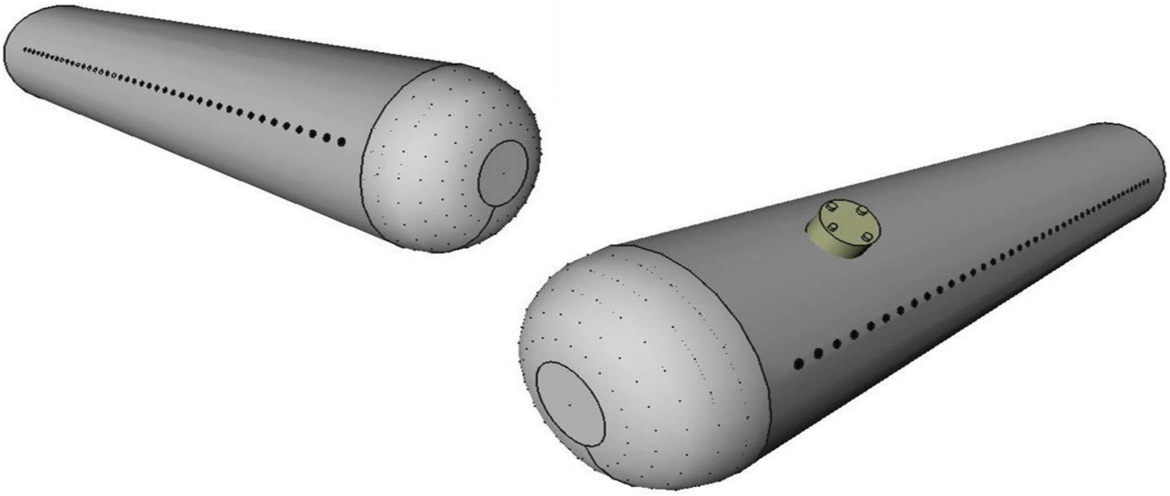


Figure 2.4.7: Design of Drum in FreeCAD

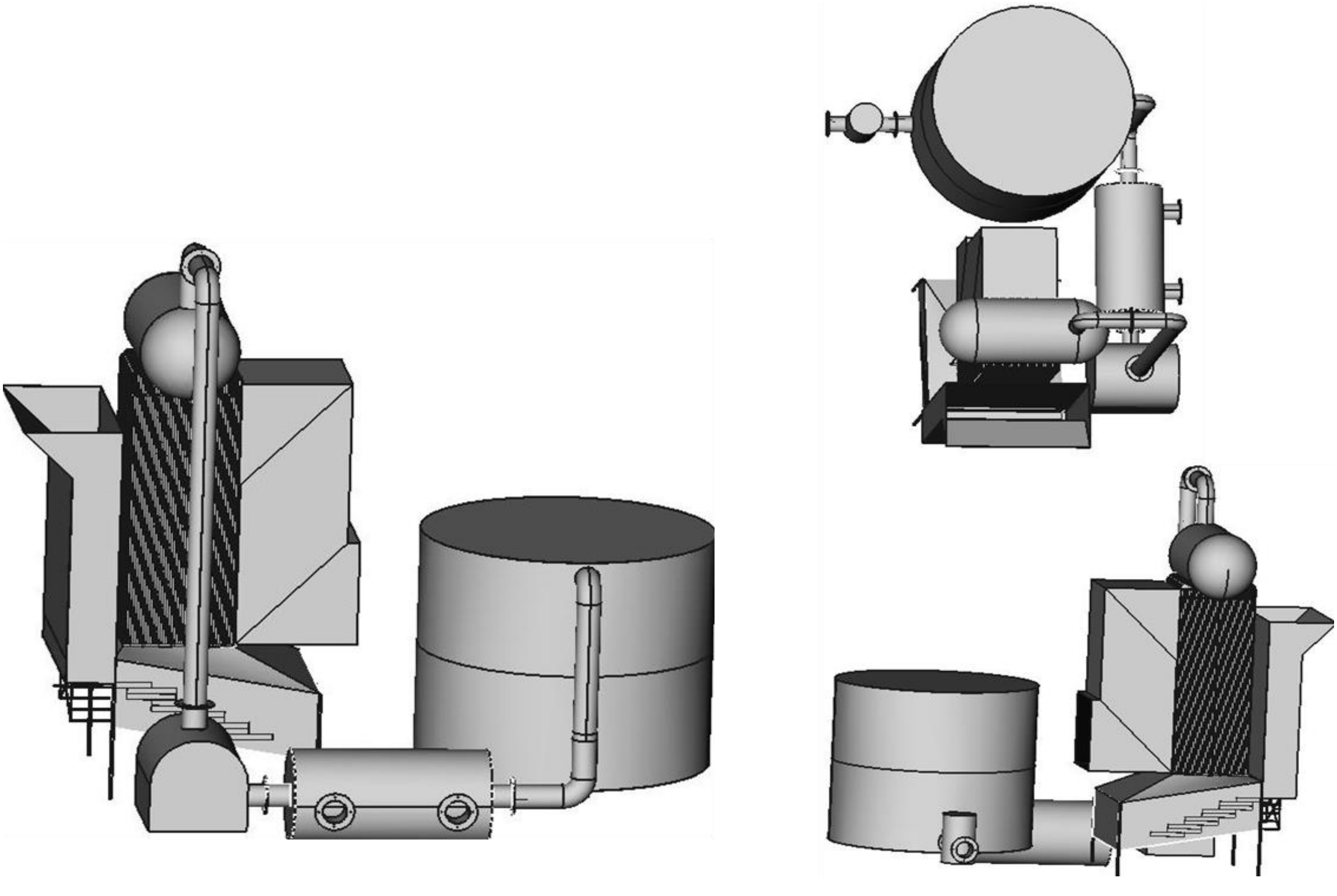


Figure 2.4.8: Group of all parts of a power plant in FreeCAD (boiler, drum, turbine, and condenser)

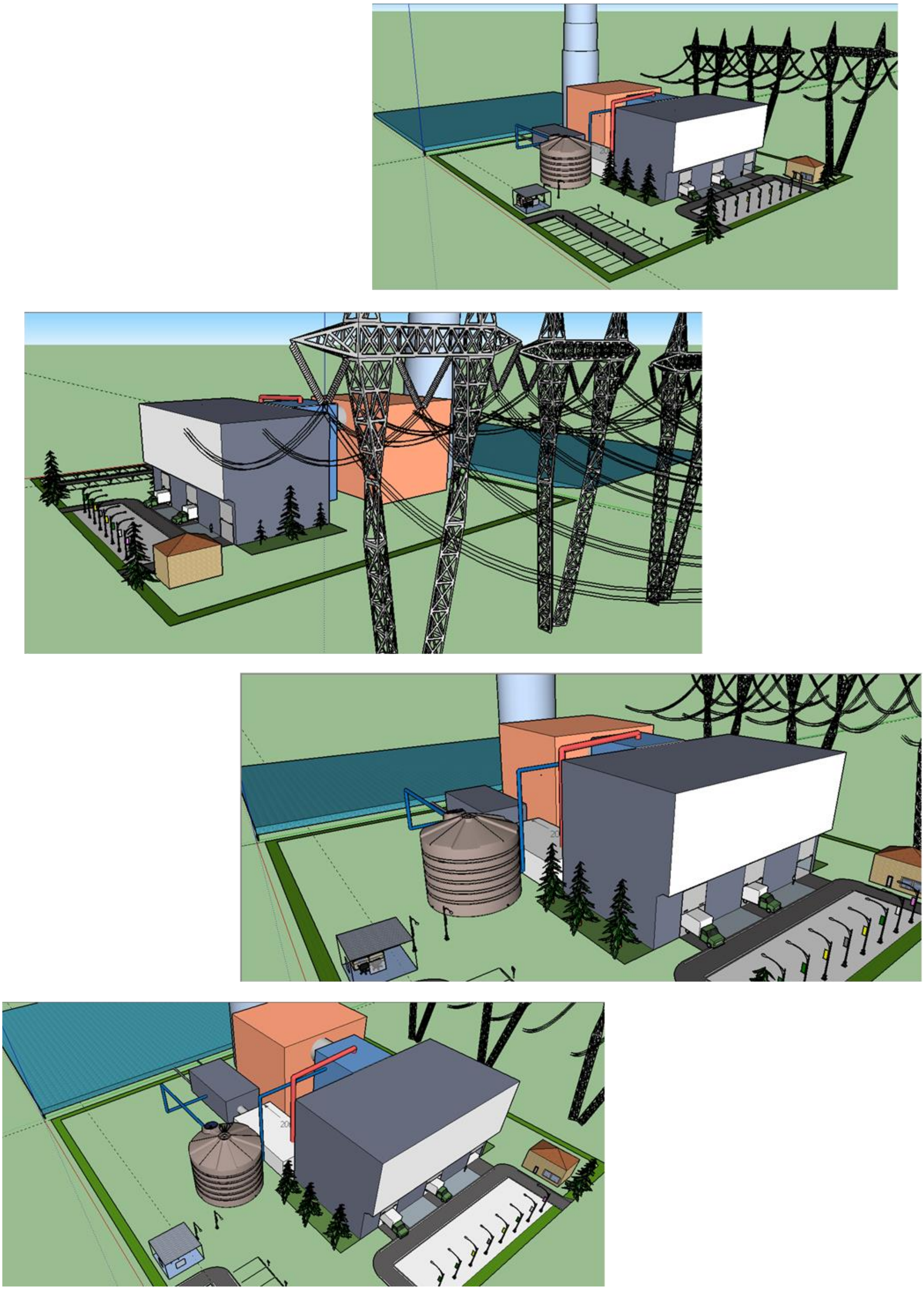


Figure 2.4.9: Design for of the incineration thermal power plant on a real ground using sketch-up (100 m ×100 m)

7.5 2.4. Meshing the CAD model

To mesh the CAD model we adopted first FreeCAD(FEM module), but we discovered that FreeCAD is unable to mesh our design entirely. FreeCAD is under construction and actually it can mesh only one element.

So we searched for other software to make the mesh and we found: Nastran, Netgen and Gmsh. All this tools are Free and open source.

We tried all this software and we found that the best is Gmsh because of the possibility of identifying the type of shape in FEM and its ability to mesh complex design in a time relativley short in comparaison with the others.

Gmsh is built around four modules: geometry, mesh, solver and post-processing. Each module can be controlled either interactively using the GUI or using the scripting language.

The design of all four modules relies on a simple philosophy "be fast, light and user-friendly".

Fast: on a standard personal computer at any given point in time Gmsh should launch instantaneously, be able to generate a "larger than average" mesh (compared to the standards of the finite element community; say, one million tetrahedra in 2008) in less than a minute, and be able to visualize such a mesh together with associated post-processing datasets at interactive speeds.

Light: the memory footprint of the application should be minimal and the source code should be small enough so that a single developer can understand it. Installing or running the software should not depend on any non-widely available third-party software package.

User-friendly: the graphical user interface should be designed in such a way that a new user can create simple meshes in a matter of minutes. In addition, the code should be robust, portable, scriptable, extensible and thoroughly documented|all features contributing to a user-friendly experience.

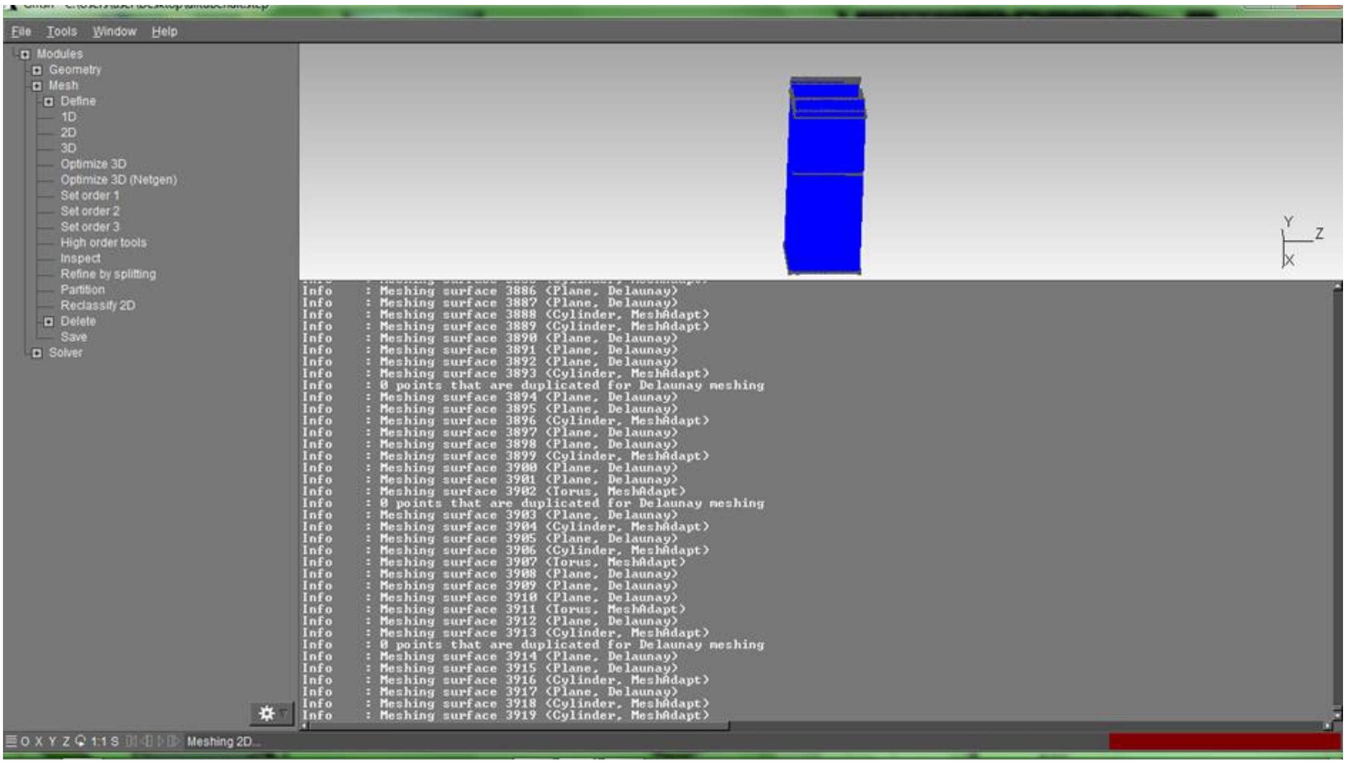


Figure 2.4.1: User Interface of Gmsh

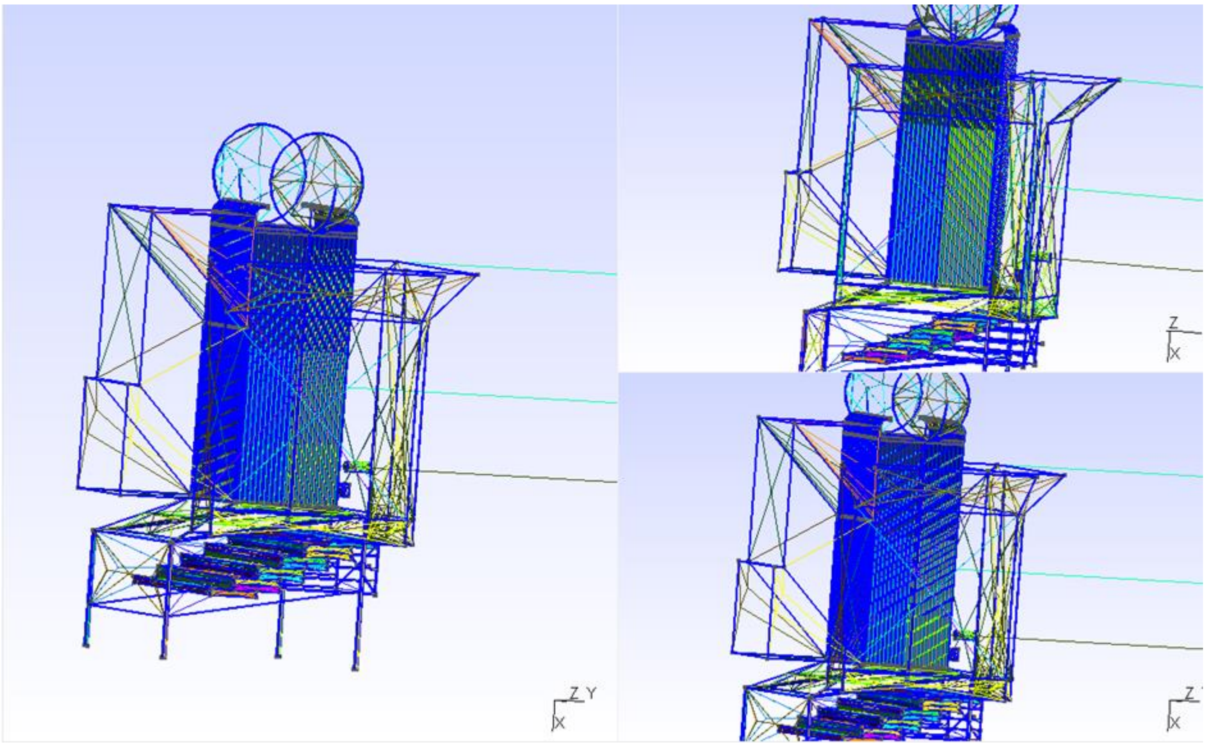


Figure 2.4.2: Mesh of the incinerator CAD model in Gmsh

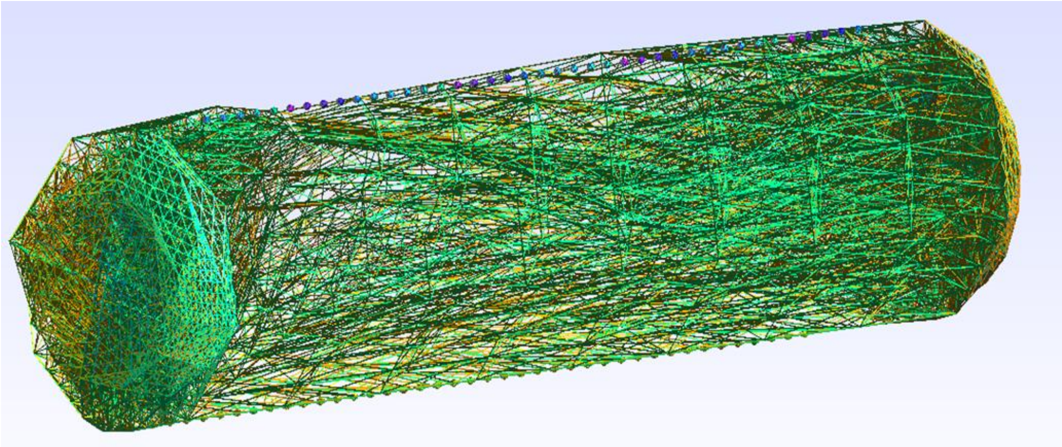


Figure 2.4.3: Mesh of the drum CAD model in Gmsh

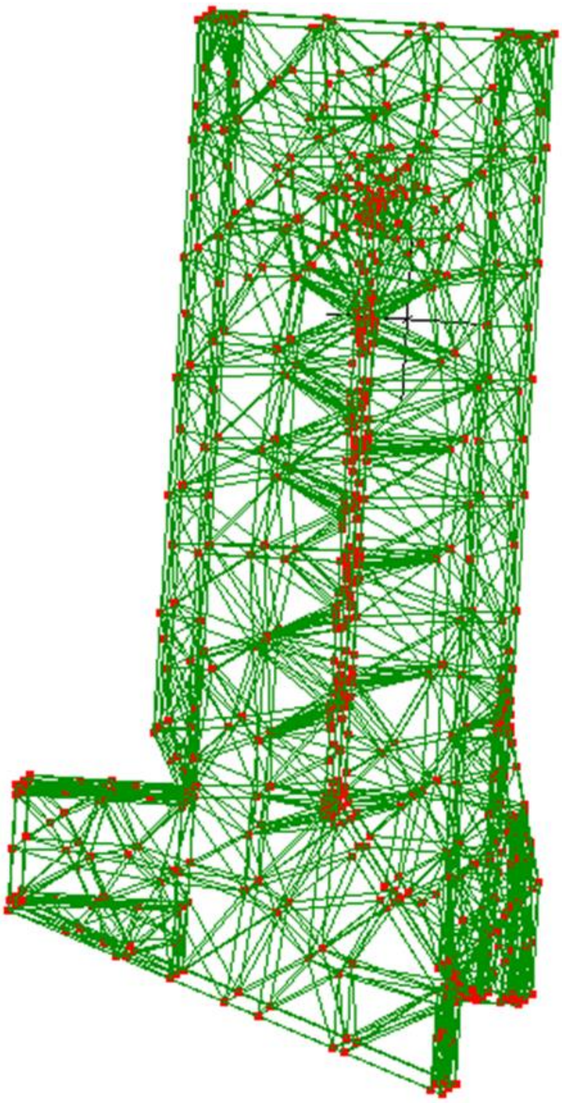


Figure 2.4.4: Mesh of the combustion chamber CAD model in Gmsh

7.6 2.5. The solver Elmer

Elmer is a combination of different software packages for the simulation of multiphysics problems using the Finite Element Method (FEM). Three of these software packages are: ElmerGUI, ElmerSolver, ElmerPost. Elmer is an open source software, released under the GNU General Public License (GPL).

Elmer can be used in two different ways:

- By using its Graphical User Interface (GUI). (A command text file can be generated after a GUI session).
- By using a command text file

Elmer has not good capabilities for geometry generation (CAD model) and meshing. Therefore, as a general procedure, the geometry and mesh should be imported into Elmer. It accepts different geometry and mesh formats. Among them, it accepts the GMSH mesh format.

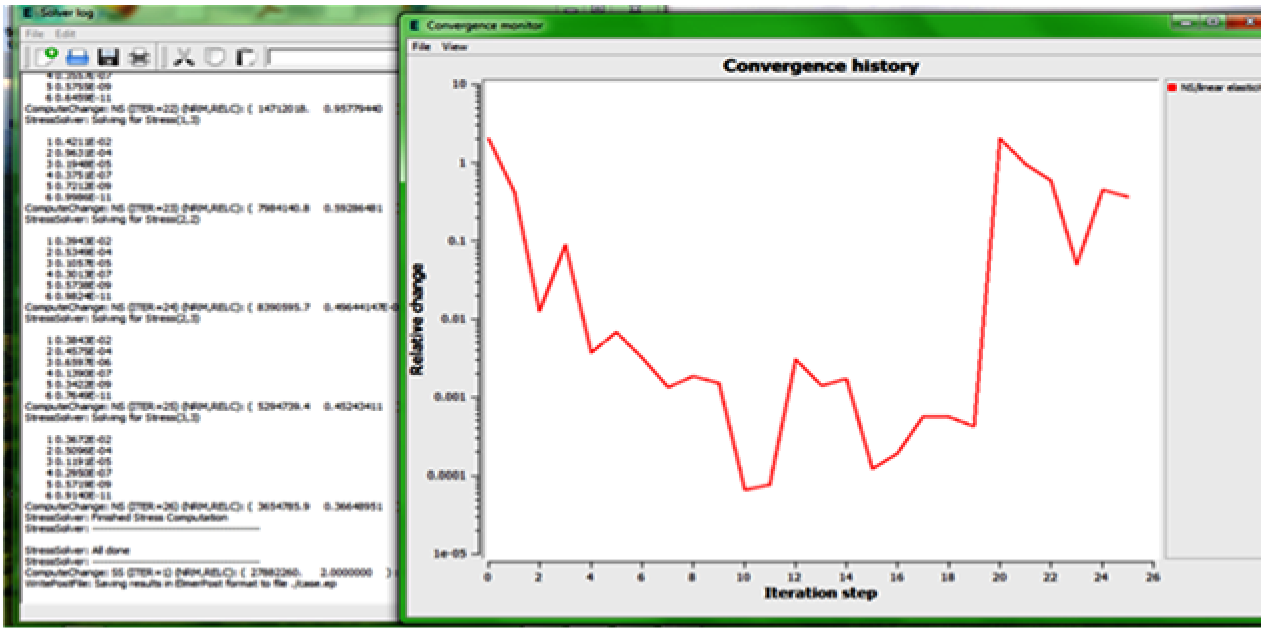


Figure 2.4.5: Convergence history window in ElmerSolver.

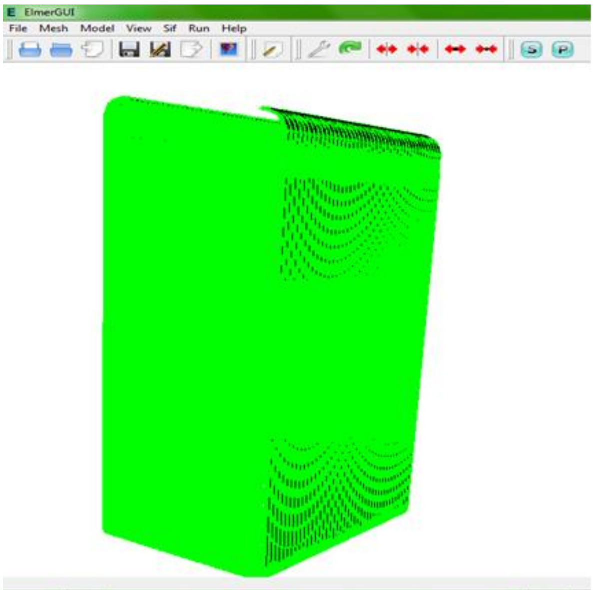
The convergence story appears during solving the partial differential equations (PDE) by the processor.

The vertex of the graph indicates that the processor solves the PDEs easily , whereas a peak indicates that the resolution of PDE faces difficulties in the system and it needs extra time.

8 CHAPTER III: RESULTS AND DISCUSSION

8.1 3.1 CAD Model and Meshing of vaporizer and steam drum

In this master thesis one of the important tasks is to determinate the location of the region exposed to a high stress. With Elmer we determinate the stress in the boiler.



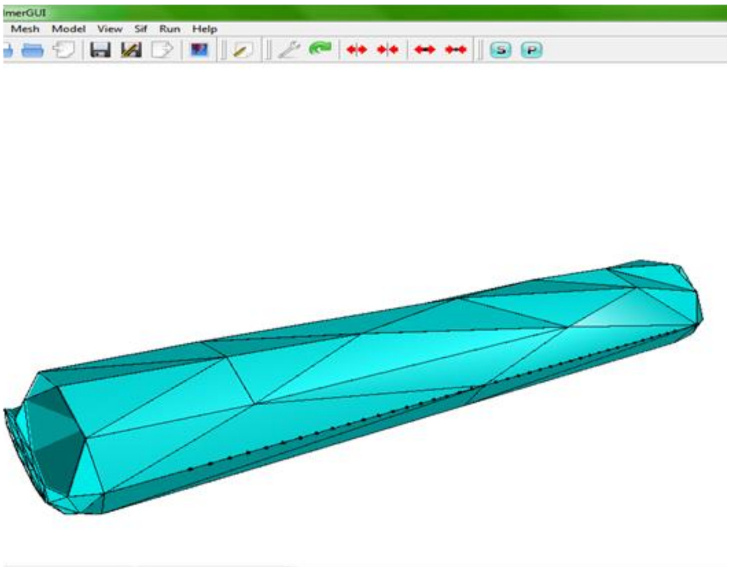


Figure 3.1: Imported meshed Vaporizer and steam drum in Elmer

The import of the file in .msh format requires a bit of time. Then the initial conditions, the boundary conditions and the type of material for the whole model must be determined. This is a process which about 6 hours.

After putting meshes on the chamber of combustion (evaporator, furnace) and on the drum we have to import this meshes separately to Elmer.

As shown in the figure 2.4.5 we have succeeded to import the mesh of the boiler and also we have determinate the type of material used in this study, the boundary condition and the equation used to determinate the stress.

8.2 3.2 Running the solver

After the execution of the work, the Elmer software requires approximately 4 hours to complete the calculations. A "convergence history" window appears on the user interface.

After running the Elmer solver which took a lot of time to finish calculation (approximately 4 hours) without counting the time used to determinate the boundary condition for each body (in the case of boiler we have 40000 body) each one needed to determinate her equation, her material type and his boundary condition (approximately 6 hours). A convergence history appeared during solving us shown in the figure 3.3-3.4:

Figure3.2: convergence history for the vaporizer in Elmer

Figure3.3: convergence history for the vaporizer in (Elmer)

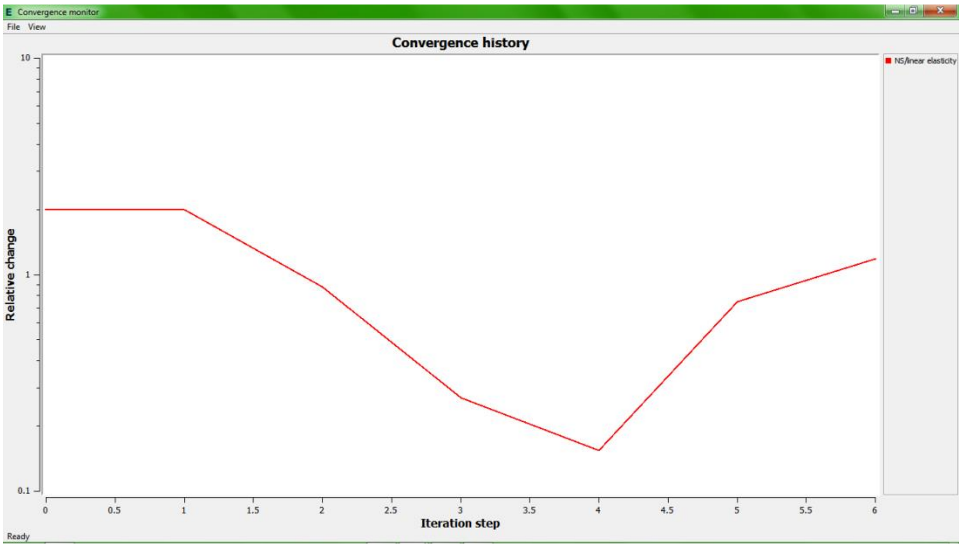
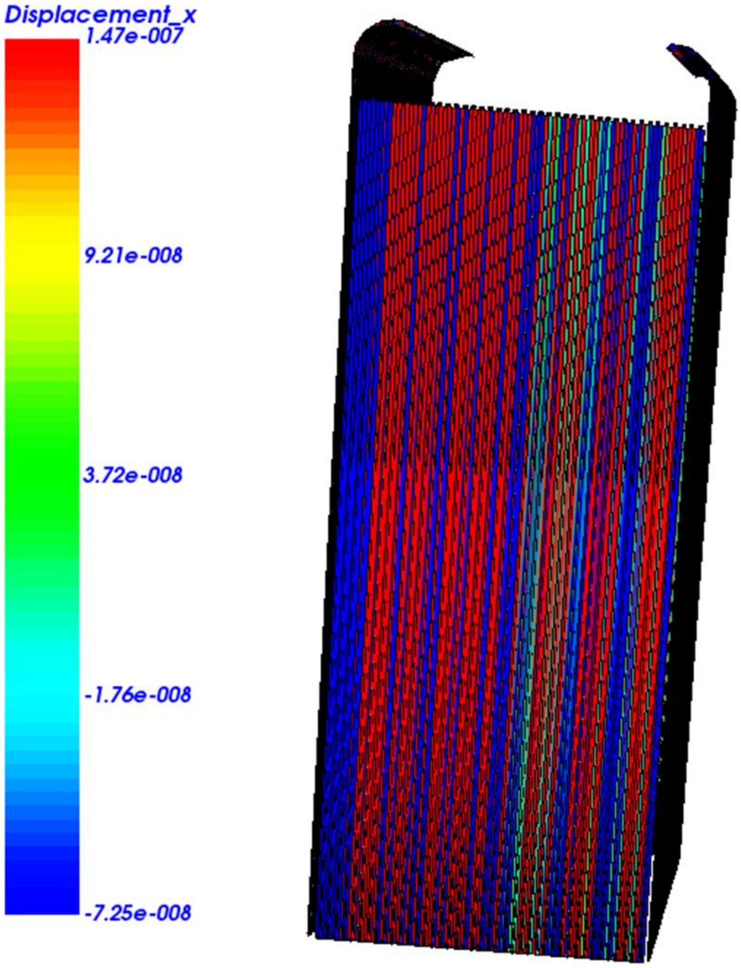
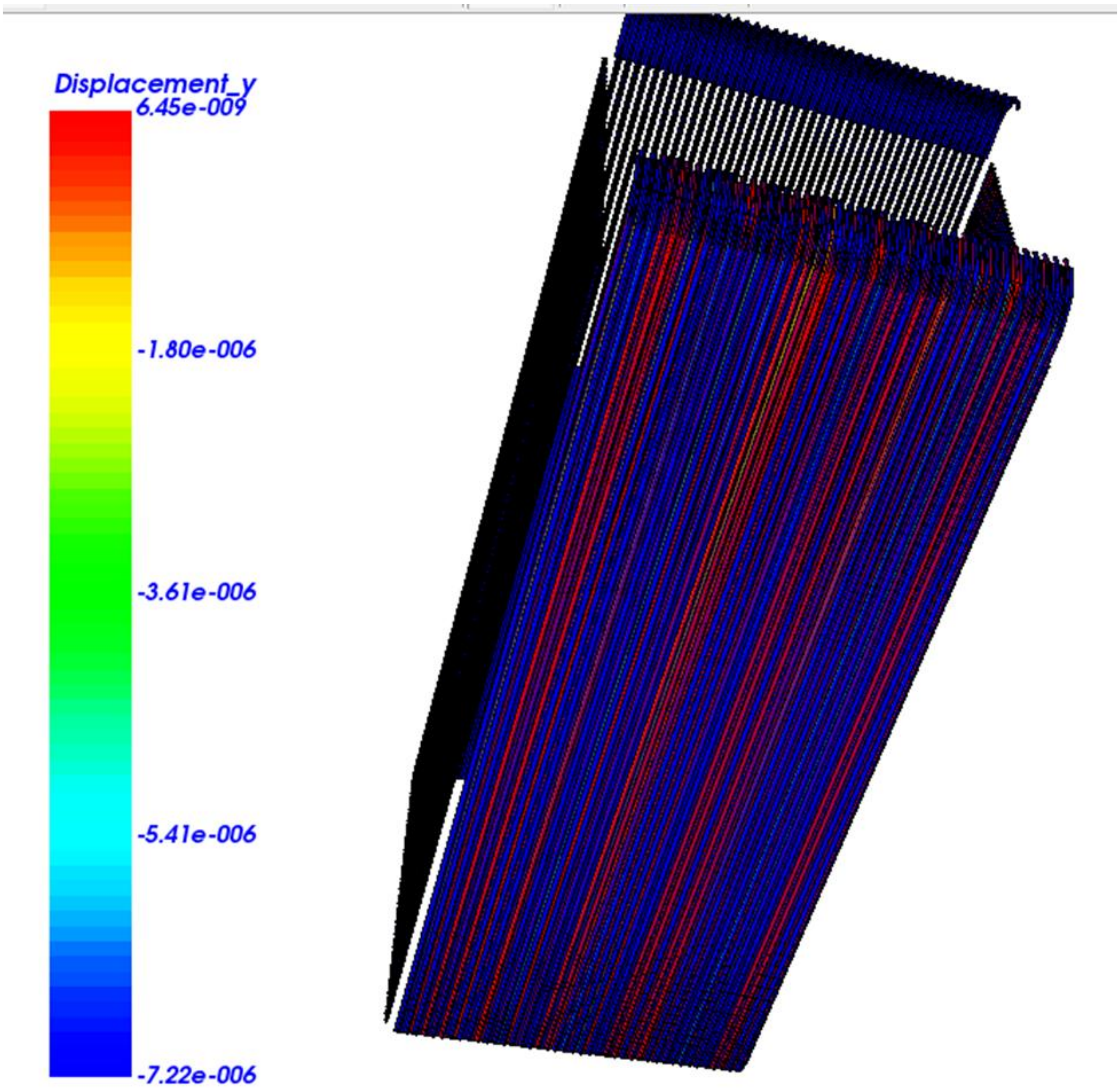


Figure 3.4: convergence history for the drum in Elmer

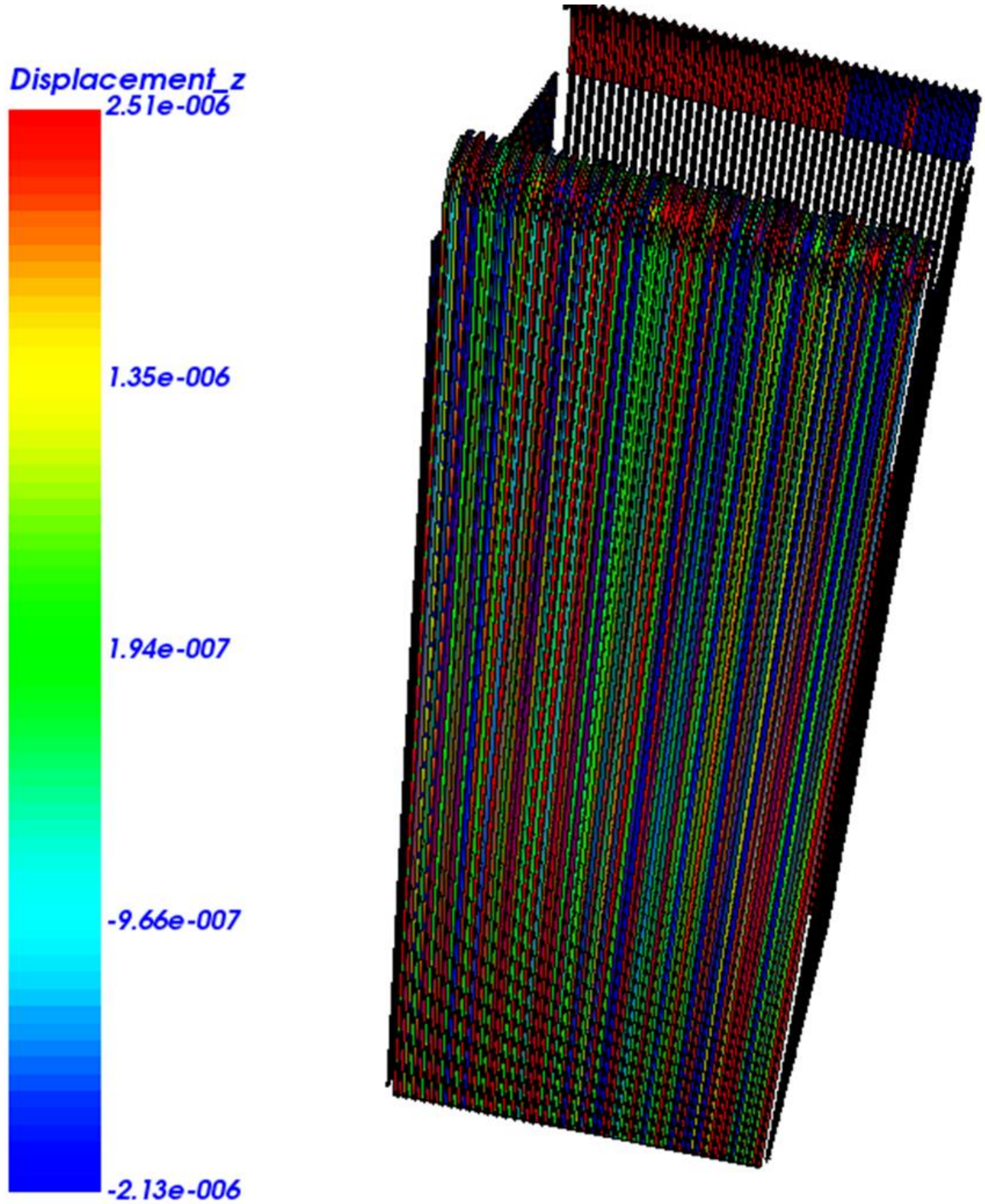
8.3 3.3 Viewing results Paraview / VTK

The unit of the displacement in the figure is meter (m).



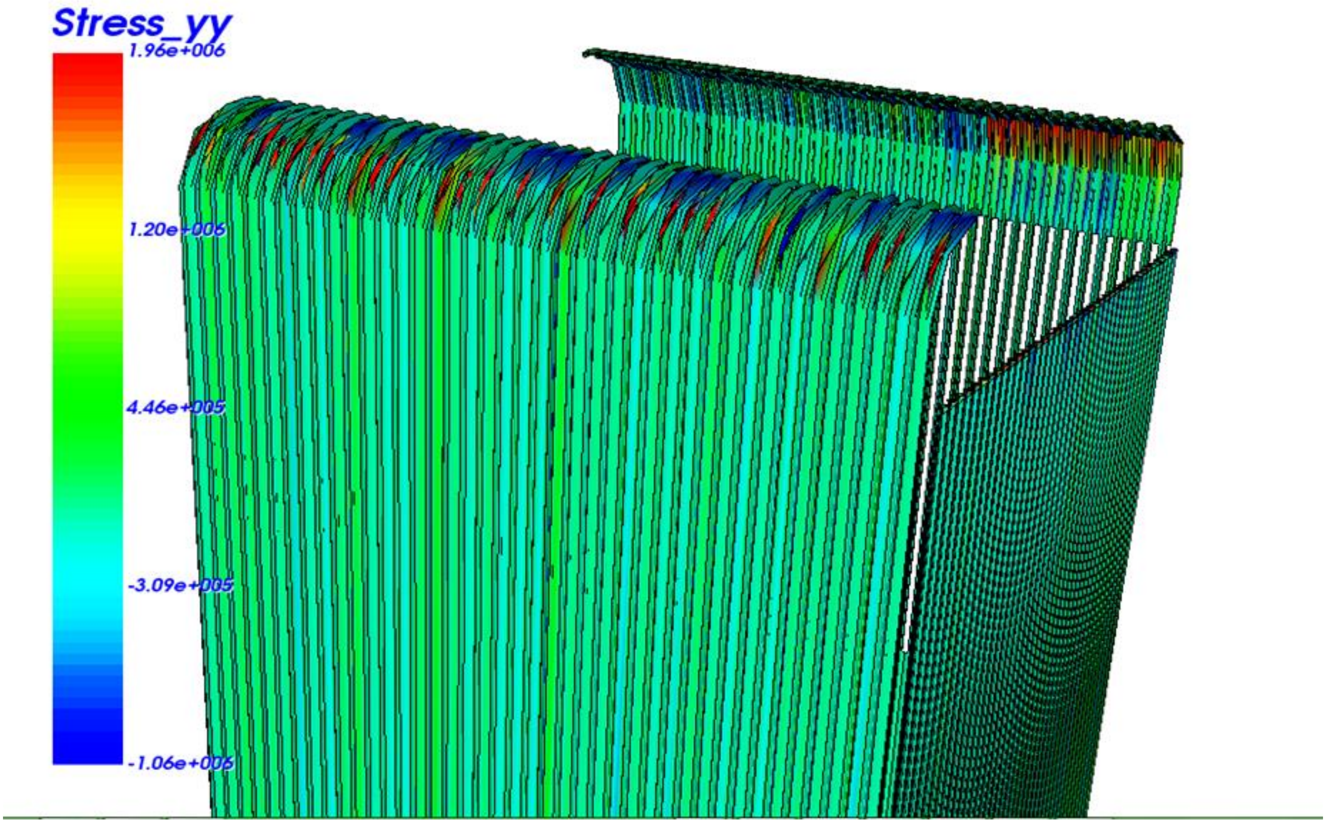


The unit of the displacement in the figure is meter (m).

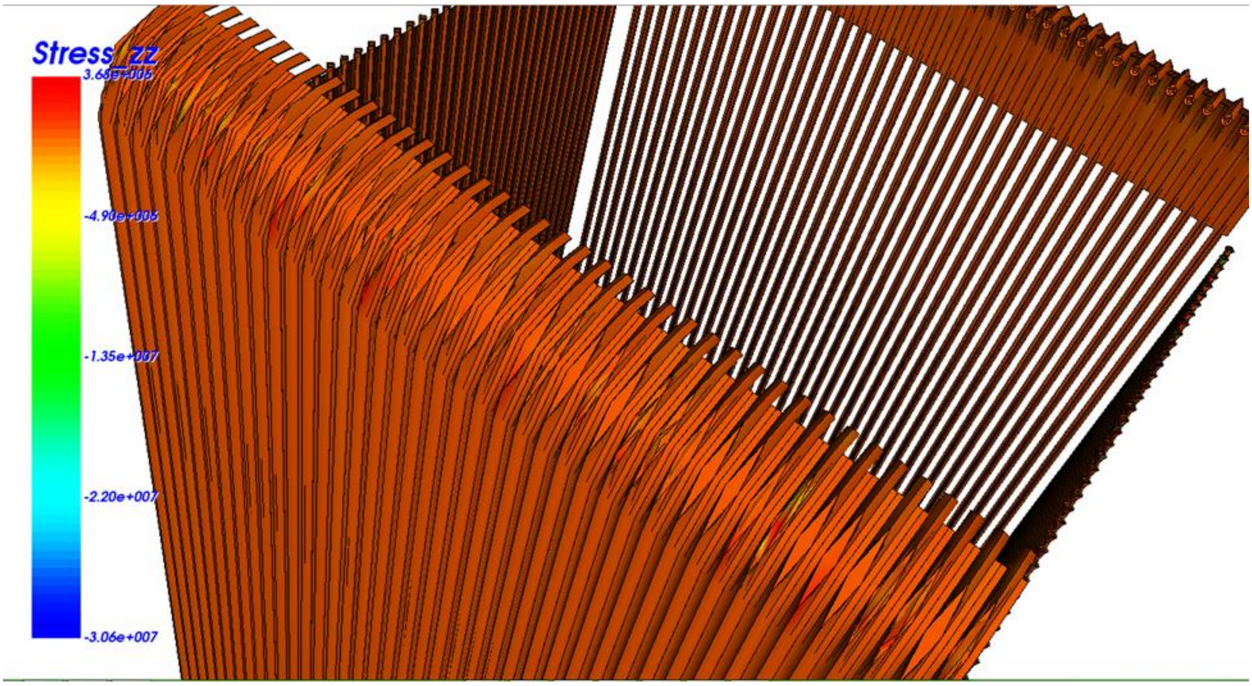


The unit of the displacement in the figure is meter (m).

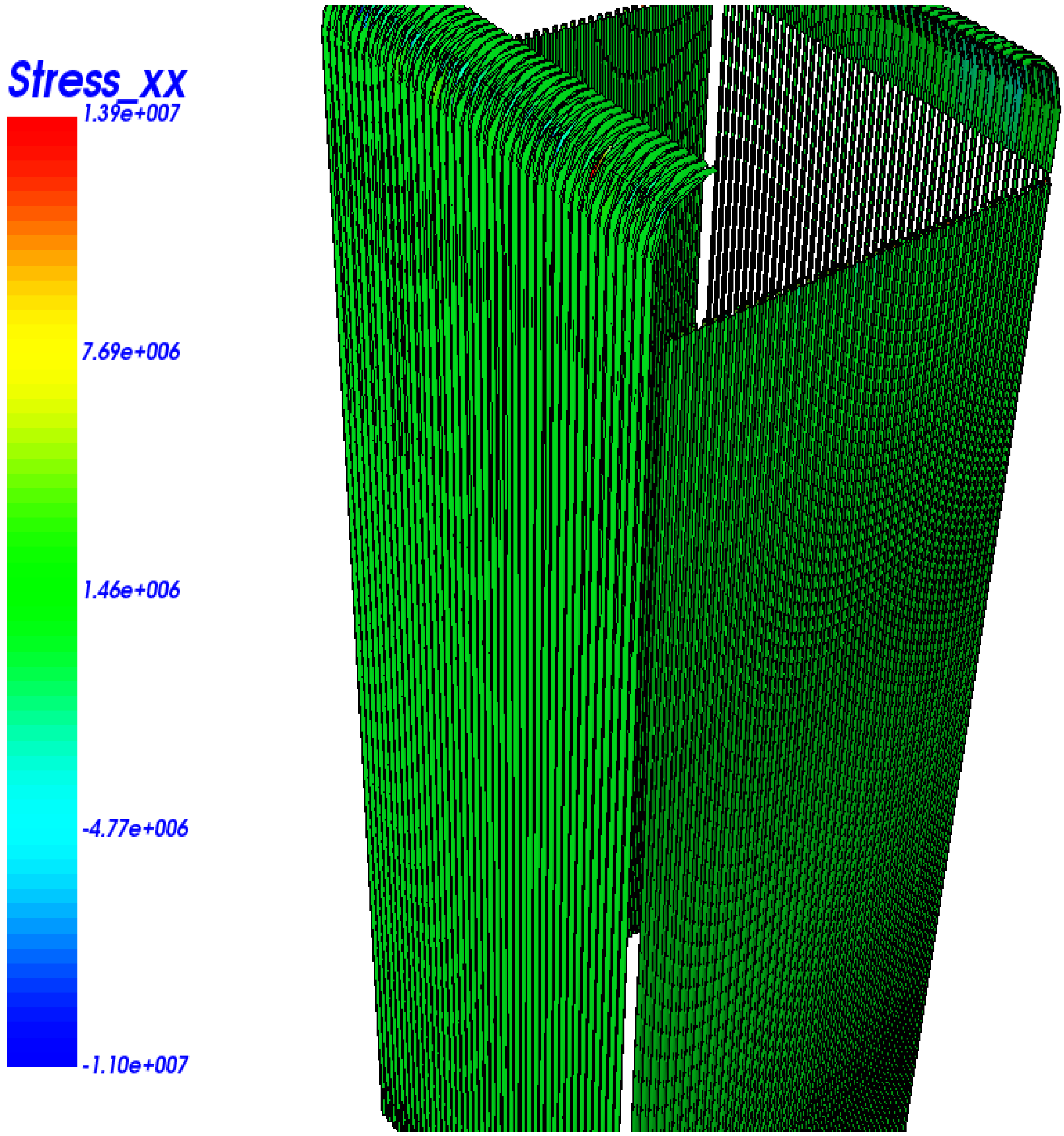
In the figure: The unit of the stress is the Pascal (Pa). 1 Pa = 1 N/m^2



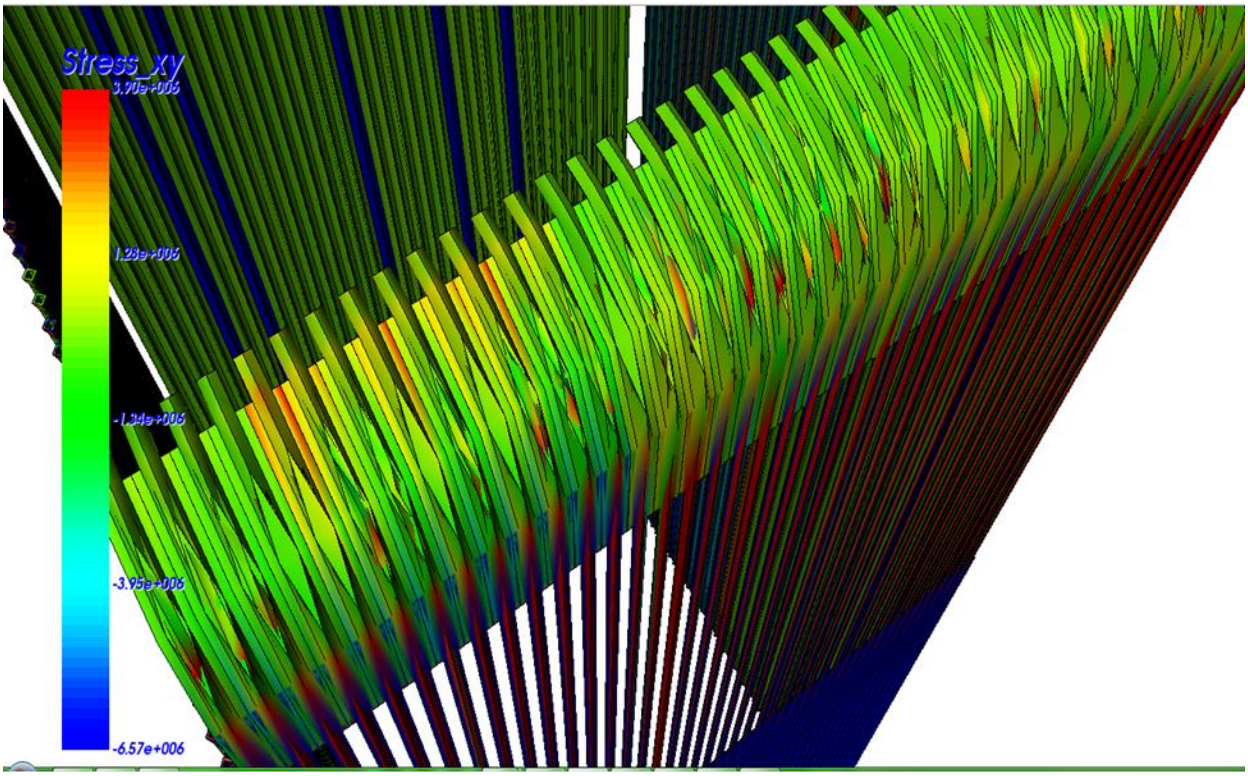
In the figure: The unit of the stress is the Pascal (Pa). 1 Pa = 1 N/m^2



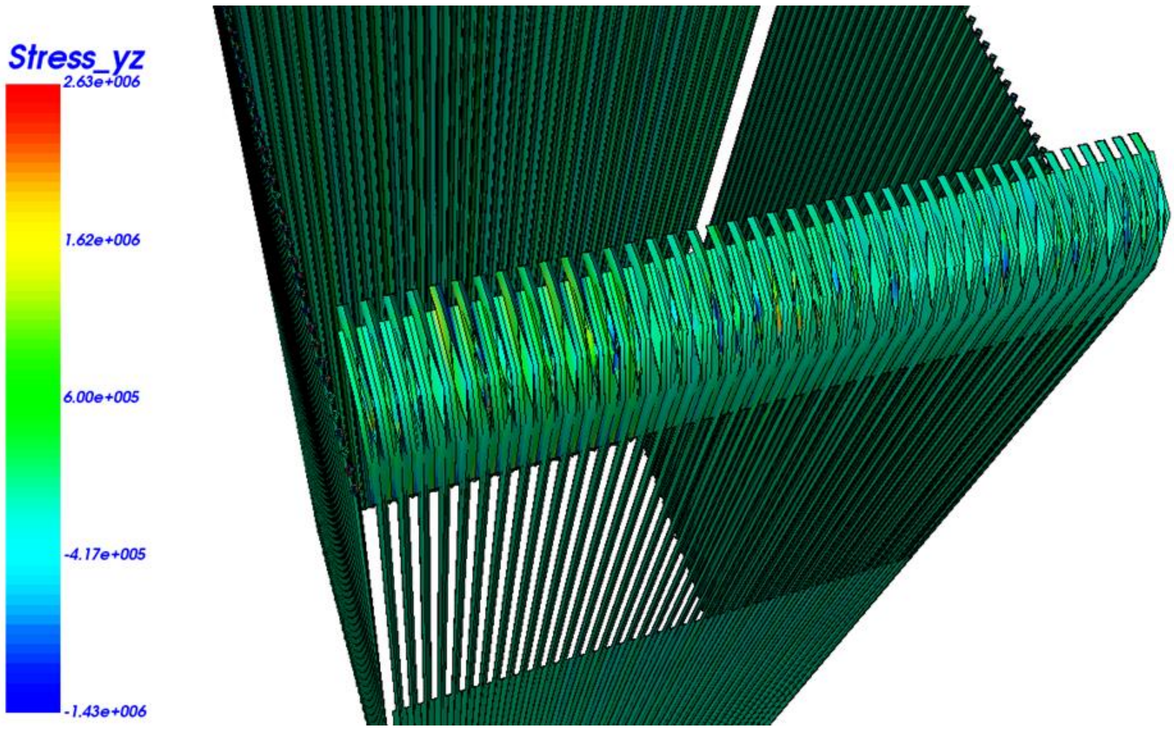
In the figure: The unit of the stress is the Pascal (Pa). 1 Pa = 1 N/m^2

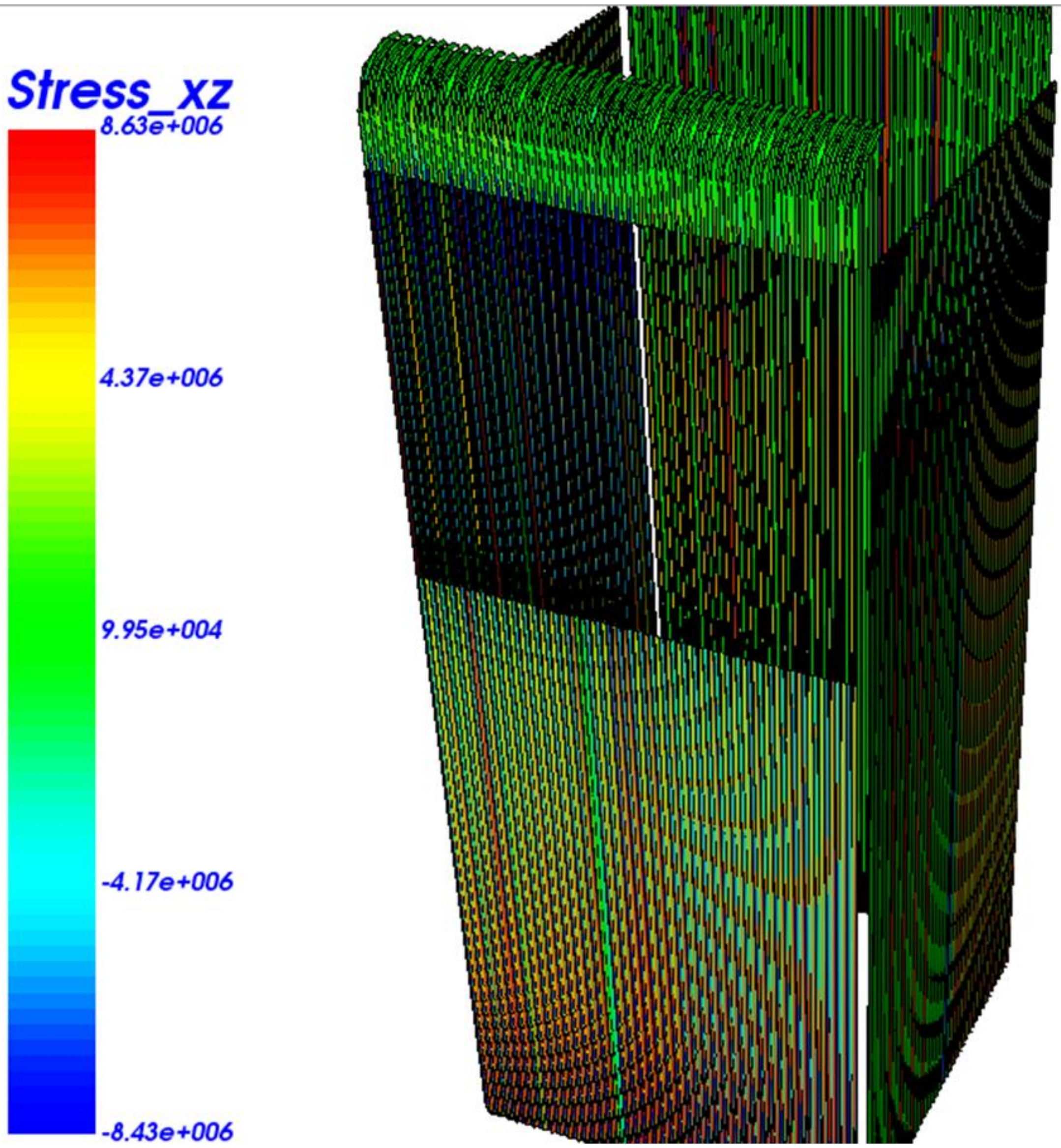


In the figure: The unit of the stress is the Pascal (Pa). 1 Pa = 1 N/m^2:

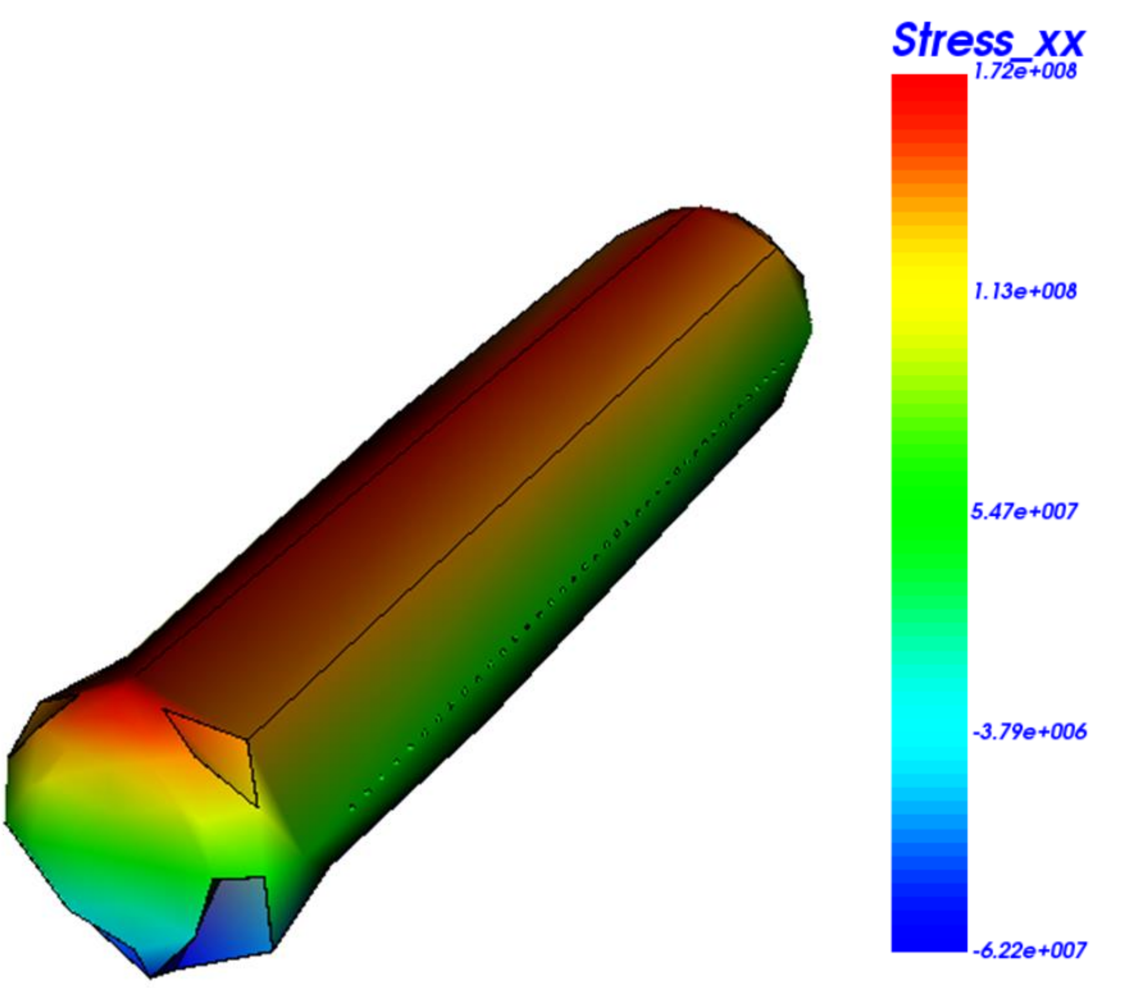


In the figure: The unit of the stress is the Pascal (Pa). 1 Pa = 1 N/m^2:

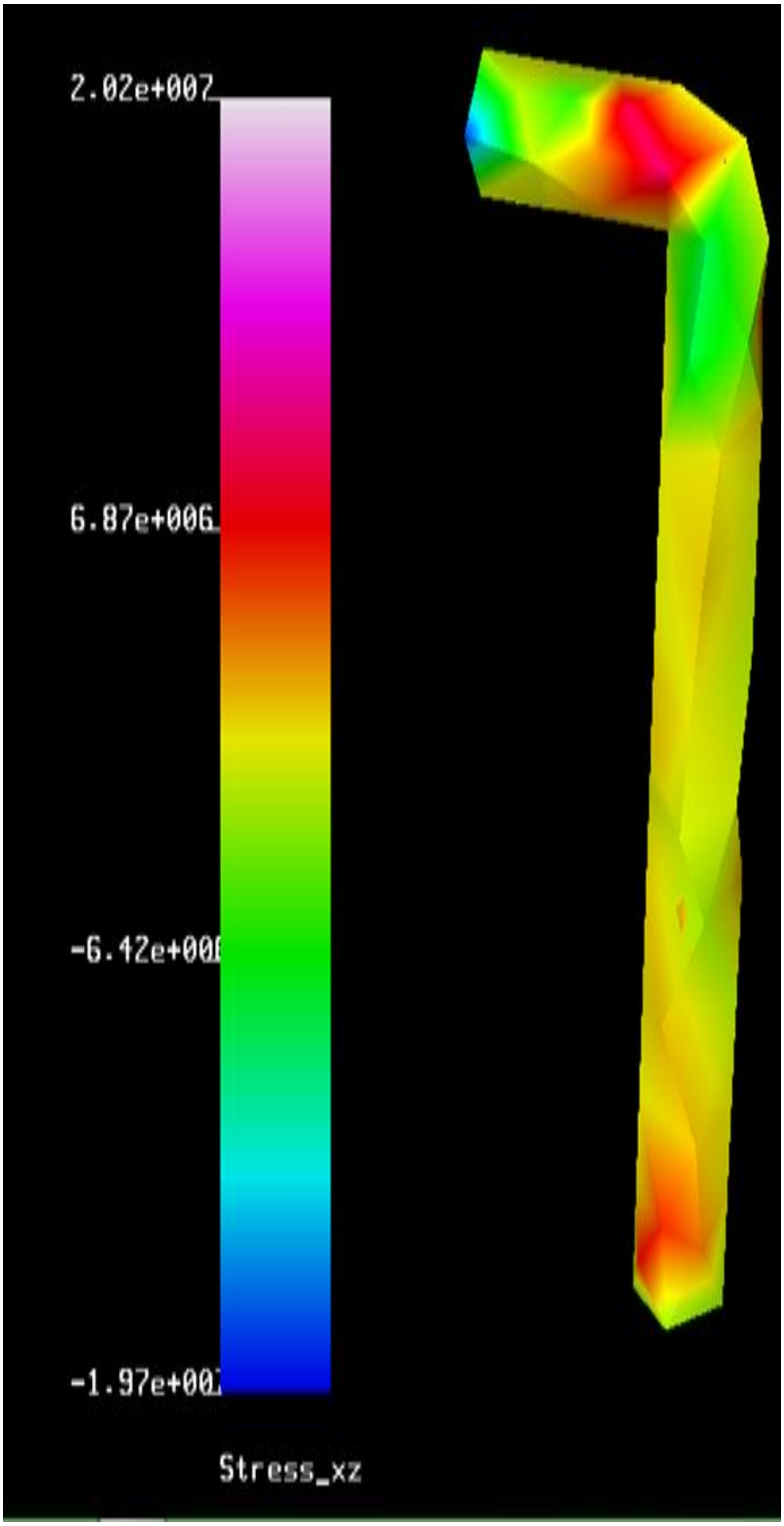




In the figure: The unit of the stress is the Pascal (Pa). 1 Pa = 1 N/m^2



In the figure: The unit of the stress is the Pascal (Pa). 1 Pa = 1 N/m^2



In the figure: The unit of the stress is the Pascal (Pa). 1 Pa = 1 N/m^2

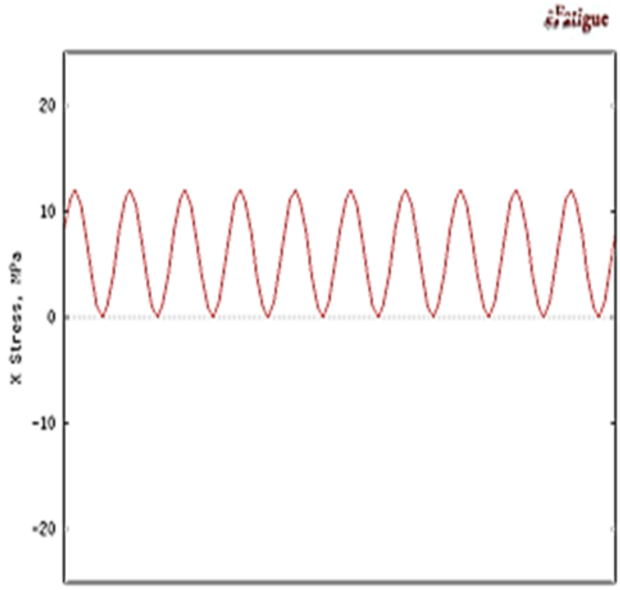
8.4 Estimated number of constant amplitude fatigue cycles

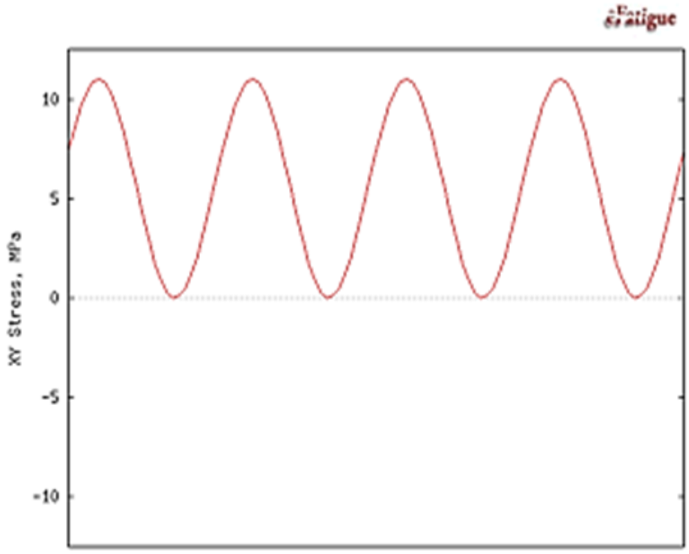
The maximum value considered of 13 MPa is used for calculation of the life due to fatigue at a constant amplitude.

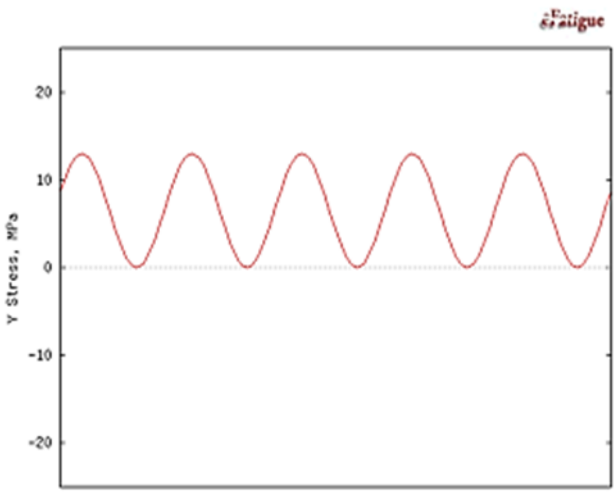
Constante mécanique relative à l'acier inox 304 L Smax or emax = 12 MPa Smin or emin = 0 MPa Sa or ea = 6 MPa Sm or em = 6 MPa Material Type = stainless steel Material Name = Stainless Steel 30304, Su=650.0 Su = 650 MPa E = 183000 MPa SFL = 147 MPa NFL = 10E+07 Sf' = 924 MPa b = -0.114	Surface Finish Type = hot rolled Loading Factor Type = axial ksize = 0.1 d = 10 mm Kt = 3.65 Use Fatigue Notch Factor = No Kf = 1 r = 5 mm n = 3 Mean Stress Definition = Maximum Stress Mean Stress Parameter = 13 MPa SFL = 113 MPa kSF = 0.551 kL = 0.923	**Résultats obtenus** Smax = 13 MPa Smin = 12 MPa Sa = 0 MPa Sm = 13 MPa

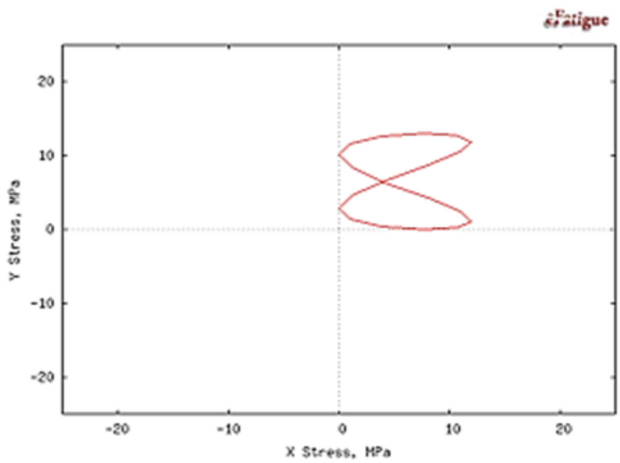
The estimated number of cycles N f = 136000

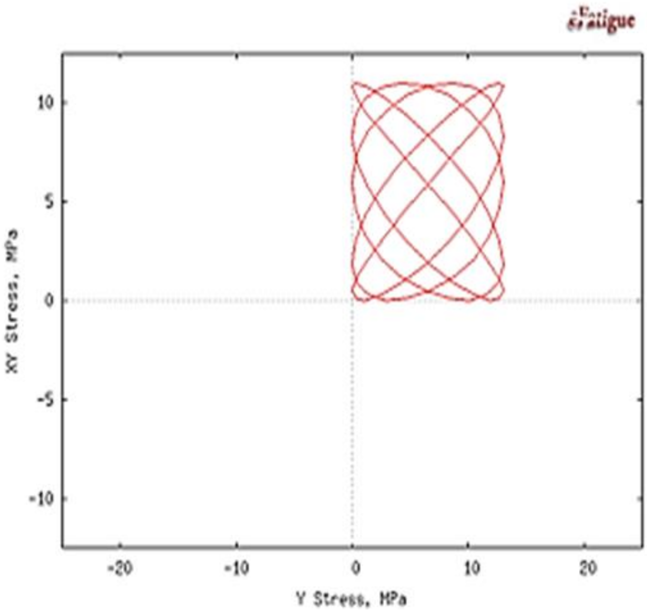
8.5 Estimated fatigue safety factor caused by a multiaxial load



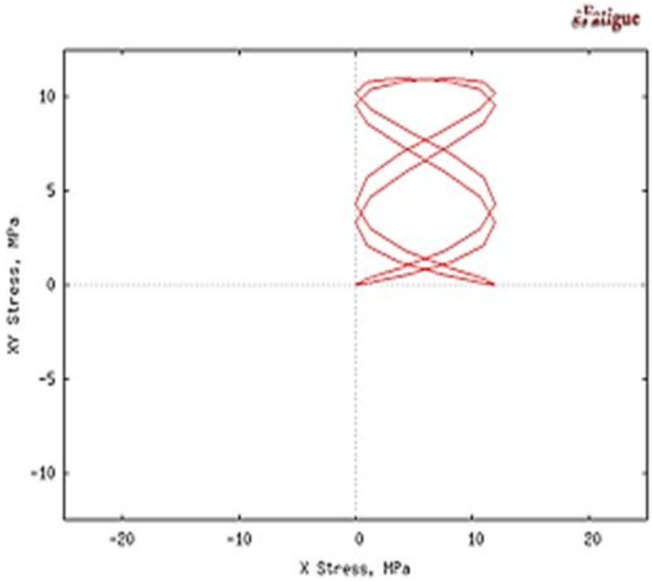








) M

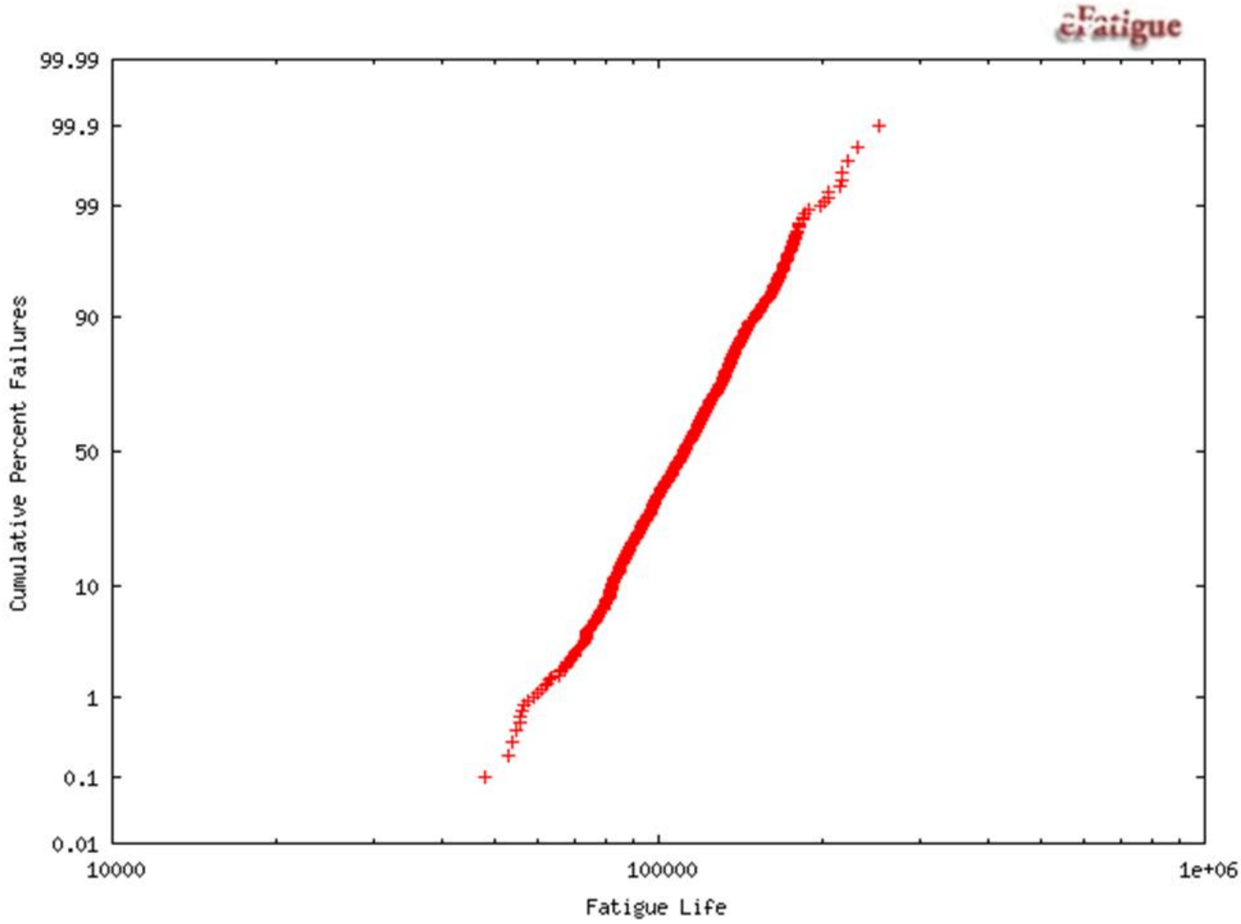


Constante mécanique relative à l'acier inox 304 L	**Résultats obtenus**
SFL = 113 MPa TFLmax = 73 MPa Tf'max = 595 MPa bTmax = -0.114 TFLoct = 53 MPa Tf'oct = 436 MPa bToct = -0.114 G = 73200 MPa kFindley = 0.300 αSines = 0.150 aDV = 0.400 bDV = 73 MPa	n (Goodman) = 5.768 n (Findley) = 3.076 n (Sines) = 3.505 n (Dang Van) = 4.301e+00 n (MCE) = 2.958

8.6 3.6. Probabilistic analysis of the number of fatigue cycles.

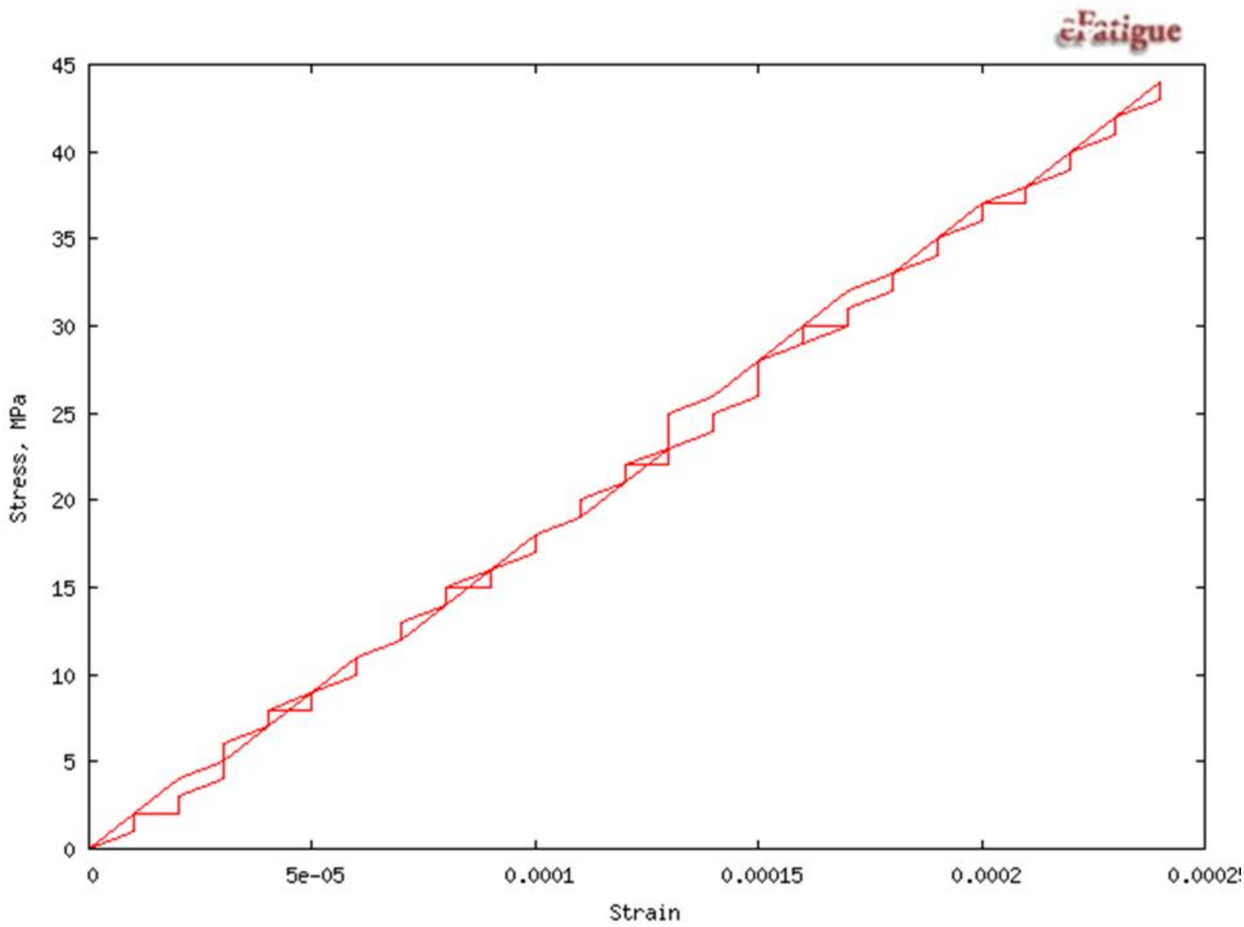
		Deterministi	**Probabilisti**		

		c	**c**		
Variable	**Value**	**Sensitivity**	**Sensitivity**	**Mean**	**COV**
Loading			0		
S_{max} or e_{max}	13 MPa	-2.41	0.00	13	0.000
S_{min} or e_{min}	0 MPa	0.00	0.00	0.00e+00	0.00e+00
Material Properties			0.15		
S_u	650 MPa	2.23	0.00	650	0.000
S_f'	L(924 MPa,0.10,0.90)	-0.77	0.15	928	0.099
b	C(-0.114,0.00,1.00)	-3.07	0.00	-0.114	0.047
Surface Finish			0.88		
k_{SF}	N(0.551,0.10)	2.00	0.88	0.550	0.099
Stress Concentrators			0.45		
K_f	N(3.65,0.05)	-2.04	0.45	3.65	0.050



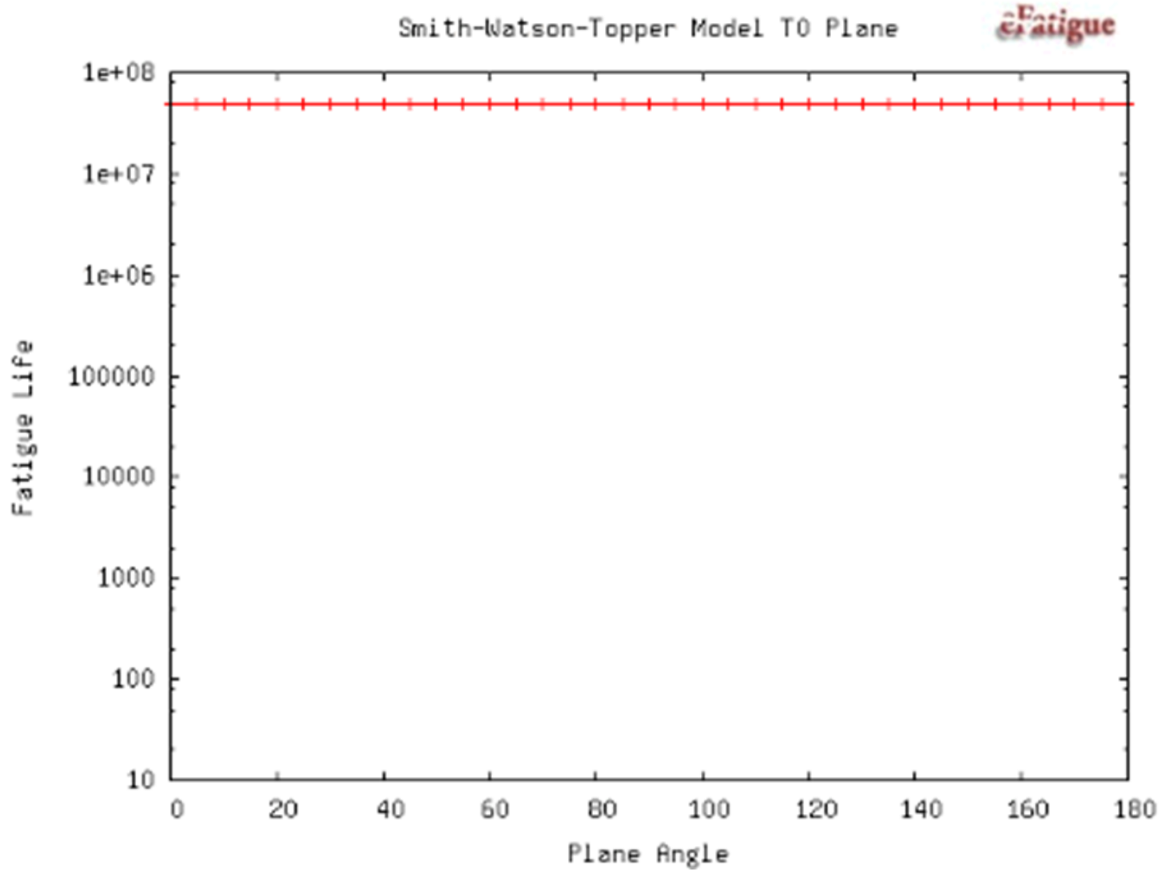
Nf , median = 111215 cycles

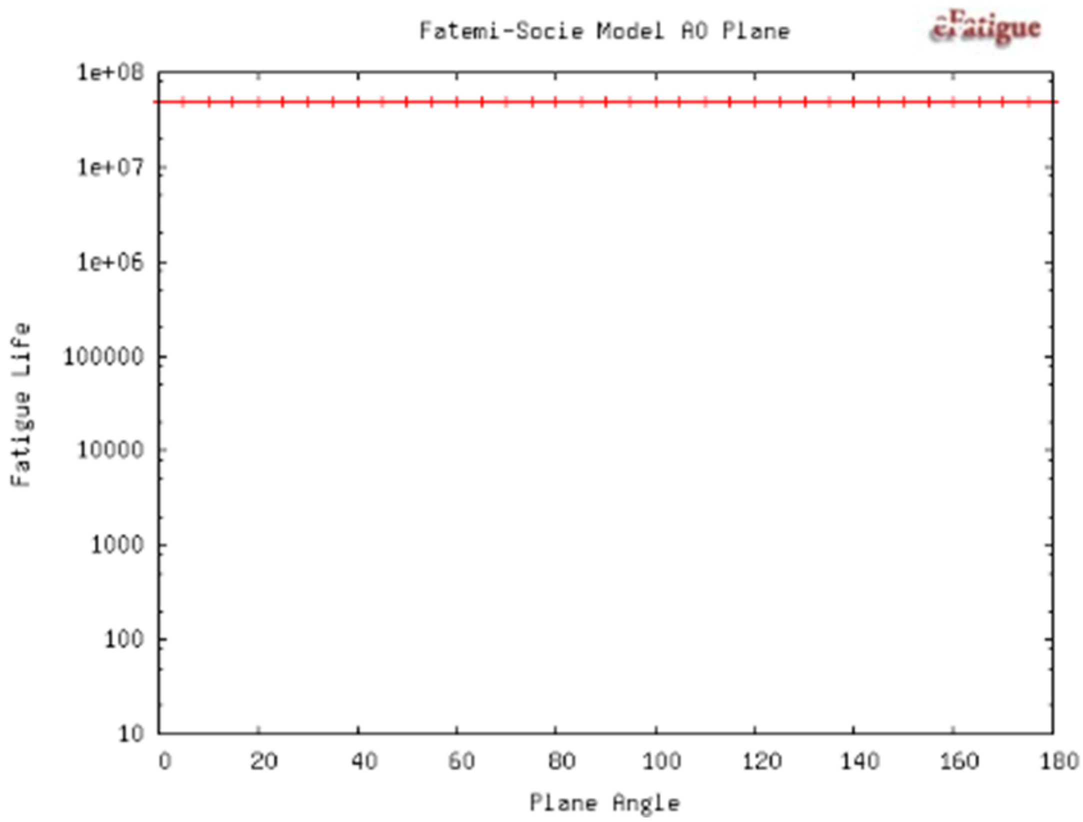
8.7 3.7. Estimate of the number of cycles of elongation at constant amplitude

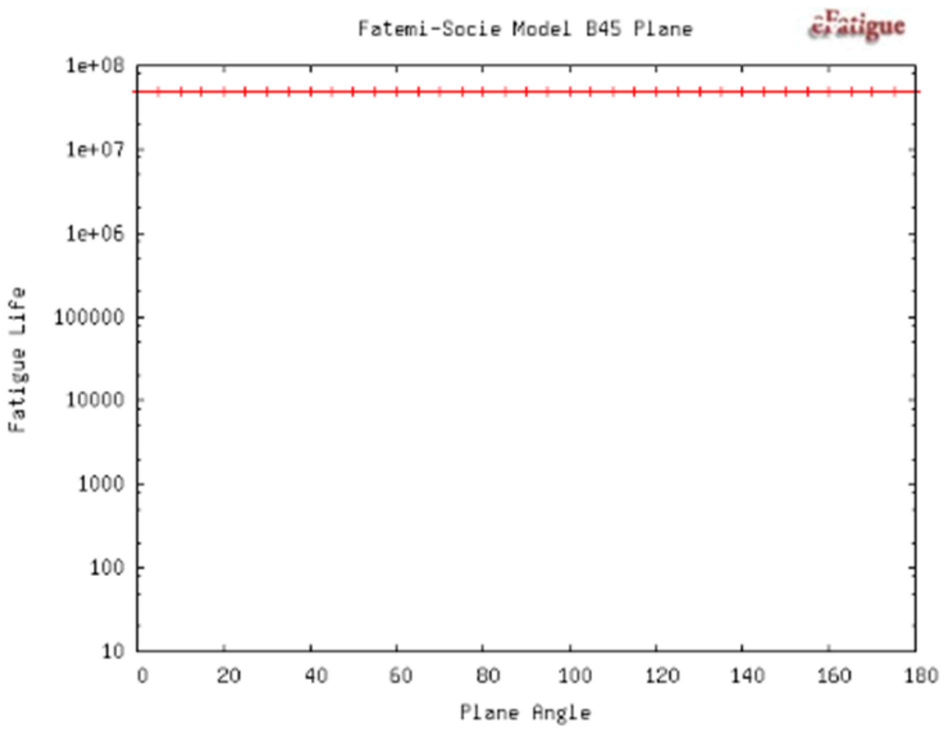


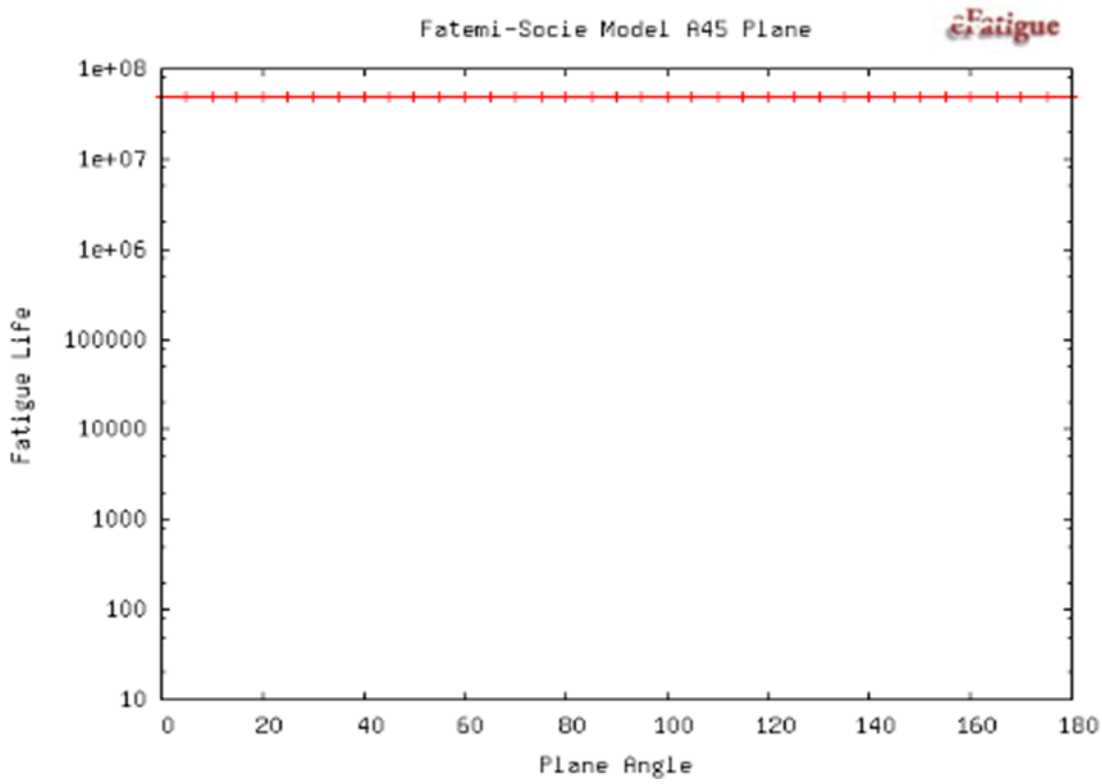
Nf = > Limite de la fatigue 50000000 cycles , n ~ 6.12

8.8 3.8. Estimated nuber of cycles due to displacement caused by a multiaxial load

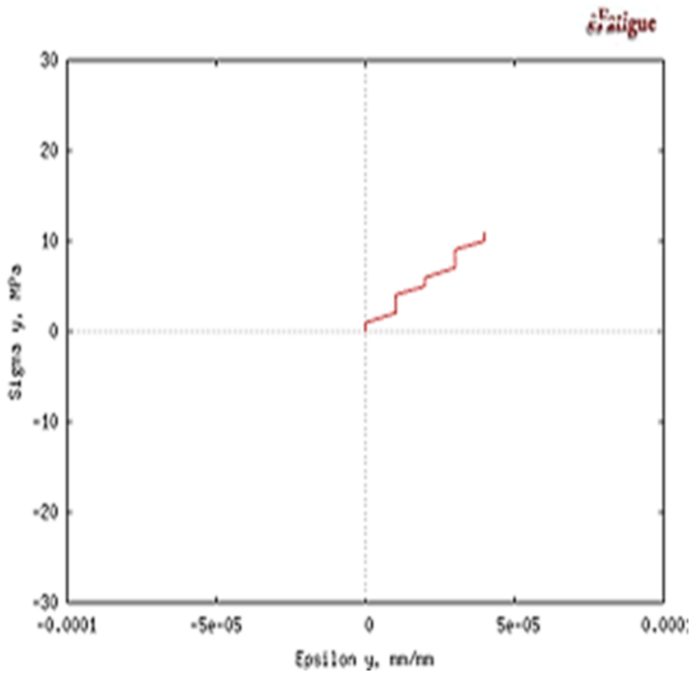

Smith-Watson-Topper Model T0 Plane
eFatigue
1e+08
1e+07
1e+06
100000
10000
1000
100
10
Fatigue Life
0
20
40
60
80
100
120
140
160
180
Plane Angle


Fatemi-Socie Model A0 Plane
eFatigue
Fatigue Life
1e+08
1e+07
1e+06
100000
10000
1000
100
10
0
20
40
60
80
100
120
140
160
180
Plane Angle

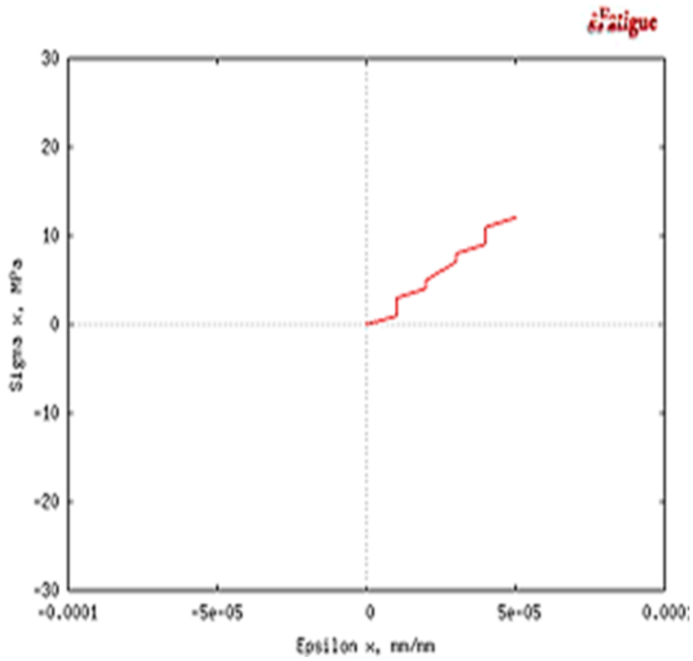

Fatemi-Socie Model B45 Plane
eFatigue
Fatigue Life
1e+08
1e+07
1e+06
100000
10000
1000
100
10
0
20
40
60
80
100
120
140
160
180
Plane Angle



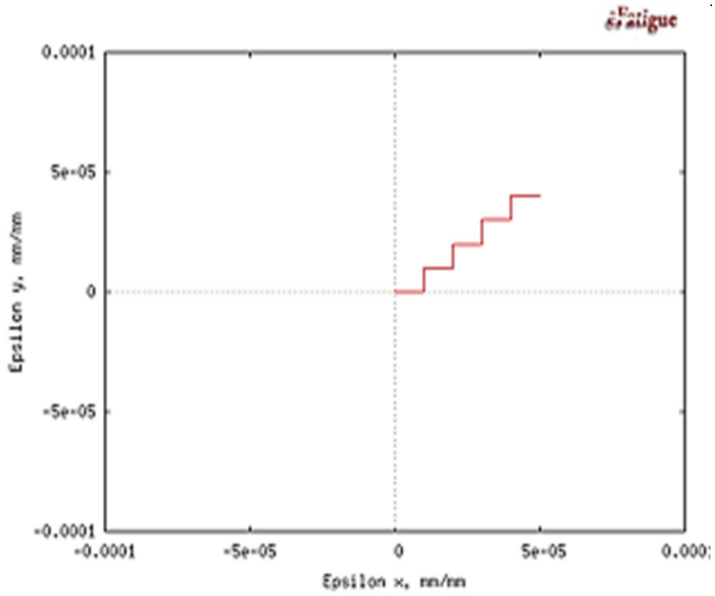
Fatemi-Socie Model A45 Plane
eFatigue
Fatigue Life
1e+08
1e+07
1e+06
100000
10000
1000
100
10
0
20
40
60
80
100
120
140
160
180
Plane Angle

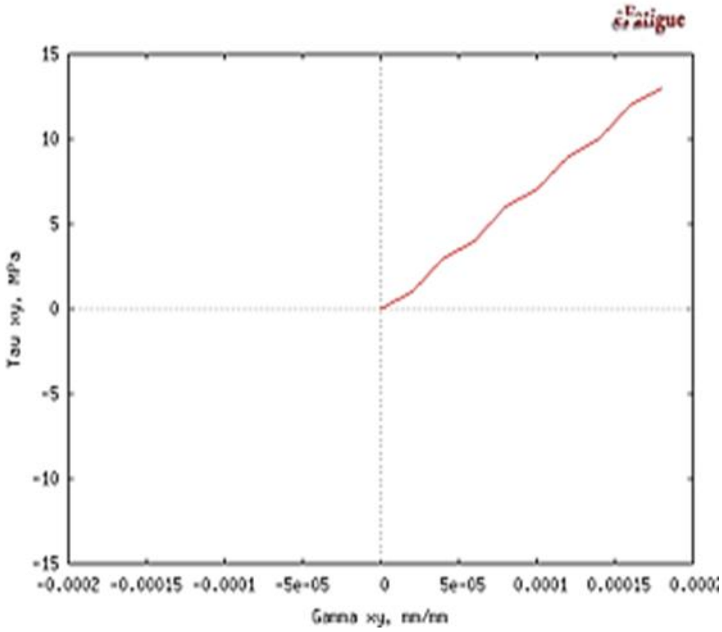


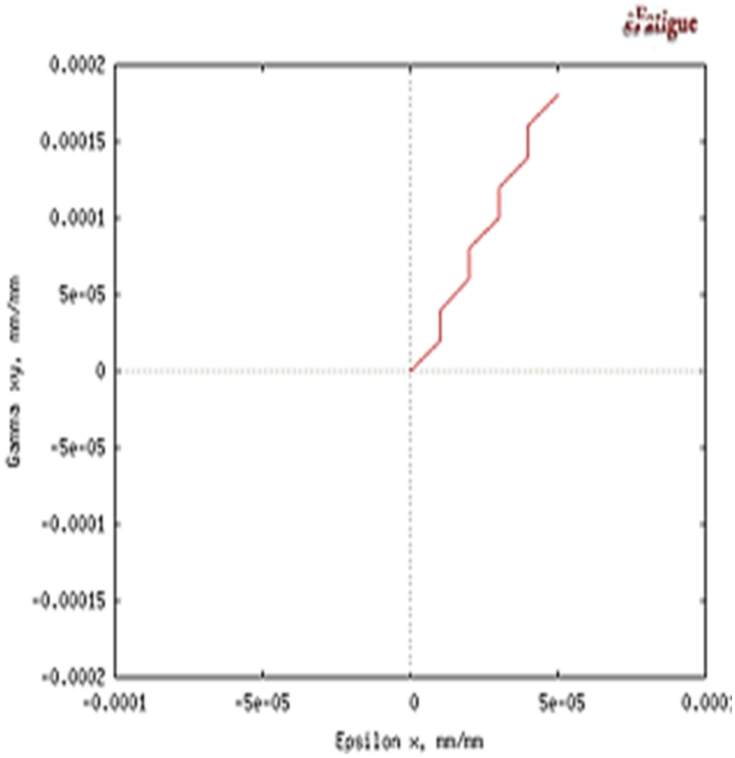
eFatigue
Sigma y, MPa
Epsilon y, mm/mm

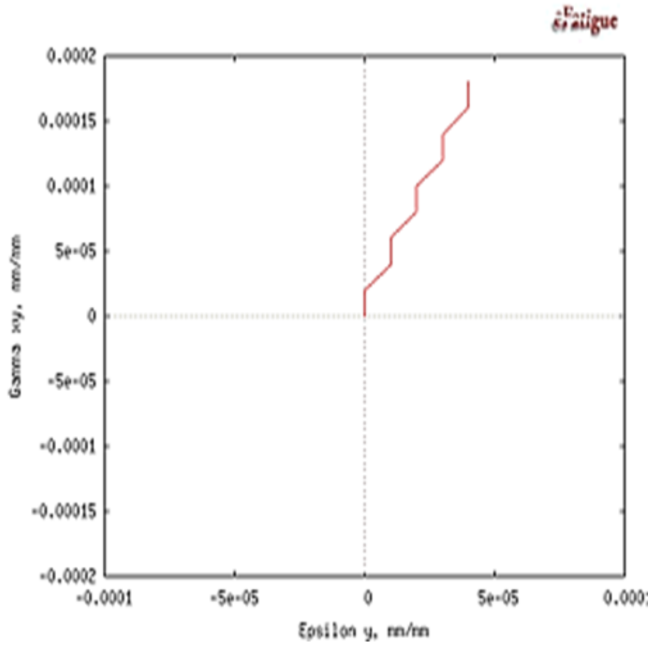


eFatigue
Sigma x, MPa
Epsilon x, mm/mm

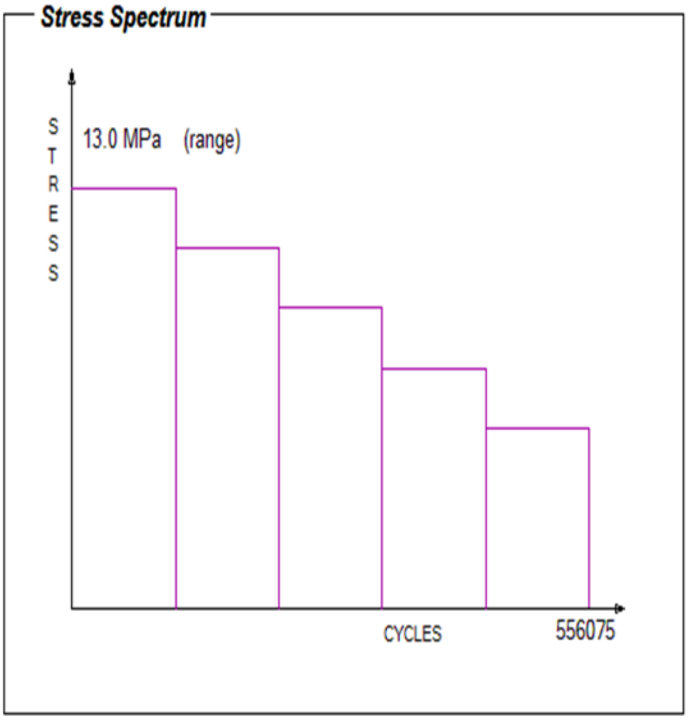


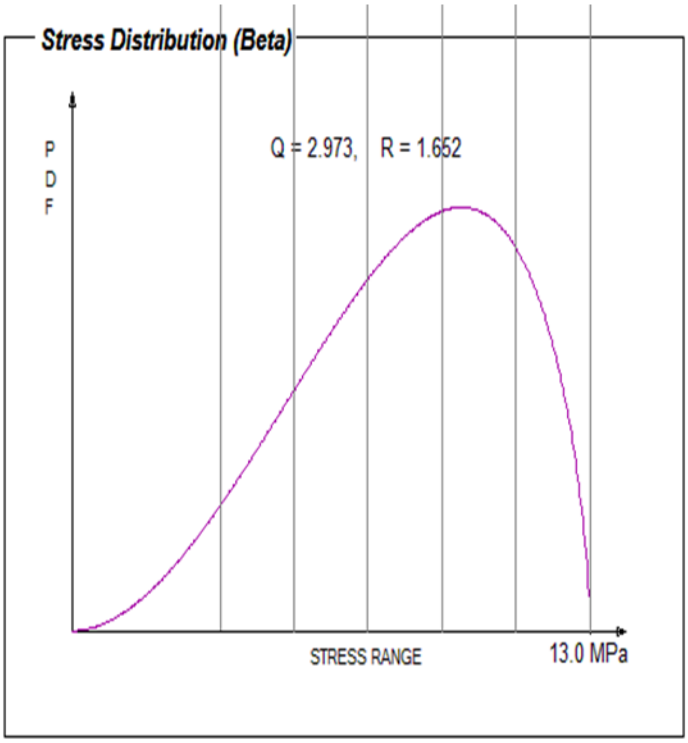






8.9 3.9. Results of Fallo software

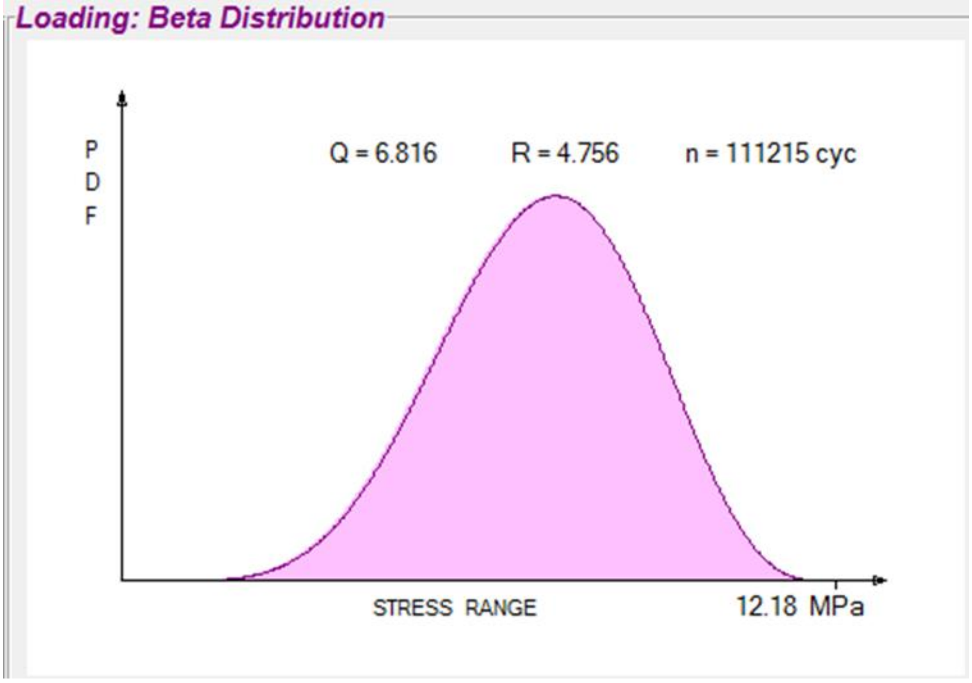


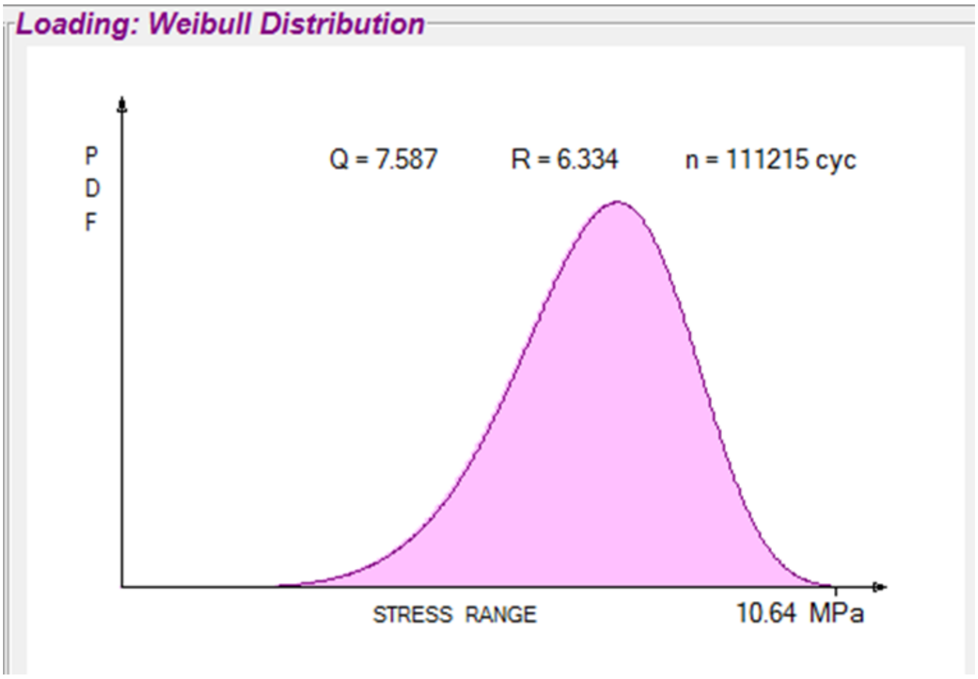


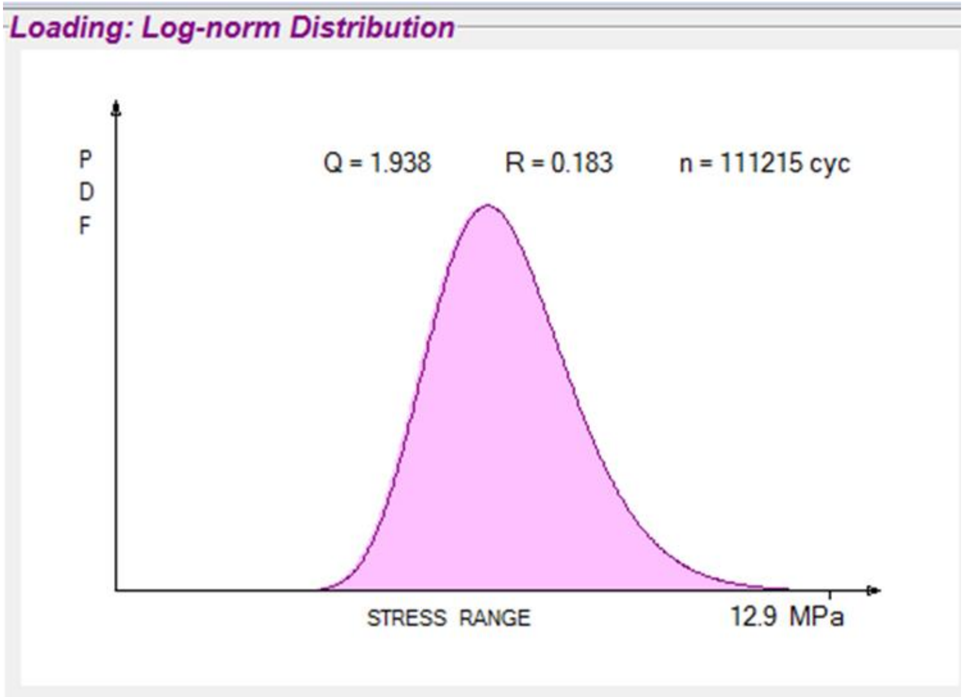
Stress Spectrum Information

Level	Stress [MPa]	Cycles
1	13.0	111215
2	11.143	111215
3	9.286	111215
4	7.429	111215
5	5.571	111215

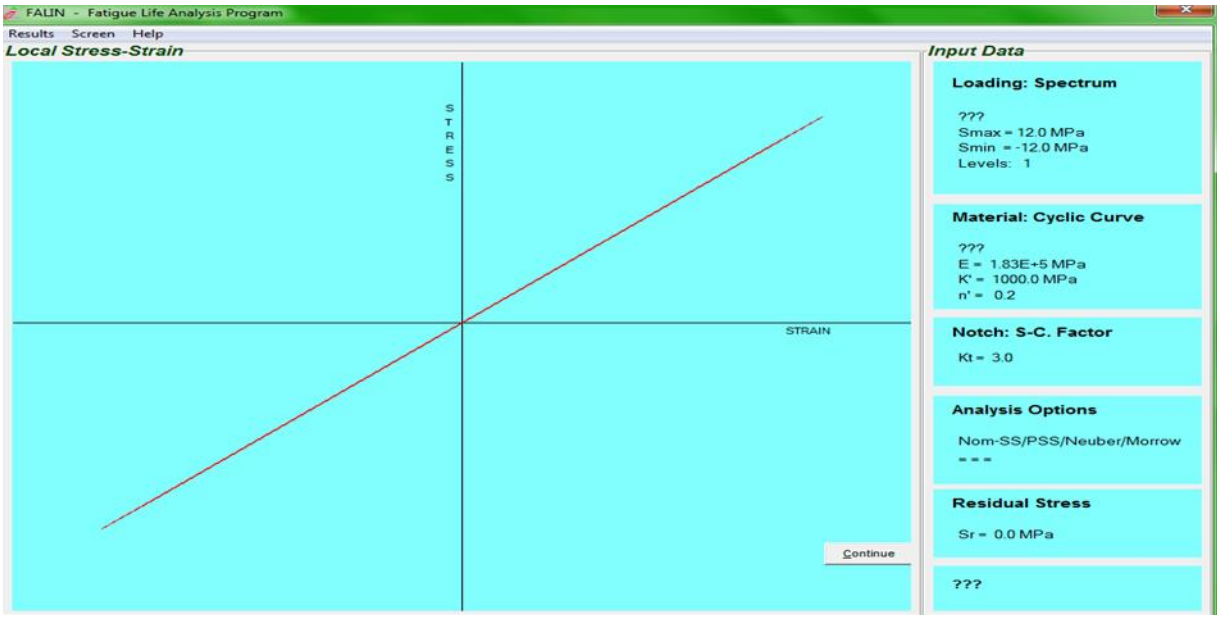
8.10 3.10. Results of FALSN software

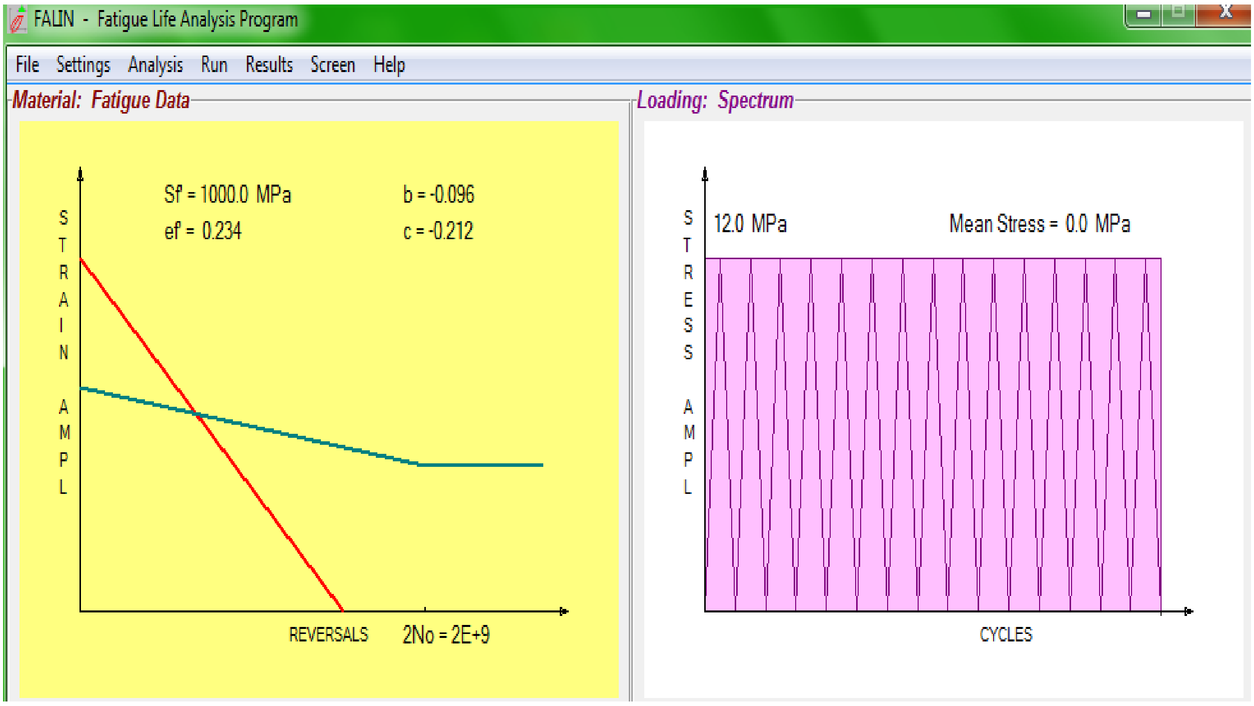

Loading: Beta Distribution
P
D
F
Q = 6.816
R = 4.756
n = 111215 cyc
STRESS RANGE
12.18 MPa

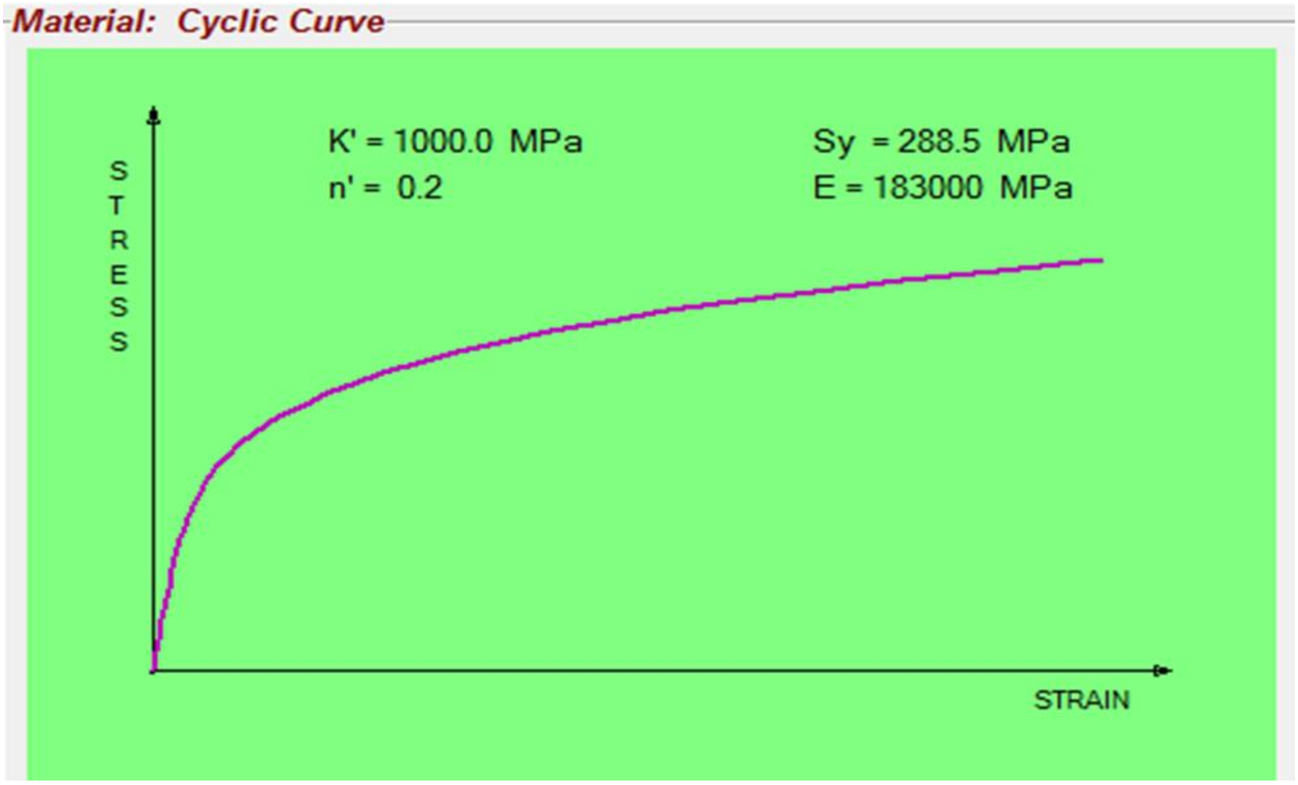

Loading: Weibull Distribution
P
D
F
Q = 7.587
R = 6.334
n = 111215 cyc
STRESS RANGE
10.64 MPa



8.11 3.11. Results of FALIN software







8.12 3.12. Discussions of all results

In the figure shown above, it is clear that the stress distribution undergoes significant variation during the passage of fluid in the tube neck. This enormous variation is expected and planned, since steam has a significant speed and pressure and it will undergo two flow direction changes during a short time.

Moreover, of the number of cycles calculated in previous sections, the one we chose to lower value to avoid any risk.

The lowest number received is N = 111215, followed by the number of cycles multiplied by the time during which it stops the operation of the apparatus, and it was found that the time of operation before the break is almost 20 years .

9 CHAPTER IV: CONCLUSION AND FUTURE WORK

About the technological side, Elmer simulation requires a long time to determine the initial and boundary conditions, and then it is recommended to make a script to get rid of and to reduce the time.

And finally this study does not take into account or stress due to the high temperature or the effect of corrosion caused by steam. In addition, these two conditions are able to reduce the lifetime of the vaporizer.

10 BIBLIOGRAPHY

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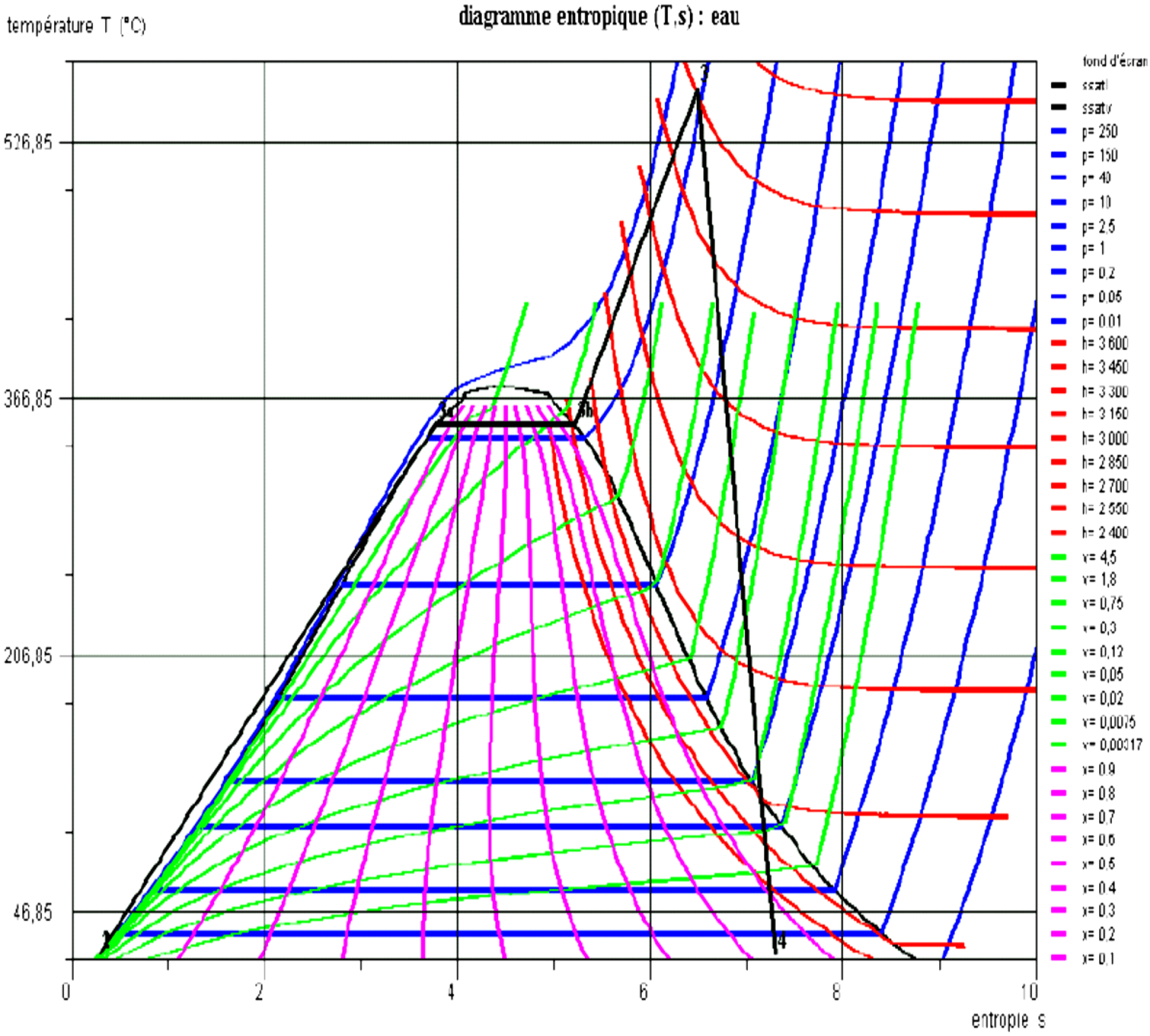
[12] Combustion and heat calculation of an incinerator, E. R. KAISER, Department of Chemical Enigineering New York University,pg.81

11 Annex

1. Annex 1: Water steam Diagram



2. Annex 2: Task of master thesis

AECENAR
Association for Economical and Technological Cooperation in the Euro-Asian and North-African Region
www.aecenar.com

LASeR
Lebanese Association for Scientific Research
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www.temo-ek.de

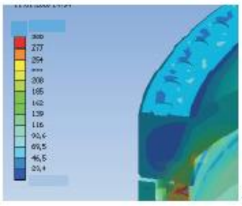
MEAE – A member of AECENAR Applied Research Center
www.aecenar.com/institutes/meae

Ras Nhache/Batroun - Tripoli, 11th Jan 2015

TEMO-IPP Incineration Demonstration Plant Ras Nhache/Batroun, Lebanon

Vaporizer of TEMO-IPP incineration demonstration plant at Ras Nhache/Batroun

Upscaled vaporizer train element (TEMO-IPP has to be upscaled in such a way) (picture is from Dr.-Ing. M. Franz, "Dampferzeuger", www.axpo-holz.ch/Dampferzeuger.pdf)



Stress distribution (FEM Analysis) at vaporizer

Master Thesis

Mechanical Analysis of an upscaled version of the Vaporizer (pressure vessel and circulation tubes) of the incineration pilot power plant TEMO-IPP

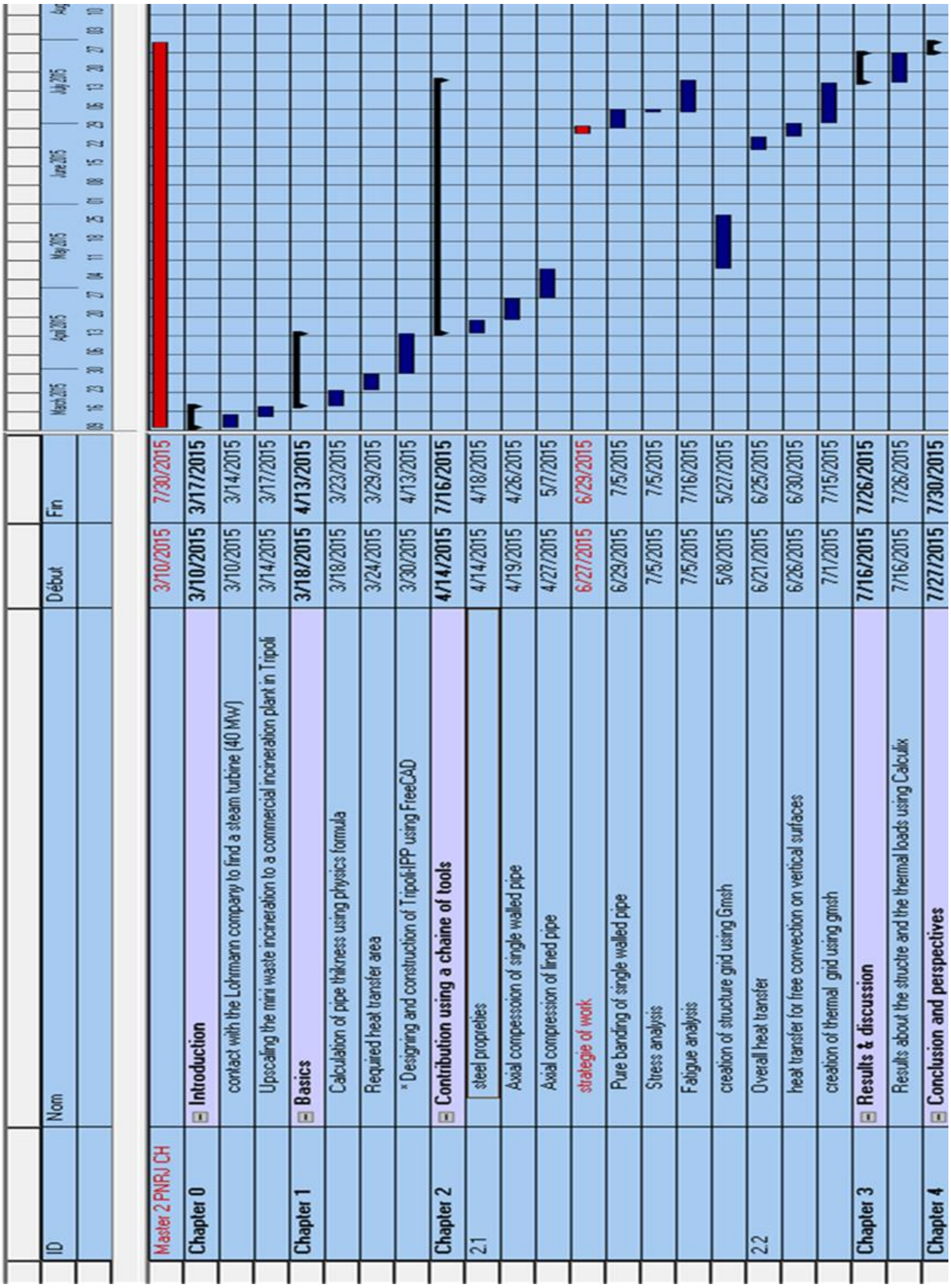
To be able to upscale the TEMO-IPP incineration plant to a commercial incineration plant in Tripoli (about 40 MW) critical components shall be verified by Finite Element Analysis with the tool Abaqus. The main critical component is the pressure vessel with about 100 bar pressure difference. Working packages:

- Upscaling the CAD model of vaporizer with CAD tool ProE (2 weeks)
- Mechanical Behavior (Stress Analysis, Fatigue Analysis, Thermal Strain Analysis) with the tool Abaqus (6 weeks)
- Thermal Loads (Dimensionless Numbers, Overall Heat Transfer, Heat Transfer for Concentric Annular Gaps, Heat Transfer for Free Convection on Vertical Surfaces) with the tool Abaqus (4 weeks)
- Documentation (3 weeks)

Keywords: Alternative Energy, Incineration Power Plant, Mechanical Analysis, Finite Element Analysis (FEA), CAD

Contact: Samir Mourad, Email: samir.mourad@aecenar.com

3. Annex 3: Time plan



ID	Nom	Début	Fin
Master 2 PNRJ CH		3/10/2015	7/30/2015
Chapter 0	Introduction	3/10/2015	3/17/2015
	contact with the Lohmann company to find a steam turbine (40 MW)	3/10/2015	3/14/2015
	Upscaling the mini waste incineration to a commercial incineration plant in Tripoli	3/14/2015	3/17/2015
Chapter 1	Basics	3/18/2015	4/13/2015
	Calculation of pipe thikness using physics formula	3/18/2015	3/23/2015
	Required heat transfer area	3/24/2015	3/29/2015
	* Designing and construction of Tripoli-IPP using FreeCAD	3/30/2015	4/13/2015
Chapter 2	Contribution using a chaine of tools	4/14/2015	7/16/2015
2.1	steel proprieties	4/14/2015	4/18/2015
	Axial compessoion of single walled pipe	4/19/2015	4/26/2015
	Axial compression of lined pipe	4/27/2015	5/7/2015
	strategie of work	6/27/2015	6/29/2015
	Pure banding of single walled pipe	6/29/2015	7/5/2015
	Stress analysis	7/5/2015	7/5/2015
	Fatigue analysis	7/5/2015	7/16/2015
	creation of structure grid using Gmsh	5/8/2015	5/27/2015
2.2	Overall heat transfer	6/21/2015	6/25/2015
	heat transfer for free convection on vertical surfaces	6/26/2015	6/30/2015
	creation of thermal grid using gmsh	7/1/2015	7/15/2015
Chapter 3	Results & discussion	7/16/2015	7/26/2015
	Results about the structre and the thermal loads using Calculix	7/16/2015	7/26/2015
Chapter 4	Conclusion and perspectives	7/27/2015	7/30/2015

4. Appendix 4: The properties of the steam at the inlet of the turbine

POWER PLANTS
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SALE & RELOCATION

LOHRMANN INTERNATIONAL

Taunusstr. 5a
65183 Wiesbaden/Germany
Tel. +49 (0) 611-50402-0
Fax +49 (0) 611-50402-50
www.lohrmann.com
info@lohrmann.com

For Sale:	**Pre-owned 30.2 MW Steam Turbine Generator Extraction – Condensing Type**
Ref.-No:	**STG-29.33**

Brief plant history:

The steam turbine generator was part of a combined cycle power plant commissioned in 1996 and shut down 2012 after approx. 86,562 operating hours.

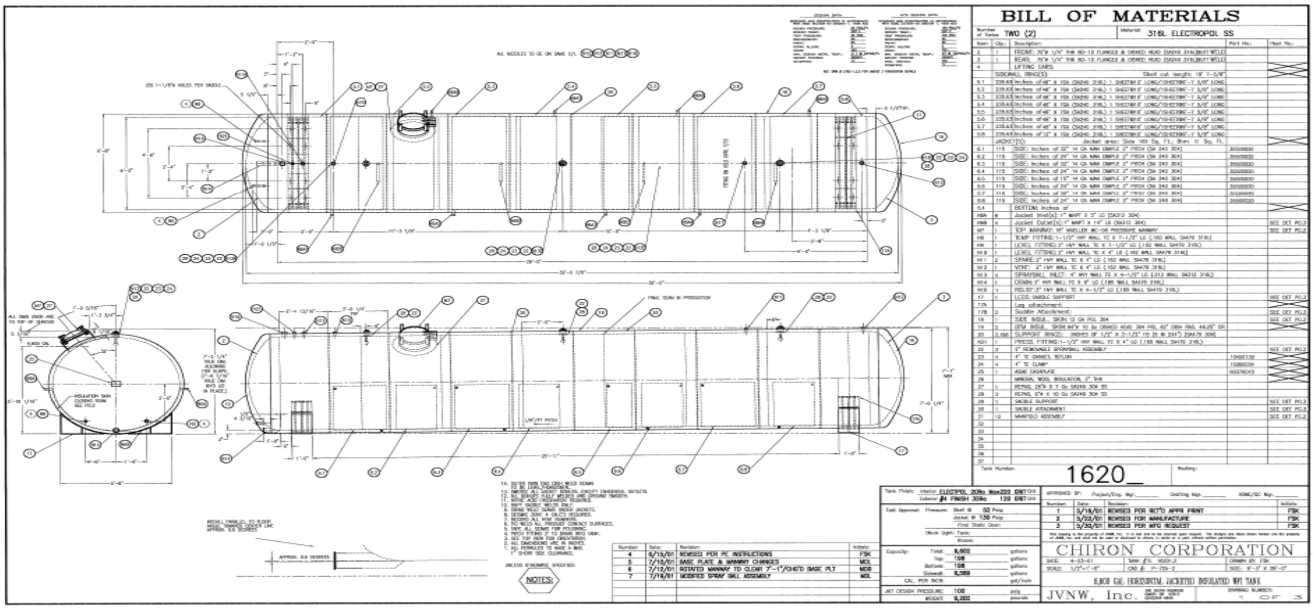
Description of major plant components:

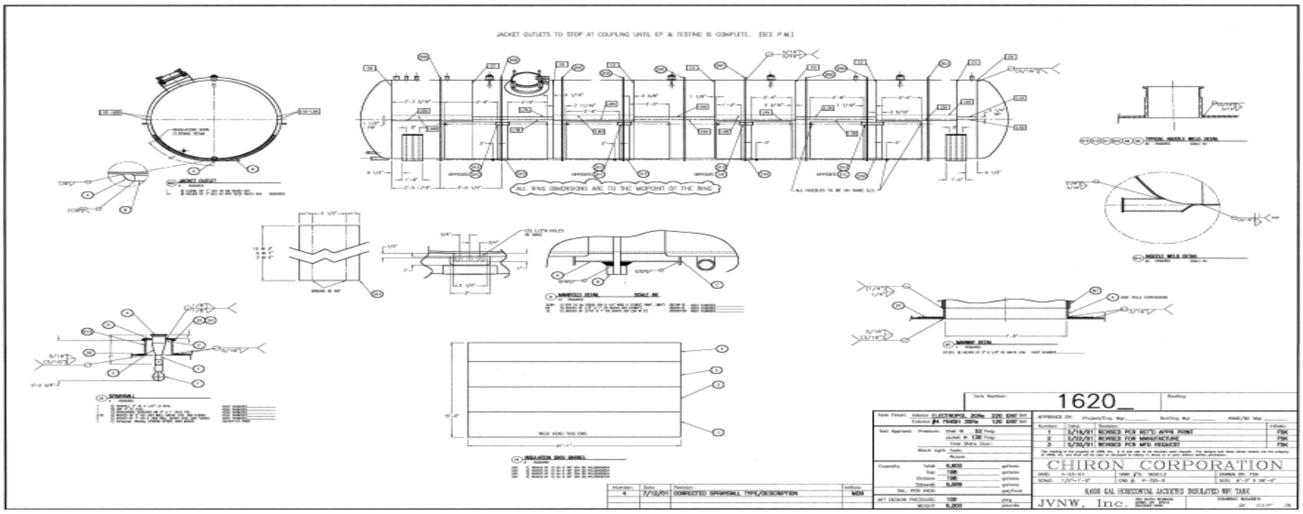
Turbine

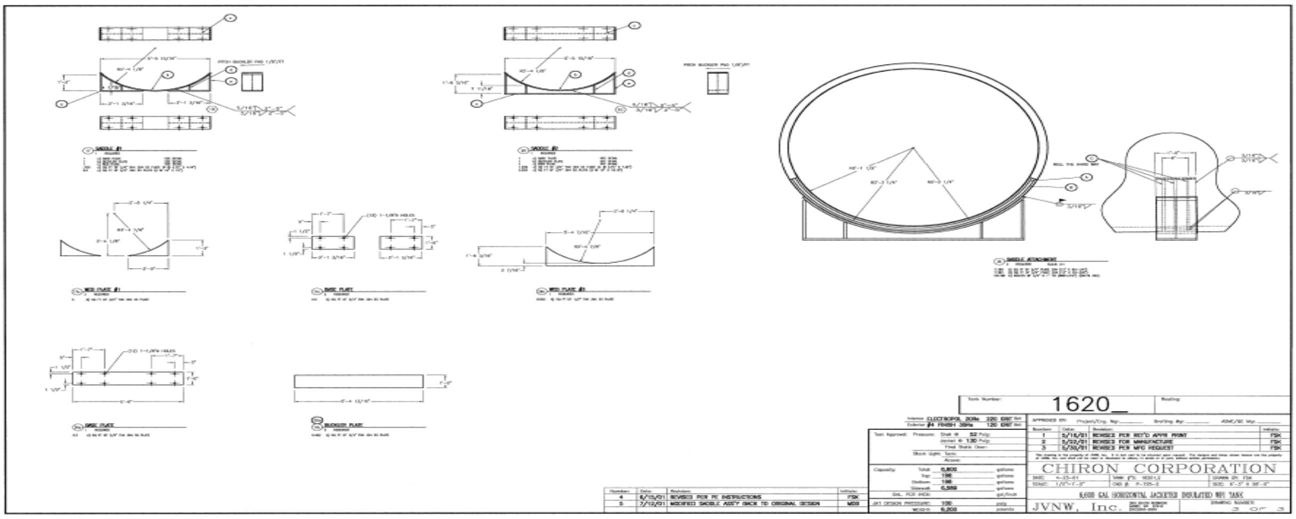
Manufacturer, Type	ABB Turbinen Nürnberg GmbH, VEE 40 Double extraction condensing turbine, Type 4 Stages HP, 9 stages MP and 9 stages LP part
Max. terminal power	30.2 MW
Number of extractions/ bleeders	1 pcs./ 2 pcs.
Live steam parameters	120 bar, 520 °C, 210 t/h
Bleeding 1 normal/max.	36 / 41 bar, 365 / 415 °C, max. 80 t/h
Bleeding 2 normal/max.	6 / 8.5 bar, 170 / 333 °C, max. 75 t/h
Extraction normal/max.	16 / 20.5 bar, 275 / 300 °C, max. 20 t/h
Exhaust normal/max.	0.047 / 0.08 bar, max.18 °C
Rate max.	10.2 / 55.6 t/h

Budget Price for STG 29.33: FOB 3.150.000 EUR (Offer from 12 Oct 2015)

5. Annex 5: Blueprints of drum







6. Annex 6: Physical properties of stainless steel 316L (Reference Materials Engineering-Mechanical Behavior Report 128)

Material Type			stainless steel
Material Specification			AISI 316
Material Alloy			30316
Elastic Modulus	E	=	190000 MPa
Crack Growth Intercept	C	=	4.26E-13 m/cycle
Crack Growth Exponent	m	=	3.6
Threshold Stress Intensity	ΔK_{TH}	=	5.15 MPa sqrt (m)

Ultimate Strength	Su	=	650 MPa
Fatigue Strength Coefficient	σf′	=	1000 MPa
Fatigue Strength Exponent	b	=	-0.114
Fatigue Ductility Coefficient	εf′	=	0.171
Fatigue Ductility Exponent	c	=	-0.402
Cyclic Strength Coefficient	K′	=	1660 MPa
Cyclic Strain Hardening Exponent	n′	=	0.287

Curve Intercept	Sf′	=	924 MPa
Curve Slope	b	=	-0.114

Fracture Strenght	650 MPa
Fracture strain	1.73
Poisson ration	0.25

TEMO-IPP 40 MW CFD Investigations

MASTER THESIS

In order to obtain the

PROFESSIONAL MASTER

Energetics

Issued by:
Faculty of Sciences of the Lebanese University

Presented and defended by:
Fatme Khaled Hamed

on Wednesday, September 30, 2015

Title

Computational fluid dynamics CFD analysis for water/steam flow in an upscaled version of the vaporizer of incineration power plant TEMO-IPP

Supervisor
Eng. Samir Mourad

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12 Abstract:

Computational Fluid Dynamics (CFD) is the study of fluid flow dynamic status using computer software. It is undergone for a prototype of an incineration power plant, present in Ras Nhache/Batroun, North Lebanon. There were some problems concerning the design which should be solved by a CFD study. In our study of computational fluid dynamic (CFD) we are interested to find the pressure and velocity values for this incineration power plant, in order to strengthen the used computer tools. We discretize the design in order to calculate the values for each point, the discretization makes the calculation possible - using a solver. Then the results are visualized.

Résumé:

Les dynamique des fluides computationnelle est l'étude de l'état dynamique de l'écoulement de fluide en utilisant un logiciel informatique, pour un prototype de centrales d'incinération, présents dans RasNhach, nous avons quelques problèmes devraient être résolus en faisant étude CFD pour la conception. Dans notre étude de la dynamique des fluides computationnelle (CFD), nous avons intérêt pour trouver les valeurs de pression et de vitesse pour une centrale d'incinération, afin de renforcer l'équipement utilisé. Et nous discrétisons la conception afin de calculer les valeurs pour chaque point, la discrétisation faciliter le calcul, en utilisant un solveur qui peut nous donner les résultats avec visualisation.

Table of content

13 List of figure:

14 List of symbol:

ϱ is density of the fluid (assumed to be a known constant);

u ≡ (u1, u2, u3)

p is fluid pressure; μ is viscosity, and FB is a body force.

D/Dt is the substantial derivative expressing the Lagrangian, or total, acceleration of a fluid particle in terms of a convenient laboratory-fixed Eulerian reference frame;

∇ is the gradient operator;

Δ is the Laplacian;

∇· is the divergence operator;

V (t) is the velocity;

μ is the constant shear stress and is linearly dependent on the velocity gradient;

Q is the volume flow.

15 Introduction:

Fluid dynamics is the study of fluid flow; in our case we study this flow for an incineration power plant; studying the flow of steam and liquid water into the pipes (The main critical component is the pressure vessel with about 100 bar pressure differences).

But this study should be a computational study; our goal is to obtain codes that take the fluid conditions and make us sure that we can design an upscaled version of the vaporizer of an incineration power plant (about 40 MW) in Tripoli.

These codes take the equations of fluid dynamics and make discretization to solve them with computer programs.

But we have to know that the continuous equations of fluid dynamics are hardly possible to solve and computational fluid dynamics makes it easier to solve them after discretization.

To apply this goal we have to use codes of an existing program like 0penFOAM or Elmer and use a designer program (as FreeCAD) a visualization tool as Paraview.

In the report three chapters contain the study; in the first chapter we introduce the basics that we use in our study, in the second chapter the contribution is done, in the third chapter the results are published.

At the beginning we had the following **working packages**:

- CAD Modeling: Up-scaled CAD Model with "ProE" or "FreeCAD" (was to be done by another student –see above).
- Mesh Generation: A mesh generation "C++" code shall be taken from the open source code "OpenFoam" and migrated to TEMO_IPP-CFD tool - in our research we use Gmsh for meshing.

- Solver: A finite difference and a finite volume "C++" code shall be taken from the open source code "OpenFoam" and migrated to TEMO_IPP-CFD tool or using another tool for solving (Elmer).
- Visualization: Shall be done with the tool Paraview.

16 Basics

In this chapter we introduce the fundamentals of our study, and cite some other precedent studies in this field, with a history concerning the development of computational fluid dynamics.

16.1 Incineration power plants

INCINERATION is a waste treatment technology that involves burning commercial, residential and hazardous waste. Incineration converts discarded materials, including paper, plastics, metals and food scraps into bottom ash, fly ash, combustion gases, air pollutants, wastewater, wastewater treatment sludge and heat.

It follows several steps illustrated in figure 1-1.

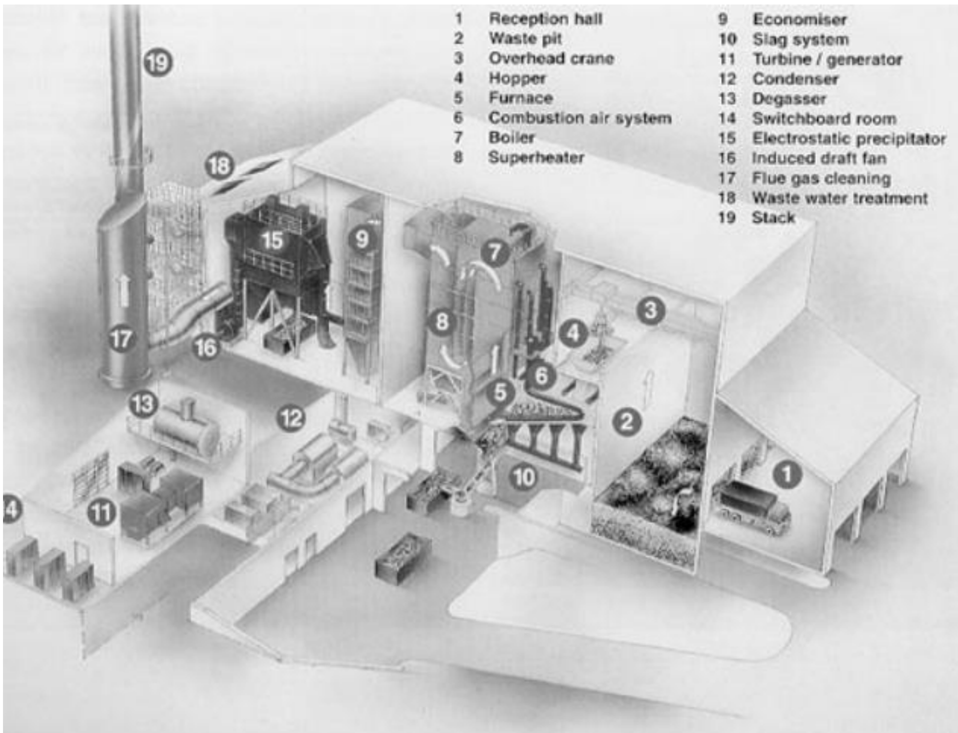


Figure 16-1: steps in a incineration an power plant

The ENERGIZE multistage grate is the core and the bottom surface of the furnace. It carries and transports the burning solid matter from the feeding section to the ash extractor.

The grate consists of identical elements grouped in 3 zones:

Drying zone, combustion zone, burnout zone.

1. In the drying zone, moisture in the waste is evaporated by the heat in the furnace and the radiation from the first empty pass which is positioned just above this zone.

2. In the combustion zone, the actual combustion takes place.

3. The burnout zone is a buffer to guarantee the burnout quality and to cool the ashes.

A step between each zone causes the waste to drop from one zone to the next, creating the necessary mixing of the burning matter[1].

The 3 zones illustrate in the figure 1-2.

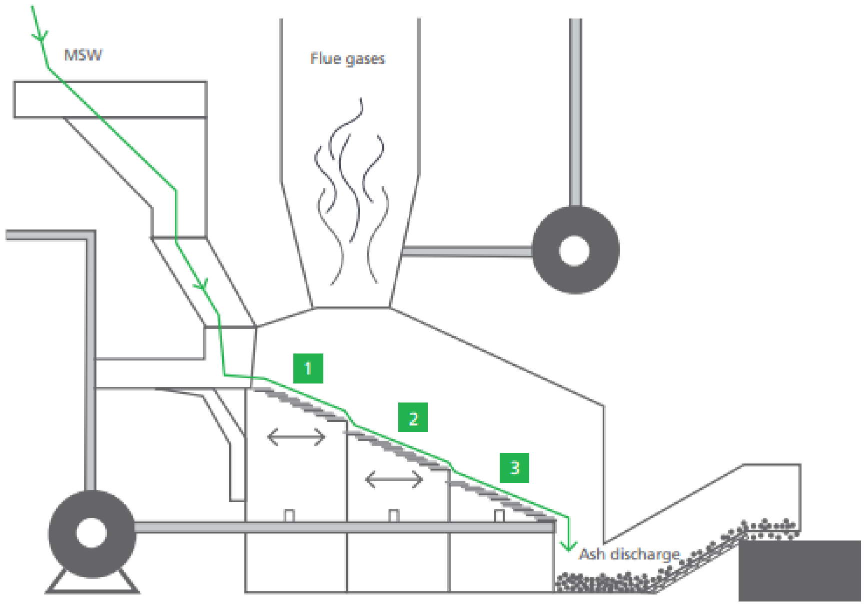


Figure 16-2: illustrating of the incineration power plant zone

16.2 Study of literature

There are many applications of waste incineration power plants, especially in Europe, see Figure 1-3, and it is necessary to study them. But it is impossible to view published studies in internet; we can only see the incineration power plant's design with global studies.

Figure 16-3: Distribution of incineration power plant in Europe

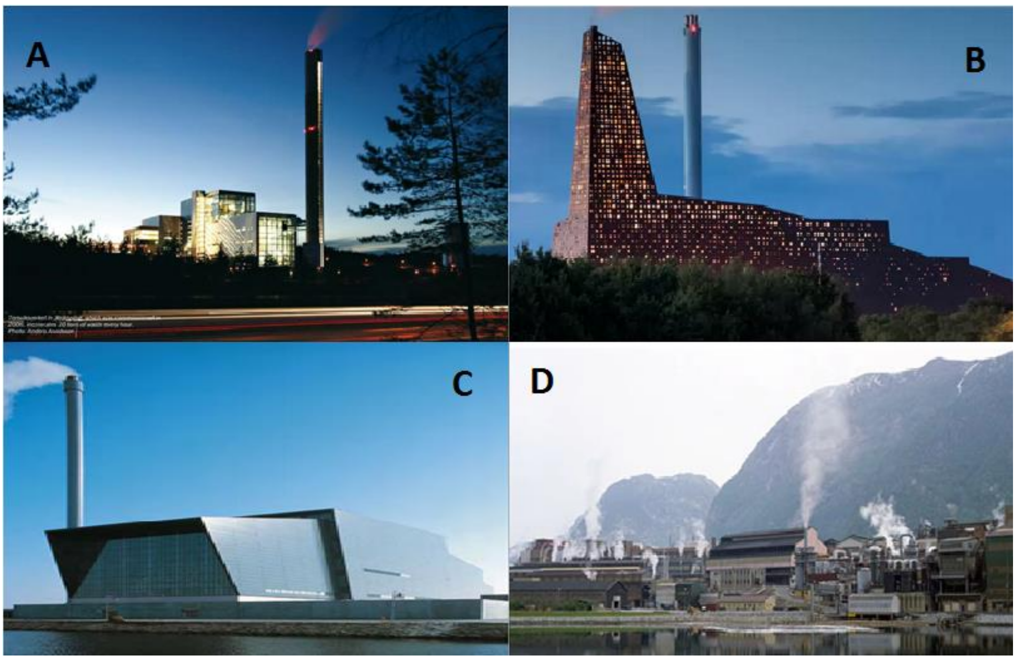


Figure 16-4: An incineration power plant in (A) Torsviksverket in Jönköping (B) Roskilde, Denmark (C) Esbjerg Denmark (D) near Bergen (Oslo).

An incineration plant in Sweden Figure 2-2 (A) represents a similar amount of waste in the industry as well. Waste incineration provides heat corresponding to the needs of 810,000 homes, around 20 per cent of all the district-heating produced. It also provides electricity corresponding to the needs of almost

250,000 homes. International comparisons show that Sweden is the global leader in recovering the energy in waste[2].

In Roskilde, Denmark figure 2-2 (B) when waste from nine surrounding municipalities and from places abroad will be incinerated at the Roskilde plant. According to its developer KARA/NOVEREN, this will be enough to produce electricity for around 65,000 homes and heat for around 40,000 homes[3].

We can say that the incineration power plant of in Esbjerg, Denmark figure 2-2 (C), attached with some historic study concerning development of the incineration power plant design and CFD information[4] in figure 2-3:

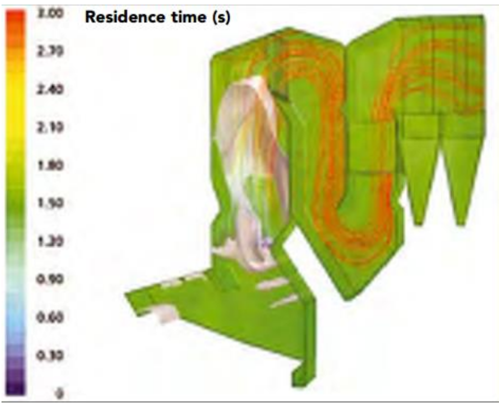


Figure 16-5: CFD plot for assessment of residence time in an afterburning chamber in Esberg, Denmark incineration power plant.

Christoffer Back Vestli says, communications adviser for the Oslo in Bergen figure 2-2 (D): municipality. "At the moment, the city of Oslo can take 410,000 tonnes of waste a year and we import 45,000 tonnes from the UK. Europe as a whole currently dumps 150m tonnes of waste in landfills every year, so there is clearly great potential in using waste for energy."[5]

16.3 Arguments supporting and against incinerations

Usage of incineration for waste management is divisive. The debate for incinerators generally involves business interests, regulations of government, activists of environment and citizens.

16.3.1 Arguments supporting incinerations

The first concern for incineration stands against its injurious effects over health due to production of furans and dioxin emission. However, the emission is controlled to greater extent by developing of modern plants and governmental regulations.

Incineration plants are capable for producing energy and can substitute power generation plants of other sort.

The bottom ash after the process is completed is considered non-injurious that still is capable for being land filled and recycled.

Fine particles are removable by processing through filters and scrubbers.

Treating and processing medical and sewage waste produces non-injurious ash as product.

16.3.2 Arguments against incinerations

Extremely injurious matter needs adequate disposing off. This requires additional miles and need special locations for land filling this material.

Although after a lot of regulations and restrictions and developments concerns are still alive about emission of furans and dioxins.

Incinerating plants are producers of heavy metals, which are injurious even in minor amounts.

IBA (**Incinerator Bottom Ash**) is consistent over a considerably high level of heavy metals and can prove fatal if they are not disposed off or reused properly.

Initial investment costs are only recovered through long periods of contract for incinerating plants.

Local communities always have opposed the presence of incinerating plant in the locality.

The upheld view is to recycle, reuse and waste reduction instead of incineration[6].

16.4 History

In the past, incineration was conducted without separating materials thus causing harm to environment. This unseparated waste was not free from bulky and recyclable materials, even. This resulted in risk for plant workers health and environment. Most of such plants and incinerations never generated electricity.

Incineration reduces the mass of the waste from 70 to 80 percent. This reduction depends upon the recovery degree and composition of materials. This means that incineration however, does not replace the need for landfilling but it reduced the amount to be thrown in it.

Incineration comes with a number of benefits in specific areas like medical wastes and other life risking waste. In this process, toxins are destroyed when waste is treated with high temperature.

Incineration or thermal treatment of waste is much popular in countries like Japan where there is scarcity of land. The energy generated by incineration is highly demanded in countries like Denmark and Sweden. In the year 2005 it was estimated that 4.8 percent of the electricity consumed by Danish nation was produced by incineration and the amount of heat was some 13.7 percent out of total. Other than Denmark and Sweden many European countries are recovering heat and electricity from waste[6].

During the last three or four decades, computer simulations of physical processes have been used in scientific research and in the analysis and design of engineered systems. The systems of interest have been existing or proposed systems that operate at design conditions, off-design conditions, failure-mode conditions, or accident scenarios. The systems of interest have also been natural systems. For example, computer simulations are used for environmental predictions, as in the analysis of surface-water quality and the risk assessment of underground nuclear-waste repositories. These kinds of predictions are beneficial in the development of public policy, in the preparation of safety procedures, and in the determination of legal liability. Thus, because of the impact that modeling and simulation predictions can have, the credibility of the computational results is of great concern to engineering designers and managers, public officials, and those who are affected by the decisions that are based on these predictions[7].

The development of computer fluid dynamics has been closely associated with the evolution of large high-speed computers. At first the principal incentive was to produce numerical techniques for solving problems related to national defense. Soon, however, it was recognized that numerous additional scientific and engineering applications could be accomplished by means of modified techniques that extended considerably the capabilities of the early procedures. This paper describes some of this work at The Los Alamos National Laboratory[1], where many types of problems were solved for the first time with the newly emerging sequence of numerical capabilities. The discussions focus principally on those with which the author has been directly involved[8].

CFD **Computational fluid dynamics** is a branch of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems that involve fluid flows. Computers are used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions[1].

---

[1] at Los Alamos Laboratories the first nuclear bomb was developed during World War II.

Computational Fluid Dynamics (CFD) provides a qualitative (and sometimes even quantitative) prediction of fluid flows by means of

- Mathematical modeling (partial differential equations)
- Numerical methods (discretization and solution techniques)
- Software tools (solvers, pre- and post-processing utilities)

CFD enables scientists and engineers to perform "numerical experiments" (i.e. computer simulations) in a "virtual flow laboratory"[9].

In the figure 1-1 we see the comparison of the real fluid flow which is continuous and the computational fluid flow which is discretize.

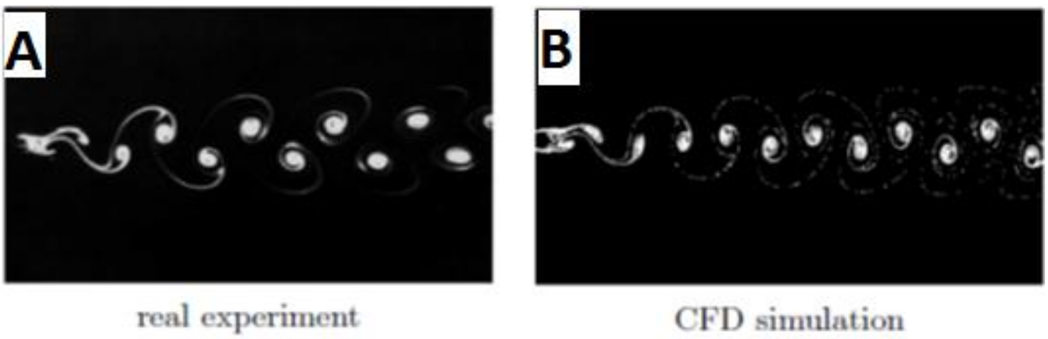


Figure 16-6: The real flow (A) and the computation flow form (B)

1.1. Pump utility

An increase in the fluid pressure from the pump inlet to its outlet is created when the pump is in operation. This pressure difference drives the fluid through the system or plant. The centrifugal pump creates an increase in pressure by transferring mechanical energy from the motor to the fluid through the rotating impeller. The fluid flows from the inlet to the impeller center and out along its blades. The centrifugal force hereby increases the fluid velocity and consequently also the kinetic energy is transformed to pressure. Figure 1.7 shows an example of the fluid path through the centrifugal pump[17].

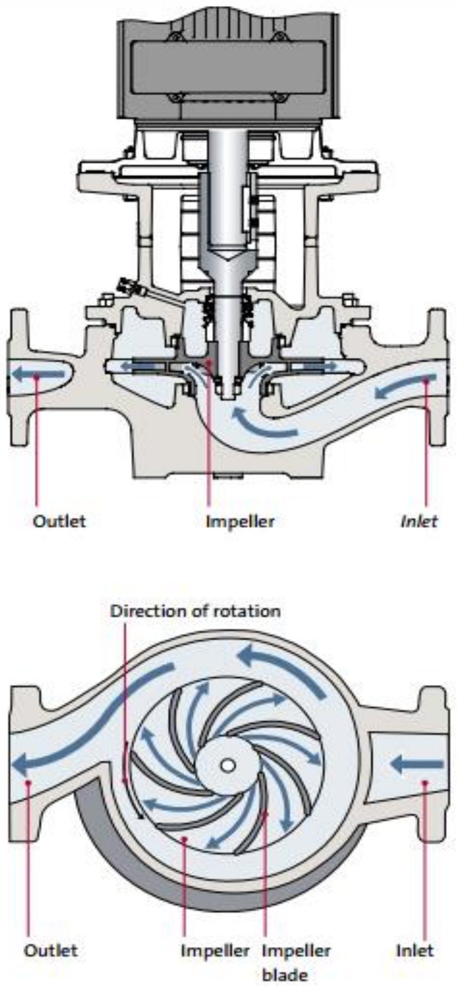


Figure 16-7: Fluid path through the centrifugal pump.

1.2. Software Tools used

FreeCAD is a parametric 3D modeler. Parametric modeling allows us to easily modify our design by going back into our model history and changing its parameters. FreeCAD is open source and completely modular, allowing for very advanced extension and customization. It used to devise the station's design. [10]

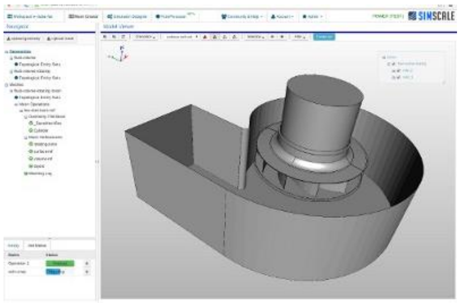
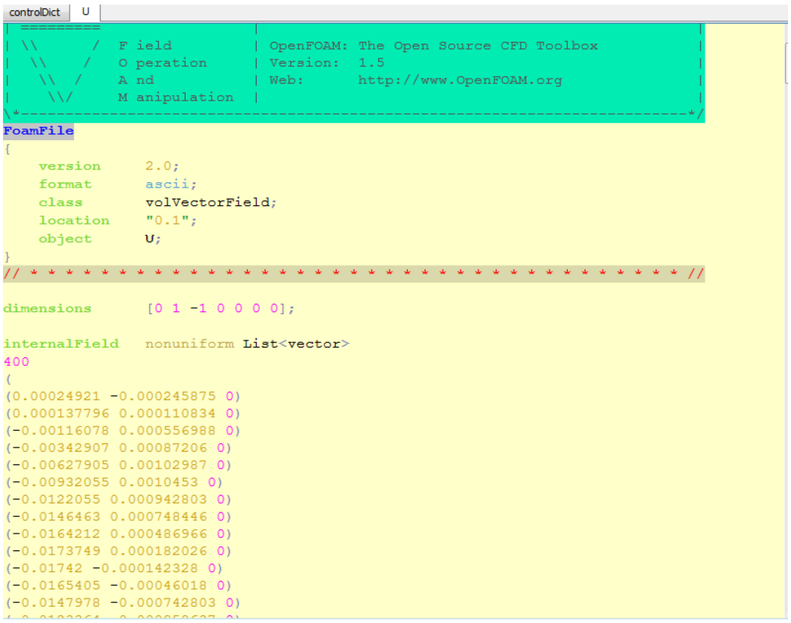


Figure 16-8: FreeCAD design example

The **OpenFOAM (Open source Field Operation And Manipulation)** is a C++ toolbox for the development of customized numerical solvers, and pre-/post-processing utilities for the solution of continuum mechanics problems, including computational fluid dynamics (CFD)[11].



```
controlDict   U
| =========                 |                                                 |
| \\      /  F ield         | OpenFOAM: The Open Source CFD Toolbox           |
|  \\    /   O peration     | Version:  1.5                                   |
|   \\  /    A nd           | Web:      http://www.OpenFOAM.org               |
|    \\/     M anipulation  |                                                 |
\*---------------------------------------------------------------------------*/
FoamFile
{
    version     2.0;
    format      ascii;
    class       volVectorField;
    location    "0.1";
    object      U;
}
// * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * //

dimensions      [0 1 -1 0 0 0 0];

internalField   nonuniform List<vector>
400
(
(0.00024921 -0.000245875 0)
(0.000137796 0.000110834 0)
(-0.00116078 0.000556988 0)
(-0.00342907 0.00087206 0)
(-0.00627905 0.00102987 0)
(-0.00932055 0.0010453 0)
(-0.0122055 0.000942803 0)
(-0.0146463 0.000748446 0)
(-0.0164212 0.000486966 0)
(-0.0173749 0.000182026 0)
(-0.01742 -0.000142328 0)
(-0.0165405 -0.00046018 0)
(-0.0147978 -0.000742803 0)
```

Figure 16-9: OpenFOAM window when calculation velocity values

Elmer is an open source solver for 3D design; he is giving a numerical solver and pre-/post-processing utilities for the solution of mechanics problems, including computational fluid dynamics (CFD).

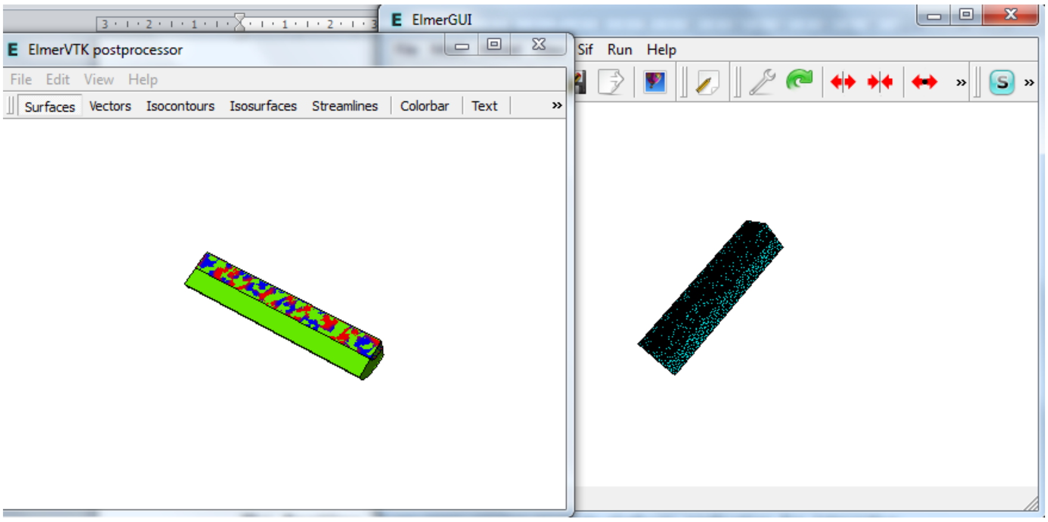


Figure 16-10: Elmer windows for a quarter pipe

The ParaView is an open source multiple-platform application for interactive, scientific visualization. It has a client–server architecture to facilitate remote visualization of datasets, and generates level of detail models to maintain interactive frame rates for large datasets.[12]

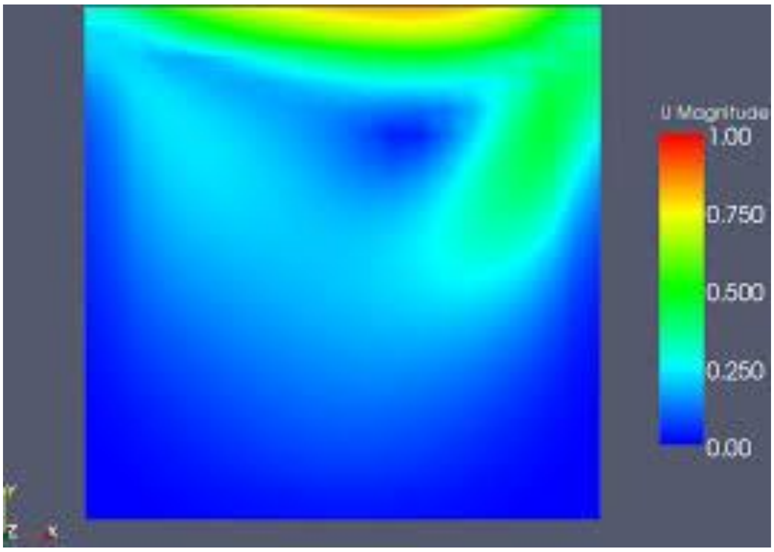


Figure 16-11: Paraview window for the velocity values

We don't compile codes but just use solver software that has already compiled codes. These programs give us results. We use only free software and if possible open source; all we need is introduce the design after we made it, and the boundary conditions with many treatments concerning the iterative.

The solvers and meshing software used discretization methods, which are described at the following - with finite volume for OpenFOAM and finite element for Elmer and Gmsh.

1.2.1. Discretization methods

The solvers in use can have three methods for solving which: finite element method, finite different method, and finite volume method.

Finite element method is the discretization in order to obtain matrix which change the equation of physical quantity to a linear equations when solve is more easy.

Finite different method is the discretization in order to transform the differential equation to different linear equations.

Finite volume method is the discretization in order to discretization of the integral forms of the conservation equations by discretization of each term except[13].

1.3. What are the Navier-Stokes Equations?

The equations of viscous, incompressible fluid flow, known as the Navier–Stokes (N.–S.) equations after the Frenchman (Claude Louis Marie Henri Navier) and Englishman (George Gabriel Stokes) who proposed them in the early to mid-19th Century, can be expressed as

$$\rho \frac{D\boldsymbol{u}}{Dt} = -\nabla p + \mu \Delta \boldsymbol{u} + \boldsymbol{F}_B \tag{1.1a}$$

$$\nabla \cdot \boldsymbol{u} = 0 \,, \tag{1.1b}$$

We remind the reader that the first of these equations (which is a threecomponent vector equation) is just Newton's second law of motion applied to a fluid parcel—the left-hand side is mass (per unit volume) times acceleration, while the right-hand side is the sum of forces acting on the fluid element. Equation (1.1b) is simply conservation of mass in the context of constant-density flow. In the sequel we will provide alternative forms of these basic equations[14].

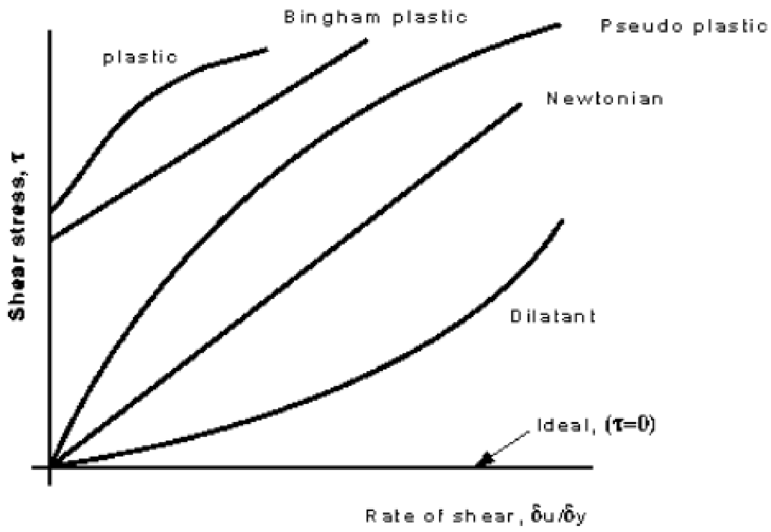
1.3.1. Incompressible fluid flow

A fluid flow is said to be incompressible if volumes of blobs of fluid do not change. So we have the general law: A fluid flow is incompressible if and only if div u ≡ 0.

In fact, we have that incompressibility holds if and only if $\int_{V(t)}$ div u = 0 for all V (t). Since u is a smooth function and V can be any blob, this implies the assertion[15].

1.3.2. Newtonian and Non-Newtonian fluid flow

Even among fluids which are accepted as fluids there can be wide differences in behaviour under stress. Fluids obeying Newton's law where the value of μ is constant are known as Newtonian fluids. If μ is constant the shear stress is linearly dependent on velocity gradient. This is true for most common fluids. Fluids in which the value of μ is not constant are known as non-Newtonian fluids. There are several categories of these, and they are outlined briefly below. These categories are based on the relationship between shear stress and the velocity gradient (rate of shear strain) in the fluid. These relationships can be seen in the graph below figure 1-12 for several categories[16].



Shear stress vs. Rate of shear strain δu/δy

Figure 16-12: Shear stress vs Rate of shear strain for several categories

In our report we study the incompressible Newtonian fluid flow.

2. Contribution

2.1. Solve incineration design

Our study is to find out the pressure and the velocity values for path of water from the pump into the water tank of an incineration power plant, so we should insert the design of this part of the power plant, which is a freeCAD design, into a solver in order to run program and obtain results.

2.1.1. OpenFOAM solver

First we used OpenFOAM (finite volume method solver) as solver. We tried many methods (use command, change format files…) to input the FreeCAD design to the OpenFOAM solver but we didn't manage it. So we changed the solver. But one of these methods is the use of Gmsh which can mesh the design; we use Gmsh despite we changed the solver because it can mesh a big design (water tank 6 meters length and a pipe with 12 meters length) like ours.

2.1.2. Using Gmsh

Using OpenFoam didn't resolve our study, so we used new meshing software - Gmsh (discretization is implemented by finite element method) which we used afterwards in the study.

The first way to solve:

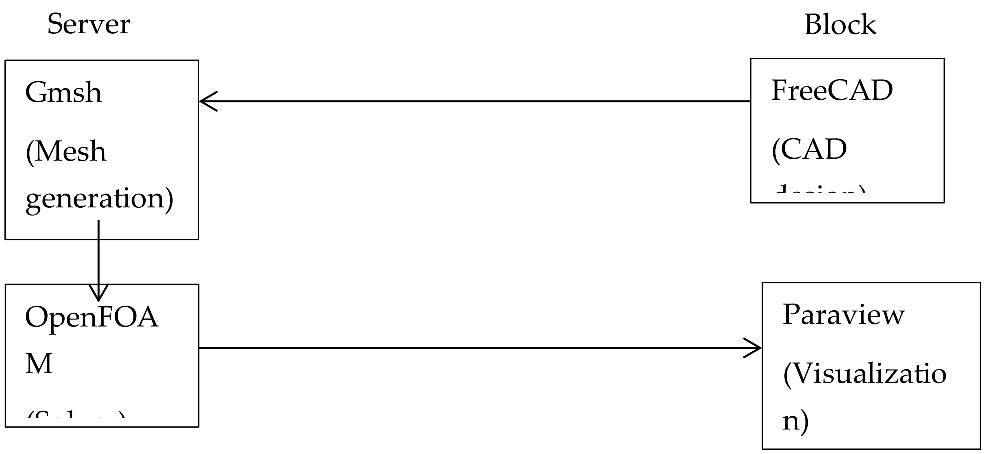


Figure 2-1: Chain of tools 1 using OpenFOAM

The design of incineration power plant in FreeCAD, from [18]:

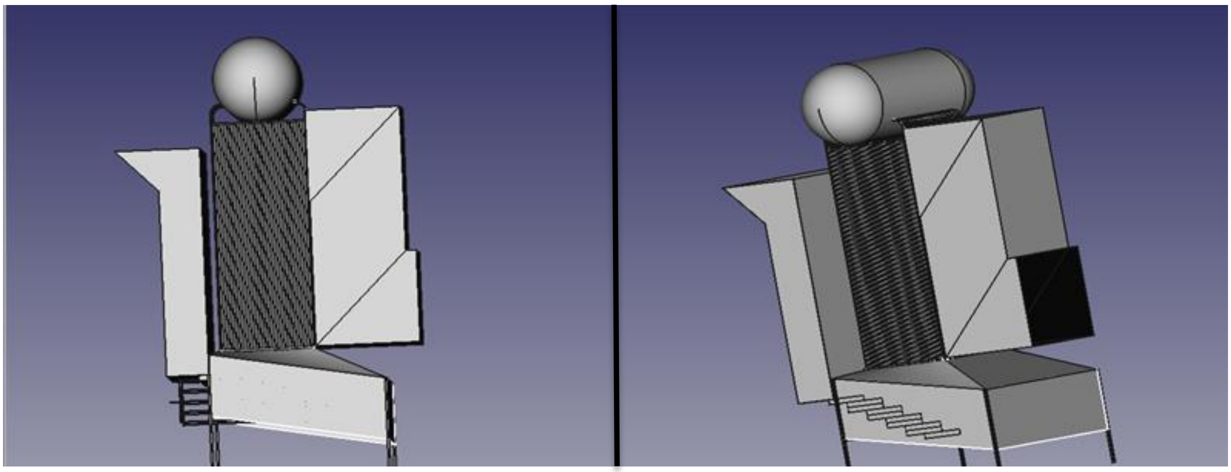


Figure 2-2: FreeCAD incineration power plant design

We obtain meshing design using Gmsh

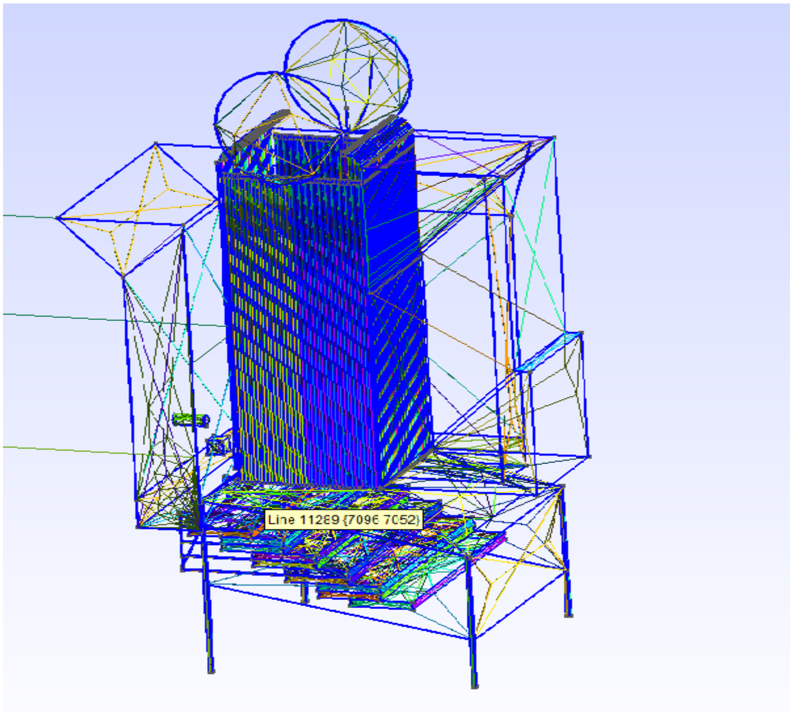


Figure 2-3: Meshing incineration power plant design

To input the CAD design into Gmsh we have to save FreeCAD design in STEP exchange format (e.g. file.stp).

We have to say that we tried to input the meshing design into OpenFOAM in many ways (using command, change format…), in windows and Linux, but we didn't succeed. For this reason we changed the solver and tried another chain of tools.

2.1.3. Elmer solver

The Elmer solver implements the finite element method.

The new way to solve "all in server":

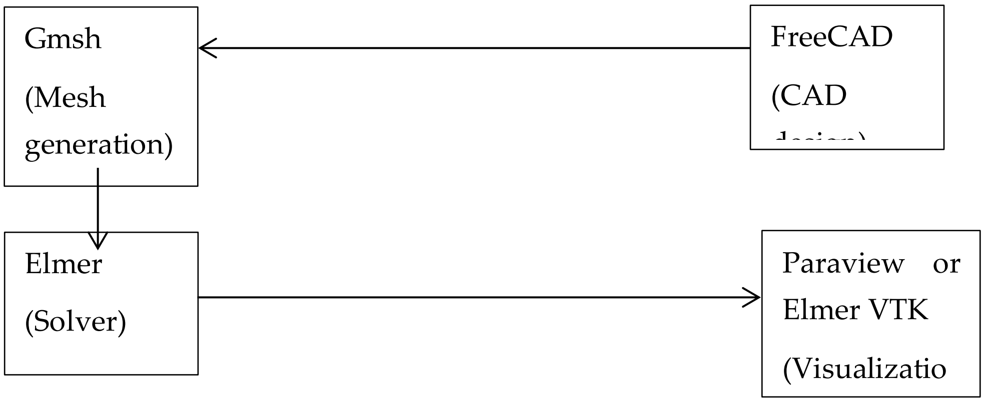


Figure 2-4: Chain of tools 2 using Elmer

Elmer can read the design of pipe (example: quarter pipe in figure 2-5). Then the following is done:

Figure 2-5: Design of a quarter pipe introduce in Elmer

- Design of pipe with meshing on gmsh and saving in file.msh format
- Specify the Initial conditions
- Choose the **Navier-Stokes equation**
- Specify the material used (water for the internal face, and steel (stainless) for the external face)
- Define the boundaries in the design before introducing the condition of each boundary
- Select **run start solver**
- Then select start **ElmerPost** (Paraview) or **ElmerVTK**.

Before we move to the results, we should know how we obtain the initial conditions:

- We need a pump which generates 40 bars (40*10^5 Pa), and we can find conditions in Annex 4.
- So the pressure is 40*10^5 Pa, the flow rate is 450 m^3/h= 0.125 m^3/s.
- We use water, so density is 1000 kg/m^3=mass/volume; so$\frac{mass/s}{volume/s}$; we can deduct that the volume flow Q equal 0.125 m^3/s.
- Q=$\frac{volume}{time}$= $\frac{section*displacement}{time}$= section*velocity; with section=π*$radius^2$=0.003 m^2.
- So velocity is 41.67 m/s.
- We observed that the flow is in 2 dimensions in each path, and we assume that the values in both velocity directions are equal:
  - ♦ When we have v_x and v_y for example, $v_x^2+v_y^2=v^2$ so $v_x=v_y=29.47$ m/s, and $v_z=0$.
  - ♦ And so on.

And before we show results we have to know some notes to illustrate in the figure bellow:

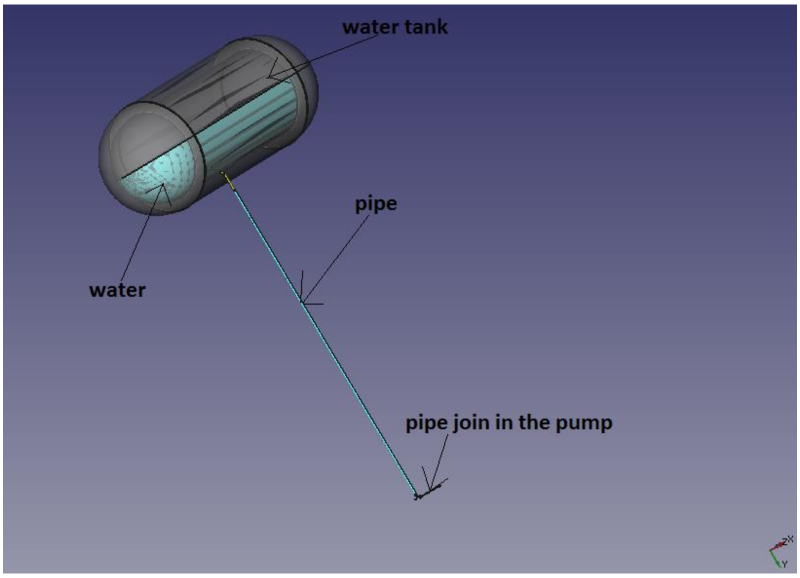


Figure 2-6: Noted design

Where in the figure 2-6 the pipe (height=12m, radius=0.38m) is connected to a Water tank (height=6m, radius=2m) to supply it of water; than the pipe connect with another pipe which connect it to the pump that pumps water into the water tank.

2.1.4. Using Elmer

First we define setup (see Figure 2-7) for each part which we study:

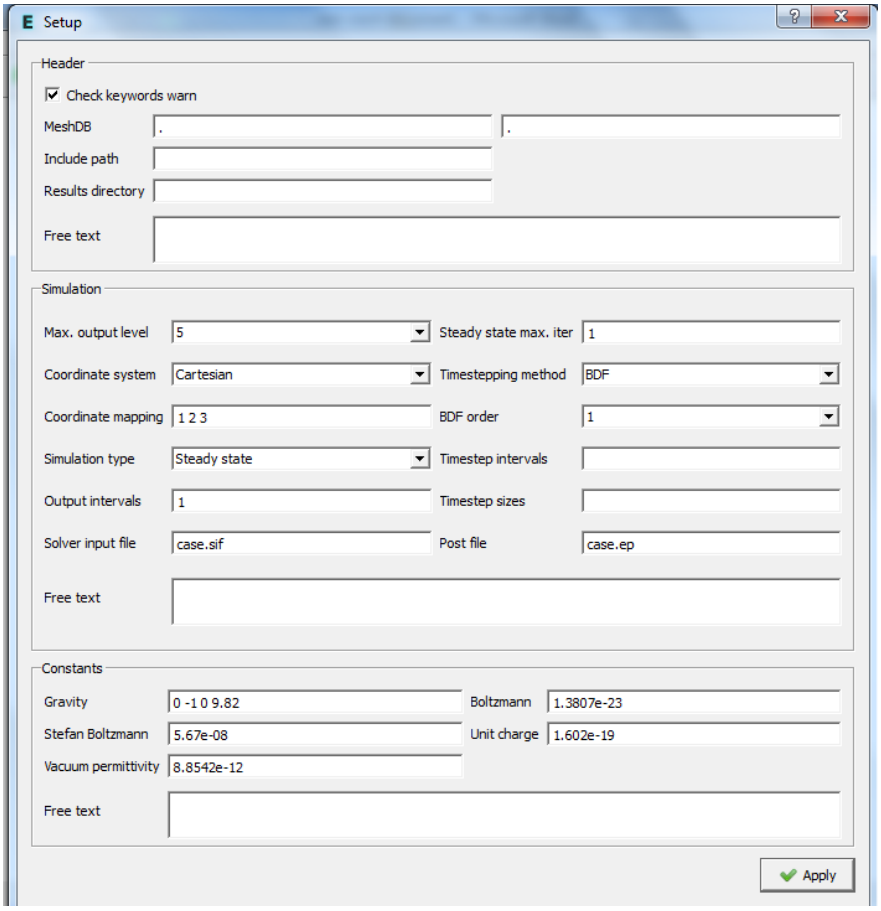


Figure 2-7: Setup for each part (the same)

Then we define the equation as seen in Figure 2-8 (Navier-Stokes equation in our case):

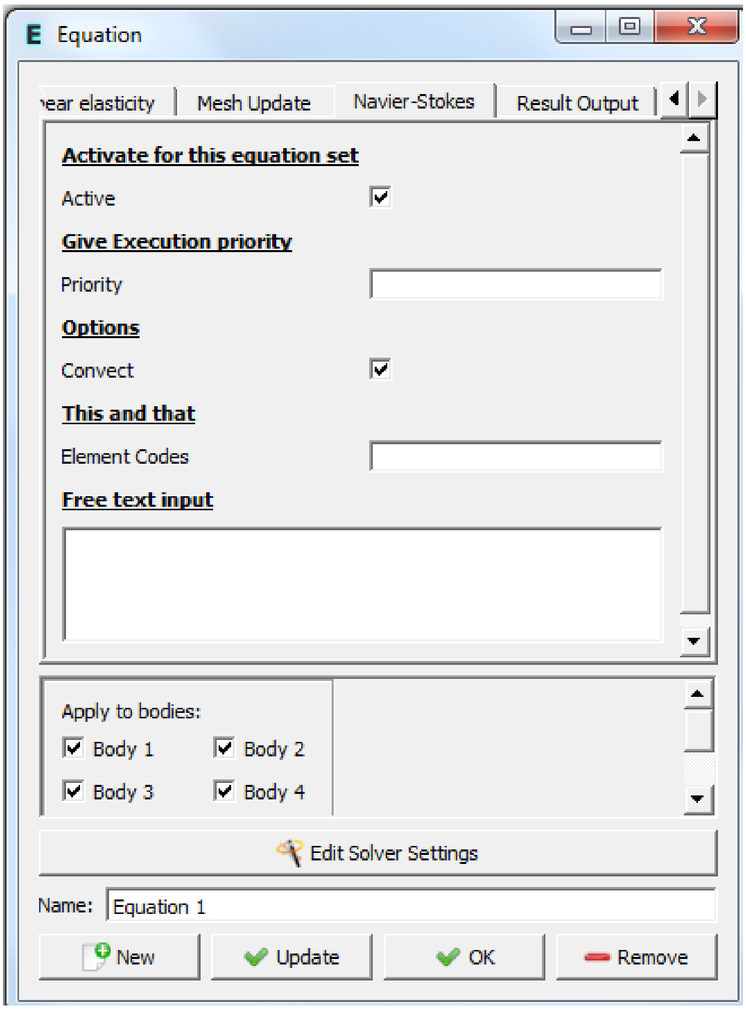


Figure 2-8: Choice of Navier-Stokes equation

We have to say that in Edit Solver Settings we define the solve properties; e.g. number maximal iterations (see Figure 2-9).

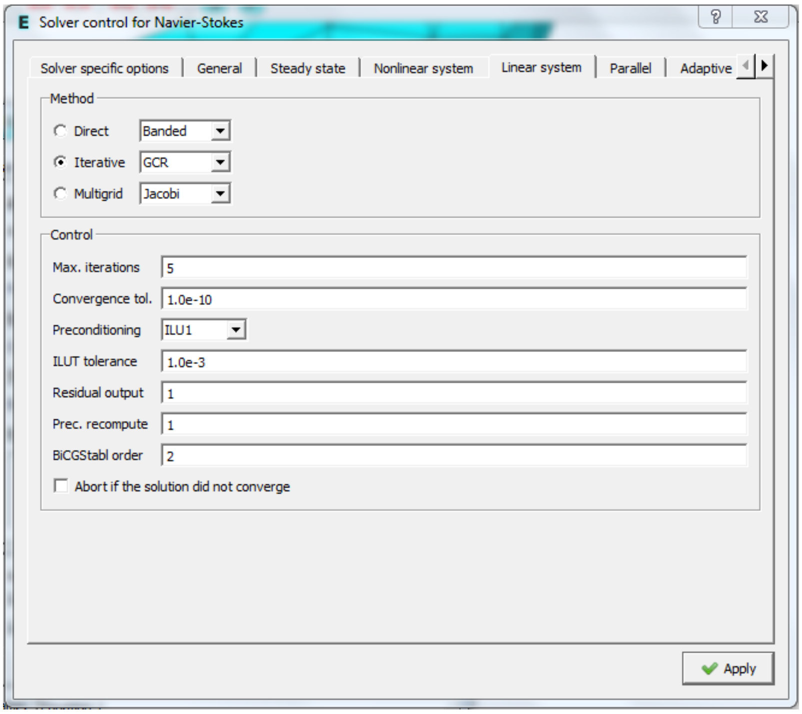


Figure 2-9: iteration conditions in Elmer

Thirdly we introduce the properties of the used material (Figure 2-10):

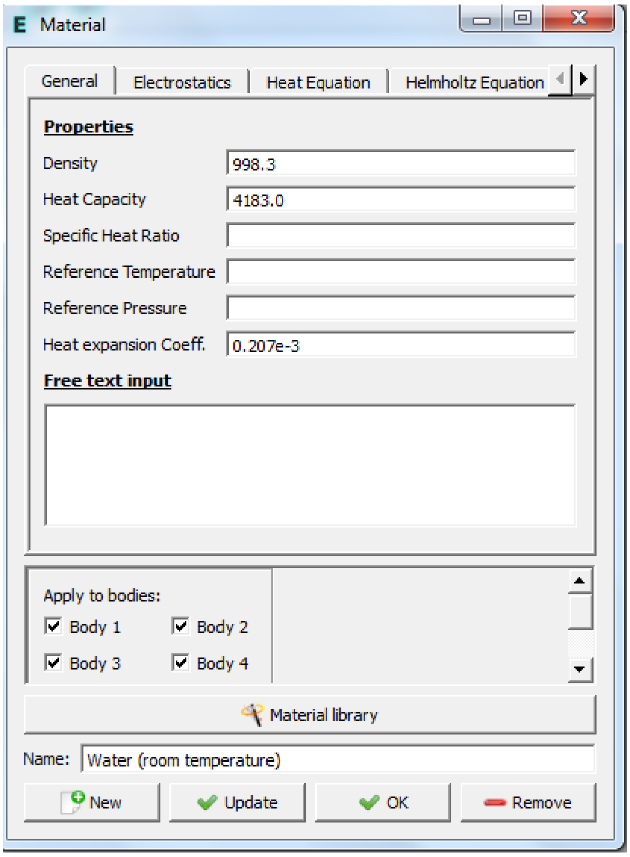


Figure 2-10: Material used for study

But we can choose an existing material like water, as in our case, when the properties are already defined.

Fourthly we introduce the initial conditions (see Figure 2-11) - velocity in m/s and pressure in Pa:

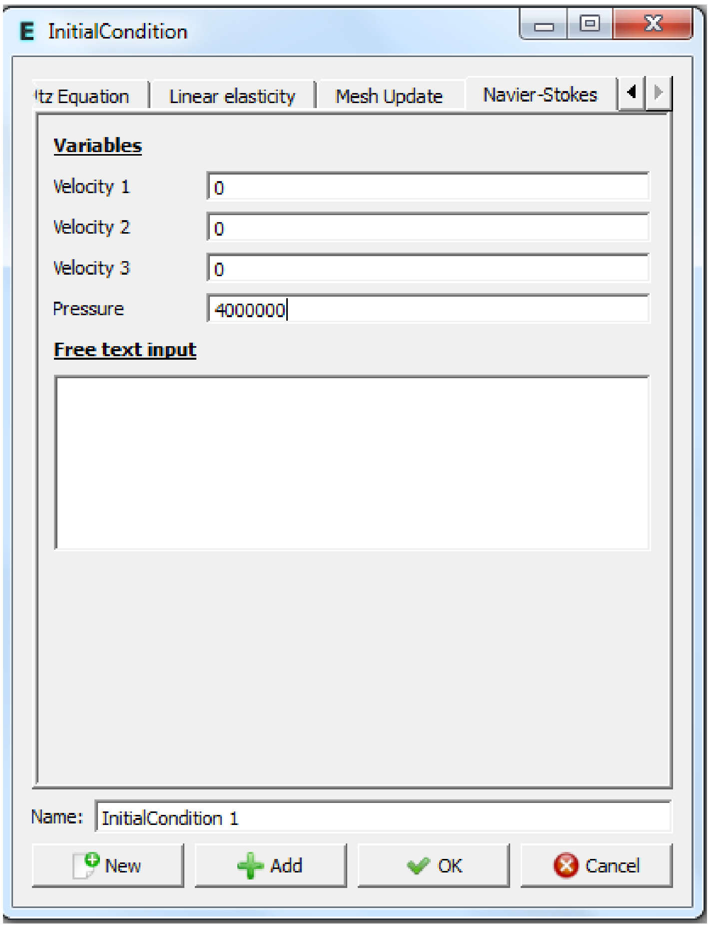


Figure 2-11: Initial conditions introduce in Elmer

We propose that the velocity is beginning by 0 and the pressure 4*10^5 Pa.

Finally we introduce the boundary conditions that based in the conditions of turbine used.

Boundary conditions divide in two part; inlet boundary conditions where we introduce the turbine conditions figure 2-12:

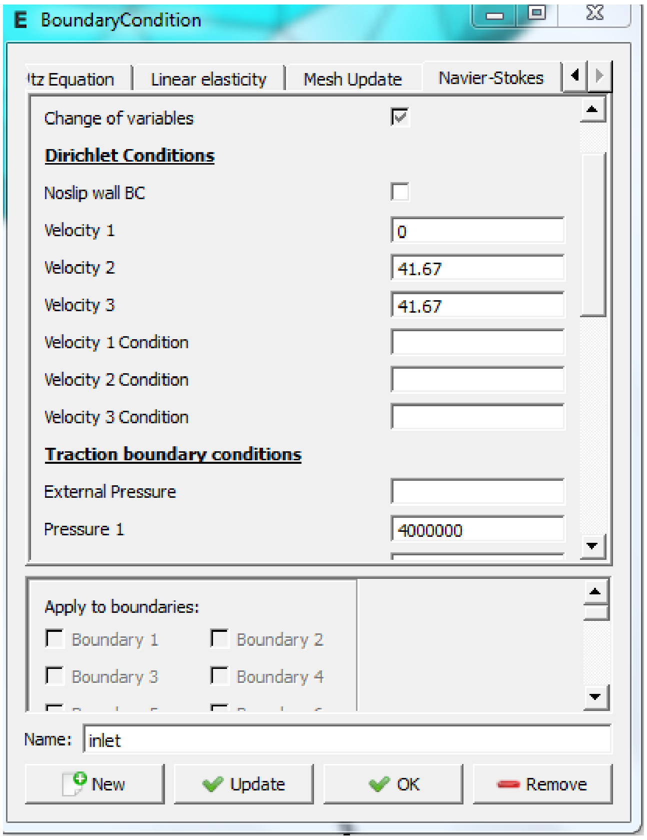


Figure 2-12: Inlet boudary conditions given by the turbine

And outlet boundary conditions where the axes which not affect the flow must not be concidered; so it differs from one part to another; we considered each part separately.

First we take a 1 direction fluid flow, fluid flow in the pipe figure 2-13:

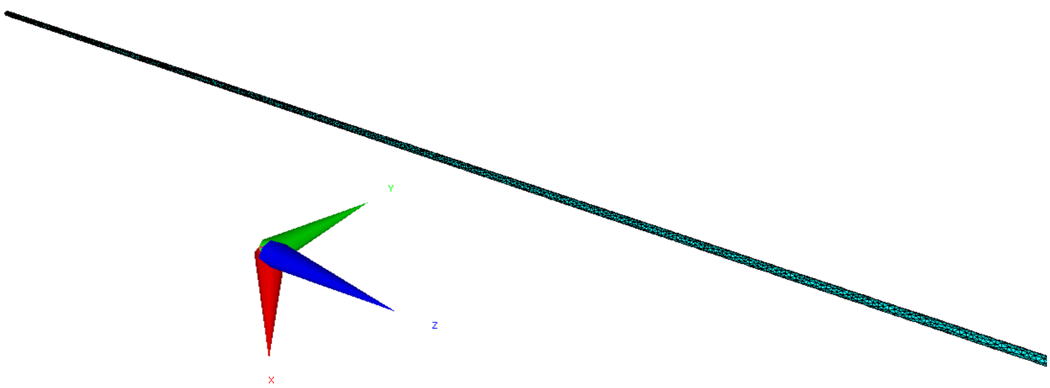


Figure 2-13: Meshed pipe viewing in Elmer

The outlet condition figure 2-14:

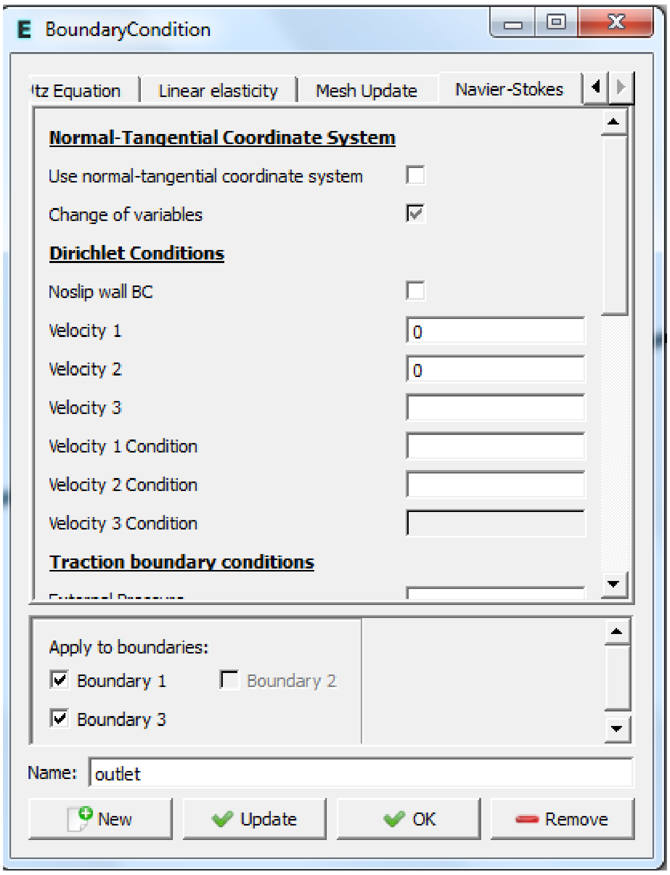


Figure 2-14: Pipe outlet boundary condition

We have to enter the x and y components, and leave the z component empty where the solver gives us the solution.

Taking now a 2 directions fluid flow, fluid flow in the corner figure 2-15:

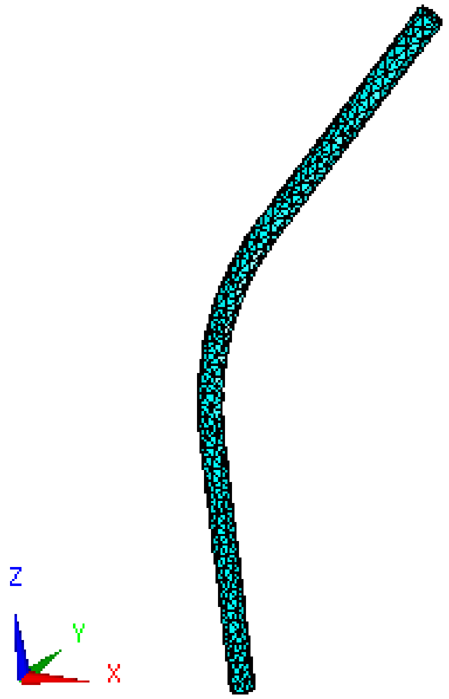


Figure 2-15: Meshed corner viewing in Elmer

We see that the water is flowing following x and z axes. The outlet condition of corner figure 2-16:

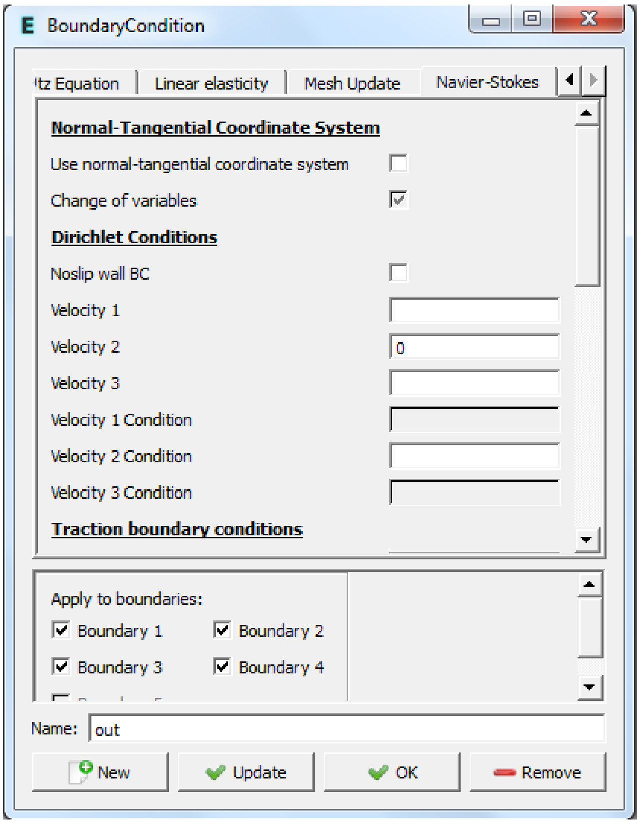


Figure 2-16: Corner outlet boundary condition

The water path from pump to the water tank figure 2-17: Now we have to discretize the water in the pressure tank using gmsh or Elmer, but Elmer is unable to discretize a big design so we use gmsh:

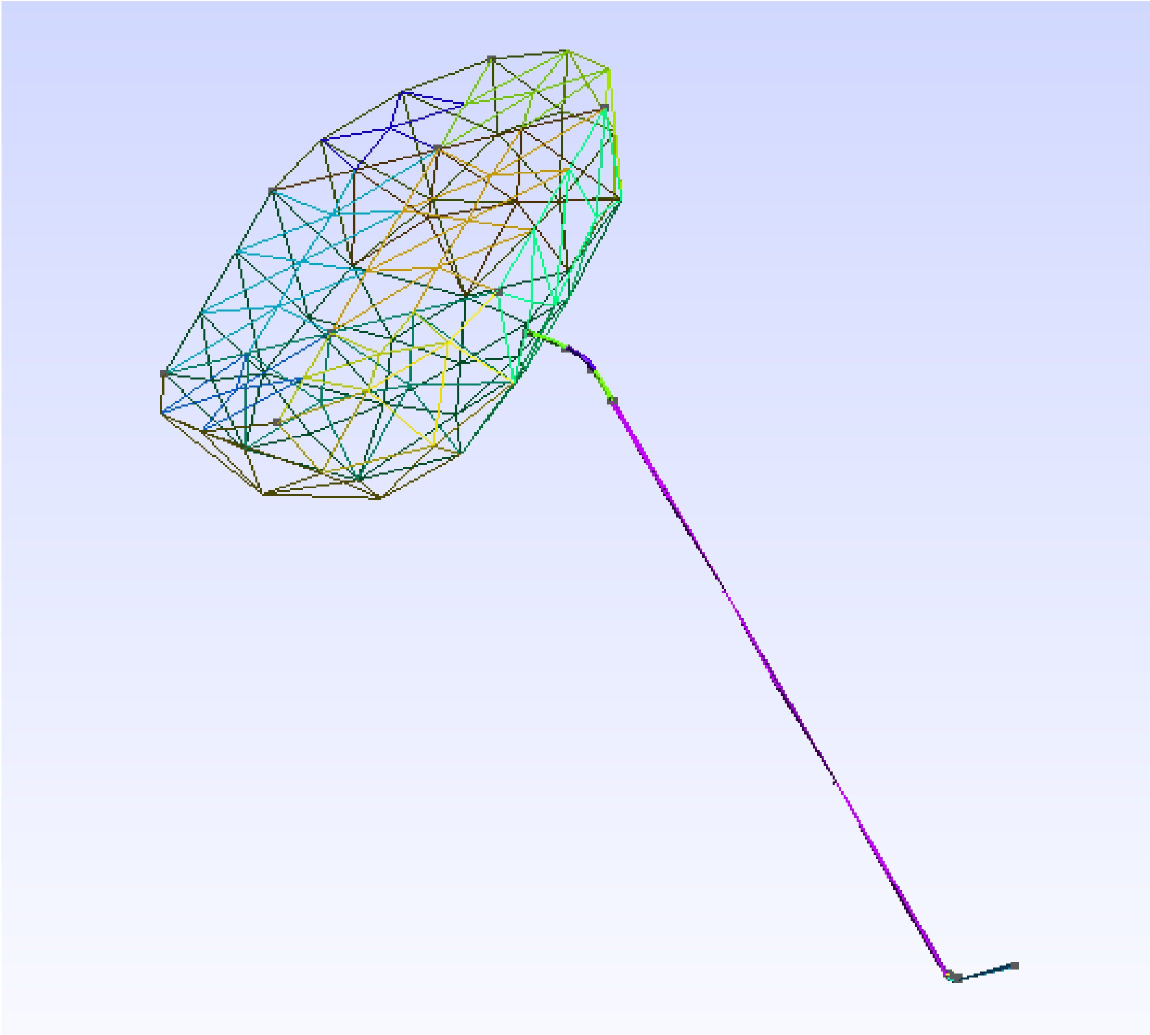


Figure 2-17: Water path meshing in Gmsh

We introduce the water design to the Elmer software with the initial conditions, velocity equation, and boundary conditions that we make in the Elmer model:

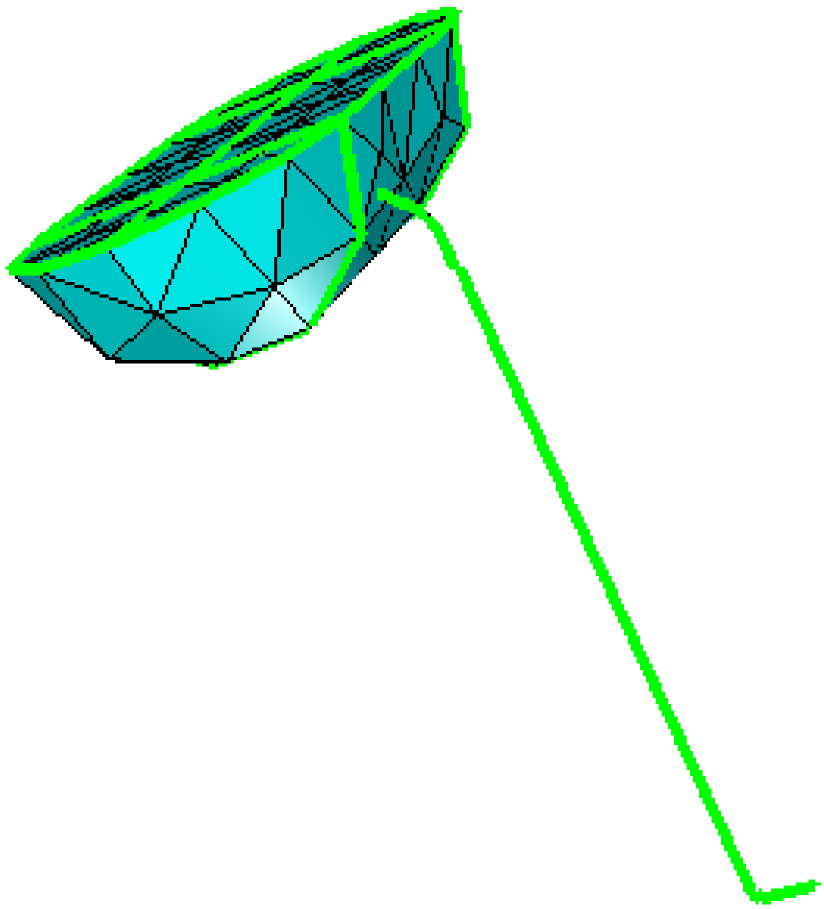


Figure 2-18: Water path illustrated in Elmer

We see that the water is flowing following y and z axes, so we have to introduce the initial conditions following yz plane:

The outlet conditions of the water path are shown in Figure 2-19:

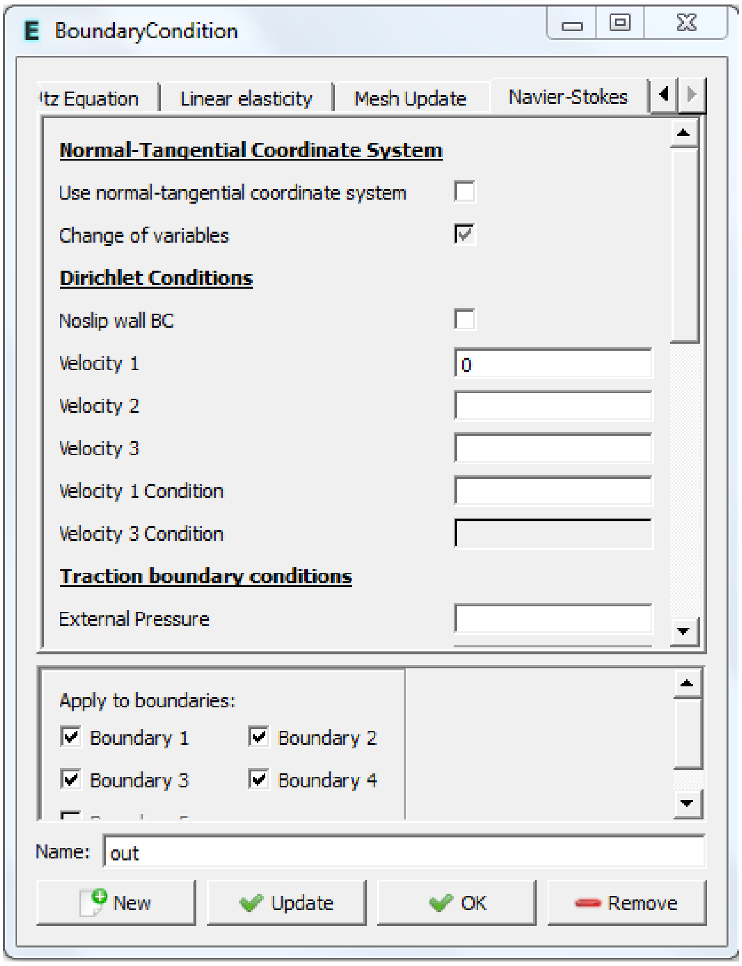


Figure 2-19: Water path outlet boundary condition

3. Results and discussion

We obtain the velocity values (start solver) and visualization (ElmerPost) of water in the pipe example that we maked:

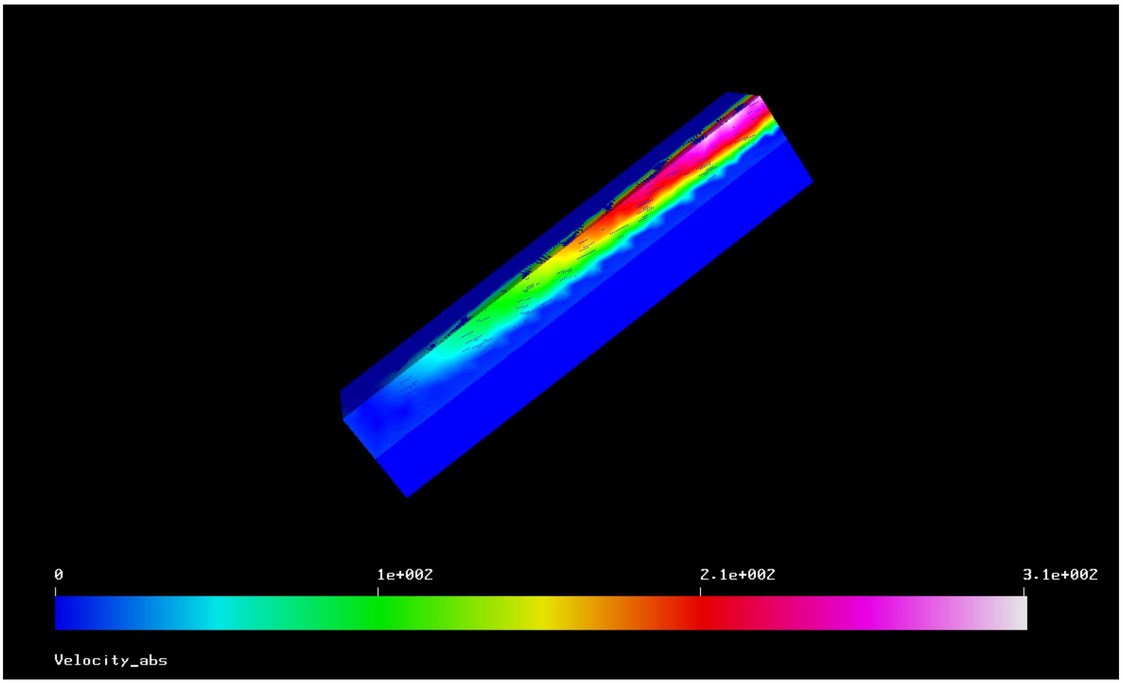


Figure 3-1: Elmer velocity color results (in m/s)

The velocity is changed as follows:

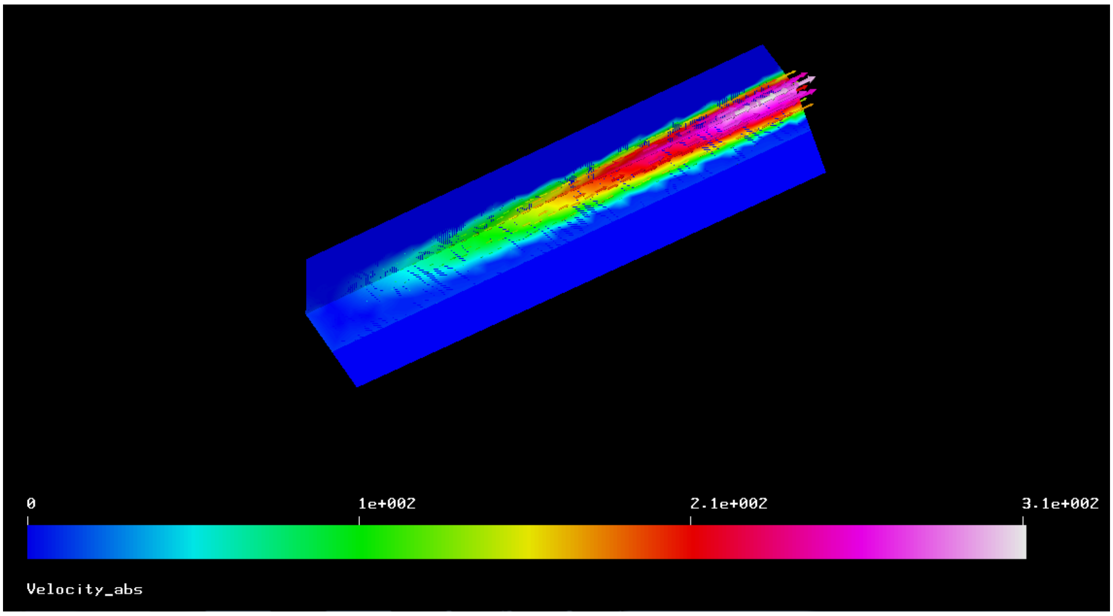


Figure 3-2: Elmer velocity vector results in m/s

And the pressure is following the figure 3-3:

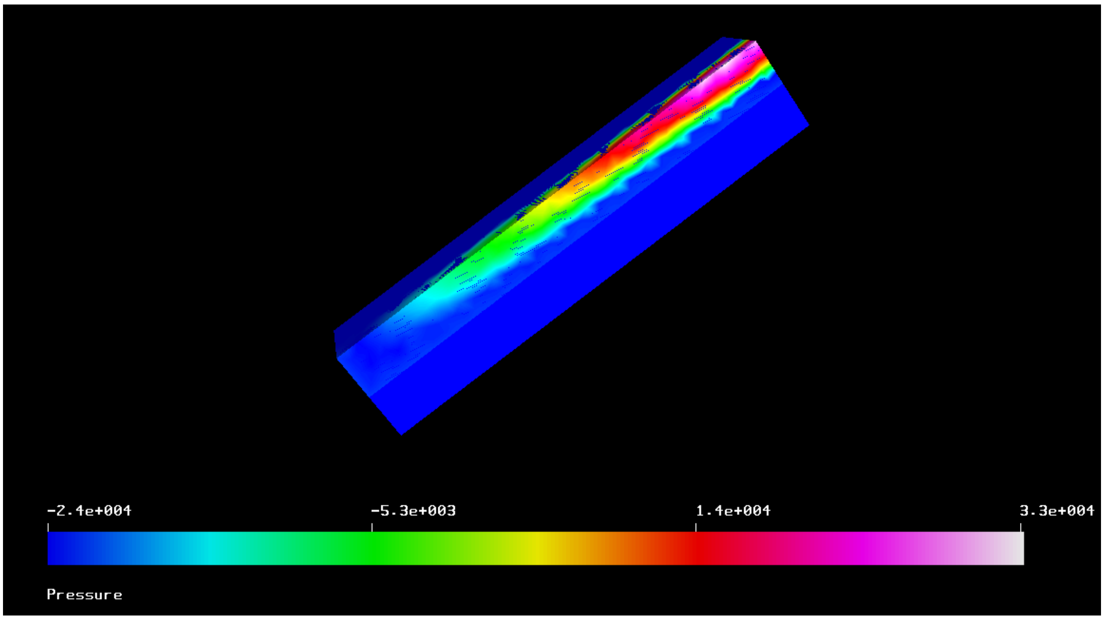


Figure 3-3: Elmer pressure color results in Pa

The velocity and pressure values are maximum in the middle than it decreases going towards the ends of the pipe and that because of friction of pipe in the fluid which illustrated in figures 3-1, 3-2, and 3-3.

Now we introduce the incineration power plant design (pump-water tank) to Elmer software in the following figure:

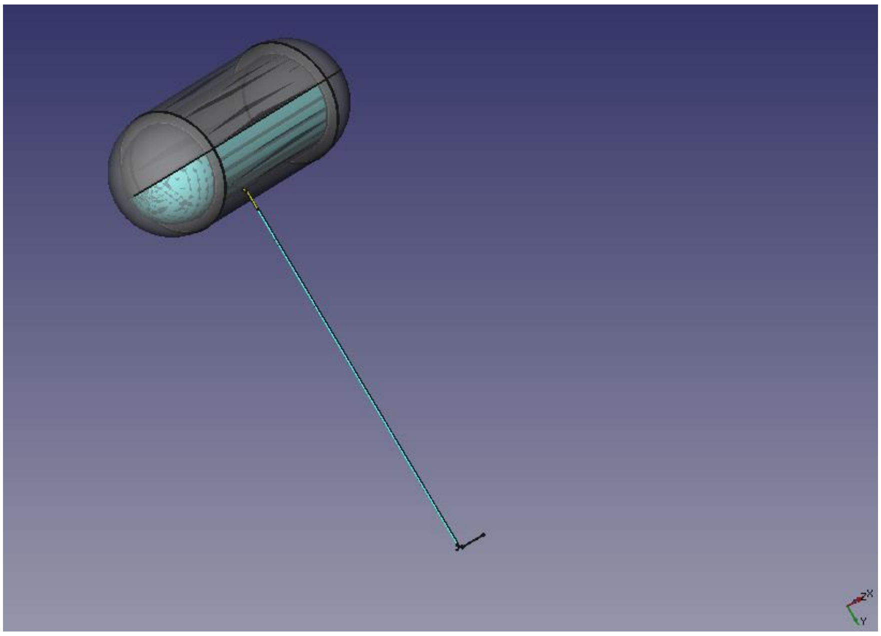


Figure 3-4: The studied design

The materialization of water makes us introduce the following design into Elmer:

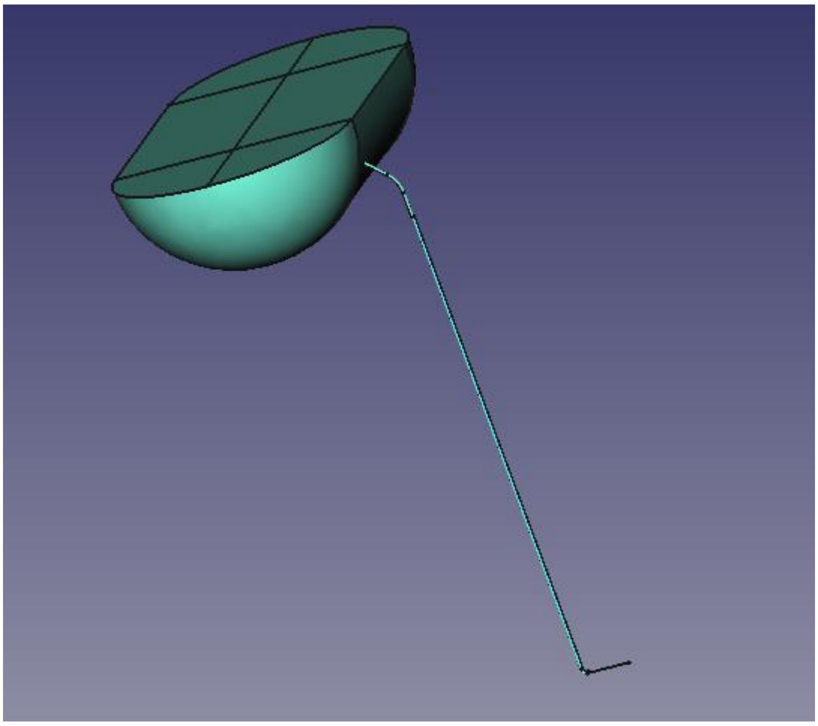


Figure 3-5: Water path

Our study is difficult in a dual core personal computer; so we do the studies in a quadcore server networked with the personal computer. We make study in the server and move the result (files and figures) to the personal computer. After we run the program with the finite element method, we obtain some files shown below:

Name	Date modified	Type	Size
case.ep	18/8/2015 11:46 AM	EP File	1,564 KB
case.sif	20/8/2015 11:51 PM	SIF File	3 KB
egproject	17/8/2015 11:02 AM	XML File	96 KB
ELMERSOLVER_STARTINFO	20/8/2015 11:51 PM	File	1 KB
mesh.boundary	18/8/2015 11:44 AM	BOUNDARY File	322 KB
mesh.elements	18/8/2015 11:44 AM	ELEMENTS File	431 KB
mesh.header	18/8/2015 11:44 AM	HEADER File	1 KB
mesh.nodes	18/8/2015 11:44 AM	NODES File	161 KB
netgen.prof	20/8/2015 11:57 PM	PROF File	1 KB
water.FCStd	17/8/2015 11:02 AM	FCSTD File	11 KB
water.msh	17/8/2015 11:02 AM	MSH File	1,028 KB
water.stp	17/8/2015 11:02 AM	STP File	76 KB

Figure 3-6: Result files in Elmer

Case.ep is the file that contains the velocity and pressure values.

Case.sif is the file that contains the conditions introduced.

Mesh.boundary is the file that contains number of boundary elements, number of elements belongs to the boundaries, the elements surround the boundary, type of codes of the elements, and the nodes of elements.

Mesh.elements is the file that contains identification of the elements, body's material of this element, type of code, nodes of element.

Mesh.header is the file that contains number of nodes, number of elements, and number of boundary elements.

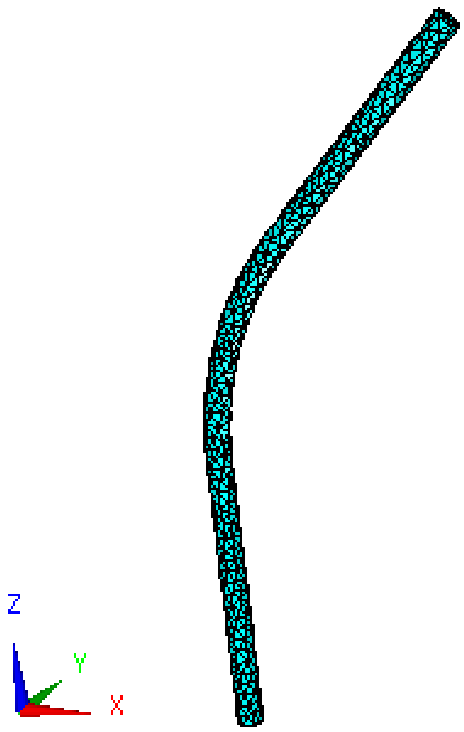
Mesh.node is the file that contains number of nodes, index of parallel execution nodes, and the node coordinates.

Water.FCStd is the FreeCAD design file.

Water.stp is the gmsh design file.

And water.msh is the Elmer meshing file.[10]

We remember the coordinate system x,y and z:



The color of variable value of velocity and pressure illustration:

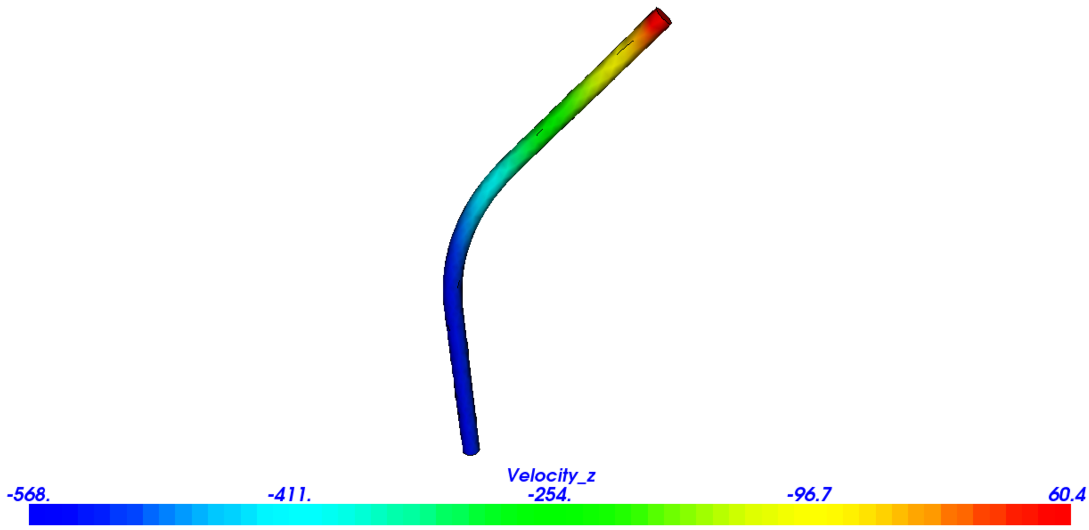


Figure 3-7: Velocity variation z-component in m/s

This figure (figure 3-7) of velocity values z component shows that the blue color identify the minimum value (or the value which the velocity is in opposite direction) of velocity; then the value increases to reach the maximum in the red color.

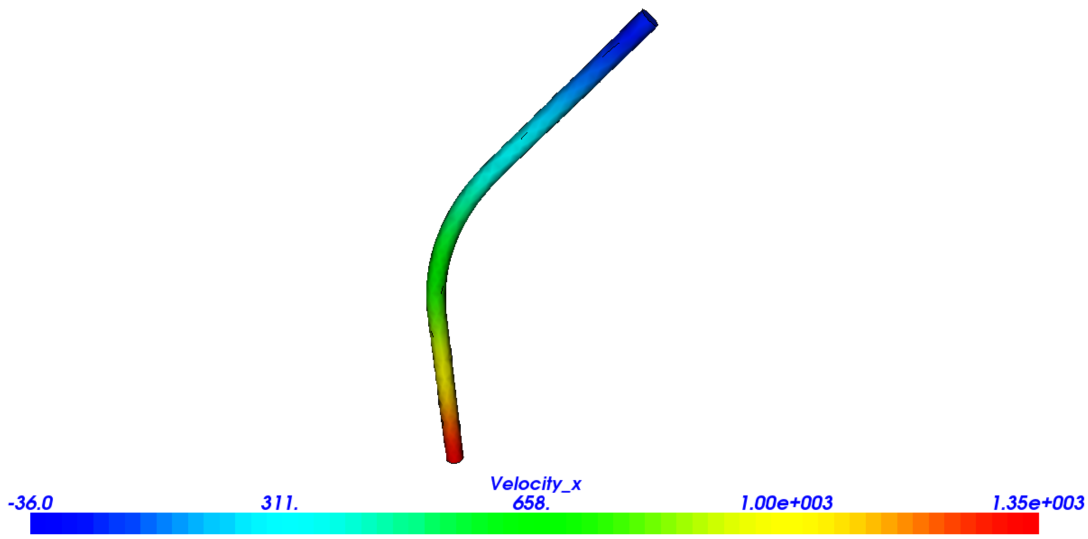


Figure 3-8: Velocity variation x-component in m/s

In the figure 3-8 we see the same result concerning the arrangement of color but for the x-component of velocity.

And the same for the y-component in the figure 3-9 but we deduct that the velocity_y is constant because the flow is following 2-directions x and z.

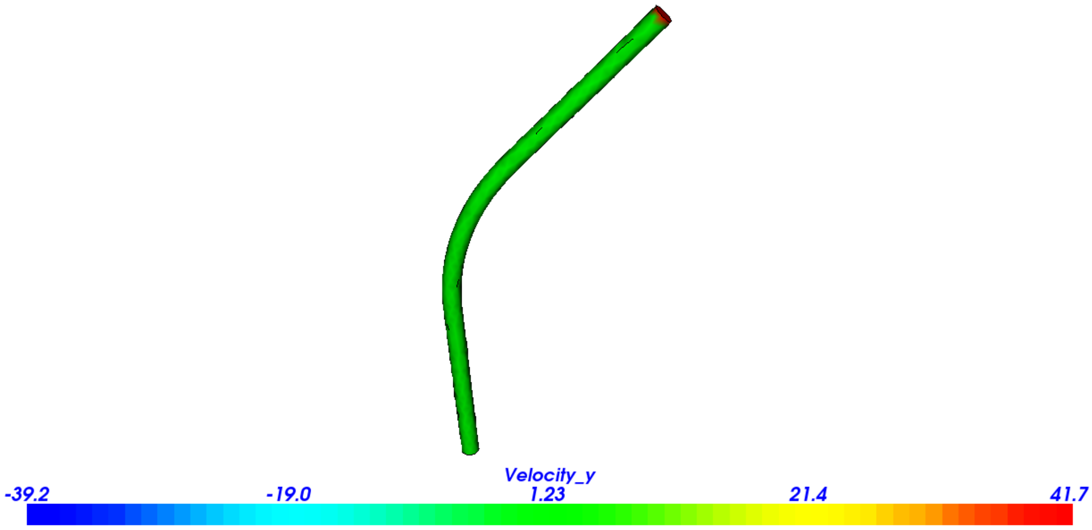


Figure 3-9: Velocity variation y-component in m/s

So we should interest to the position of green, yellow, and red color for velocity and pressure to know where study is should be fixed.

Moving to the pipe in figures 3-10, 3-11, and 3-12:

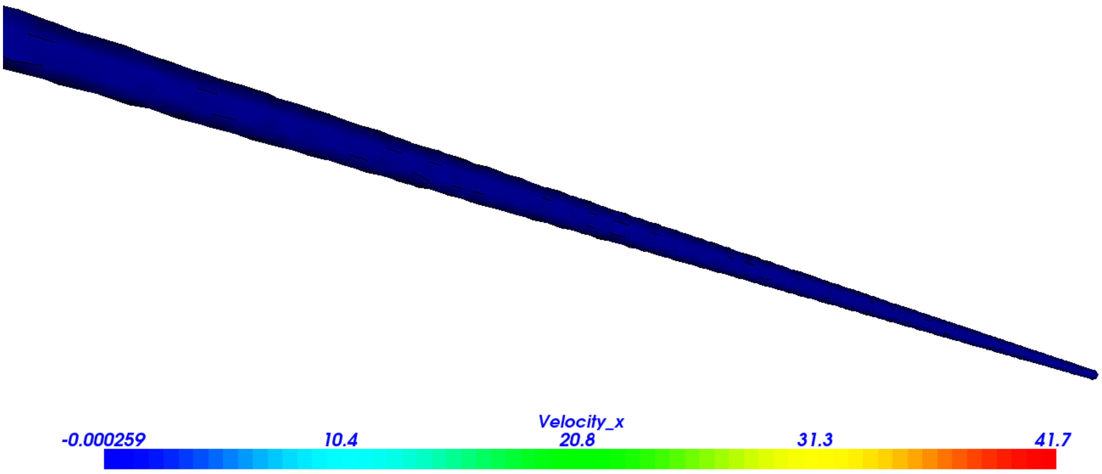


Figure 3-10: Velocity variation x-component in m/s

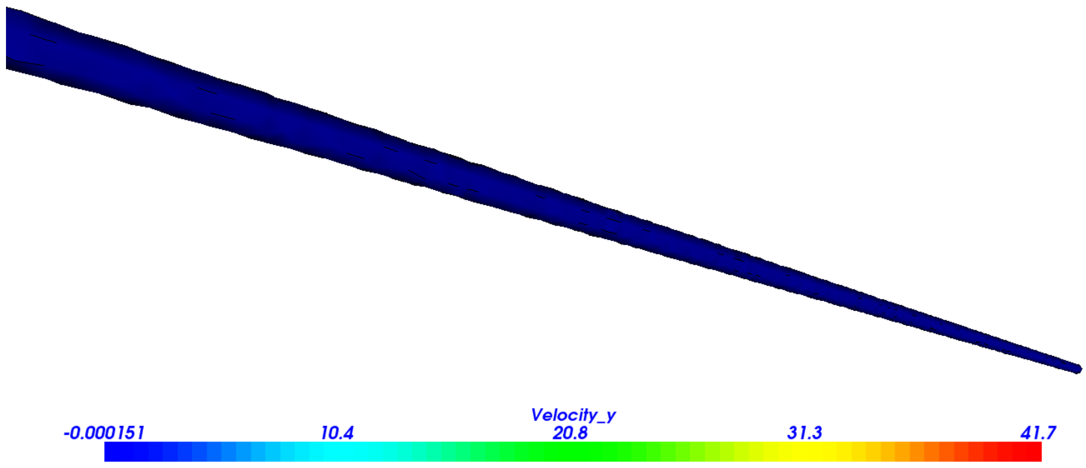


Figure 3-11: Velocity variation y-component in m/s

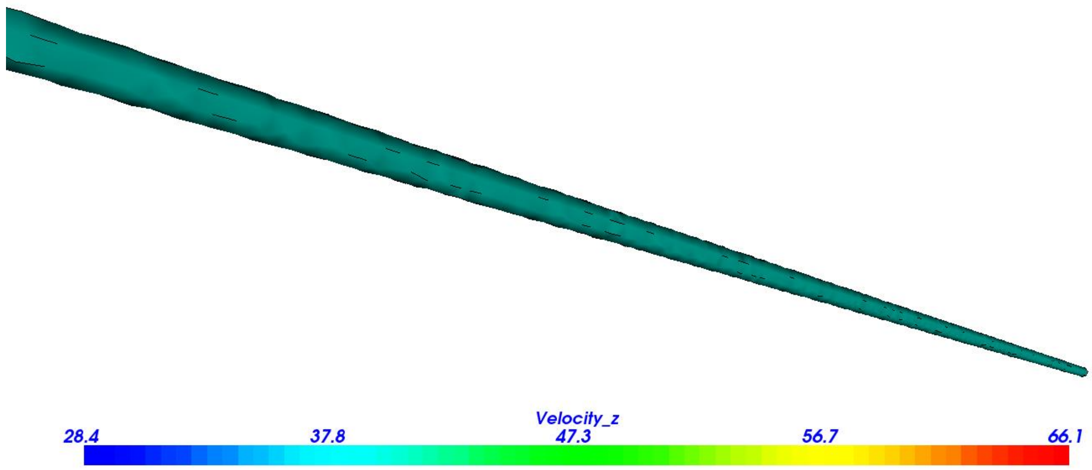


Figure 3-12: Velocity variation z-component in m/s

Water flowing into the pipe following the z direction so the velocity in the x and y direction are null and it is constant following the z direction.

Now we should show results for the complete path from the pump into the water.

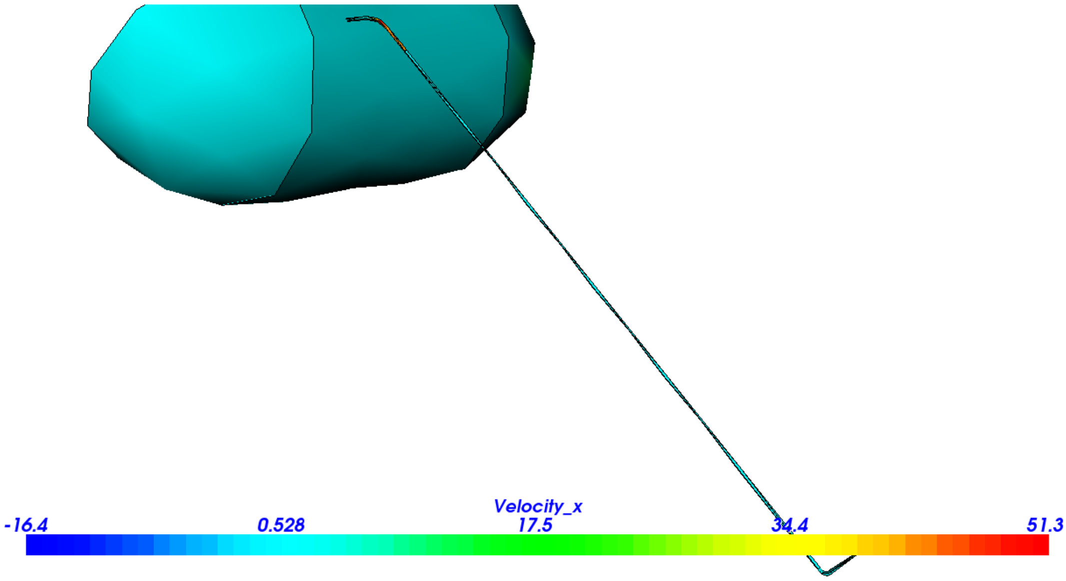


Figure 3-13: Velocity variation x-component in m/s

The x-component of velocity for the path water is constant and negligible, except in the corner where it reaches 51.3 m/s figure 3-13.

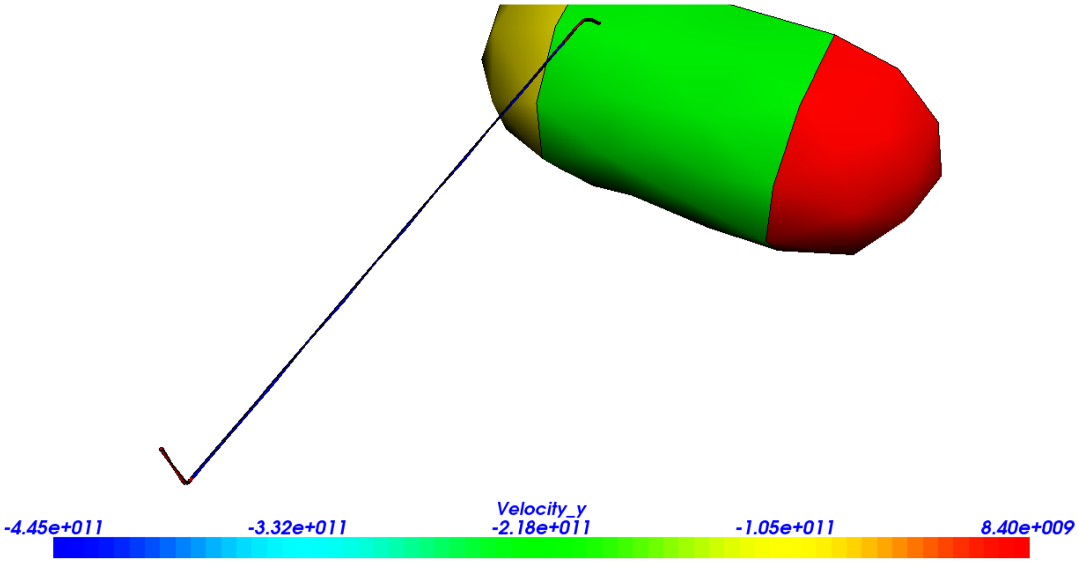


Figure 3-14: Velocity variation y-component in m/s

The velocity is in the opposite direction of y, except in a part of water tank where it reaches 8.4*10^9 figure 3-14.

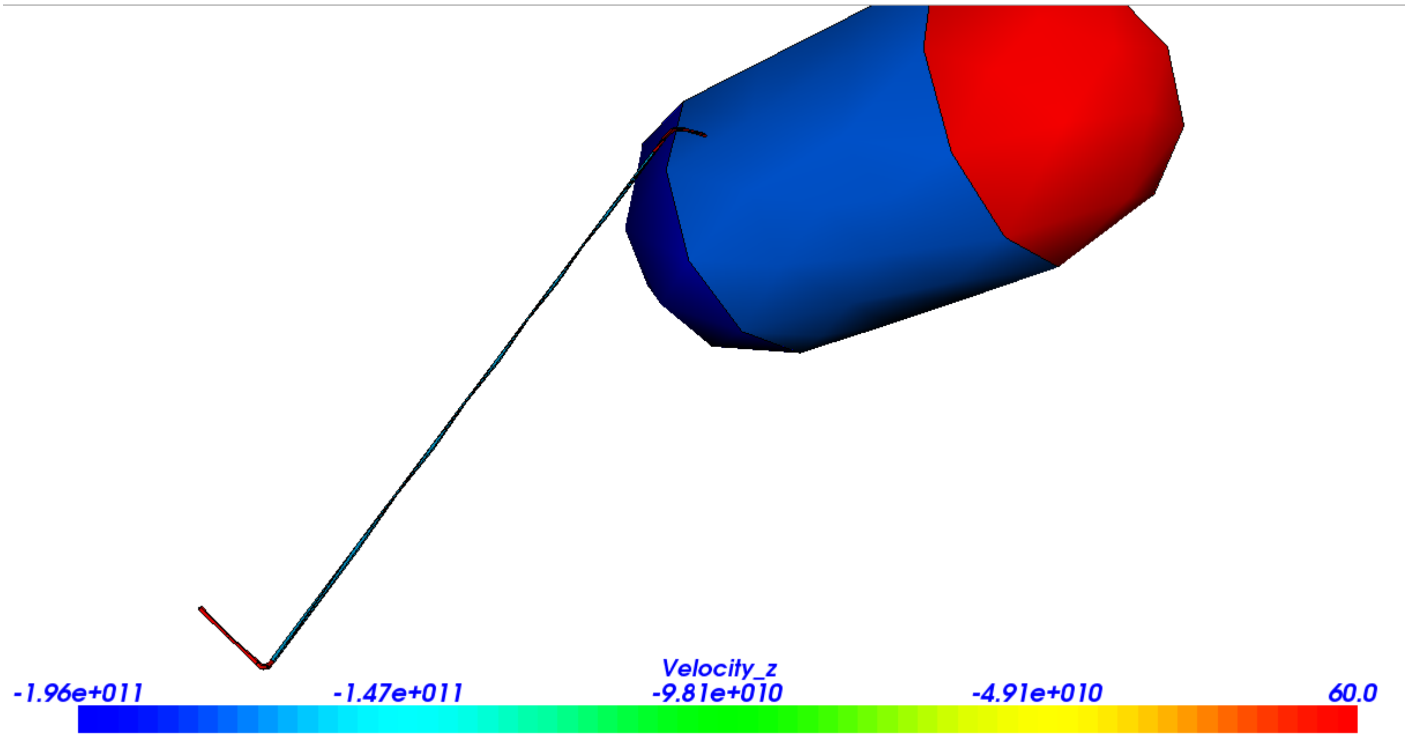


Figure 3-15: Velocity variation z-component in m/s

The velocity in the opposite of z direction, except in a part of water tank where it is reaches 60 m/s figure 3-15.

We have to note that the pressure is constant in the all water path figure 3-16:

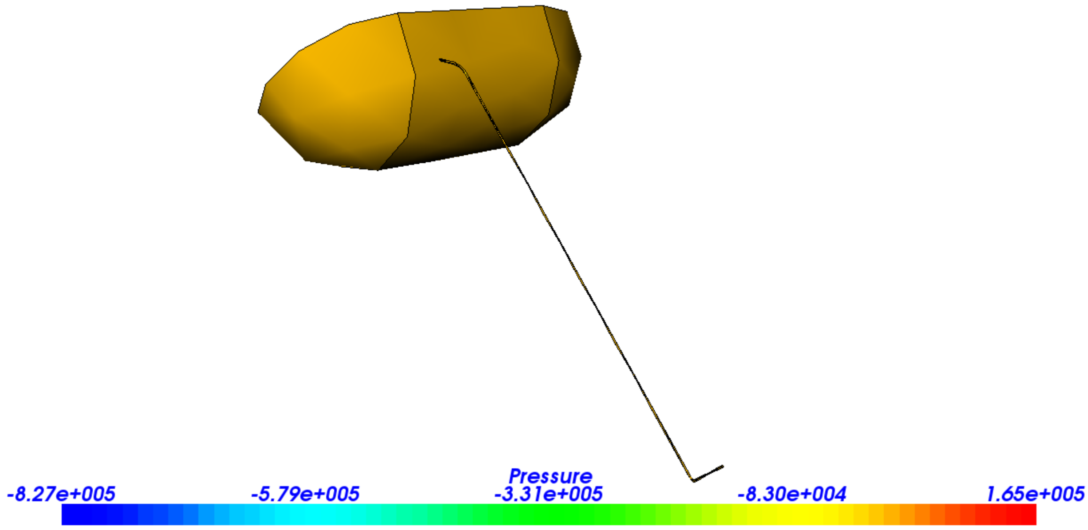


Figure 3-16: Pressure variation in Pascal

4. Conclusion and future work

Our study was to know the fluid flow pressure and velocity of a part of an incineration power plant using finite element method. We investigated the path of water and evaluated the velocity and pressure for the pipe which feeds water from the pump to the pressure tank under conditions which we introduced. We used FreeCAD to draw the design, then Gmsh for meshing and at the end Elmer for solving (the fluid dynamic equations) and visualizing (the resulting flow).

The velocity and pressure values that we obtain are necessary for knowing the conditions of material used in the design, and for improvement of the incineration power plant by adding a valve or vary the thickness.

It shall also be remarked that OpenFOAM can solve the CFD problem but our study was limited in time, so the OpenFOAM study should be continued and the correct command should be found so that we can insert the FreeCAD design (or Gmsh meshing design) into OpenFOAM and solve it to find velocity and pressure using the finite volume method, and visualize using Paraview.

And we have to say that our study concerned the incompressible fluid flow, so it is probably to change the condition of study and add the necessary condition to study the compressible fluid flow for example. So our study is open to use by another students to continue it.

And we have to know that our study is not just useful for the steam path to incineration power plant, it is useful for any domain of fluid mechanic when it is important to discretize the domain and obtain results which can use in industrial applications.

5. References

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[2] AVFALL SEVERAGE; Swedish Waste Management. © Avfall Sverige AB Literature references, www.avfallsverige.se Prostgatan 2, SE-211 25 Malmö +46 40-35 66 00 +46 40-35 66 26 info@avfallsverige.se www.avfallsverige.se

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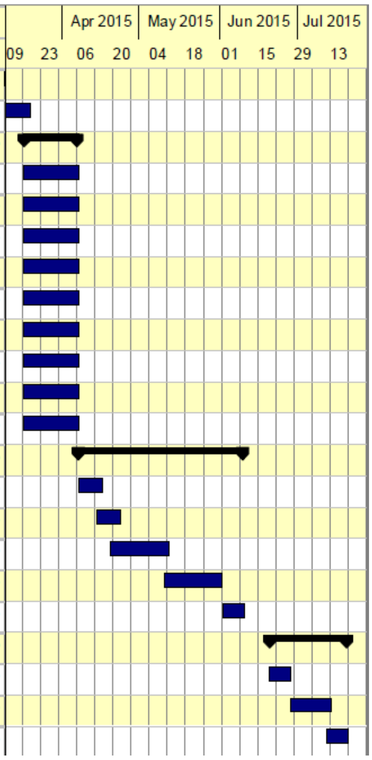
6. Annex

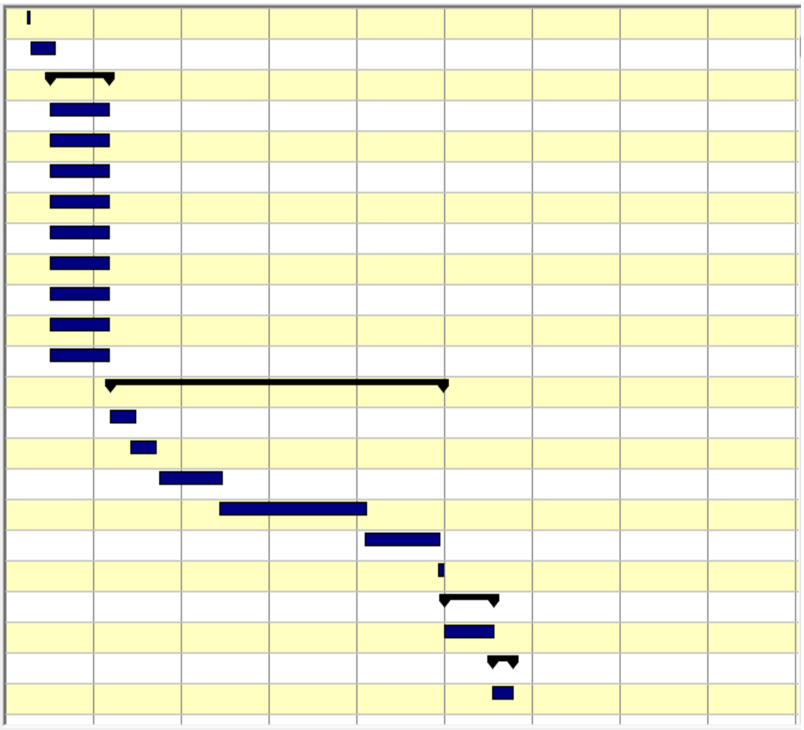
6.1. Annex 1: Planning in March 2015

ID	Name	Start	Finish
MSThesis Ch.		3/9/2015	3/9/2015
Ch1: Intro	The incineration piltot plant TEMO-IPP and planned Tripoli-IPP	3/10/2015	3/18/2015
Ch2:Basics	**CFD method description (وضع الكتاب)**	**3/17/2015**	**4/6/2015**
2.1	short description of FreeCAD	3/17/2015	4/6/2015
2.2	Fluid Dynamics Eq.s (Navier-Stokes, Euler Eq.)	3/17/2015	4/6/2015
2.3	visualization with paraview	3/17/2015	4/6/2015
2.4	description of PDE	3/17/2015	4/6/2015
2.5	discretization	3/17/2015	4/6/2015
2.6	Grid transformation	3/17/2015	4/6/2015
2.7	finite-difference solver (7.1)	3/17/2015	4/6/2015
2.8	finite volume solver	3/17/2015	4/6/2015
2.9	finite element solver	3/17/2015	4/6/2015
Ch3:Contributi	**Development of the program TEMO-IPP_CFD**	**4/7/2015**	**6/9/2015**
3.1	Specification of program TEMO-IPP_CFD	4/7/2015	4/15/2015
3.2	VC++ User Interface for Program TEMO-IPP_CFD	4/14/2015	4/22/2015
3.3	Implementation of grid creation using OpenFOAM packages	4/19/2015	5/11/2015
3.4	implementation of FV solver using OpenFOAM packages	5/10/2015	5/31/2015
3.5	visualisation module (script calling of Paraview)	6/2/2015	6/9/2015
Ch 4: Results	**Testing the program TEMO-IPP_CFD (مثل تطبيق في الكتاب)**	**6/20/2015**	**7/19/2015**
4.1	Design of Tripoli-IPP vaporizer using FreeCAD	6/20/2015	6/27/2015
4.2	Computing FD of Tripoli-IPP vaporizer (init.param. for normal operating state of Tripoli-	6/28/2015	7/13/2015
Ch 5: Conclusio	Discussion of results (how to improve the vaporizer)	7/12/2015	7/19/2015

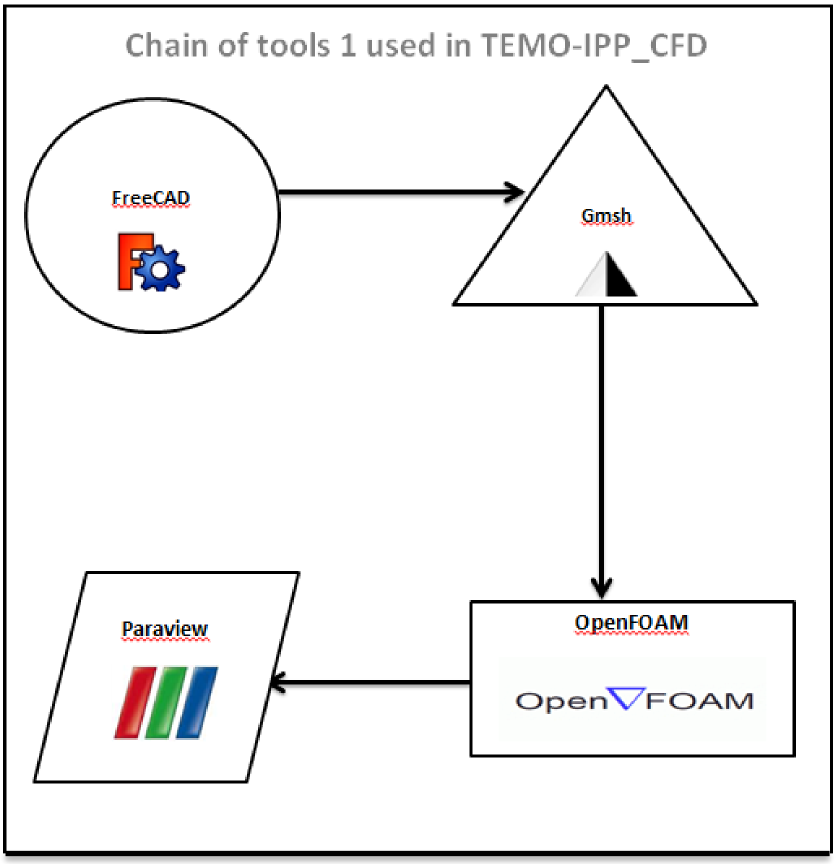


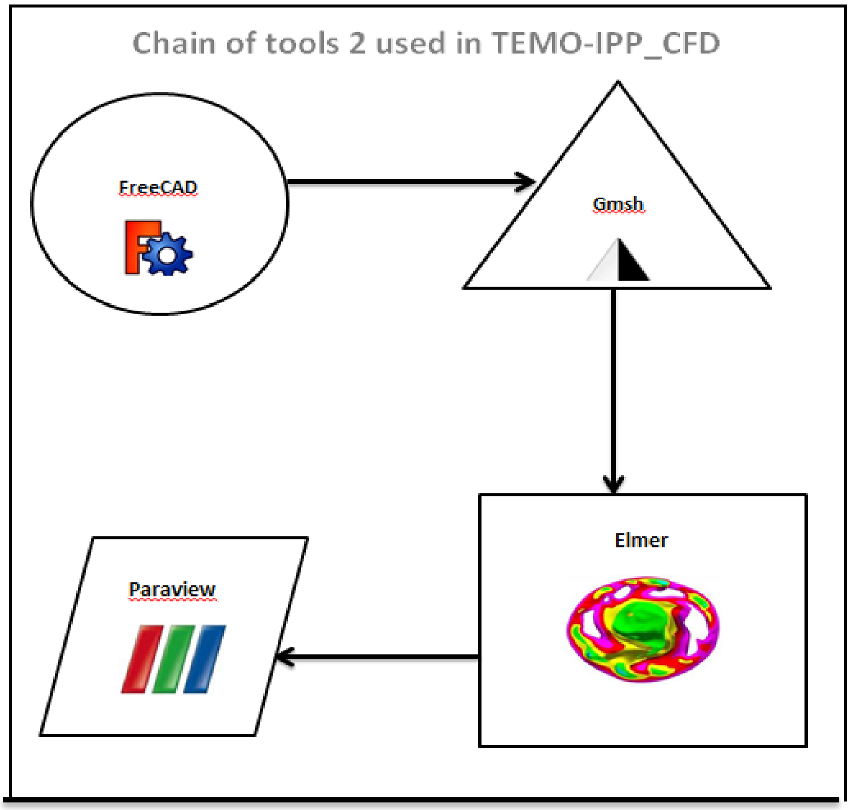
6.2. Annex 2: Updated Planning July 2015

MSThes		9/3/2015	9/3/2015
Ch1: Intr	The incineration piltot plant TEMO-IPP and planned Tripoli-IPP	10/3/2015	18/3/2015
Ch2:B	**CFD method description (وضع الكتاب)**	**17/3/2015**	**6/4/2015**
2.1	short description of FreeCAD	17/3/2015	6/4/2015
2.2	Fluid Dynamics Eq.s (Navier-Stokes, Euler Eq.)	17/3/2015	6/4/2015
2.3	visualization with paraview	17/3/2015	6/4/2015
2.4	description of PDE	17/3/2015	6/4/2015
2.5	discretization	17/3/2015	6/4/2015
2.6	Grid transformation	17/3/2015	6/4/2015
2.7	finite-difference solver (7.1)	17/3/2015	6/4/2015
2.8	finite volume solver	17/3/2015	6/4/2015
2.9	finite element solver	17/3/2015	6/4/2015
Ch3:C	**Development of the program TEMO-IPP_CFD**	**7/4/2015**	**31/7/2015**
3.1	Specification of program TEMO-IPP_CFD	7/4/2015	15/4/2015
3.2	VC++ User Interface for Program TEMO-IPP_CFD	14/4/2015	22/4/2015
3.3	Implementation of grid creation using gmsh	24/4/2015	15/5/2015
3.4	implementation of FV solver using OpenFOAM packages	15/5/2015	4/7/2015
3.5	implementation of FE solver using Elmer packages	4/7/2015	30/7/2015
3.6	visualisation module (script calling of Paraview (ElmerPost) or Elm	30/7/2015	31/7/2015
Ch 4:	**Testing the program TEMO-IPP_CFD (مثل تطبيق في ال**	**1/8/2015**	**18/8/2015**
4.2	Computing FD of Tripoli-IPP vaporizer (init.param. for normal oper	1/8/2015	18/8/2015
Ch 5:	**Discussion of results (how to improve the vaporizer)**	**18/8/2015**	**25/8/2015**
5	write results	18/8/2015	25/8/2015



6.3. Annex 3: Tool chains used for CFD analysis





6.4. Annex 4: Offers for 30 MW Steam Turbine and Pump

POWER PLANTS
OIL REFINERIES
SALE & RELOCATION

LOHRMANN INTERNATIONAL

Taunusstr. 5a
65183 Wiesbaden/Germany
Tel. +49 (0) 611-50402-0
Fax +49 (0) 611-50402-50
www.lohrmann.com
info@lohrmann.com

For Sale:	Pre-owned 30.2 MW Steam Turbine Generator Extraction – Condensing Type
Ref.-No:	STG-29.33

Brief plant history:
The steam turbine generator was part of a combined cycle power plant commissioned in 1996 and shut down 2012 after approx. 86,562 operating hours.

Description of major plant components:

Turbine	
Manufacturer, Type	ABB Turbinen Nürnberg GmbH, VEE 40 Double extraction condensing turbine, Type 4 Stages HP, 9 stages MP and 9 stages LP part
Max. terminal power	30.2 MW
Number of extractions/ bleeders	1 pcs./ 2 pcs.
Live steam parameters	120 bar, 520 °C, 210 t/h
Bleeding 1 normal/max.	36 / 41 bar, 365 / 415 °C, max. 80 t/h
Bleeding 2 normal/max.	6 / 8.5 bar, 170 / 333 °C, max. 75 t/h
Extraction normal/max.	16 / 20.5 bar, 275 / 300 °C, max. 20 t/h
Exhaust normal/max.	0.047 / 0.08 bar, max. 18 °C
Rate max.	10.2 / 55.6 t/h
Gear	Type spur gear, single helical
Parameters	30.2 MW, 1500 rpm (from 5859 rpm)
Generator	Three-phases
Parameter	37500 kVA, 10500 V, 50 Hz
Rotating speed	1500 rpm
Cooling	TEWAC
Condenser	
Pressure inside condenser	0.06 / 0.073 bar
Cool. water parameters	3000 m³/h, 27 °C
Amount of steam	41 / 56 t/h

Major auxiliary equipment / Accessories
Start system, lubrication system, hydraulic system, gears, and acoustic enclosure

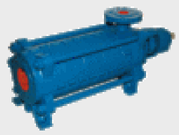
Price:	on request



Further information on request

STG-29.33 Short — Page 1 of 1

Budget Price for STG 29.33: FOB 3.150.000 EUR (Offer from 12 Oct 2015)

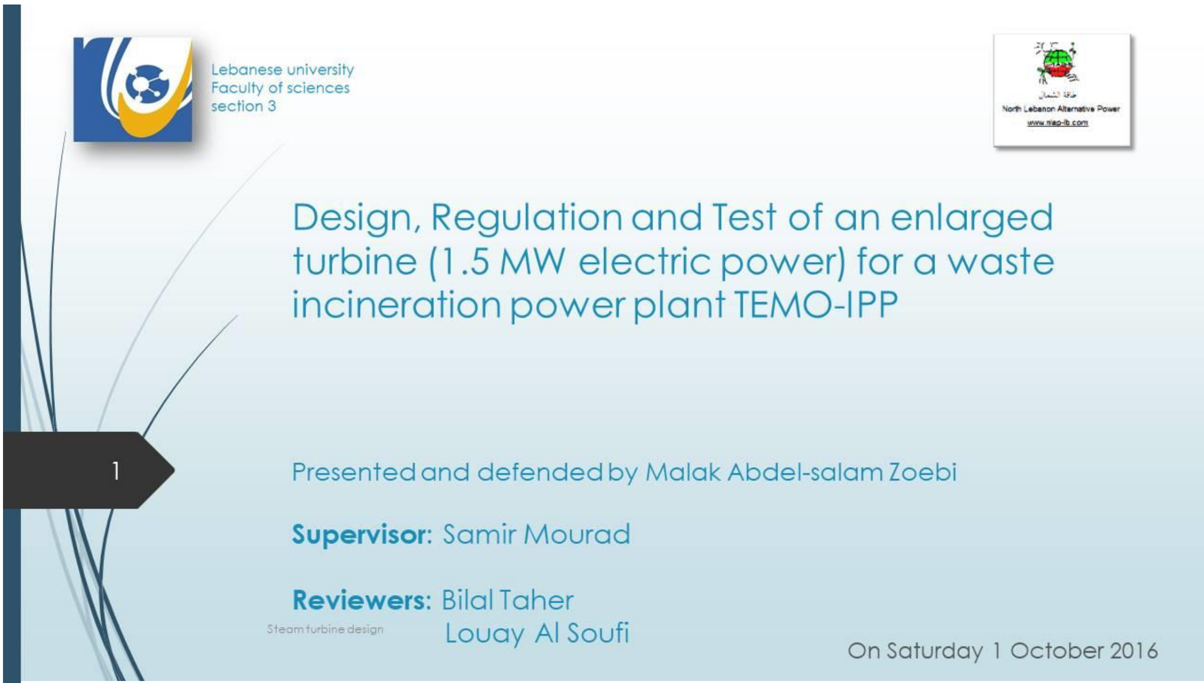


Series SIHImulti MSL, MSM
horizontal, multi-stage centrifugal pumps according to ISO 5199 / EN 25199 for pressures up to 40/63 bar.
Flow rate: up to 450 m³/h
Head: up to 630 m

http://www.sterlingsihi.com/cms/home/products-services/liquid-pumps/high-pressure-pumps.html

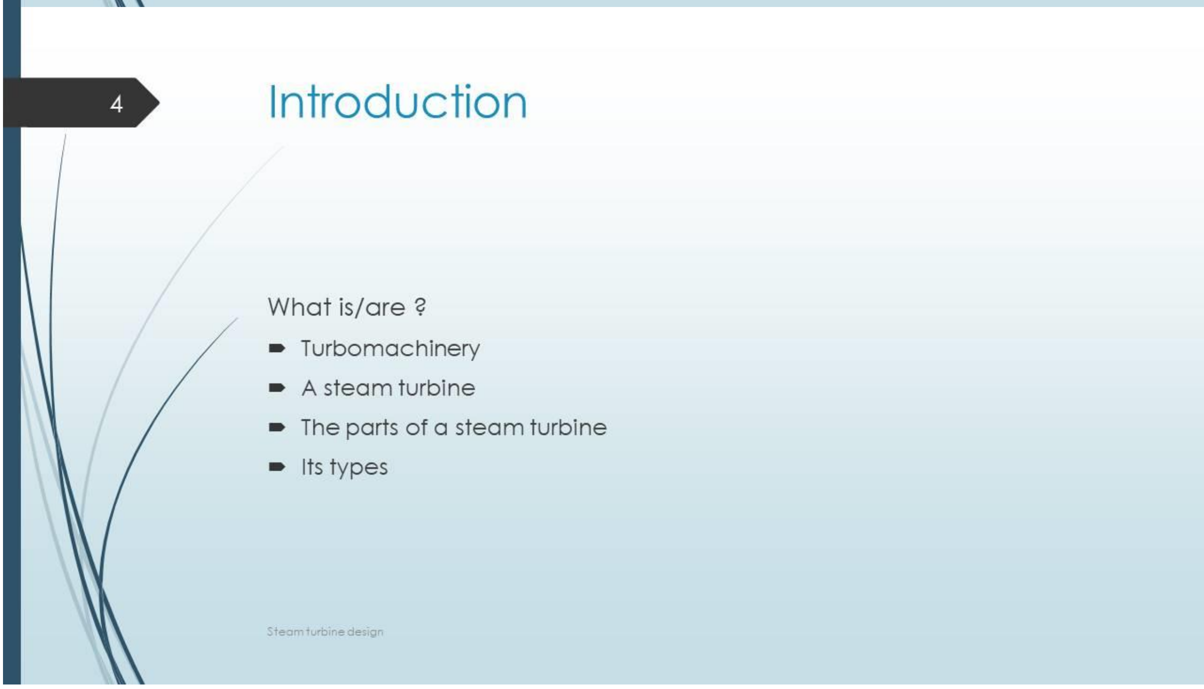
1.5 MW Turbine Design

Based on Master Thesis of Malak Zoebi, 2016

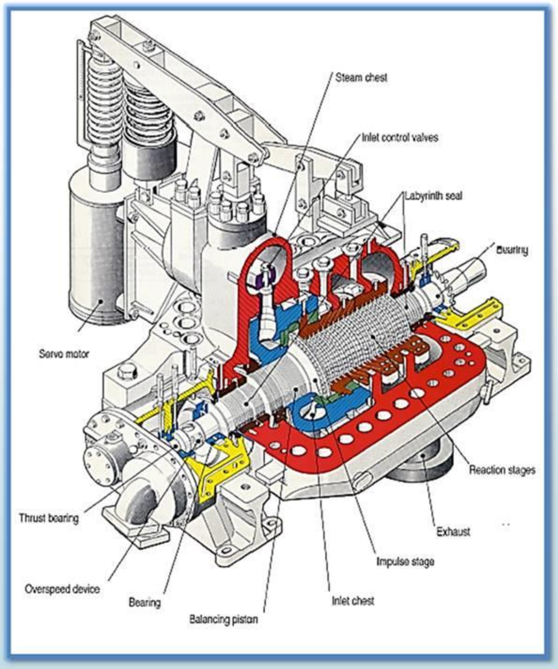

Lebanese university
Faculty of sciences
section 3
North Lebanon Alternative Power
1
Design, Regulation and Test of an enlarged turbine (1.5 MW electric power) for a waste incineration power plant TEMO-IPP
Presented and defended by Malak Abdel-salam Zoebi
Supervisor: Samir Mourad
Reviewers: Bilal Taher
Louay Al Soufi
Steam turbine design
On Saturday 1 October 2016


2
Steam turbine design


3
Plan
Introduction
Methods and calculation
Detailed design
Control
Results and discussion
General conclusion
Steam turbine design


4
Introduction
What is/are ?
Turbomachinery
A steam turbine
The parts of a steam turbine
Its types
Steam turbine design

5



Steam turbine design

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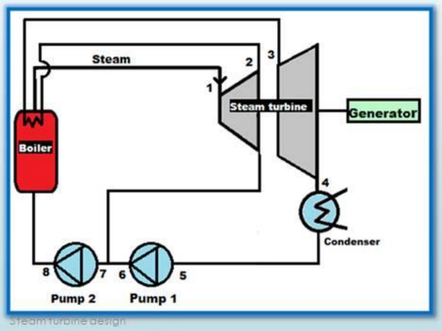
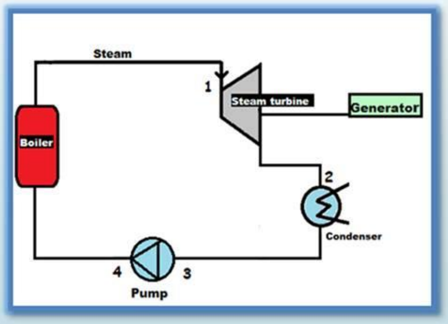
Methods and calculation

Installation of power plant

I. Superheated steam



II. Saturated steam



Steam turbine design

7

Methods and calculation

Values of some characteristics parameters

For a superheated steam:

- Electric power: 1.5 MW;
- Electric efficiency: 96 %;
- Mechanic efficiency: 95 %;
- Internal efficiency of the steam turbine: 90 %;
- Entry pressure: 14 bars;
- entry temperature: 250 °C;
- pressure in the condenser: 12 kPa.

For a saturated steam:

- Electric power: 1.5 MW;
- Electric efficiency: 96 %;
- Mechanic efficiency: 95 %;
- Internal efficiency of the steam turbine: 90 %;
- Entry pressure: 14 bars;
- entry temperature: 195 °C
- pressure in the condenser: 1 bar.

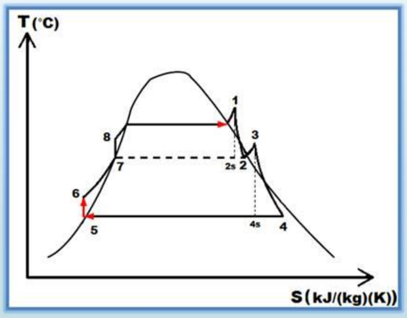
Steam turbine design

8

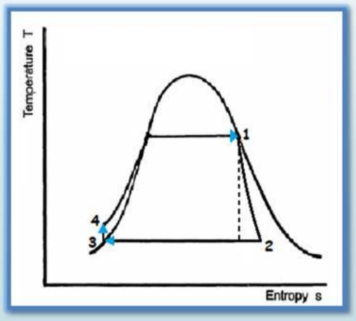
Methods and calculation

Rankine cycle

I. Superheated steam



II. Saturated steam



Steam turbine design

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Methods and calculation

Efficiency (after calculation of enthalpy for each point)

I. Superheated steam

$$\eta=\frac{Net\ work}{Quantity\ of\ steam\ additional}=\frac{\Delta W_{net}}{Q}$$

$$=\frac{(h_1-h_2)+(1-\dot{m}_1)(h_3-h_4)-[(1-\dot{m}_1)(h_6-h_5)+(h_8-h_7)]}{(h_1-h_8)+(1-\dot{m}_1)(h_3-h_2)}$$

=26.26 %

II. Saturated steam

$$\eta=\frac{Net\ work}{Quantity\ of\ steam\ additional}=\frac{\Delta W_{net}}{Q};$$

$$\eta=\frac{W_T-W_p}{h_1-h_4}$$

$$=\frac{(h_1-h_2)-(h_4-h_3)}{(h_1-h_4)}$$

=16.89 %

Steam turbine design

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Methods and calculation

Mass flow

I. Superheated steam

Q_m=2.402 kg/s

II. Saturated steam

Q_m=3.996 kg/s

Steam turbine design

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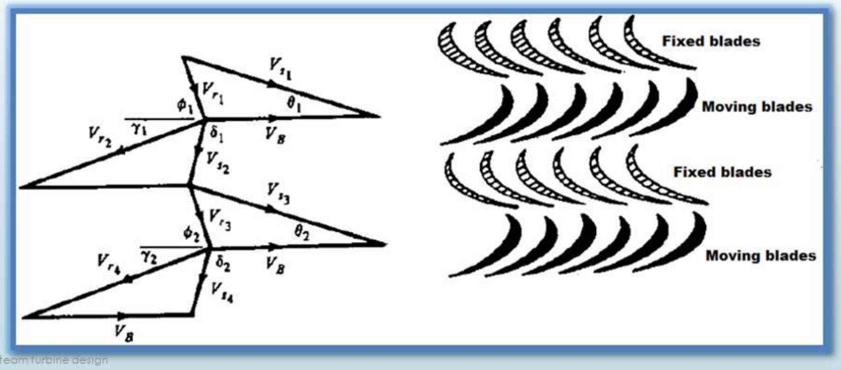
Methods and calculation

Velocity diagram



Steam turbine design

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Methods and calculation

Calculate of velocities and angles

Equations utilized for this calculation:

- $v_{s_1} = \sqrt{(2 \times \Delta hf)}$.
  (Equation 1)
- $v_B = \pi\, D\, N = \pi(D_1 + l) \times N$.
  (Equation 2)
- $\tan \Phi_1 = \frac{v_{s_1} \times sin\theta_1}{v_{s_1} \times \cos\theta_1 - VB}$.
  (Equation 3)
- $v_{r_1} = \frac{v_{s_1} \times sin\theta_1}{\sin \emptyset_1}$.
  (Equation 4)
- $v_{r_2} = \sqrt{(2 \times \Delta hm + {v_{r_1}}^2)}$.
  (Equation 5)
- $\cos \gamma_1 = \frac{v_B}{vr_2}$.
  (Equation 6)
- $v_{s_2} = v_{r_2} \times \cos\left(\frac{\pi}{2} - \gamma_1\right)$
  (Equation 7)

Steam turbine design

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Methods and calculation

I. Superheated steam

- first stage-first part

Parameter	Value
debit (Kg/s)	2.402
delta H of first part (KJ/Kg)	130.667265
delta H of second part	236.370375
percentage of fixed blades	0.1
percentage of moving blades (KJ/Kg)	0.9
delta h fixe of first part (KJ/Kg)	13.0667265
delta h mobile of first part (KJ/Kg)	117.6005385
Vs1 (absolute velocity)(m/s)	161.6584455
diameter (m)	0.3
N (round per minute)	3000
VB (velocity of blade) (m/s)	50.57964172
teta1 (degree)	30
tan ϕ1	0.903920925
ϕ1 (rad)	0.73497714
ϕ1 (degree)	42.11108818
Vr1 (relative velocity)(m/s)	120.5380481
δ1 (degree)	90
Vr2	121.5097614
cos(ϒ1)	0.416259905
ϒ1(rad)	1.141468303
ϒ1(degree)	65.40131623
Vs2	110.4822247

Steam turbine design

14

Methods and calculation

I. Superheated steam

- Second stage-first part

Parameter	Value
debit (kg/s)	2.402
delta H of first part (kJ/kg)	130.667265
delta H of second part (kJ/kg)	236.370375
percentage of fixed blades	0.1
percentage of moving blades	0.9
delta h fixe of first part (kJ/kg)	13.0667265
delta h mobile of first part (kJ/kg)	117.6005385
Vs3 (absolute velocity)(m/s)	161.6584455
diameter (m)	0.3
N (round per minute)	3000
VB (velocity of blade) (m/s)	52.93583621
teta 2 (degree)	30
tan ϕ2	0.928383409
ϕ2 (rad)	0.748277074
ϕ2 (degree)	42.87311825
Vr3 (relative velocity)(m/s)	118.8006215
δ2 (degree)	90
Vr4	119.7864298
cos(ϒ2)	0.441918474
ϒ2(rad)	1.113060142
ϒ2(degree)	63.77364849
Vs4	107.4550418

Steam turbine design

15

Methods and calculation

I. Superheated steam

- First stage-second part

Parameter	Value
debit (Kg/s)	2.402
delta H of first part (KJ/Kg)	130.667265
delta H of second part	236.370375
percentage of fixed blades	0.05
percentage of moving blades (KJ/Kg)	0.95
delta h fixe of second part (KJ/Kg)	11.81851875
delta h mobile of second part (KJ/Kg)	224.5518563
Vs1 (absolute velocity)(m/s)	153.7434145
diameter (m)	0.3
N (round per minute)	3000
VB (velocity of blade) (m/s)	62.36061417
teta 1 (degree)	30
tan ϕ1	1.085987302
ϕ1 (rad)	0.826596232
ϕ1 (degree)	47.36047547
Vr1 (relative velocity)(m/s)	104.49779
δ1 (degree)	90
Vr2	106.6250057
cos(Y1)	0.584859187
Y1(rad)	0.946089879
Y1(degree)	54.20695713
Vs2	86.48725706

Steam turbine design

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Methods and calculation

I. Superheated steam

- Second stage-second part

Parameter	Value
debit (kg/s)	2.402
delta H of first part (kJ/kg)	130.667265
delta H of second part (kJ/kg)	236.370375
percentage of fixed blades	0.05
percentage of moving blades	0.95
delta h fixe of second part (kJ/kg)	11.81851875
delta h mobile of second part (kJ/kg)	224.5518563
Vs3 (absolute velocity)(m/s)	153.7434145
diameter (m)	0.3
N (round per minute)	3000
VB (velocity of blade) (m/s)	87.4933554
teta 2 (degree)	30
tan ϕ2	1.683850052
ϕ2 (rad)	1.034891117
ϕ2 (degree)	59.29489323
Vr3 (relative velocity)(m/s)	89.40579501
δ2 (degree)	90
Vr4	91.8830773
cos(Y2)	0.952224914
Y2(rad)	0.310355982
Y2(degree)	17.78208789
Vs4	28.06087408

Steam turbine design

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Methods and calculation

II. Saturated steam

- First stage

Parameter	Value
debit (Kg/s)	3.996
delta h fixe (KJ/Kg)	100.6
delta h mobile (KJ/Kg)	99
Vs1 (absolute velocity)(m/s)	448.5532298
diameter (m)	0.15
N (round per minute)	3000
VB (velocity of blade) (m/s)	28.11725425
teta1 (degree)	30
tan ϕ1	0.622400634
ϕ1 (rad)	0.556727924
ϕ1 (degree)	31.89816041
Vr1 (relative velocity)(m/s)	424.4358699
δ1 (degree)	90
Vr2	424.6690566
cos(Υ1)	0.066209802
Υ1(rad)	1.504538054
Υ1(degree)	86.20368064
Vs2	423.7372153

Steam turbine design

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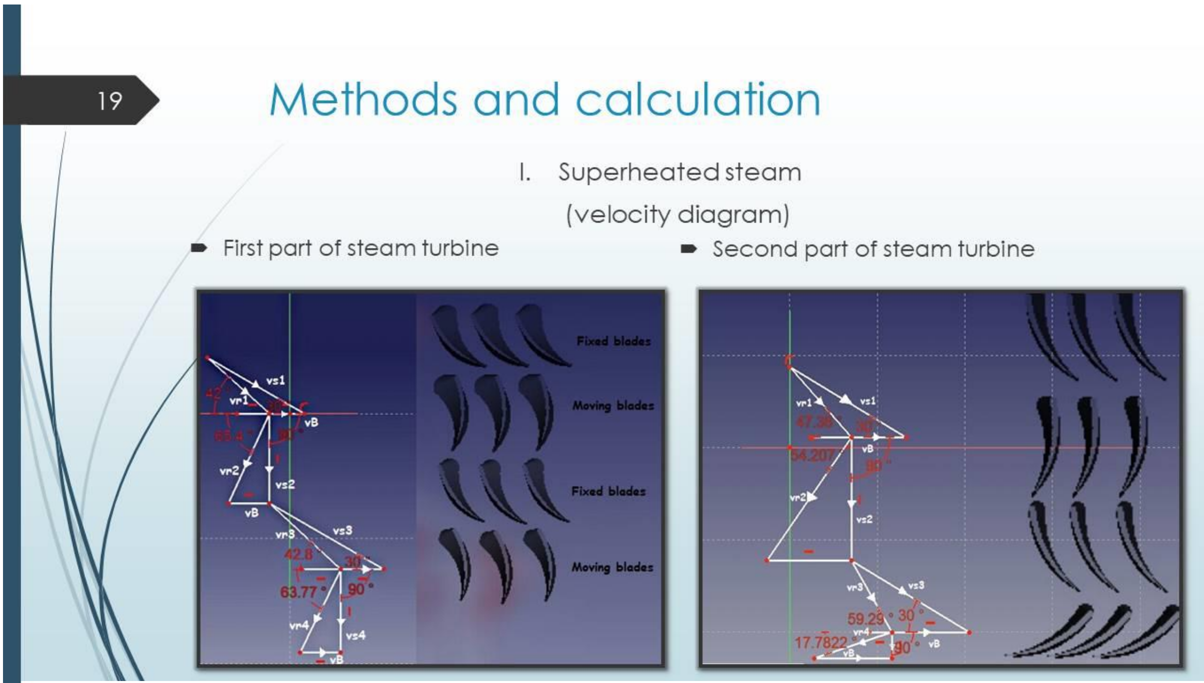
Methods and calculation

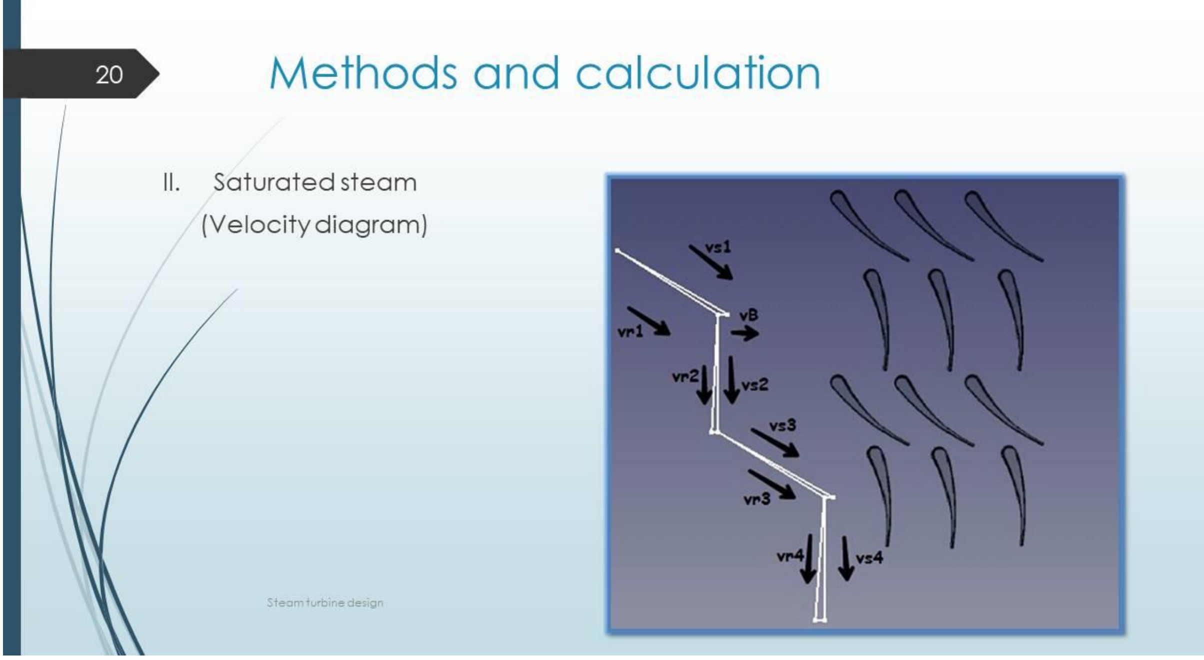
II. Saturated steam

- Second stage

Parameter	Value
debit (kg/s)	3.996
delta h fixe (kJ/kg)	106.7
delta h mobile (kJ/kg)	95.4411
Vs3 (absolute velocity)(m/s)	461.9523785
diameter (m)	0.15
N (round per minute)	3000
VB (velocity of blade) (m/s)	30.94468764
teta2 (degree)	30
tan ϕ2	0.625751954
ϕ2 (rad)	0.559139864
ϕ2 (degree)	32.03635434
Vr3 (relative velocity)(m/s)	435.4284738
δ2 (degree)	90
Vr4	435.6476076
cos(Υ2)	0.071031465
Υ2(rad)	1.499704995
Υ2(degree)	85.92676673
Vs4	434.5471946

Steam turbine design


19
Methods and calculation
I. Superheated steam
(velocity diagram)
First part of steam turbine
Second part of steam turbine
Fixed blades
Moving blades
Fixed blades
Moving blades


20
Methods and calculation
II. Saturated steam
(Velocity diagram)
vs1
vr1
vB
vr2
vs2
vs3
vr3
vr4
vs4
Steam turbine design

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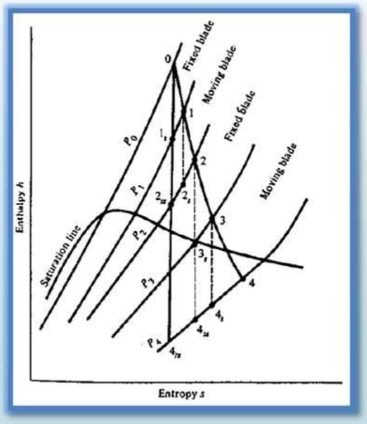
Methods and calculation

Condition curve for a two-stage reaction turbine, drawn on the Mollier (enthalpy-entropy) chart.



Steam turbine design

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Methods and calculation

Calculate the height of the blades

- Second degree's equation

$$\pi L^2 + \frac{\pi D_1 c}{c+d} L - S_t = 0$$

Steam turbine design

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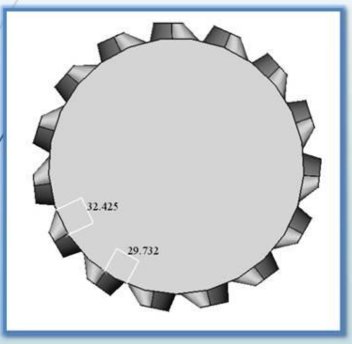
Methods and calculation

Calculate the height of blades

I. Superheated steam

- first stage-first part



Steam turbine design

Parameter	Value
v(specific volume)(m³/Kg)	0.2875
Qv (volume flow rate) (m³/s)	0.690575
St(total section)(cm²)	56.83288254
distance per blades (cm)	2.9
width (cm)	3.2
Diameter (cm)	30
Δ	2721.789507
height of blade (cm)	1.172088793
height (m)	0.011720888

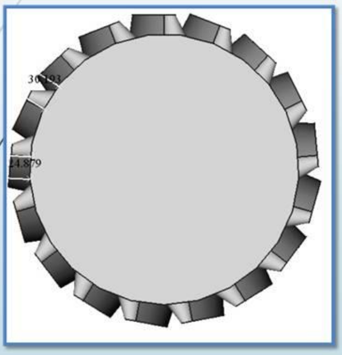
24

Methods and calculation

Calculate the height of blades

I. Superheated steam

- second stage-first part



Steam turbine design

Parameter	Value
v(specific volume)(m³/Kg)	0.571152
Qv (volume flow rate) (m³/s)	1.371907104
St(total section)(cm²)	114.529426
distance per blades (cm)	2.4879
width (cm)	3.0193
Diameter (cm)	30
Δ	3252.004625
height of blade (cm)	2.299714521
height in (m)	0.022997145

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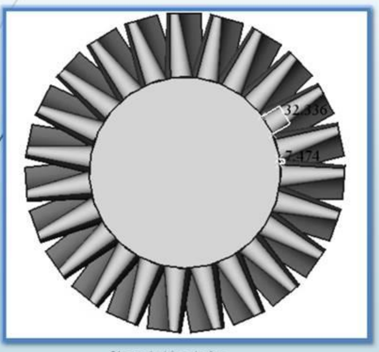
Methods and calculation

Calculate the height of blades

I. Superheated steam

- First stage-second part



Steam turbine design

Parameter	Value
v(specific volume)(m³/Kg)	2.226115
Qv (volume flow rate) (m³/s)	5.34712823
St(total section)(cm²)	501.4891391
distance per blades (cm)	0.7474
width (cm)	3.2336
Diameter (cm)	30
Δ	6614.984697
height of blade (cm)	10.12835175
height (m)	0.101283518

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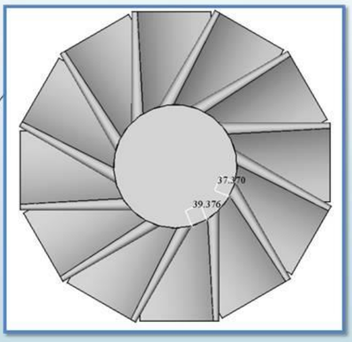
Methods and calculation

Calculate the height of blades

I. Superheated steam

- First stage-second part



Steam turbine design

Parameter	Value
v(specific volume)(m³/Kg)	10.499588
Qv (volume flow rate) (m³/s)	25.22001038
St(total section)(cm²)	2744.793831
distance per blades (cm)	3.9376
width (cm)	3.737
Diameter (cm)	30
Δ	36830.36273
height of blade (cm)	22.84776811
height (m)	0.228477681

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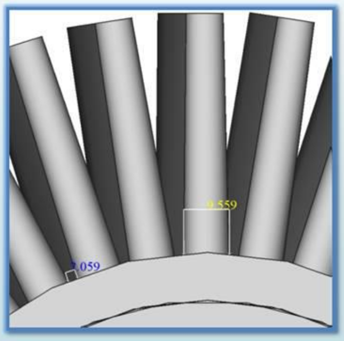
Methods and calculation

Calculate the height of blades

II. Saturated steam

- First stage



Parameter	Value
v(specific volume)(m^3/Kg)	0.379
Qv (volume flow rate) (m^3/s)	1.514484
St(total section)(cm^2)	35.66268784
distance per blades (cm)	0.2059
width (cm)	0.9559
Diameter (cm)	15
Δ	517.8986253
height of blade (cm)	2.292763033
height in m	0.02292763

Steam turbine design

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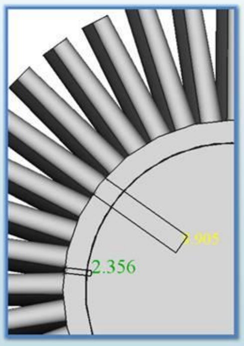
Methods and calculation

Calculate the height of blades

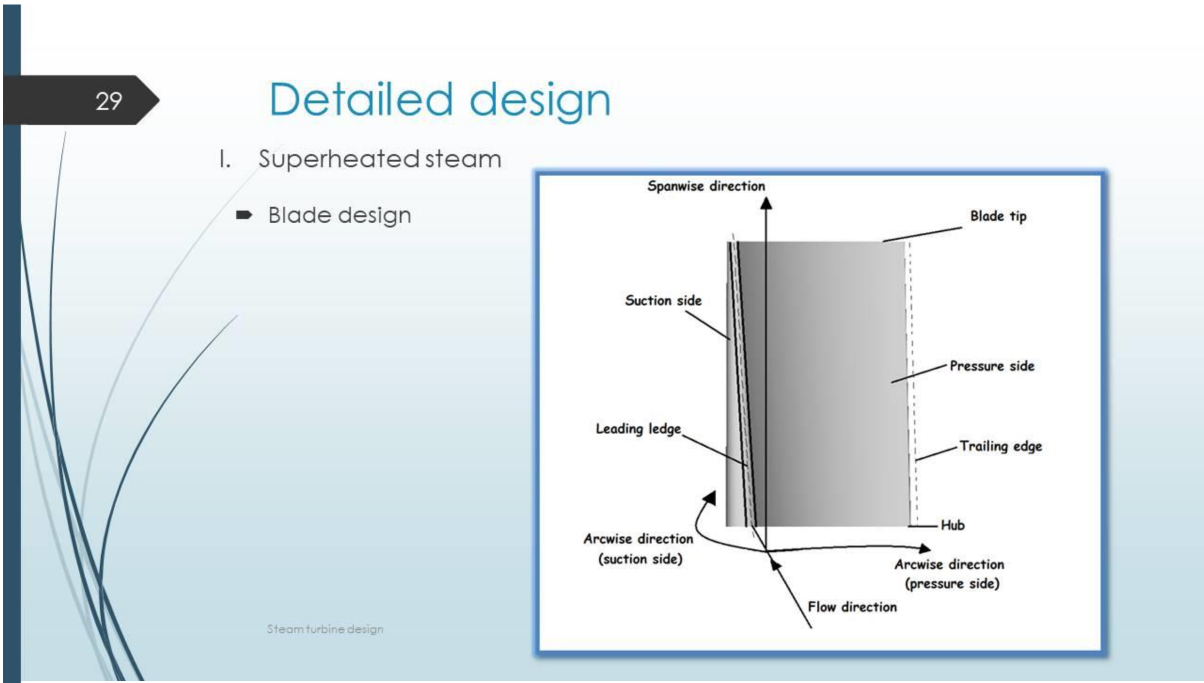
II. Saturated steam

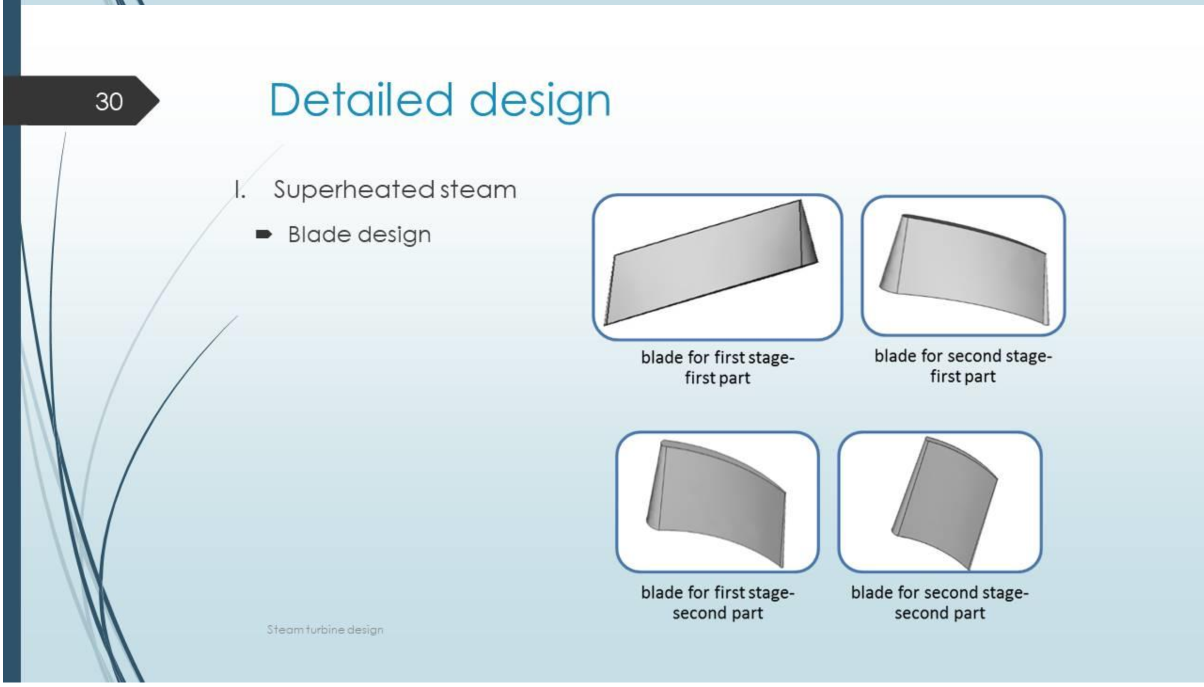
- second stage



Parameter	Value
v(specific volume)(m^3/Kg)	1.262
Qv (volume flow rate) (m^3/s)	5.042952
St(total section)(cm^2)	115.7575966
distance per blades (cm)	0.2356
width (cm)	0.8905
Diameter (cm)	15
Δ	1551.855692
height of blade (cm)	4.700553704
height in m	0.047005537

Steam turbine design


29
Detailed design
I. Superheated steam
Blade design
Spanwise direction
Blade tip
Suction side
Pressure side
Leading ledge
Trailing edge
Hub
Arcwise direction
(suction side)
Arcwise direction
(pressure side)
Flow direction
Steam turbine design


30
Detailed design
I. Superheated steam
Blade design
blade for first stage-
first part
blade for second stage-
first part
blade for first stage-
second part
blade for second stage-
second part
Steam turbine design

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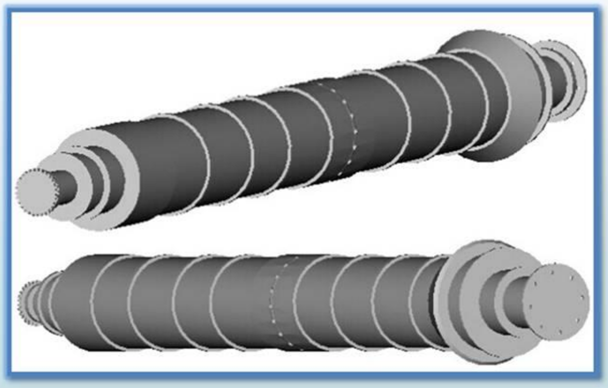
Detailed design

I. Superheated steam

- Shaft design



Steam turbine design

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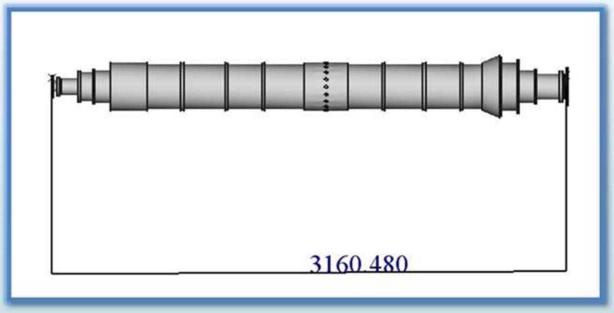
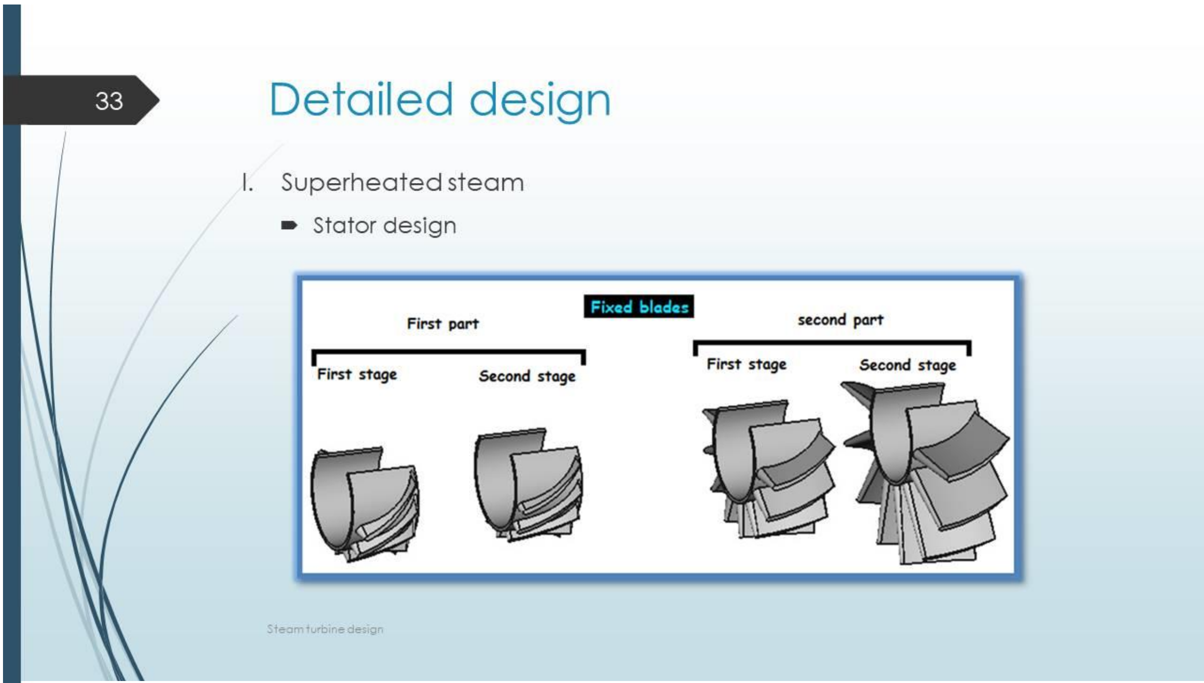
Detailed design

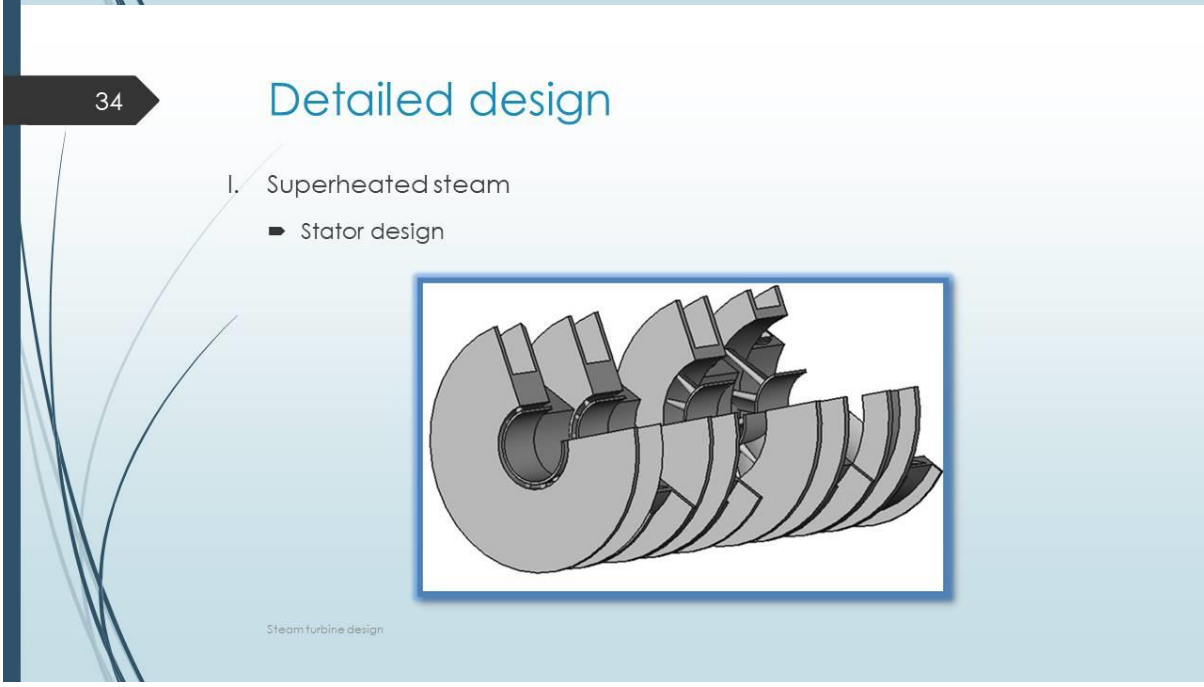
I. Superheated steam

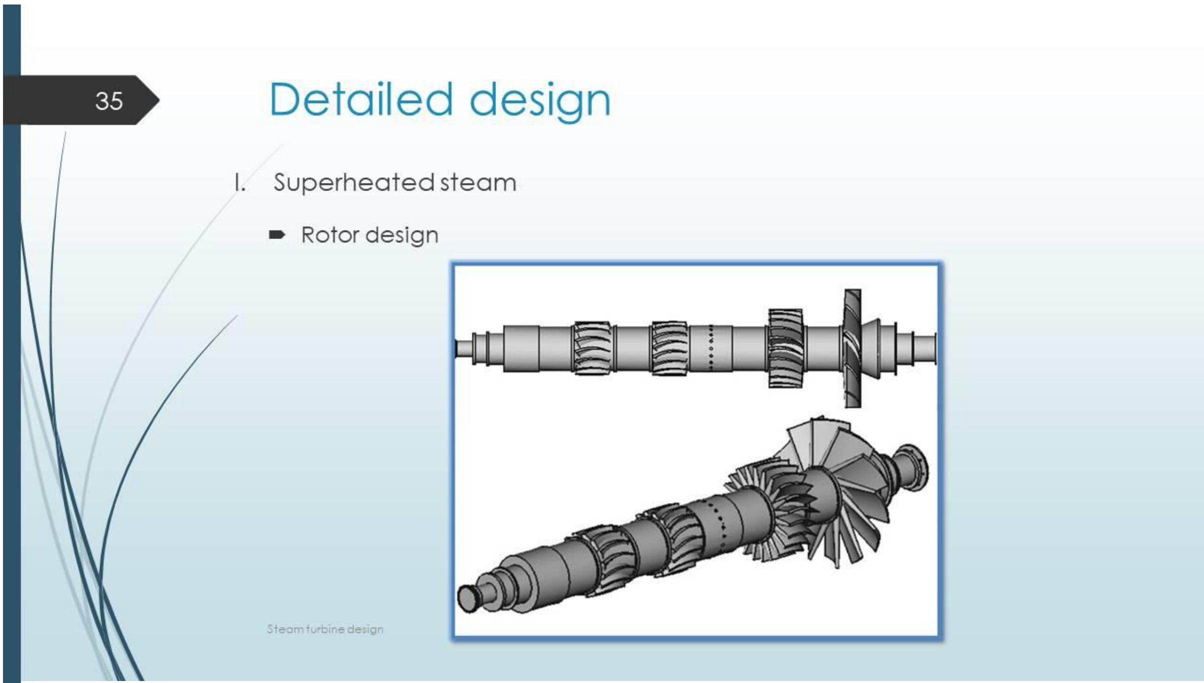
- Shaft design

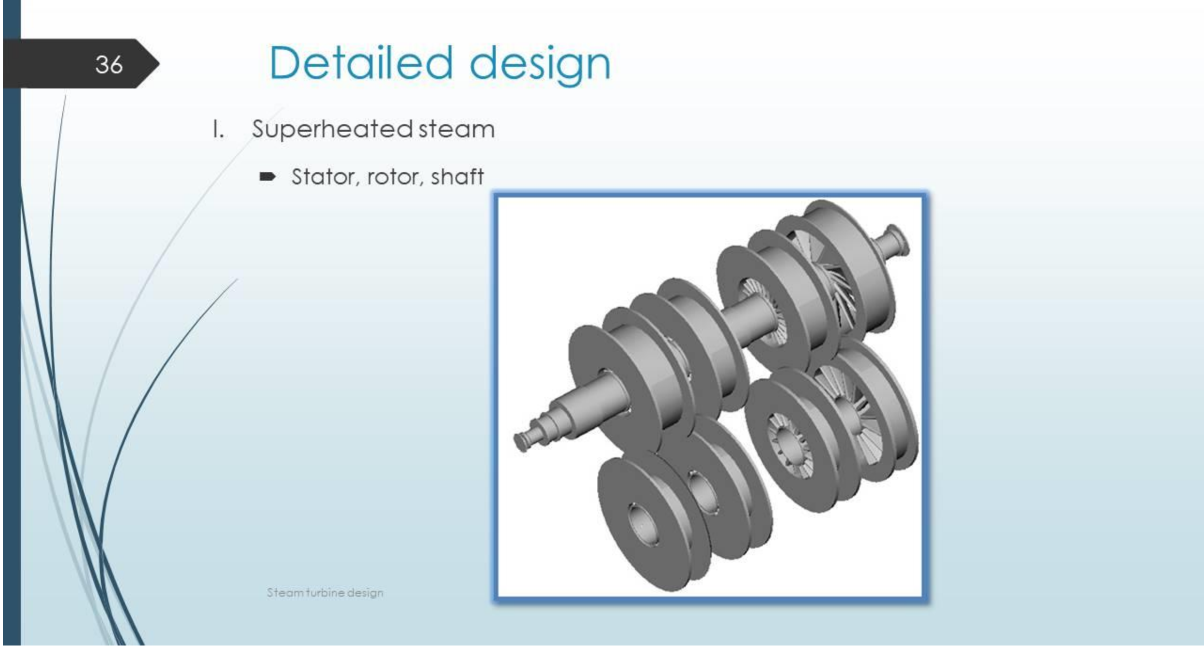


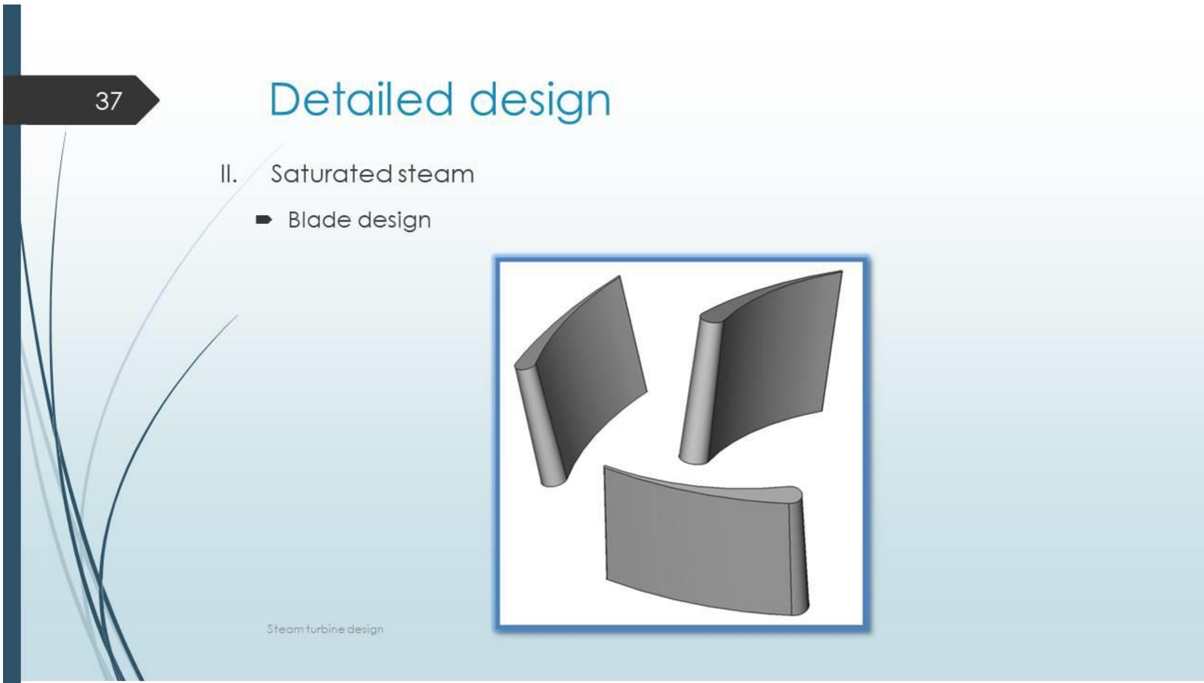
Steam turbine design

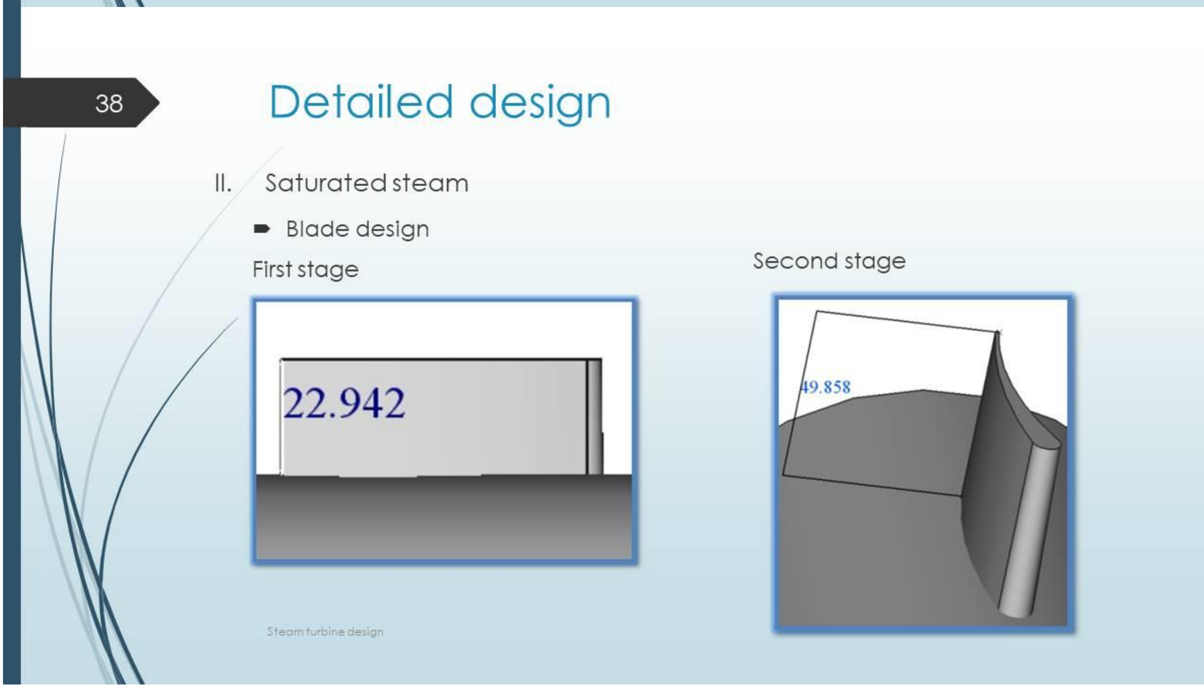

33
Detailed design
I. Superheated steam
Stator design
Fixed blades
First part
First stage
Second stage
second part
First stage
Second stage
Steam turbine design

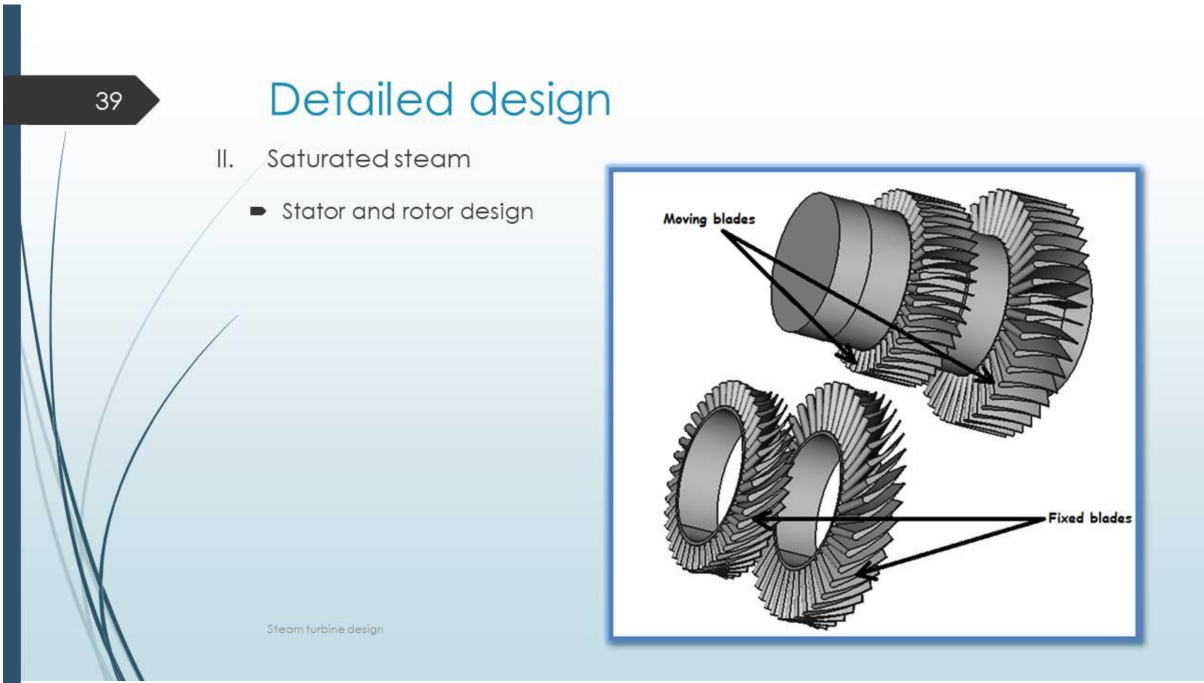

34
Detailed design
I. Superheated steam
Stator design
Steam turbine design

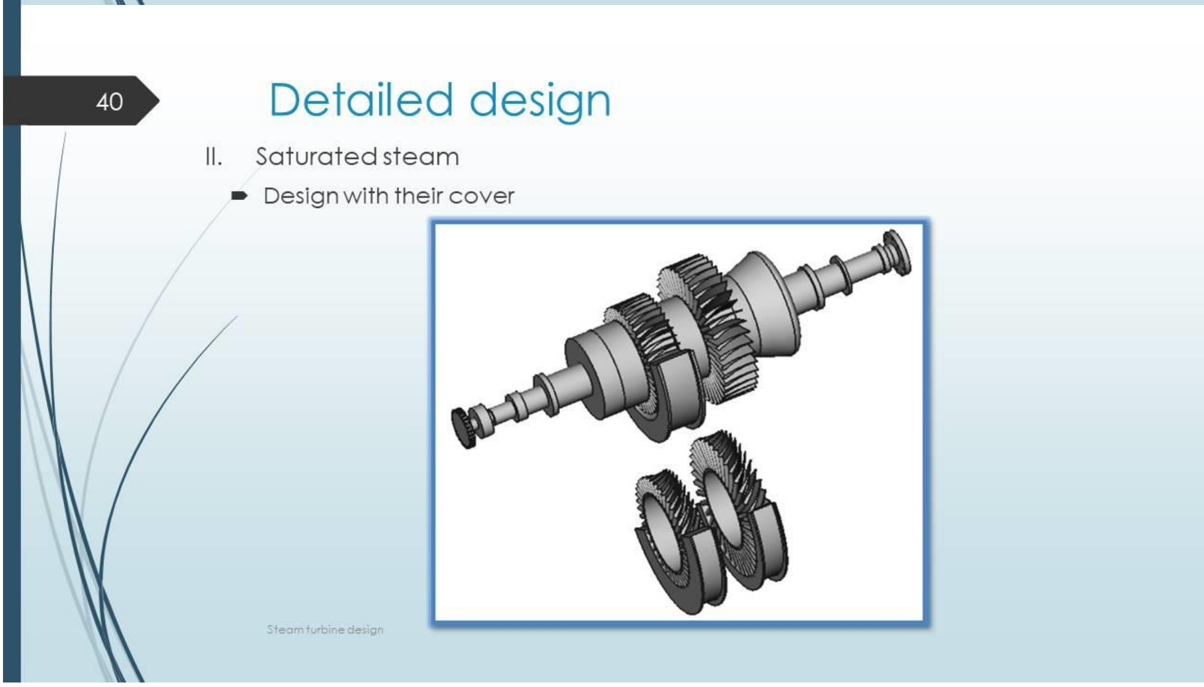

35
Detailed design
I. Superheated steam
Rotor design
Steam turbine design

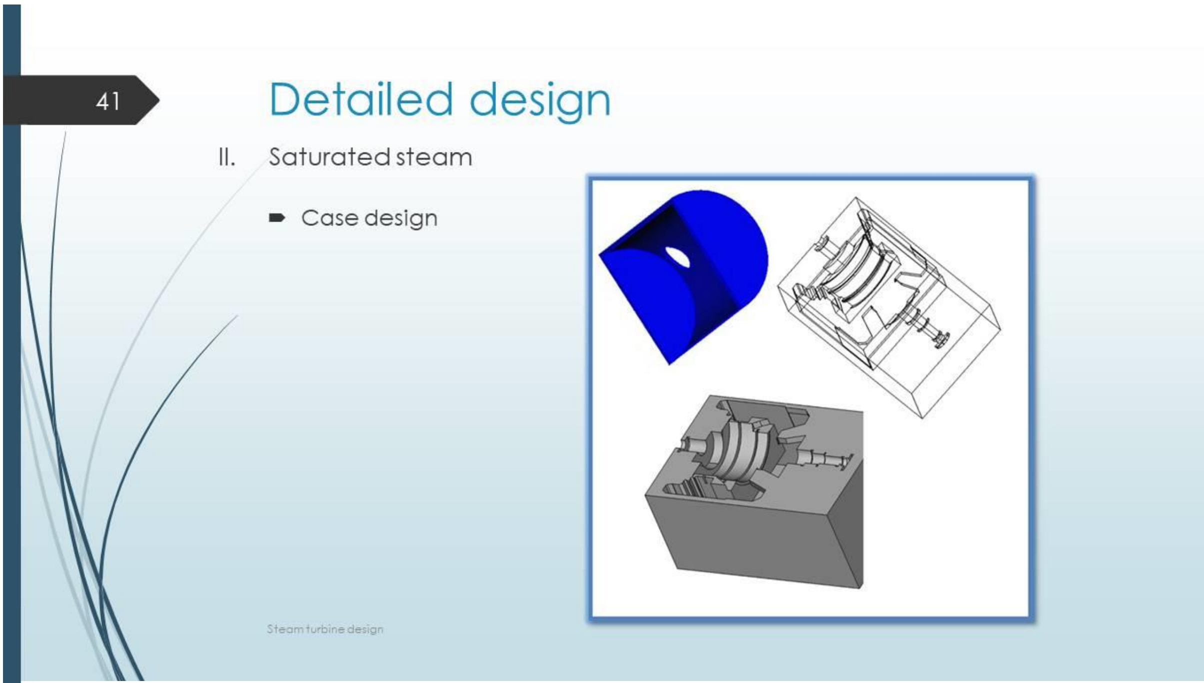

36
Detailed design
I. Superheated steam
Stator, rotor, shaft
Steam turbine design

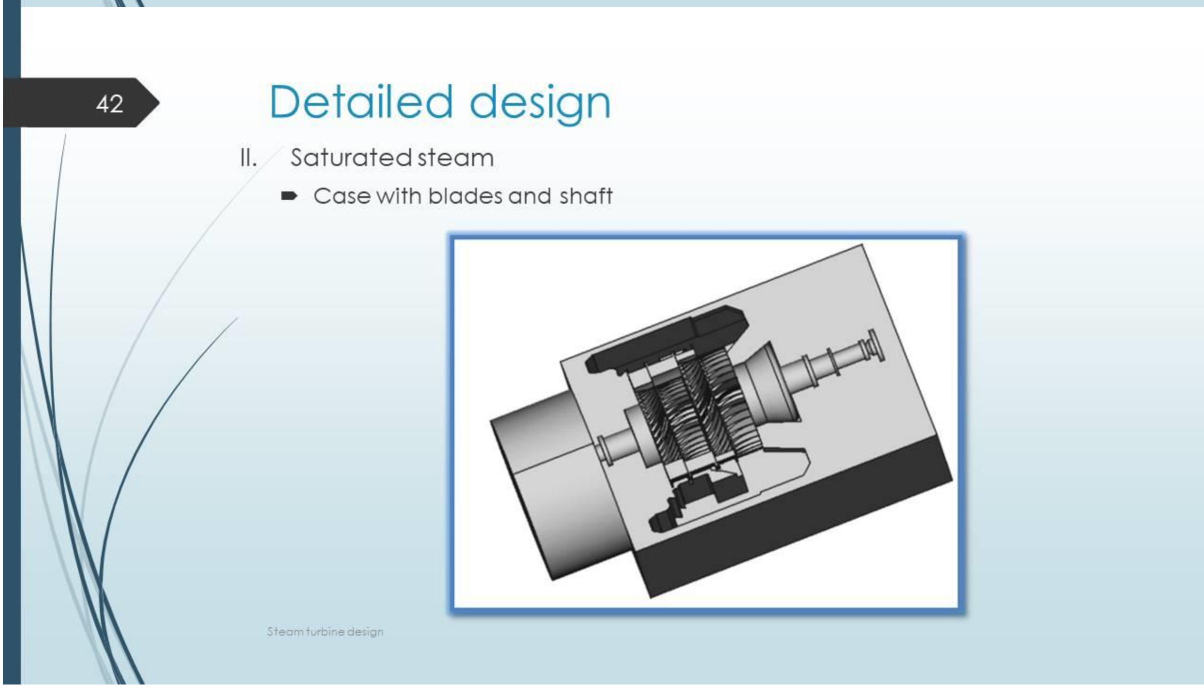

37
Detailed design
II. Saturated steam
Blade design
Steam turbine design

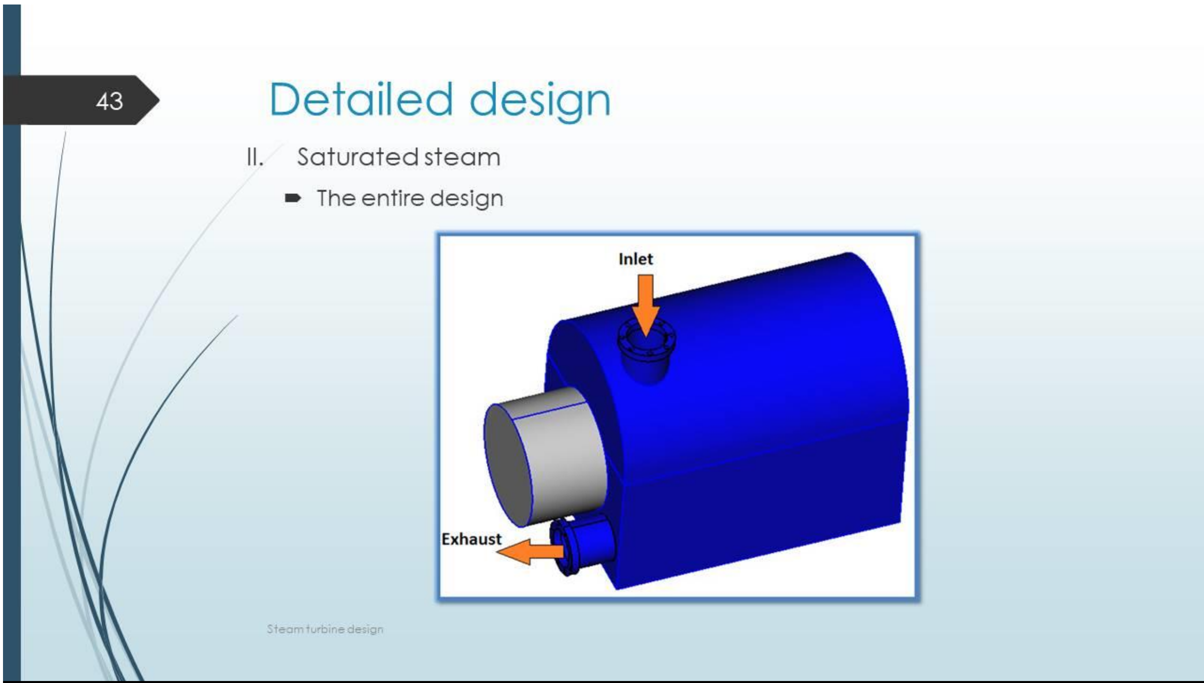

38
Detailed design
II. Saturated steam
Blade design
First stage
Second stage
22.942
49.858
Steam turbine design

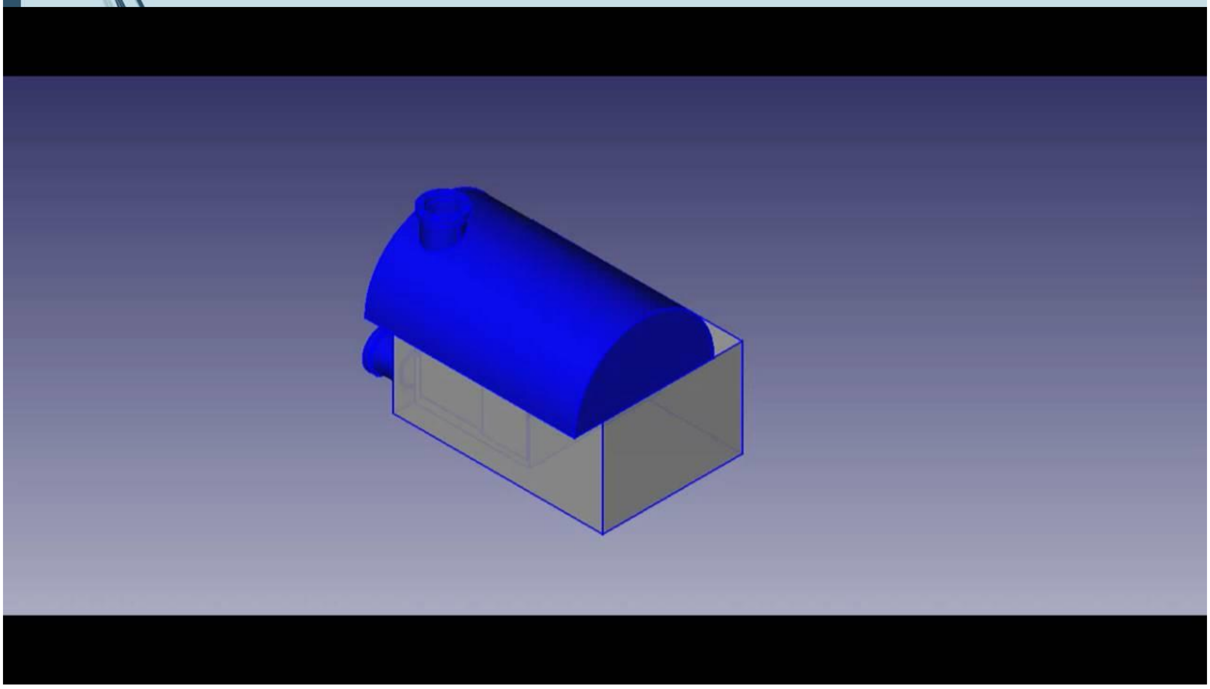

39
Detailed design
II. Saturated steam
Stator and rotor design
Moving blades
Fixed blades
Steam turbine design

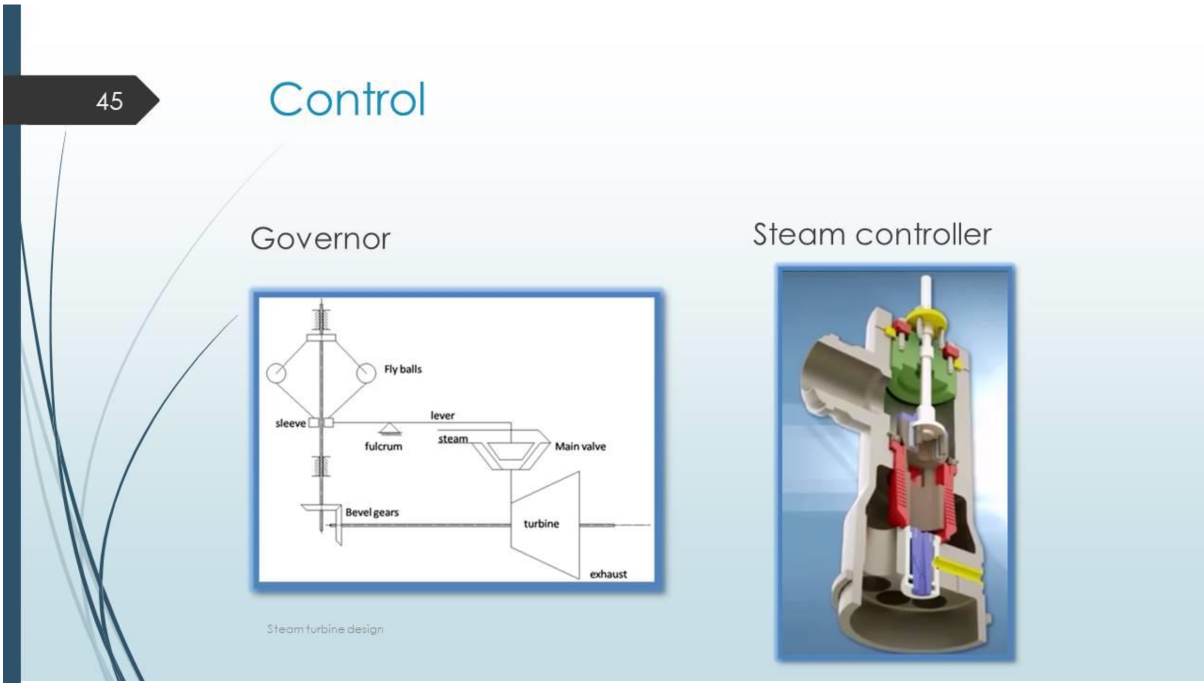

40
Detailed design
II. Saturated steam
Design with their cover
Steam turbine design


41
Detailed design
II. Saturated steam
Case design
Steam turbine design

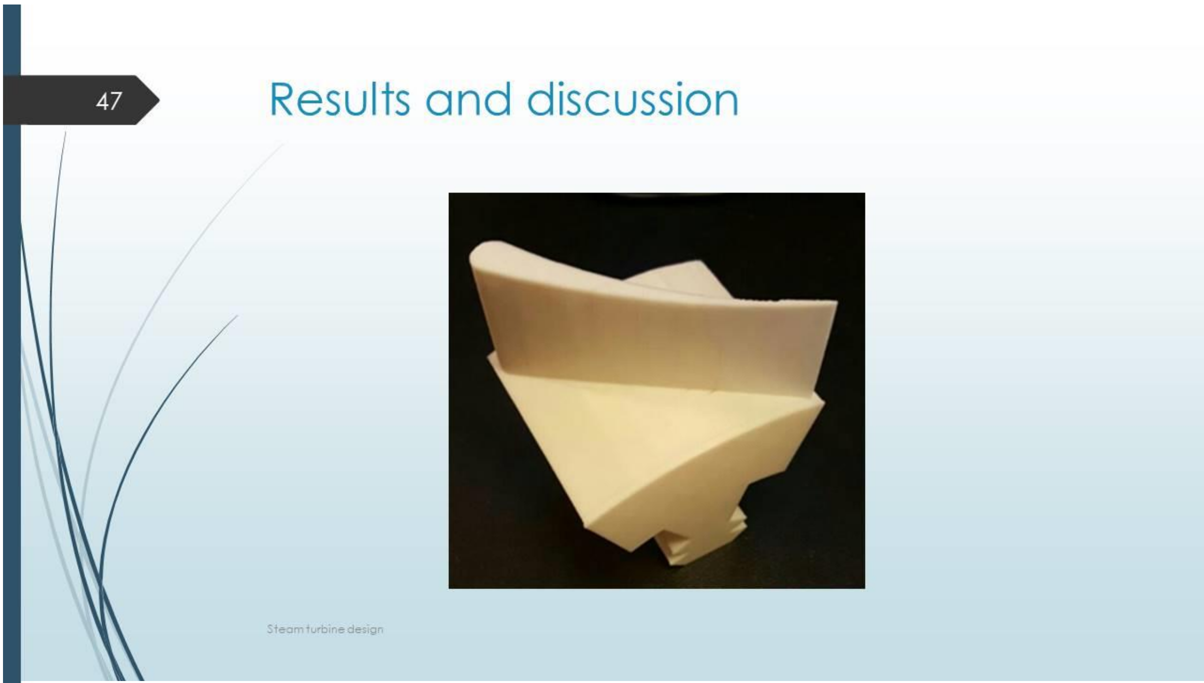

42
Detailed design
II. Saturated steam
Case with blades and shaft
Steam turbine design


43
Detailed design
II. Saturated steam
The entire design
Inlet
Exhaust
Steam turbine design

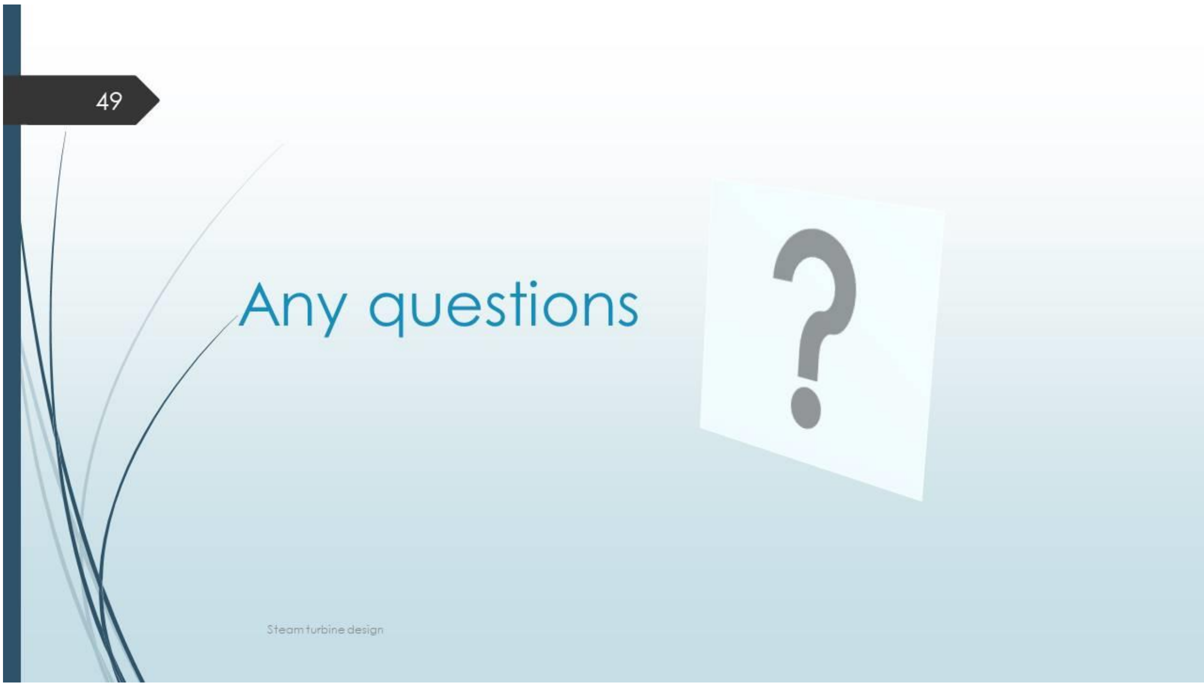



45
Control
Governor
Steam controller
Fly balls
sleeve
lever
fulcrum
steam
Main valve
Bevel gears
turbine
exhaust
Steam turbine design


46
Control
Steam controller designed in Free CAD
Steam turbine design


47
Results and discussion
Steam turbine design


48
General conclusion
We need more time for manufacturing and it is expansive
Steam turbine design


49
Any questions
?
Steam turbine design

NLAP 1.5 MW Incineration Power Plant, Technical&Business Specification

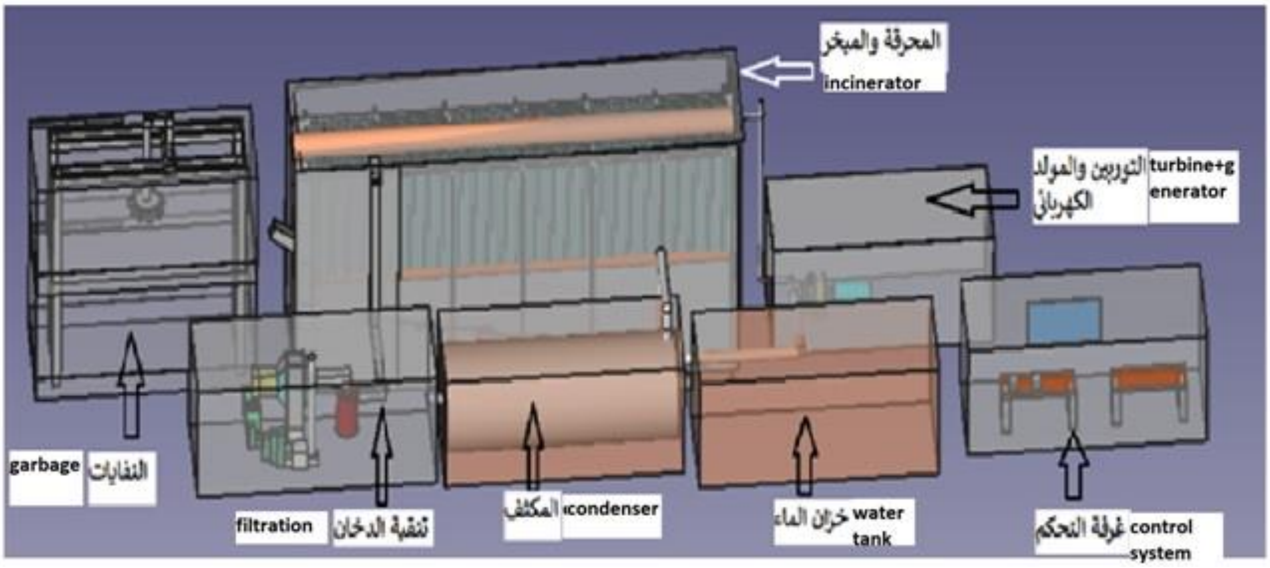
محطة طاقة كهربائية عن طريق حرق النفايات بحجم

1.5 MW

المواصفات الفنية والادارية

NLAP 1.5 MW Incineration Power Plant, Technical&Business Specification

Last update: 6. 2. 2019



Authors:

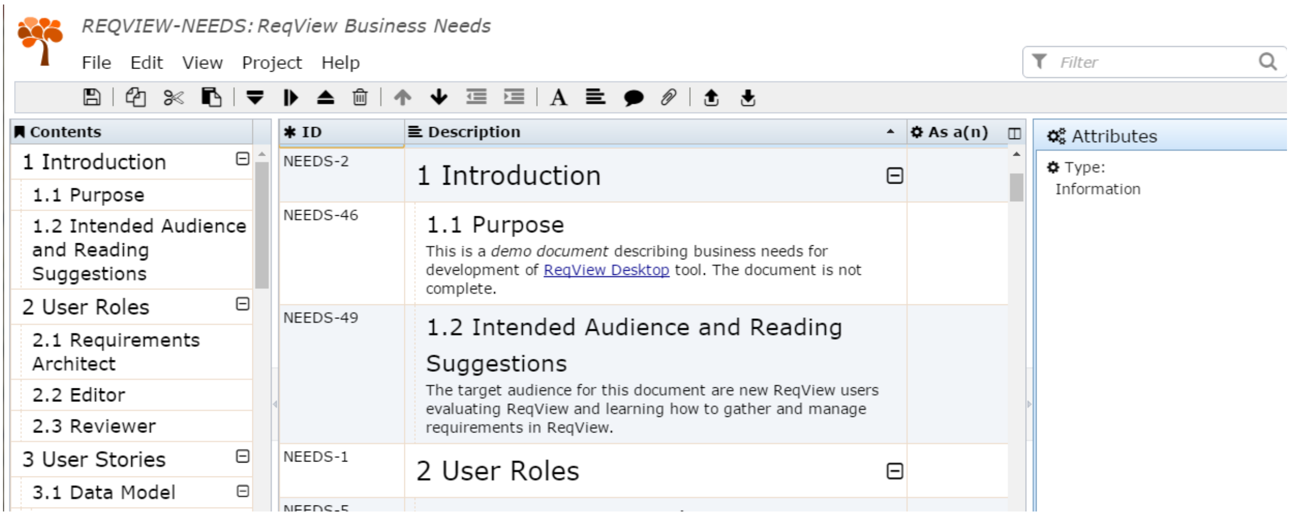
Samir Mourad, Maysaa Kamareddine, Malak Zoebi

Responsible for Document: Samir Mourad

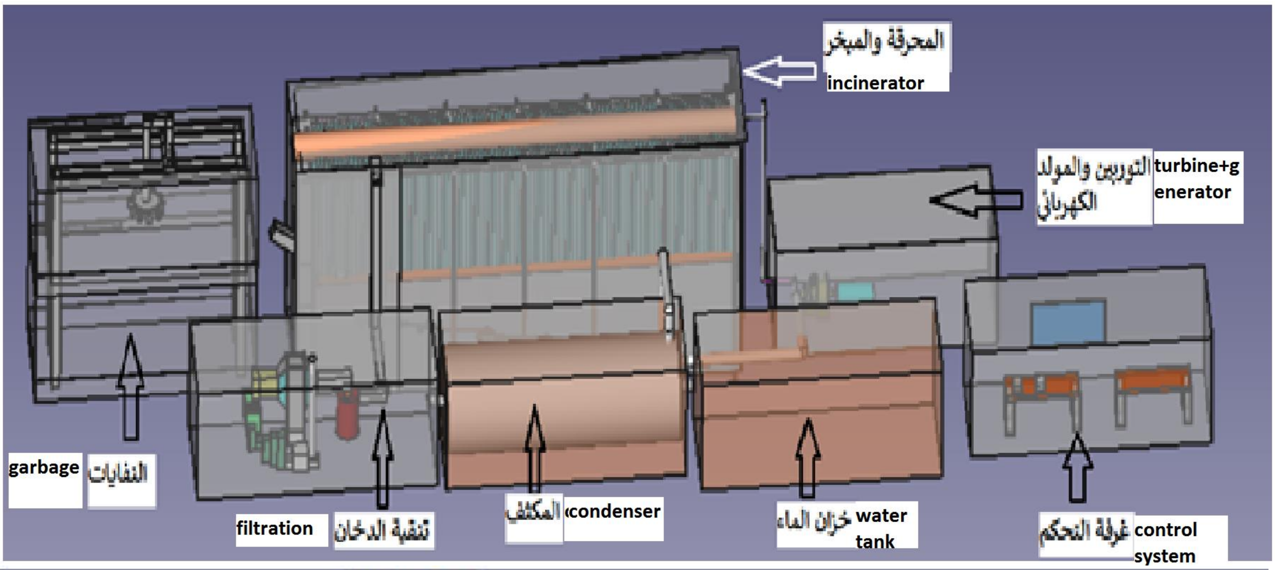
هذا المشروع يهدف الى تصنيع اول محطة صنع معظم الاجزاء من مؤسسة طاقة الشمال ومن ضمن ذلك التوربين.

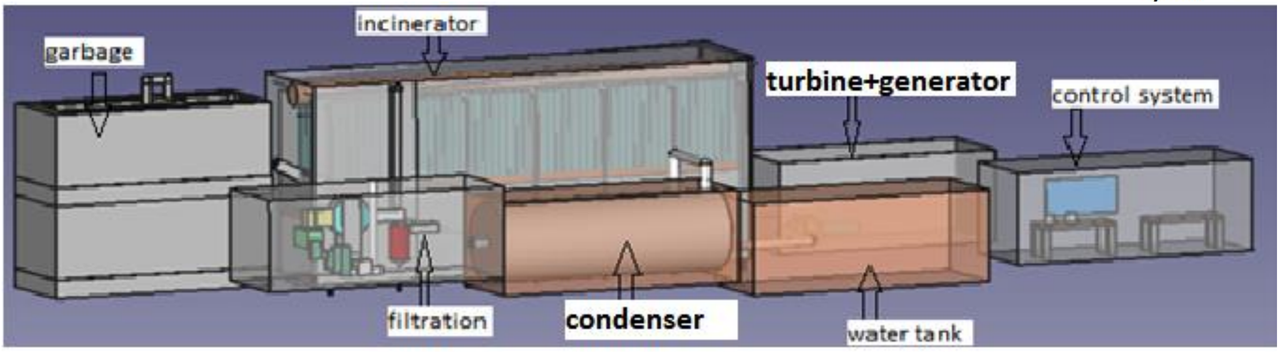
17 الاحتياجات (Requirements)

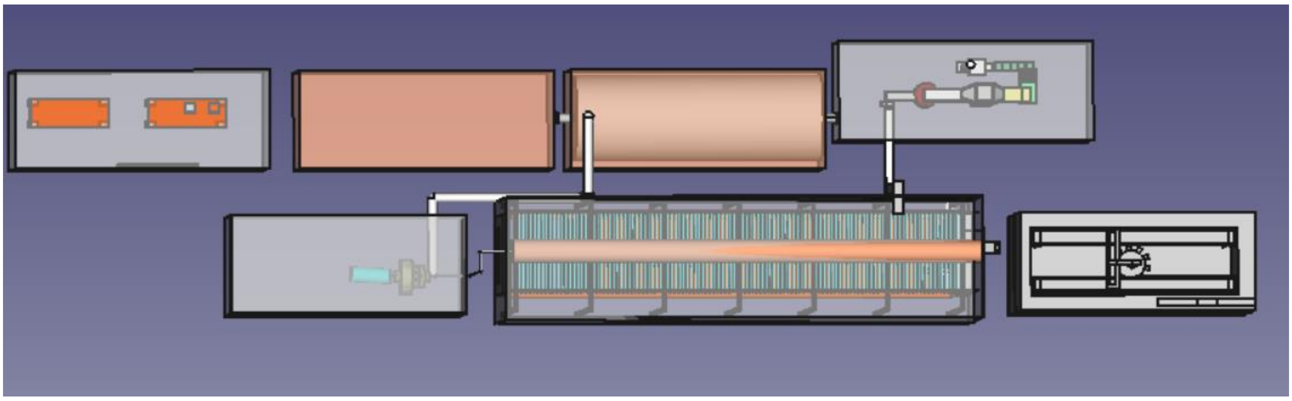
17.1 مثال لوضع الاحتياجات



18 تصميم المنظومة (System design)

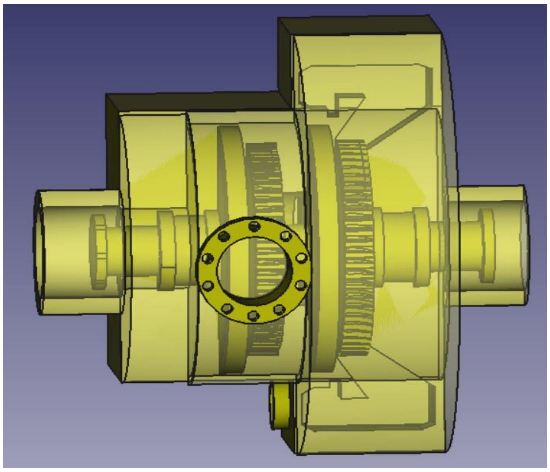


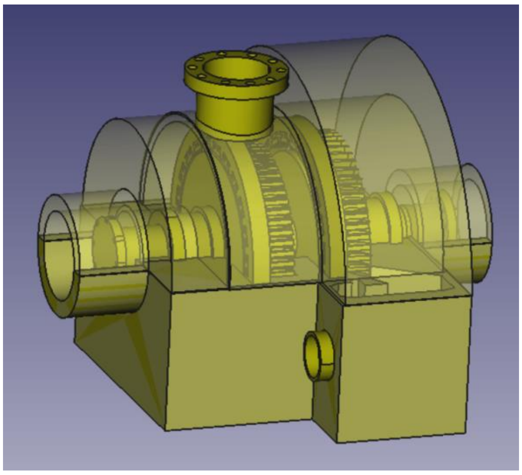




19 التوربين (Turbine)

19.1 تصميم في برنامج FreeCAD

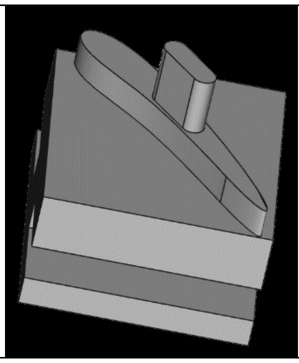




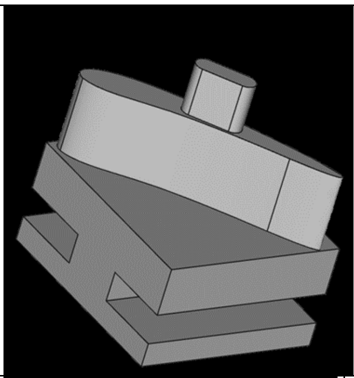
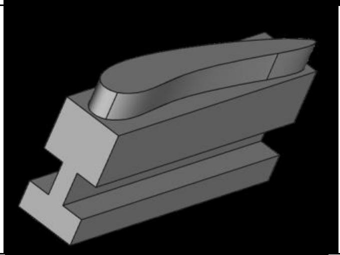
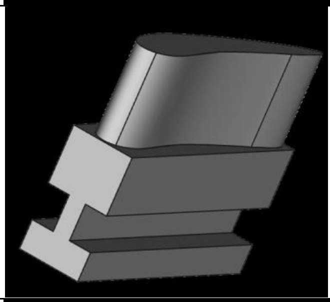
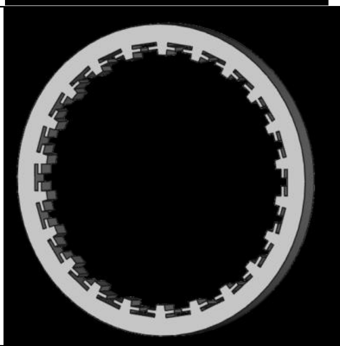
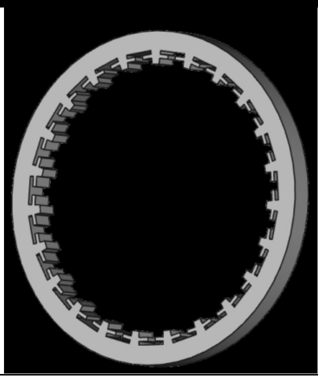
D:\NLAP\NLAP-FreeCAD_DATABASE\TURBINE\1.5MW_14bar_195C\turbine_integration\071216-NLap-1.5 MW Plant_steam turbine.FCStd

071216-NLap-1.5 MW Plant_steam turb

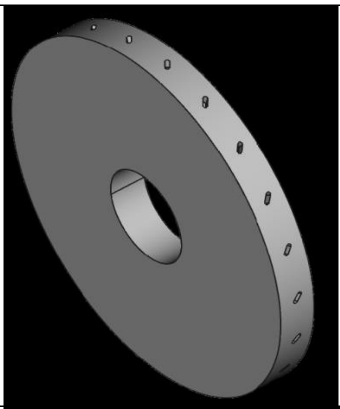
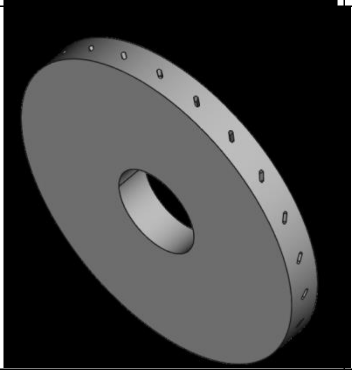
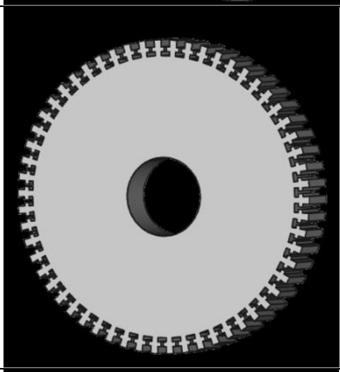
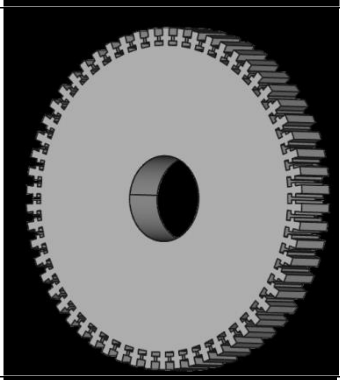
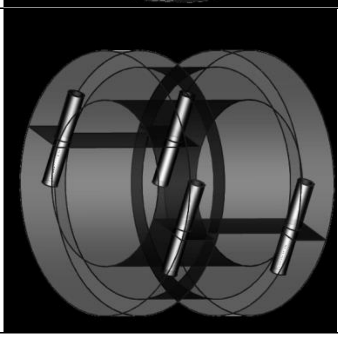
19.2 Parts and costs of our 1.5 MW steam turbine

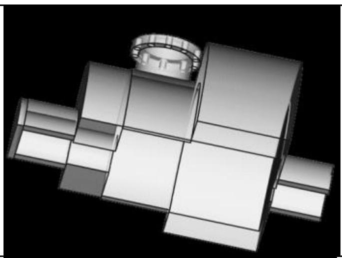
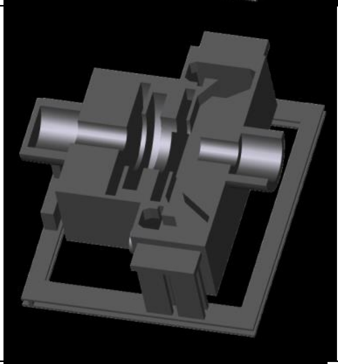
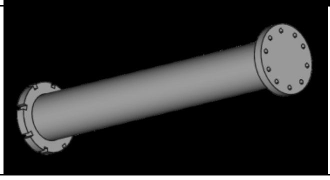
Name	3D design			عدد القطع المطلوبة #pieces	كيفية الصناعة How it is manufactured	Material	سعر القطعة الواحدة
FB-FS[2]	Figure 1			22	CNC machine	Stainless steel	50$

- [2] FB-FS: Fixed blades for the first stage.

FB-SS[3]	Figure 2		23	CNC machine	Stainless steel	50$
MB-FS[4]	Figure 3		58	CNC machine	Stainless steel	50$
MB-SS[5]	Figure 4		58	CNC machine	Stainless steel	50$
Outer cylinder for FB-FS	Figure 5		1	CNC machine		
Outer cylinder for FB-SS	Figure 6		1	CNC machine		

- [3] FB-SS: Fixed blades for the second stage.
- [4] MB-FS: Moving blades for the first stage.
- [5] MB-SS: Moving blades for the second stage.

Inner cylinder for FB-FS	Figure 7		1	CNC machine		
Inner cylinder for FB-SS	Figure 8		1	CNC machine		
Cylinder for MB-FS	Figure 9		1	CNC machine		
Cylinder for MB-SS	Figure 10		1	CNC machine		
Bearings	Figure 11		2	CNC machine		

Case (upside)	Figure 12		1	CNC machine		
Case (down side)	Figure 13		1	CNC machine		
Shaft	Figure 14		1	CNC machine		

Note: that cost is without the material only for the CNC machining.

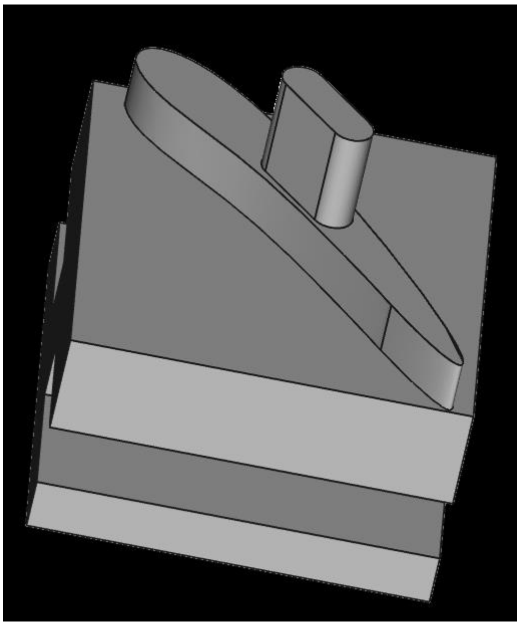


Figure 17

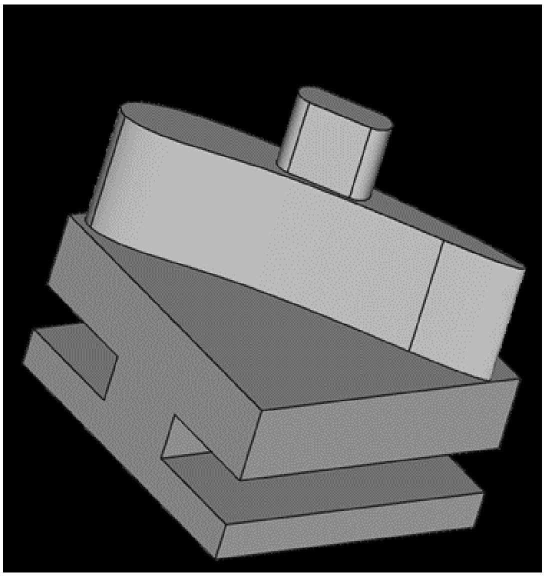


Figure 18

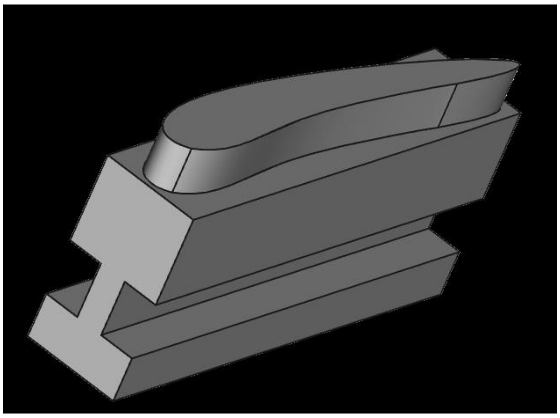


Figure 19

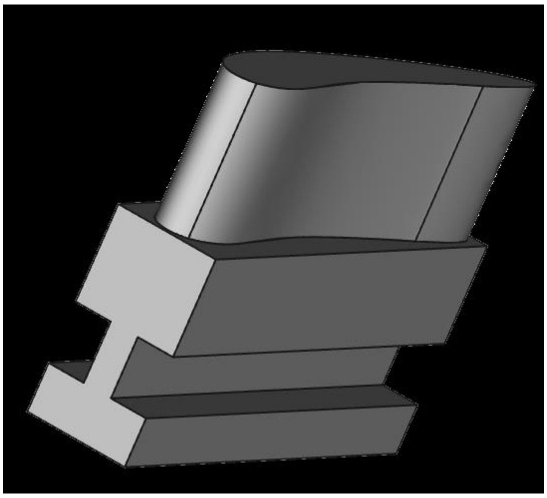


Figure 20

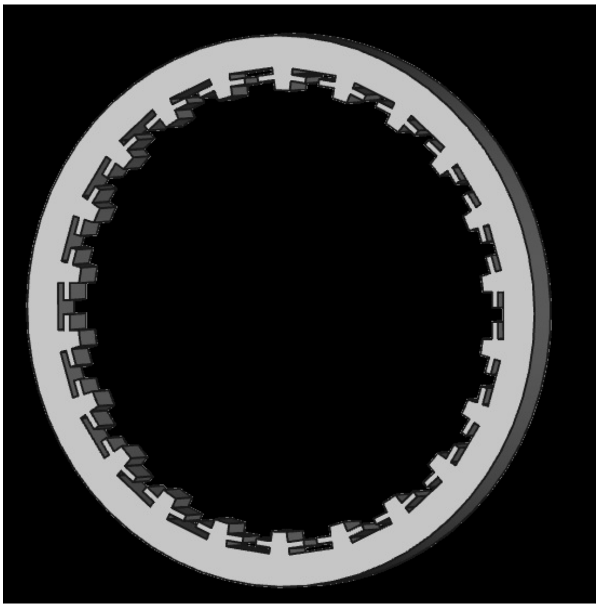


Figure 21

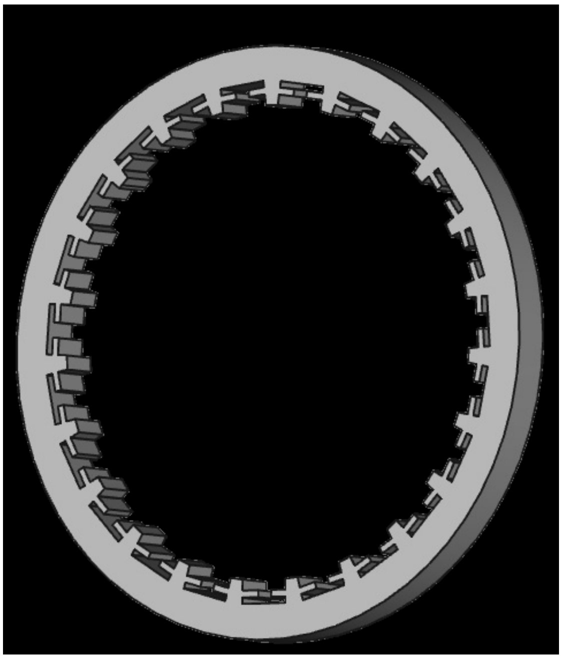


Figure 22

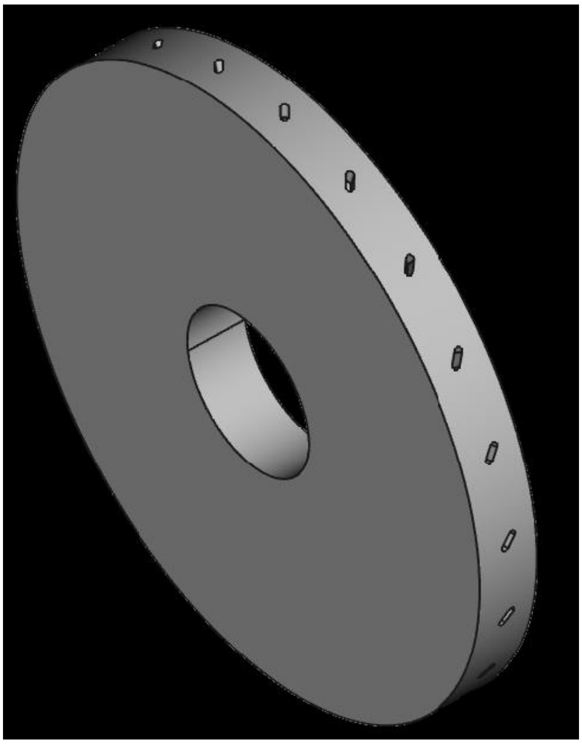


Figure 23

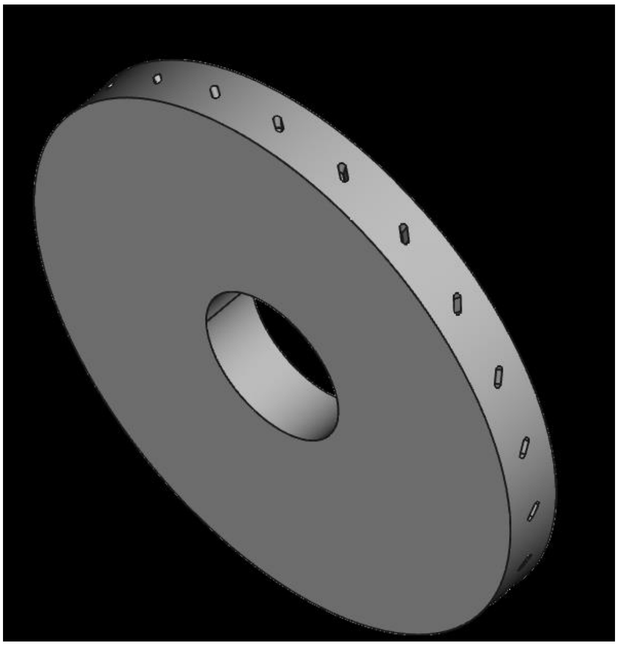


Figure 24

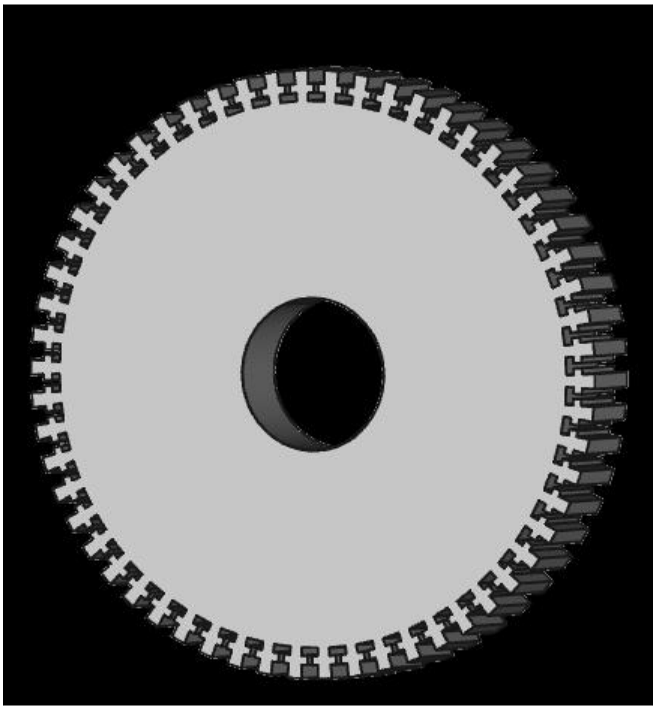


Figure 25

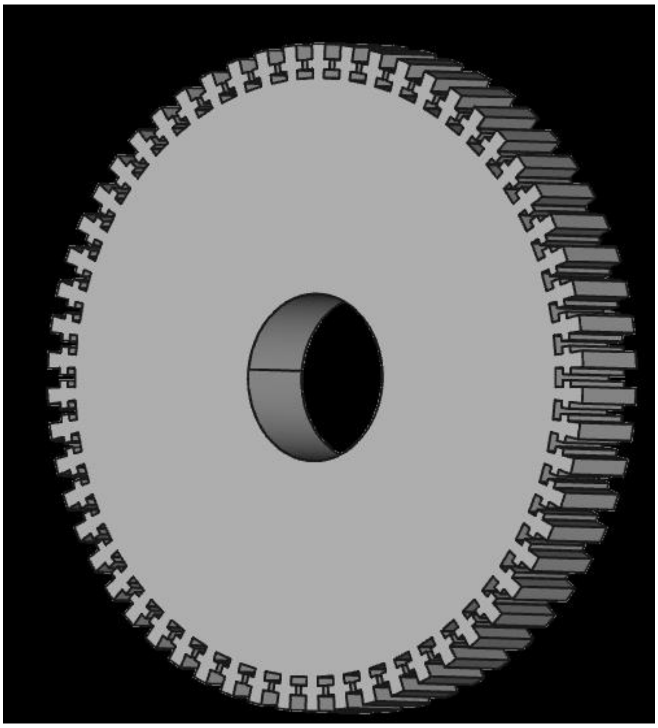


Figure 26

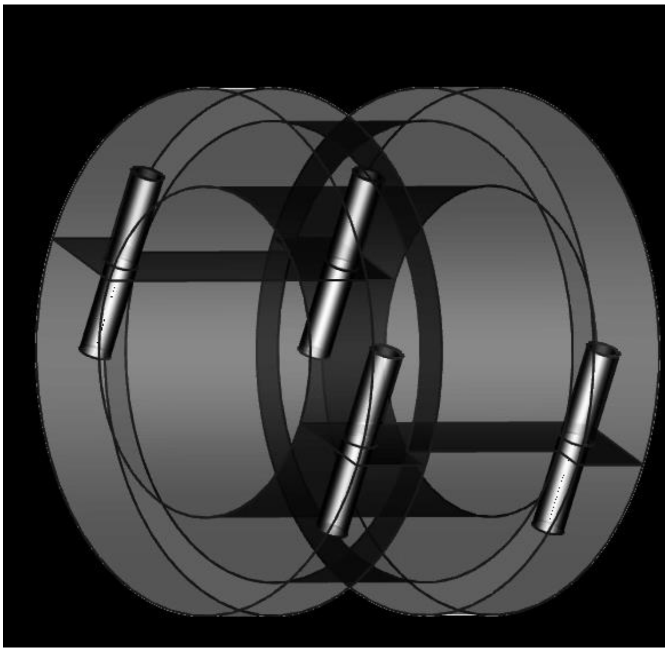


Figure 27

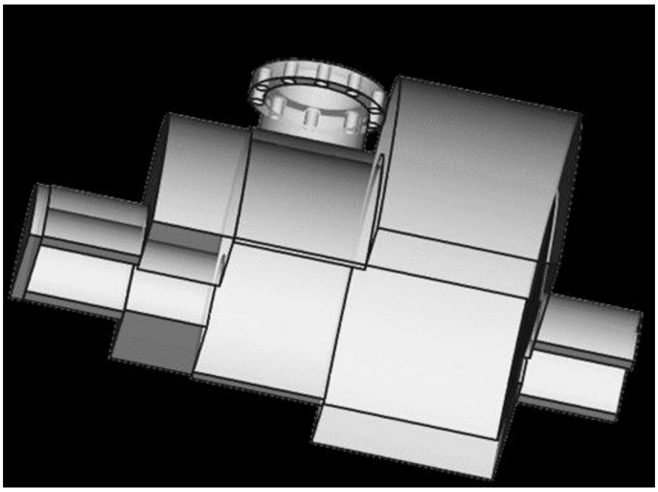


Figure 28

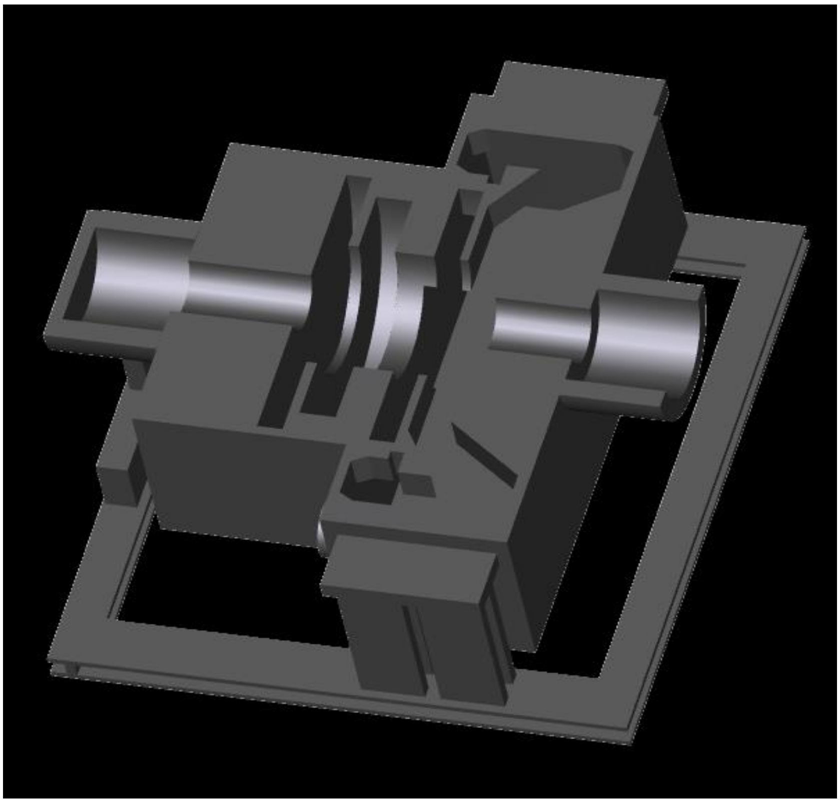


Figure 29

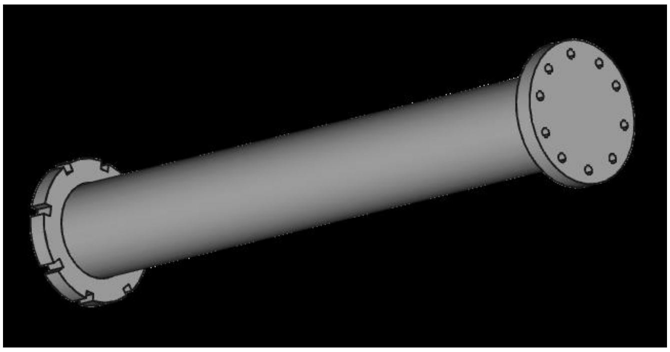


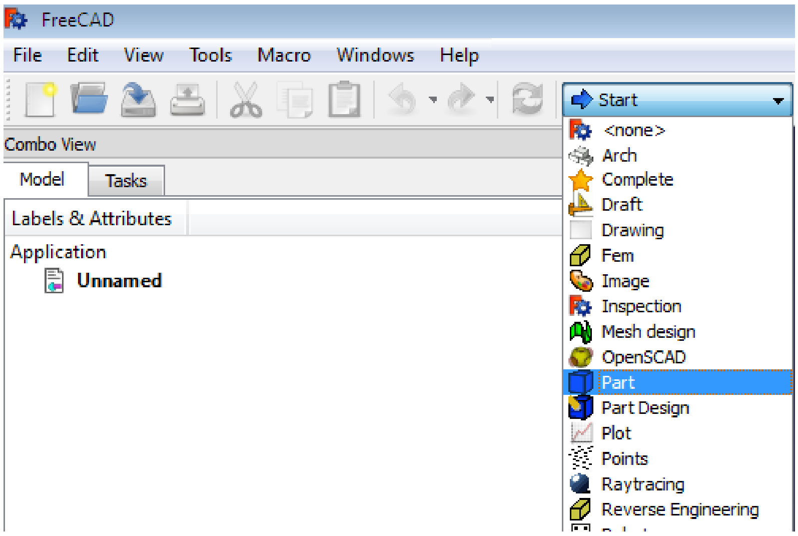
Figure 30

19.3 FreeCAD 2D Drawings of Turbine for manufactoring

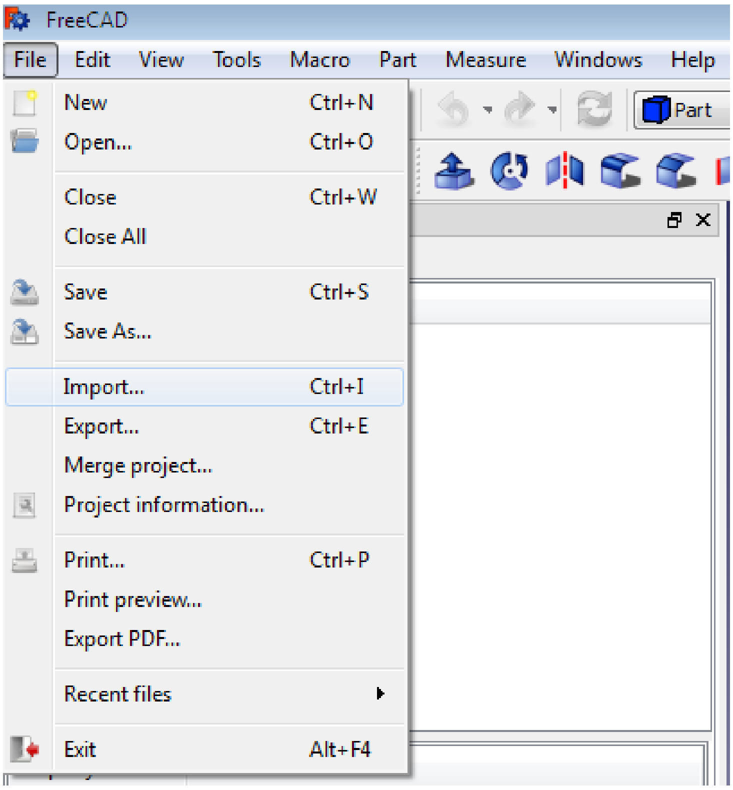
19.3.1 Drawing a FreeCAD 3D object to 2D

Follow those step to obtain it:

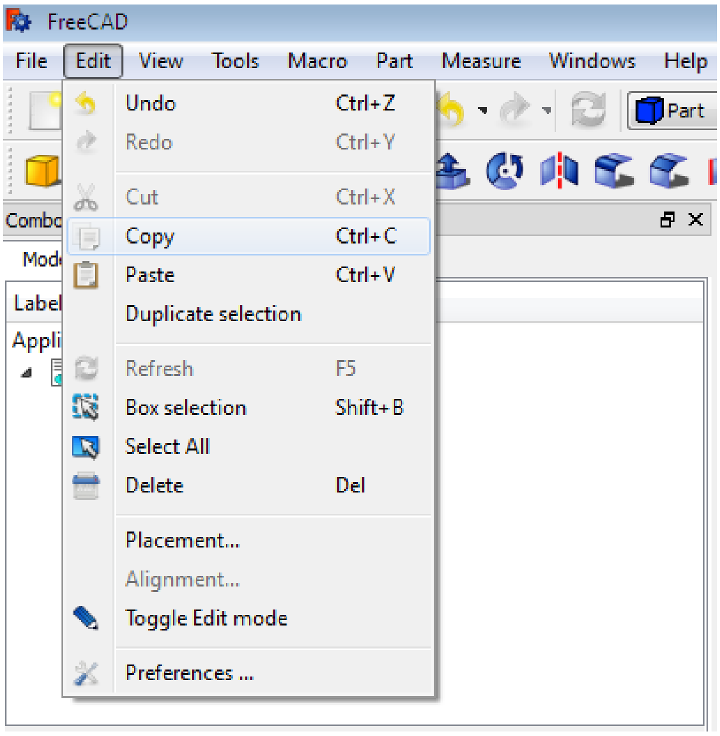
1 Select in “Start “menu, the part section.



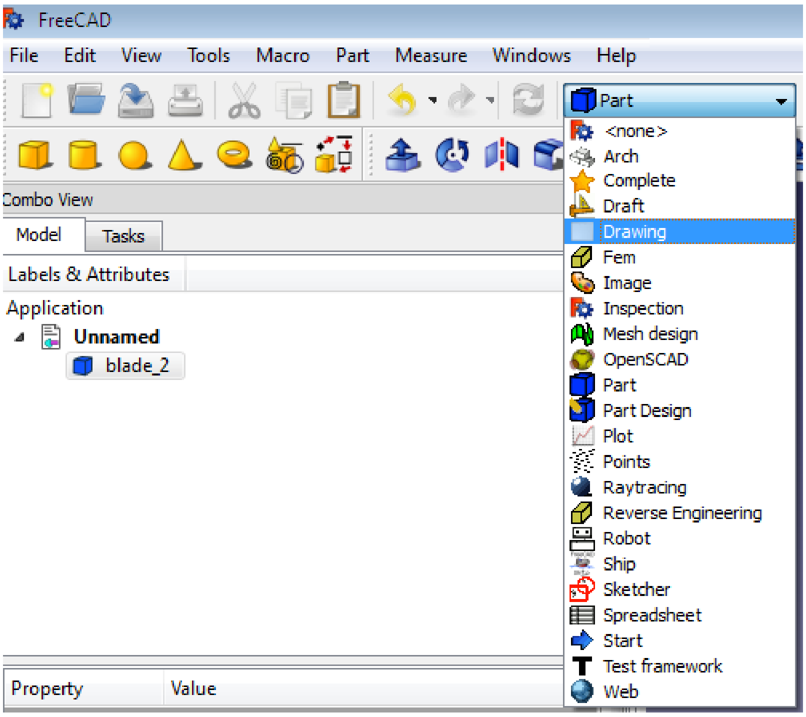
2 Create simple copy of the object that was designed, or import an exported file of a Free CAD.



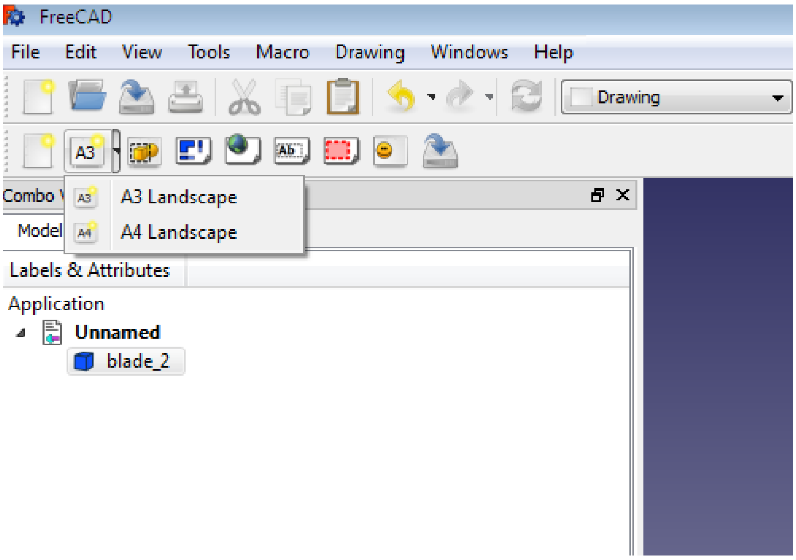
3 Select "Edit" in the toolbar, copy then paste. (After selecting of the object).



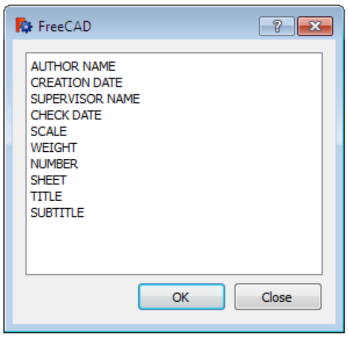
4 Select in Start menu, the “drawing” section.

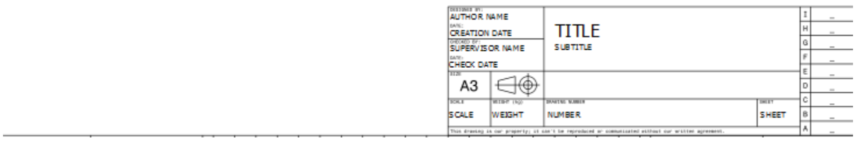


5 Select “A3” then “A3 Landscape”.

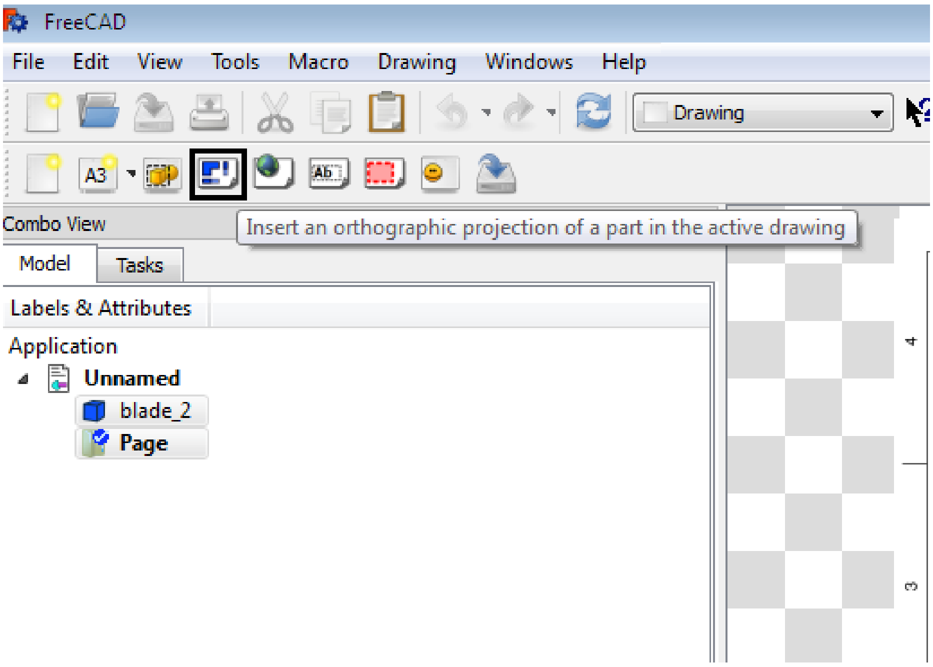


6 Double click on the folder named "page" in the left, "data" in down, 3 points in left of "Editable Texts" then you can change texts in the option pane. (Then it is changed in the rectangle down).

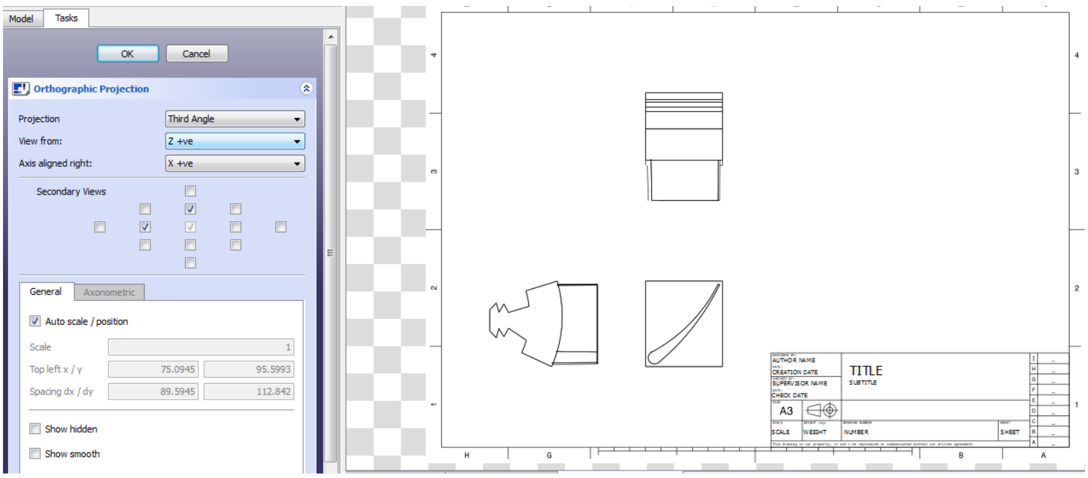




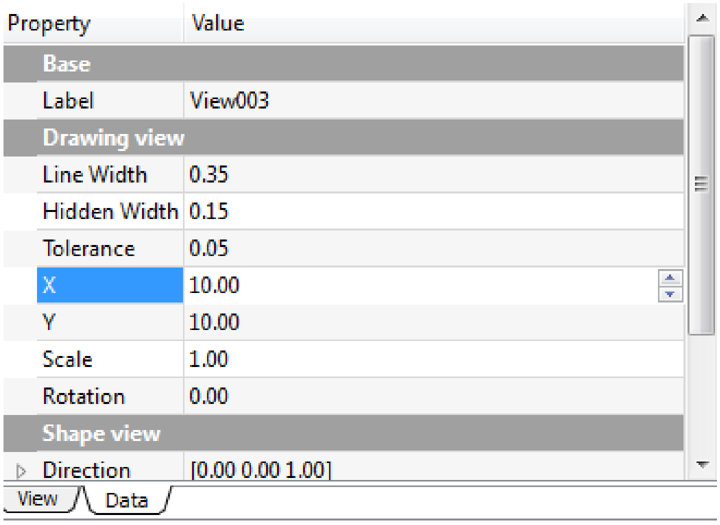
7 Select the part and the page in the left together (by CTRL), insert an orthographic projection of a part in the active drawing.



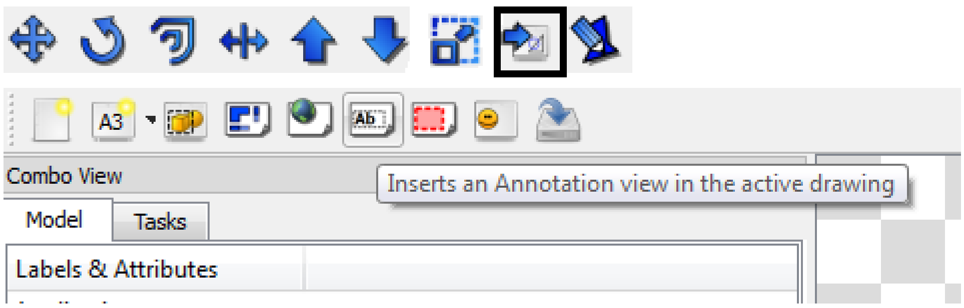
8 Choose Z +ve, in view form, and then put the right symbol in two cases.



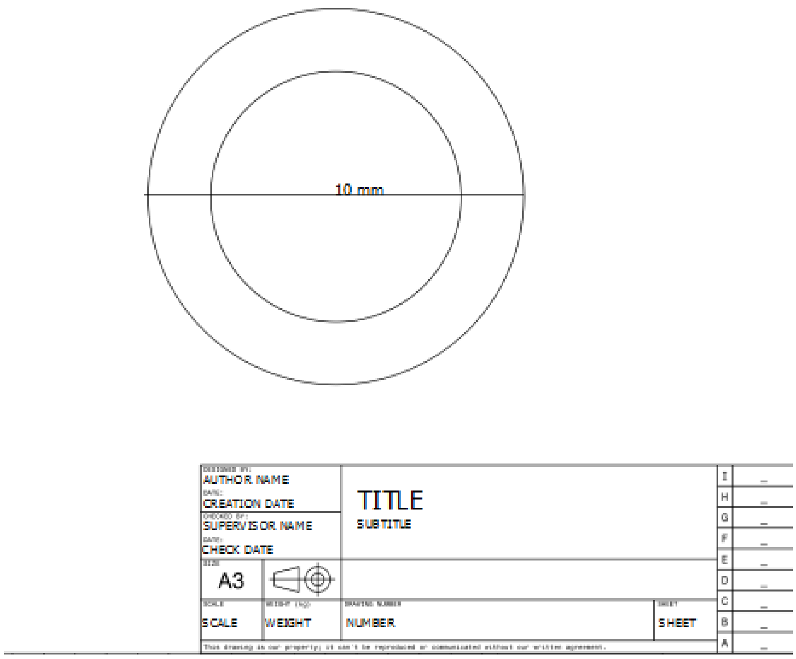
9 You can insert a new view, then change the placement of the view according to the placement of the others.



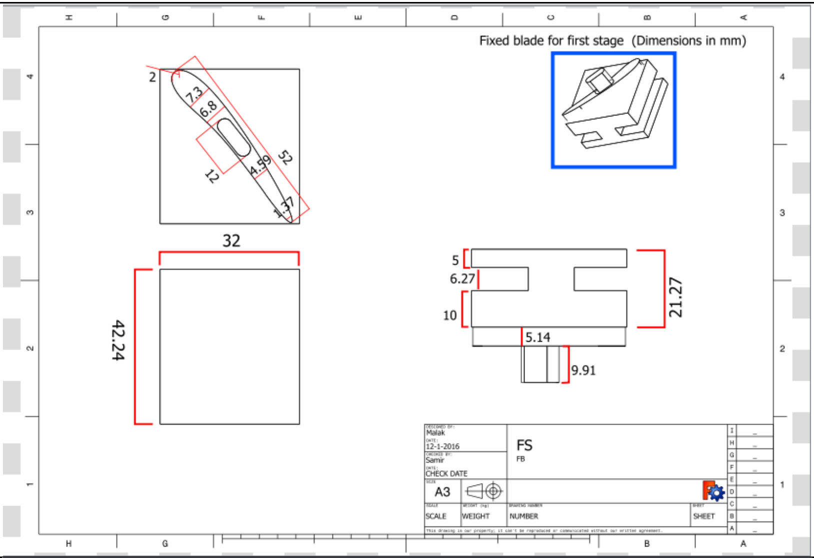
10 In the start menu, use the “sketcher” for putting any lines or other, then you can put it on the drawing sheet by select an icon in the draft section. (After selection the “page” and the “sketcher” together). And also you can inserts an annotation (after selection of the objet and page together).



You obtain as this (for example):



19.3.2 2D drawings of our 1.5 MW turbine

<table>
<tr><th>Name</th><th>2D Drawing</th></tr>
<tr><td>FB-FS</td><td>
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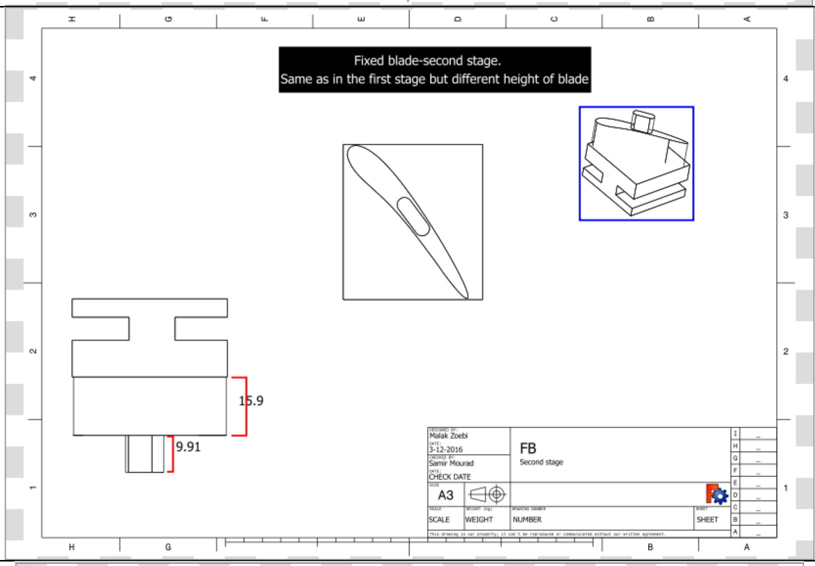
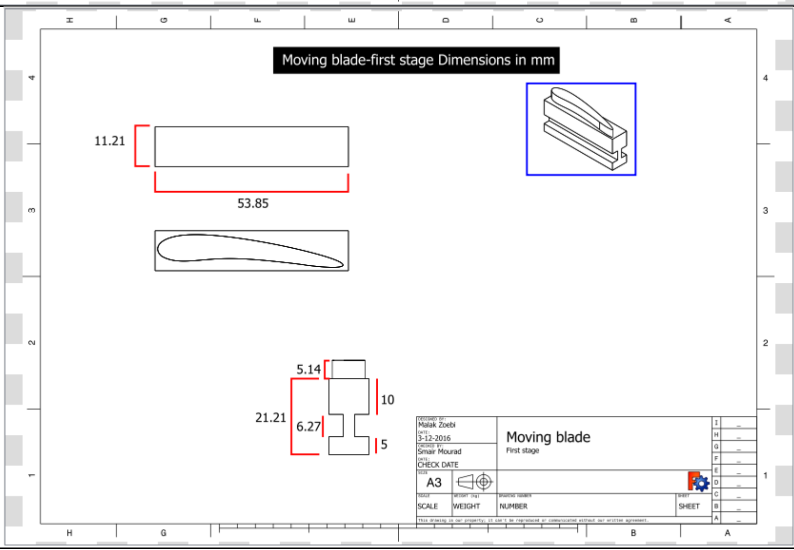
<tr><td>FB-SS</td><td>
</td></tr>
<tr><td>MB-FS</td><td>
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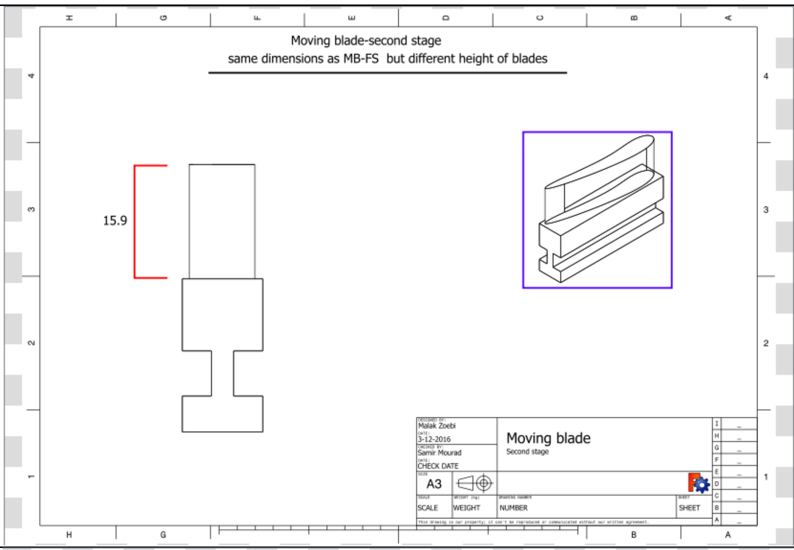
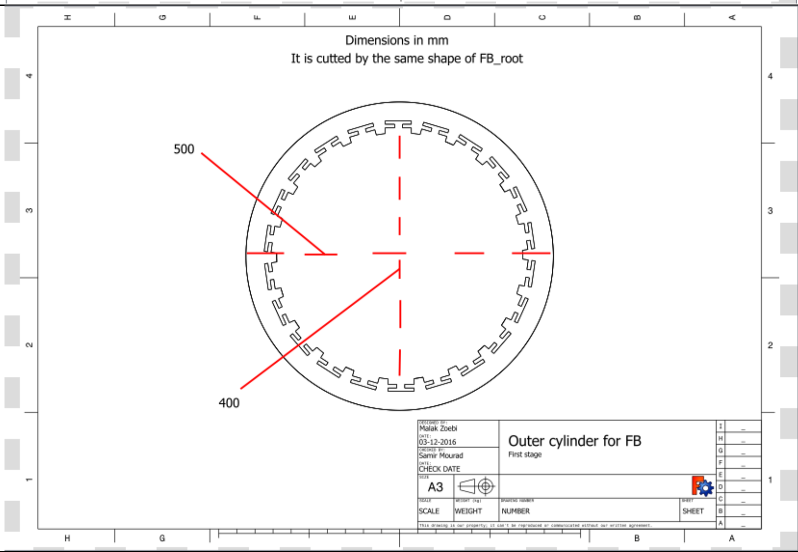
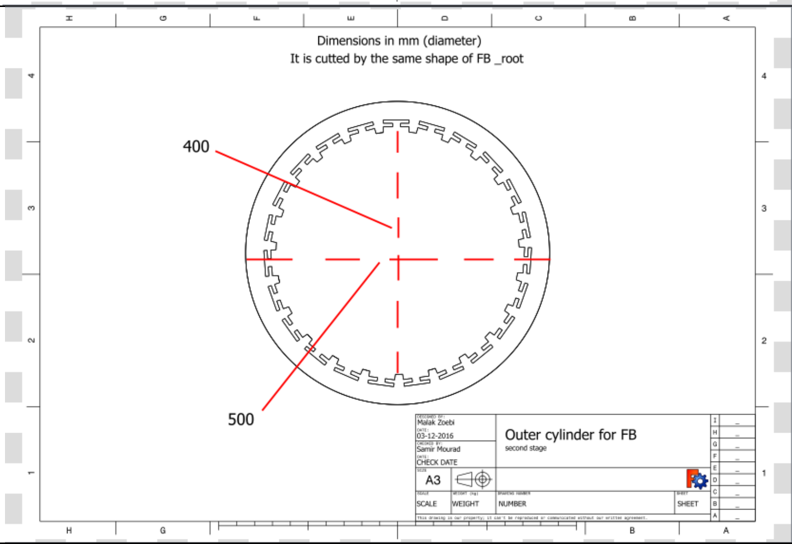
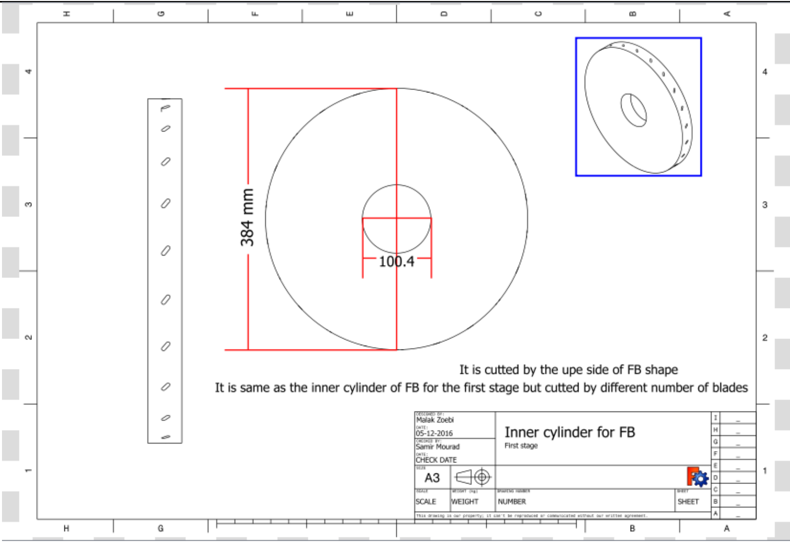
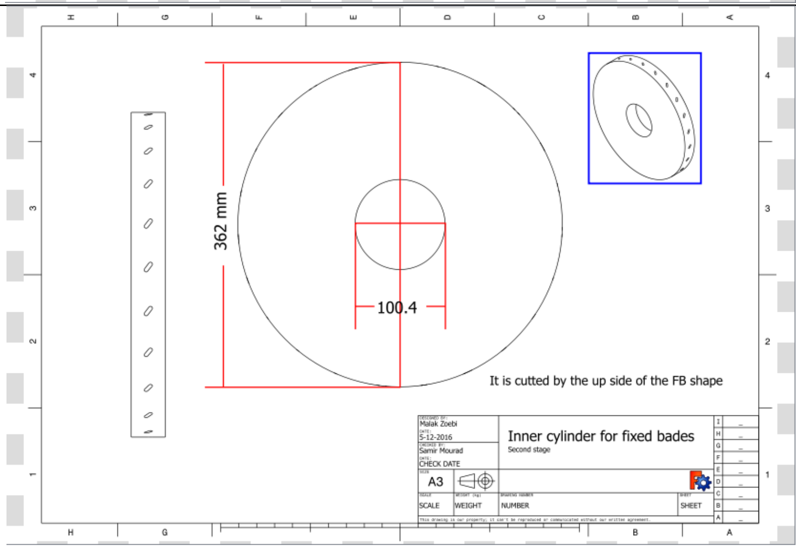
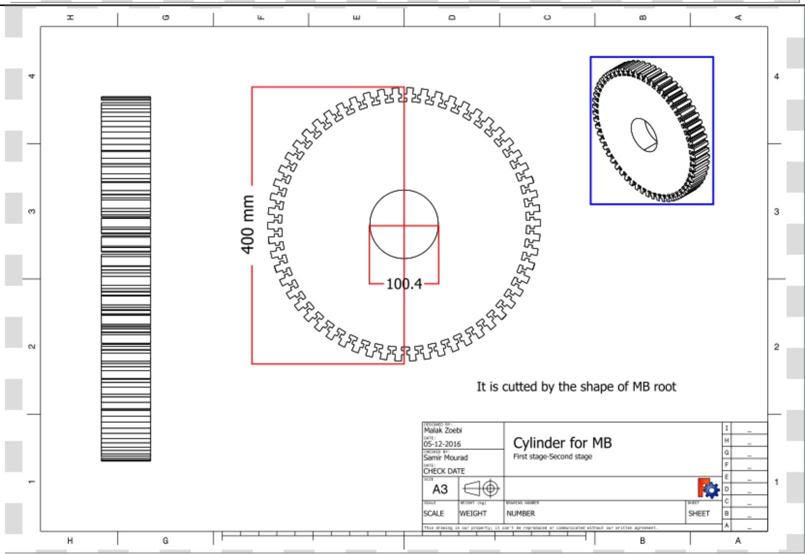
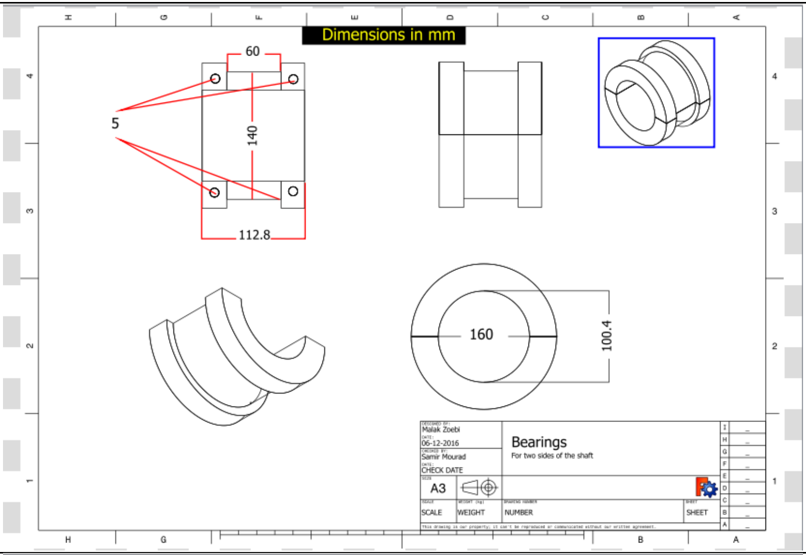
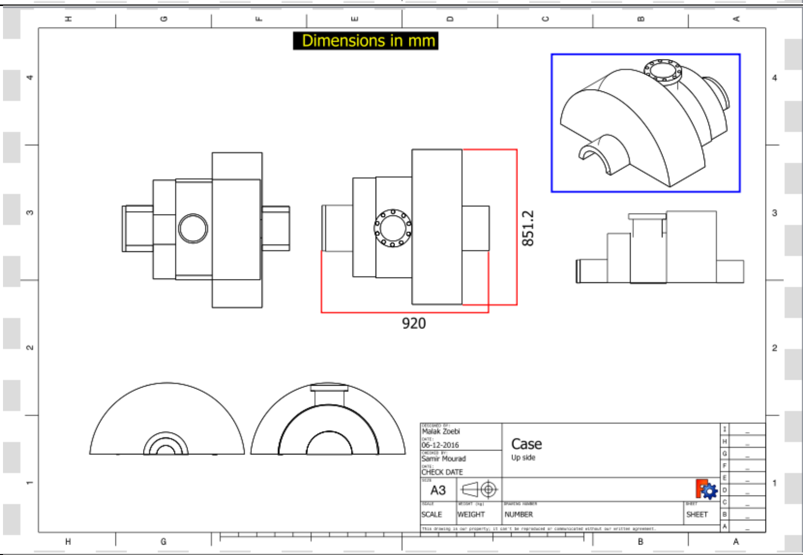
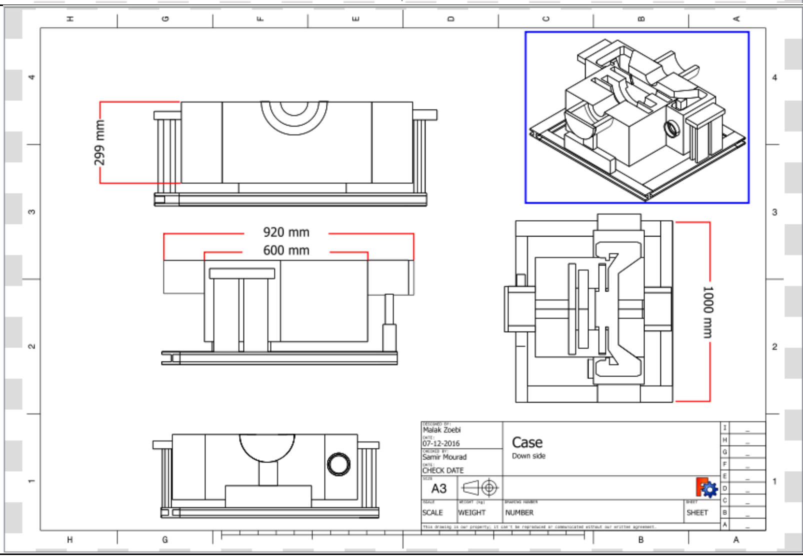
MB-SS	
Outer cylinder for FB-FS	
Outer cylinder for FB-SS	

Inner cylinder for FB-FS	
Inner cylinder for FB-SS	
Cylinder for MB	

Bearings	
Case (upside)	
Case (down side)	

19.4 Steam system parameters for a 2MW Turbine (14 bar, 195°C)

Main
- About
- Preferences
- Glossary
- Resources
- Tutorials

Properties Calculators:
- Saturated Properties
- Steam Properties

Equipment Calculators:
- Boiler
- Heat Loss
- Flash Tank
- PRV w/ Desuperheating
- Header
- Deaerator
- Steam Turbine

Steam System Modeler

Steam Turbine Calculator

watch tutorial | view guide

Calculates the energy generated or steam outlet conditions for a steam turbine.

Solve for:	
	Outlet Properties
Inlet Steam	
Pressure*	200 psig
Temperature *	383 °F
Turbine Properties	
Selected Turbine Property	Power Out
Isentropic Efficiency *	30 %
Generator Efficiency *	50 %
Power Out *	2000 kW
Outlet Steam	
Pressure*	30 psig
* Required	Enter [reset]

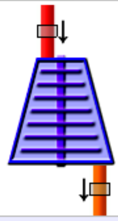
Examples:	Mouse Over

Calculation Details and Assumptions below

WARNING:

- Inlet Steam Contains Condensate
- Steam Condensing in Turbine

Inlet Steam		Mass Flow	5,502.0 klb/hr
Pressure	200.0 psig	Sp. Enthalpy	356.8 btu/lbm
Temperature	383.0 °F	Sp. Entropy	0.545 btu/lbm/R
Phase	Liquid	Energy Flow	1,963.2 MMBtu/hr



Isentropic Efficiency	30.0 %
Energy Out	13.6 MMBtu/hr
Generator Efficiency	50.0 %
Power Out	2,000.0 kW

Outlet Steam		Mass Flow	5,502.0 klb/hr
Pressure	30.0 psig	Sp. Enthalpy	354.3 btu/lbm
Temperature	274.0 °F	Sp. Entropy	0.553 btu/lbm/R
Saturated	0.12	Energy Flow	1,949.5 MMBtu/hr

Required steam: about 2500 kg / hour.

19.4.1 Calculation details

Step 1: Determine Inlet Properties

Using the Steam Property Calculator, properties are determined using Inlet Pressure and the selected second parameter (Temperature, Specific Enthalpy, Specific Entropy, or Quality). The Specific Enthalpy is then multiplied by the Mass Flow to get the Energy Flow:

- Pressure = 200.0 psig
- Temperature = 383.0 °F
- [Steam Property Calculator] => Specific Enthalpy = 356.8 btu/lbm

- Inlet Energy Flow = Specific Enthalpy * Mass Flow
  [Inlet Energy Flow = 1,963.2 MMBtu/hr = 356.8 btu/lbm * 5,502.0 klb/hr]

Step 2: Calculate Ideal Outlet Properties (Inlet Entropy equals Outlet Entropy)

- Pressure = 30.0 psig
- Specific Entropy = 0.545 btu/lbm/R
- [Steam Property Calculator] => Specific Enthalpy = 348.5 btu/lbm

Step 3: If solve for 'Isentropic Efficiency', Determine Outlet Properties

Using the outlet specific enthalpy, calculate the isentropic efficiency:

- Isentropic Efficiency = (Inlet Specific Enthalpy - Outlet Specific Enthalpy) / (Inlet Specific Enthalpy - IDEAL Outlet Specific Enthalpy)

Step 3: If solve for 'Outlet Properties', Determine Outlet Specific Enthalpy

1. Isentropic Efficiency = (Inlet Specific Enthalpy - Outlet Specific Enthalpy) / (Inlet Specific Enthalpy - IDEAL Outlet Specific Enthalpy)
2. Isentropic Efficiency * (Inlet Specific Enthalpy - IDEAL Outlet Specific Enthalpy) = (Inlet Specific Enthalpy - Outlet Specific Enthalpy)
3. Outlet Specific Enthalpy = Inlet Specific Enthalpy - Isentropic Efficiency * (Inlet Specific Enthalpy - IDEAL Outlet Specific Enthalpy)
   [Outlet Specific Enthalpy = 354.3 btu/lbm = 356.8 btu/lbm - 30.00 % * (356.8 btu/lbm - 348.5 btu/lbm)]

Using the outlet specific enthalpy, calculate the outlet properties:

- Pressure = 30.0 psig
- Specific Enthalpy = 354.3 btu/lbm
- [Steam Property Calculator] => Temperature = 274.0 °F

Step 4: Calculate Steam Turbine Energy Out and Generation (Power Out)

- Energy Out = (Inlet Specific Enthalpy - Outlet Specific Enthalpy) * Mass Flow
  [Energy Out = 13.6 MMBtu/hr = (356.8 btu/lbm - 354.3 btu/lbm) * 5,502.0 klb/hr]

- Power Out = Energy Out * Generator Efficiency
  [Power Out = 2,000.0 kW = 13.6 MMBtu/hr * 50.00 %]

19.5 Competetors: Backpressure Steam Turbines (500kW, 3 MW, 15 MW): Cost ($/kW) and Performance Characteristics

	System		
Steam Turbine Parameters[6]	1	2	3
Nominal Electricity Capacity (kW)	500	3000	15000
Typical Application	Industrial, PRV application	Industrial, universities,hospitals	Industrial, universities, hospitals
Equipment Cost ($/kW)[7]	668 $	401 $	392 $
Total Installed Cost ($/kW)[8]	1136 $	682 $	666 $
O&M Costs[9]	0.010 $	0.009 $	0.006 $
Turbine Isentropic Efficiency (%)[10]	52.5 %	61.2 %	78.0 %
Generator/Gearbox Efficiency (%)	94 %	96 %	96 %
Steam Flow (lbs/hr)	20050	152600	494464
Inlet Pressure (psig)	500	600	700
Inlet Temperature (° Fahrenheit)	550	575	650
Outlet Pressure (psig)	50	150	150
Outlet Temperature (° Fahrenheit)	298	373	379.7
CHP System Parameters	1	2	3
Boiler Efficiency (%), HHV	80 %	80 %	80 %
Electric Efficiency (%), HHV[11]	6.27 %	4.92 %	7.31 %
Fuel Input (MMBtu/hr)	27.2	208.3	700.1
Steam to Process (MMBtu/hr)	19.9	155.7	506.8
Steam to Process (kW)	5844	45624	148484
Total CHP Efficiency (%), HHV[12]	79.60 %	79.68 %	79.70 %
Power/Heat Ratio[13]	0.086	0.066	0. 101
Net Heat Rate (Btu/kWh)[14]	4541	4540	4442

[6]Characteristics for "typical" commercially available steam turbine generator systems provided by Elliott Group.

[7]Equipment cost includes turbine, gearbox, generator, control system, couplings, oil system (if required), and packaging; boiler and steam system costs are not included.

[8]Installed costs vary greatly based on site-specific conditions; installed costs of a "typical" simple installation were estimated to be 50-70% of the equipment costs.

[9]Maintenance assumes normal service intervals over a 5 year period, excludes parts.

[10]The Isentropic efficiency of a turbine is a comparison of the actual power output compared to the ideal, or isentropic, output. It is a measure of the effectiveness of extracting work from the expansion process and is used to determine the outlet conditions of the steam from the turbine.

[11] CHP electrical efficiency = Net electricity generated/Total fuel into boiler. A measure of the amount of boiler fuel converted into electricity.

[12]Total CHP efficiency = (Net electricity generated + Net steam to process)/Total fuel into boiler.

[13]Power/Heat Ratio = CHP electrical power output (Btu)/useful heat output (Btu).

[14]Net Heat Rate = (total fuel input to the boiler - the fuel that would be required to generate the steam to process assuming the same boiler efficiency)/steam turbine electric output (kW).

Effective Electrical Efficiency (%), HHV	75.15	75.18	76.84
Heat/Fuel Ratio[15]	0.733	0.748	0.724

Equipment costs shown include the steam turbine, gearbox, generator, control system, couplings, oil system (if required), and packaging. Installed costs vary greatly based on site-specific conditions. Installed costs of a "typical" simple installation were estimated to be 50-70 percent of the equipment costs. Boiler and steam system costs are not included in these estimates.

19.5.1 Performance Losses

Steam turbines, especially smaller units, may leak steam around blade rows and out the end seals. When the turbine operates or exhausts at a low pressure, as is the case with condensing steam turbines, air can also leak into the system. The leakages cause less power to be produced than expected, and the makeup water has to be treated to avoid boiler and turbine material problems. Air that has leaked needs to be removed, which is usually done by a steam air ejector or a fan removing non-condensable gases from the condenser.

Steam turbine applications usually operate continuously for extended periods of time, even though the steam fed to the unit and the power delivered may vary (slowly) during such periods of continuous operation. As most steam turbines are selected for applications with high duty factors, the nature of their application often takes care of the need to have only slow temperature changes during operation, and long startup times can be tolerated. Steam boilers similarly may have long startup times, although rapid start-up boilers are available.

19.5.2 Maintenance

Steam turbines are very rugged units, with operational life often exceeding 50 years. Maintenance is simple, comprised mainly of making sure that all fluids (steam flowing through the turbine and the oil for the bearing) are always clean and at the proper temperature with low levels of moisture or high steam quality or superheat. The oil lubrication system must be clean and at the correct operating temperature and level to maintain proper performance. Other items include inspecting auxiliaries such as lubricating-oil pumps, coolers and oil strainers and checking safety devices such as the operation of over speed trips.

In order to obtain reliable service, steam turbines require long warm-up periods so that there are minimal thermal expansion stress and wear concerns. Steam turbine maintenance costs are typically below $0.01/kWh. Boilers and any associated solid fuel processing and handling equipment that is part of the boiler/steam turbine plant require their own types of maintenance which can add $0.02/kWh for maintenance and $0.015/kWh for operating labor.

[15] Effective Electrical Efficiency = (Steam turbine electric power output) / (Total fuel into boiler – (steam to process/boiler efficiency)). Equivalent to 3,412 Btu/kWh/Net Heat Rate.

* For typical systems available in 2014.

One maintenance issue with steam turbines is that solids can carry over from the boiler and deposit on turbine nozzles and other internal parts, degrading turbine efficiency and power output. Some of these are water soluble but others are not. Three methods are employed to remove such deposits: 1) manual removal; 2) cracking off deposits by shutting the turbine off and allowing it to cool; and 3) for water soluble deposits, water washing while the turbine is running.

An often-overlooked component in the steam power system is the steam (safety) stop valve, which is immediately ahead of the steam turbine and is designed to be able to experience the full temperature and pressure of the steam supply. This safety valve is necessary because if the generator electric load were lost (an occasional occurrence), the turbine would rapidly over speed and destroy itself. Other accidents are also possible, supporting the need for the turbine stop valve, which may add significant cost to the system. (4)

19.5.3 Steam Turbine Lubricating oil Characteristics

Mostly turbine of steam power plant may have its rotational 3000 rpm to produce required power. Due to friction the temperature of bearing, rotor may increase which, combined with other factors, may leads to the failure of bearing hence produce a serious damage to turbine and plant. Plant stability, production depends on the turbine and turbine stability depends on bearing life as bearing will always be damage first. This causes the shutdown of power plant and hence gives a loss of money. Lubricant has vast effect on the life of bearing that's why much care should be given while selecting it. We are going to be familiar with some of the properties, a lubricant should have. (5)

19.5.3.1 Background

For the turbine shaft to move freely, it rides upon several lubricant-filled bearings. These bearings are usually simple bearings into which the lubricating oil is pumped under high pressures. The oil lubricates the bearing through hydrodynamic lubrication. The bearings and the shaft are separated by a pressurized film of oil to prevent any metal-to-metal contact.

Figure 3 is a simple illustration of the general components and travel route of turbine oil in a steam turbine lubrication system.

Along with providing lubrication to the shaft bearings, the lubricant also lubricates the oil pump, and in some systems is used as a turbine control fluid in the hydraulic governing system. Many steam turbines have an isolated governing system that contains its own fluid. In order to ensure that the high-pressure lubricant is properly supplied to the bearings, it is pumped from an oil tank (reservoir), through an elaborate system of flow control valves, an oil cooler, through the bearing, and finally back to the oil tank.

The oil is constantly agitated as it circulates through the system. This agitation is important to note, as it provides both benefits and challenges for the oil during its lifetime in the turbine.

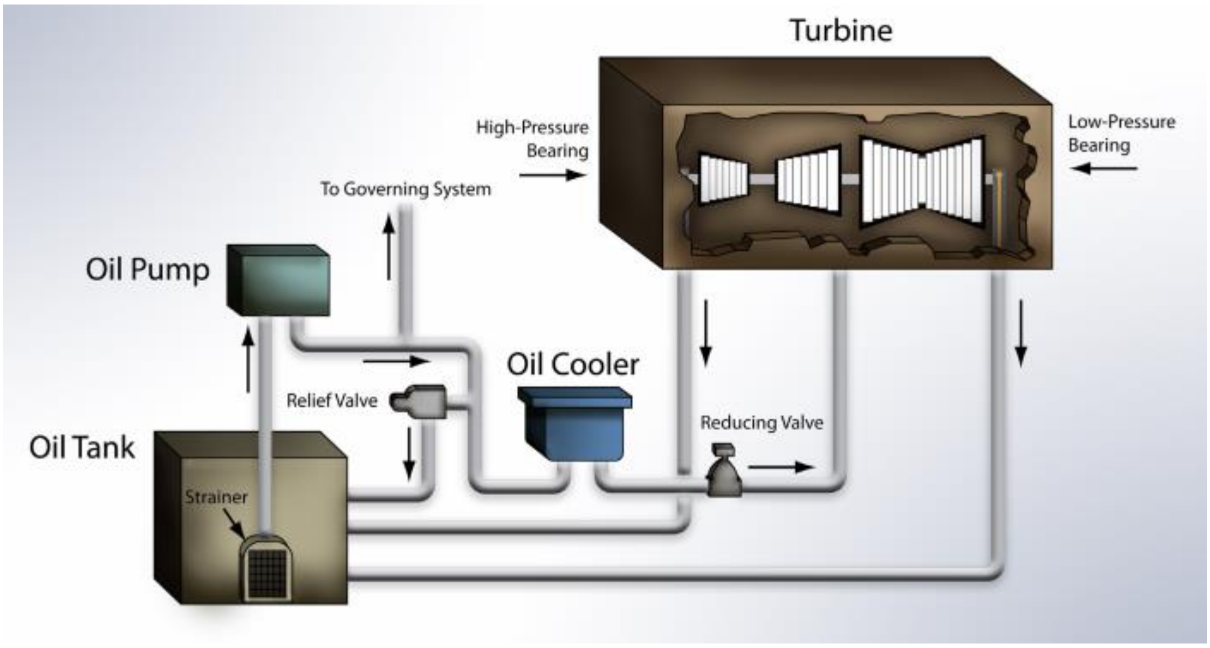


Figure 31: Steam turbine lubrication system (6)

19.5.4 Viscosity

The journal and thrust bearings of steam turbines require lubrication. Oils having higher viscosity provide a greater margin of safety in the bearings. However, its friction losses are high. In high-speed turbines, the heat generation becomes significant. Most oils used in this service have International Organization for Standardization (ISO) viscosity grade 32. Higher viscosity is used in some applications, ISO viscosity grade 46 (41.4 to 50.6 CST at 40°C). (5)

19.6 Turbine bearing

19.6.1 Introduction

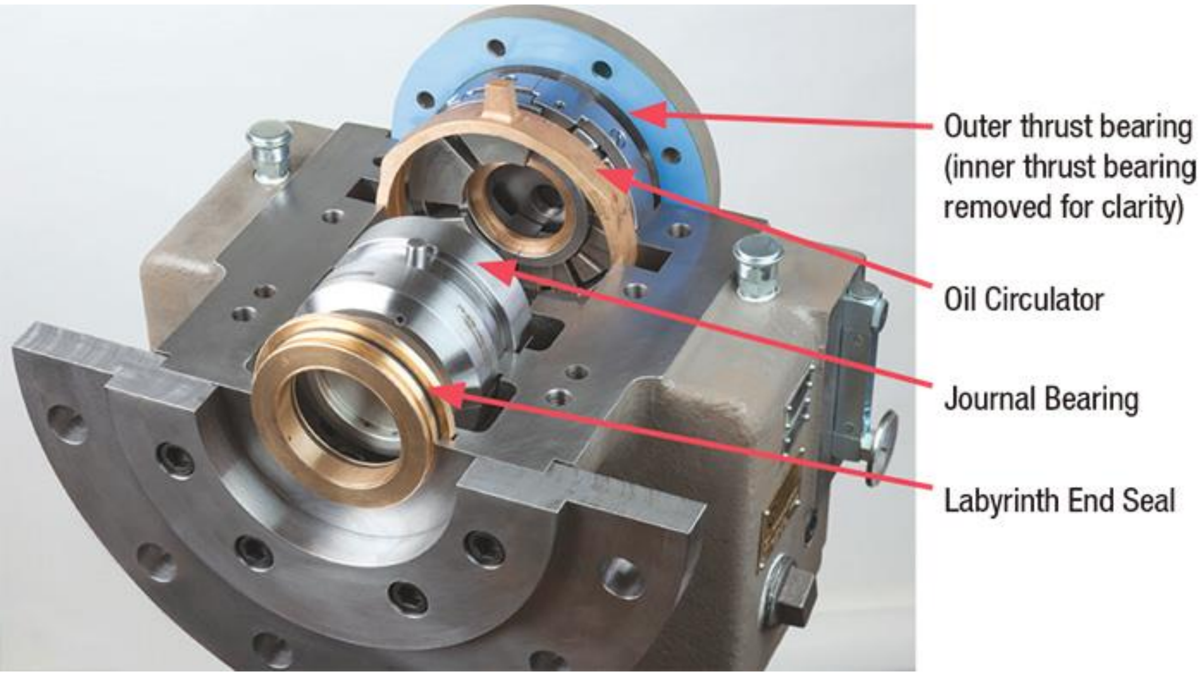
Bearings are used to prevent friction between parts during relative movement. In machinery they fall into two primary categories: anti-friction or rolling element bearings and hydrodynamic journal bearings. The primary function of a bearing is to carry load between a rotor and the case with as little wear as possible. This bearing function exists in almost every occurrence of daily life from the watch on your wrist to the automobile you drive to the disk drive in your computer. In industry, the use of journal bearings is specialized for rotating machinery both low and high speed.

The purpose of using the bearing **غايات إستعمال البيرنغ**

Seals: we use it for not moving right or left نستعملها كي لا تتحرك لا شمالاً ولا يميناً

Journal bearings: Maintain orthogonally تحافظ على التعامدية

Thrust bearings: Keeps the pivotal تحافظ على المحورية



To know how bearing is manufactured, watch this video in the link:

https://www.youtube.com/watch?v=x-cN2TRmVMk

Figure 32: Min bearings for steam turbine

Table 3: Material for bearings

Bearing Material	Hardness kg/mm^2	Minimum Shaft Hardness kg/mm^2	Hardness Ratio
Lead-base babbitt	15-20	150	8
Tin-base babbitt	20-30	150	6
Alkali-hardened lead	22-26	200-250	9
Copper-lead	20-23	300	14
Silver (overplated)	25-50	300	8
Cadmium base	30-40	200-250	6
Aluminum alloy	45-50	300	6
Lead bronze	40-80	300	5
Tin bronze	60-80	300-400	5

Source: Wilcock and Booser, *Bearing Design and Application*, McGraw-Hill, 1957.

19.7 Materials needs and calculations

The range of alloys used in steam turbines is relatively small, partly because of the need to ensure a good match of thermal properties, such as expansion and conductivity, and partly because of the need for high temperature strength at acceptable cost. The commercial alloys used depend on the maximum temperatures and pressures to which specific components will be exposed, and these are heavily dependent upon the detailed design of the turbine, which can vary significantly among the various manufacturers. Since this is the case, the starting point for any overall discussion of materials issues is to list the main components of interest, and to identify the conditions under which they will be required to operate. The main components considered here are: the turbine casing/shell (including the steam chest), cylinders and valve bodies; bolting; turbine rotors or discs; and vanes and blades.

The inner cylinder and steam chest should be fabricated from the same material as the rotor, to avoid thermal mismatch.

The alloys most commonly used for steam turbine rotors and/or discs are the CrMoVWNbN steels, which can vary in chromium content from 1-13% depending on the preference of individual manufacturers.

These alloys are widely used up to a temperature limit of about 566°C, and the higher-W, lower-Nb and -C versions are capable of 593°C. (7)

Choose for the shaft AISI 4340 Alloy Steel

And for the casing cast iron.

Its proprieties are shown in the table below:

Table 4: properties of AISI 4340 Alloy Steel. (8)

Properties	Metric	Imperial
Tensile strength	745 MPa	108000 psi
Yield strength	470 MPa	68200 psi
Bulk modulus (typical for steel)	140 GPa	20300 ksi
Shear modulus (typical for steel)	80 GPa	11600 ksi
Elastic modulus	190-210 GPa	27557-30458 ksi
Poisson's ratio	0.27-0.30	0.27-0.30
Elongation at break	22%	22%
Reduction of area	50%	50%
Hardness, Brinell	217	217
Hardness, Knoop (converted from Brinell hardness)	240	240
Hardness, Rockwell B (converted from Brinell hardness)	95	95
Hardness, Rockwell C (converted from Brinell hardness. Value below normal HRC range, for comparison purposes only)	17	17
Hardness, Vickers (converted from Brinell hardness)	228	228
Machinability (annealed and cold drawn. Based on 100 machinability for AISI 1212 steel.)	50	50

So rigidity equal to 79979185 N/ m^2 (it is called also shear modulus).

Notice that 1 ksi (Pound force per square inch) = 6894.76 N/m^2.

Twisting moment:

P=$M_t \times w$

M_t=$\frac{P}{w}$=$\frac{1.5\times10^6}{\frac{2\pi\times3000}{60}}$= 4774.65 N.m.

Shear stress:

I_p=$\frac{\pi D^4}{32}$=$\frac{\pi\times100^4}{32}$= 9817477.042$mm^4$.

$\tau = \frac{M_t\times r}{I_p}$=$\frac{4774.65\times10^3\times50}{9817477.042}$= 24.317N/$mm^2$.

Torsional deflection:

$$\frac{\theta G}{L}=\frac{M_t}{I_p}=\frac{\tau}{r}.$$

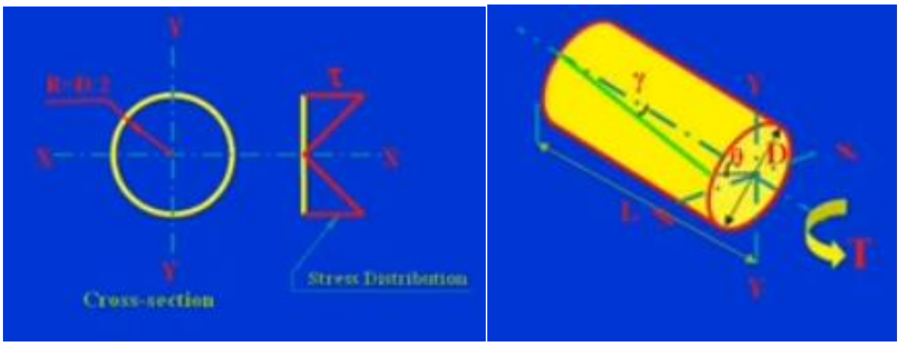


Figure 33 stress distribution

$\theta = \frac{M_t L}{I_p}$.

$\theta = \frac{4774.65\times10^3\times700}{79979185\times9817477.042}$ =4.26× 10^{-6} rad.

θ =4.26× 10^{-6} rad =4.26× 10^{-6} × $\frac{360}{2\pi}$=2.44× 10^{-4}.

Stainless steel type 403 is a special high quality steel made for blades and buckets for steam turbine and jet engine compressors. This grade is eminently suited for very highly stressed parts. This material is magnetic in all conditions.

19.8 5D CNC machining

19.8.1 What is 5-Axis?

When someone uses the term "5-axis" they are typically referring to the ability of a CNC machine to move a part or a tool on five different axes at the same time. 3-axis machining centers move a part in two directions (X and Y), and the tool moves up and down (Z). 5-Axis machining centers can rotate on two additional rotary axes (A and B) which help the cutting tool approach the part from all directions.

19.8.2 Basics of axis configuration

To understand machine configurations, it's important to understand the basic terminology of 5-axis machining centers. If you think in terms of a 3-axis machining center, it has an X-axis, Y-axis, and Z-axis. With a 5-axis machining center, the additional rotary axes will rotate about two of those three primary axes.

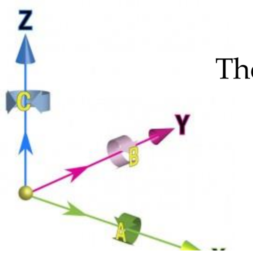


Figure 76 (Image courtesy of Hurco North America.)

The axis that rotates about or under the Z-axis is called the C-axis.

The axis that rotates about the Y-axis is called the B-axis.

The axis that rotates about the X-axis is called the A-axis. (1)

Although there are 6-axis CNC machines, such as Zimmermann's FZ 100 Portal milling machine, 5-axis configurations are more common, since adding a sixth axis typically offers few additional benefits.

One last note about axis-labeling conventions: in a vertical machining center, the X- and Y-axes reside in the horizontal plane while the Z-axis resides in the vertical plane. In a horizontal machining center, the Z-axis and Y-axis are reversed. See the diagram below: (2)

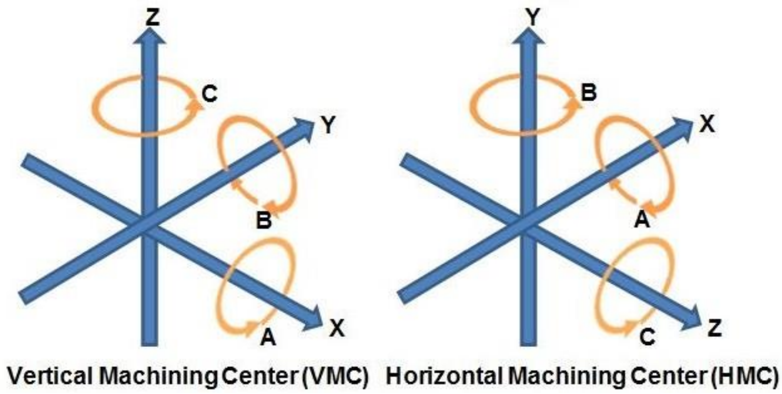


Figure 35 (Image courtesy of Cameron Anderson/Aerotech.)

19.8.3 How a router works

The power behind any router is its CAD/CAM software. The CAD software allows the user to create a design they want the router to cut. Once this design has been made, the CAM software converts the design into a tool path code that the router can understand.

The computer then translates this code into signals that control the movement of the router's drive system. The drive system contains the spindle, which is the part that holds the actual router bits. The spindle rotates these bits 8,000 to 50,000 times per minute in order to cut the material. Simply put, the user creates a design and uses software to make instructions for the router to follow.

19.9 3-axis routers vs. 5-axis routers

Now that you have a working knowledge of how a router works you can better understand the differences between various models. Although 4-axis routers exist, the most common CNC routers available and the ones MultiCam Canada offers are 3 and 5-axis routers.

3-axis CNC routers cut along three axes at the same time; the x-axis, the y-axis, and the z-axis. Cutting along the x-axis moves the router bit from front to back, cutting along the y-axis moves it from left to right, and cutting across the z-axis moves it up and down. These machines are used primarily for cutting flat, 2-dimensional parts.

5-axis CNC routers can cut along two additional axes than 3-axis routers. These routers have the ability to cut on five sides of a piece of material simultaneously, which expands the operator's capabilities and flexibility. Unlike their 3-axis counterparts, these machines are usually used to cut large 3-dimensional parts. In addition, 5-axis routers have a taller gantry and longer x-axis, which allows them to cut larger part; however, this comes at a serious cost; the taller the gantry and the longer the x-axis, the less the accurate and stable these machines are. For proper quality control, the height of the gantry and the length of the x-axis should be limited as much as possible.

Although routers seem like simple machines, they are highly sophisticated pieces of technology that require a certain level of expertise to operate. 5-axis routers tend to be more expensive than traditional 3-axis models, but ultimately offer greater flexibility and enable users to be more creative with their designs. (3)

19.10 Thermal efficiency if the steam is superheated

We worked on a steam turbine which has a power of 1.5 MW.

This turbine is composed of two parts, and each part has two stages.

The electric efficiency is equal to 0.96; mechanic efficiency is equal to 0.95; interne efficiency of turbine is equal to 0.9.

Entry pressure for the turbine is 14 bars, and the entry temperature is 250°C. The pressure in the condenser is 12 kPa.

Figure 20 shows the installation of an incineration power plant with the steam turbine in that case.

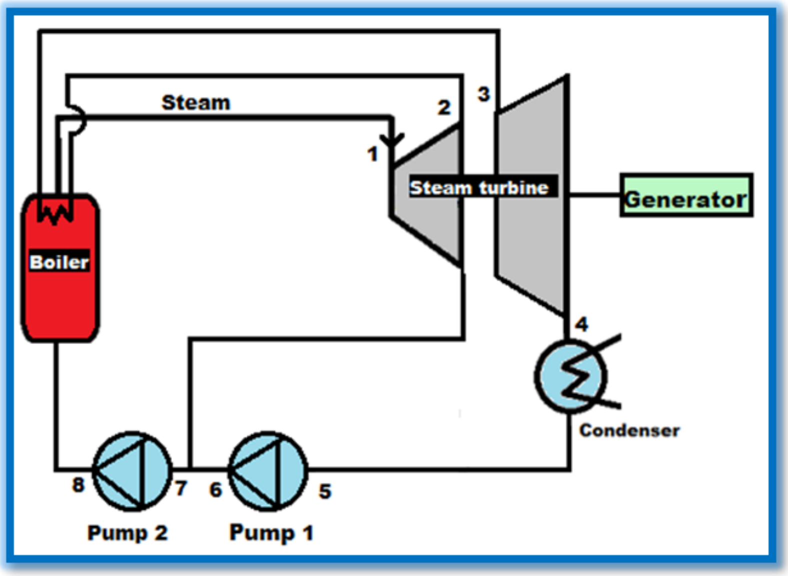


Figure 36 installation

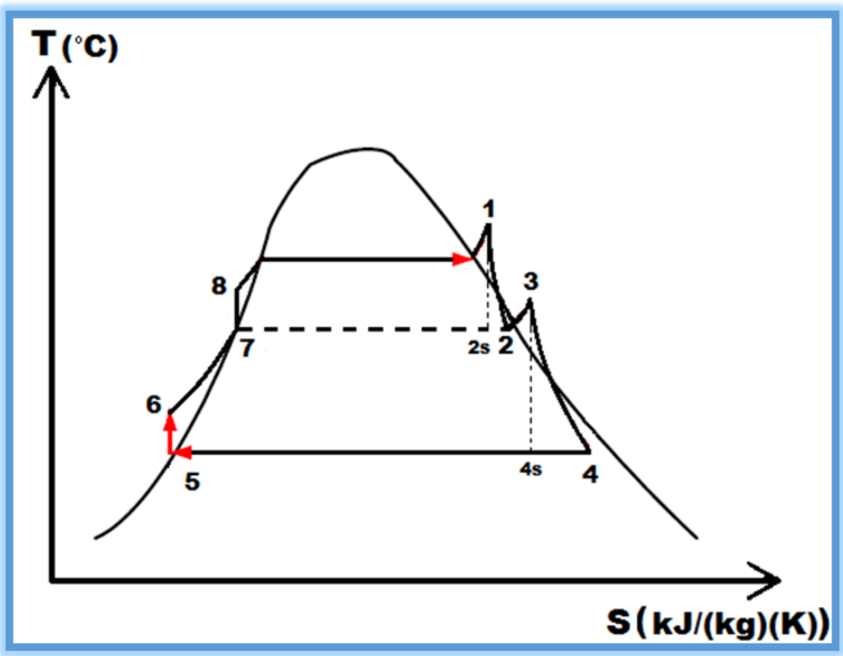


Figure 37 Rankine cycle

Calculate enthalpy, entropy, etc… for each point.

So the thermal effenciency is :

$$\eta=\frac{Net\ work}{Quantity\ of\ steam\ additional}=\frac{\Delta W_{net}}{Q};$$

$$\eta=\frac{(h_1-h_2)+(1-\dot{m}_1)(h_3-h_4)-[(1-\dot{m}_1)(h_6-h_5)+(h_8-h_7)]}{(h_1-h_8)+(1-\dot{m}_1)(h_3-h_2)};$$

$$\eta=\frac{(2926.56-2665.22547)+(1.0.14395)(2865.6-2392.85925)-[(1-0.14395)(207.388-207.1)+562.3-561.2)]}{(2926.56-562.2)+(1-0.14395)(2865.6-2665.22547)}$$

$\longrightarrow$ η=26.26%.

19.11 Dynamo generator

A generator 1 MW cost 7000 $ from alibaba

19.12 Quotation to 1.5 MW steam turbine

Shandong Qingneng Power Group Co., Ltd.
No. 3011, Haidai North Road, Qingzhou City,
Shandong Province, China
Tel : +86 536 3280887 Fax: +86 536 3259399
Website: www.qnpower.com E-mail: mark@qnpower.com

Quotation List
for
Condensing Steam Turbine N1.5-1.4

Buyer: North Lebanon Alternative Power

(Attn: Ms. Maysaa Kamardine / Tel: +961 (0)6 612 004)

Supplier: Shandong Qingneng Power Group Co., Ltd.

(Offerer: Mr. Mark Sun/ Tel: +86 13721955251)

Date: January 23, 2019
Original: China

Proposal #: QNP-STG190123-2
Expiry Date: This offer shall keep valid till March 22, 2019.

中国驰名商标
QINGNENG 青能
Shandong Qingneng Power Group Co., Ltd.
No. 3011, Haidai North Road, Qingzhou City,
Shandong Province, China
Tel : +86 536 3280887 **Fax: +86 536 3259399**
Website: www.qnpower.com **E-mail: mark@qnpower.com**

Steam turbine parameters:
Type: Condensing Steam Turbine N1.5-1.4

Rated condition:

Rated Power:	1.5MW
Rated Speed:	5600rpm
Inlet Parameters:	1.4MPa(a), Dryness: 0.995, 12.3t/h
Exhaust Parameters:	0.0106MPa (a), 47℃
Rated Steam Consumption:	8.2kg/(kw•h)
Cooling water temperature:	32℃
Area of condenser:	280m^2
Cooling water flow:	876t/h

Price:

No	Description	Qty	Unit price （RMB)	Unit price (USD)	Remark
1	Condensing Steam Turbine N1.5-1.4	1 set	2,000,000	294,118	This price includes the steam-water separator, turbine main body, gear box of 5600/ 1500rpm, condensing system, lube oil system, turning gear, primary instruments, local instruments, steam & water pipe in inside of turbine, cover for turbine, spare parts and documents.
2	Generator	1 set	320,000	47,059	1.5MW, 360KV, 1500rpm
3	DEH	1 set	280,000	41,176	Optional
4	ETS	1 set	100,000	14,706	Optional
5	TSI	1 set	100,000	14,706	Optional

Total price (FOB-Qingdao): 411,765.00USD (2,800,000.00RMB)

Note： 1) Above prices are based on FOB-Qingdao.
2) Delivery time is 6 months after the purchasing contract enter into force.
3) Installation guide charge for each engineer is 200.00USD/ day. It will needs two or three engineers.
4) Payment term: according to the discuss of buyer and supplier.
5) The exchange rate between RMB and USD is 6.8: 1.

Shandong Qingneng Power Group Co., Ltd
January 23, 2019

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中国驰名商标
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Remark:

I. Steam Turbine Supply Scope (for reference only)

1. Steam turbine proper: from MSV (include flange and connecting bolts) to turbine exhaust flange.

2. Governing system with electric/ hydraulic converter.

3. Condensing system:

   Surface type fresh water condenser with hot well,

   Flash tank

   Condensate water pump

   Internal piping and valve

   Steam jet air ejector

   Staring air ejector

   Turbine/ condenser connection piece with expansion bellows

4. Turning gear device

5. Oil system:

   Main turbine shaft driven oil pump

   HP starting oil pump

   AC lubricating oil pump

   DC emergency oil pump

   Oil tank for turbine with its accessories

   Duplex oil cooler with change – over device

   Duplex oil filter with change – over device

   Oil supply piping and return oil piping

6. Local gauge and panel of turbine and supervising instruments (primary element only)

   TSI (Turbine Supervision Instrument)

7. Safety device

   ETS (Emergency Trip System)

   Manual emergency trip gear

   Over speed trip device

   Axial displacement oil pressure protection

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8. Accessories

Turbine internal steam, drain and oil piping

Turbine cover

Spare parts

Special tools for overhaul turbine

Documents

II. Generator Supplying Scope (for reference only)

1. Generator proper (including stator, rotor, bearing, end cover, bottom plate, cooler, sizing block, foundation bolt, temperature element, filter, Brush holder, brush)
2. Double microcomputer & dual channel static SCR excitation system device (matched dry type transformer)
3. Air cooler
4. special tool: Connecting long axis to twitch and install the rotor of generator.
5. Spare parts
6. Documents

III. Gear Box 5600/ 1500rpm

IV. One set of steam-water separator.

19.12.1 Suppliers

1-QNP/Sandong Qingneng Power Group Co., Ltd.

Shandong Qingneng Steam Turbine Co.,Ltd.

3011 Haidai North Road, Qingzhou City,

Shandong Province, P. R. China

Mobile phone: +86-13721955251 (WeChat)

Tel: +86-536-3280887

Fax: +86-536-3259399

E-mail: mark@qnpower.com

http://www.qnpower.com

2-MAN Energy Solutions Middle East LLC/www.man-es.com/Phone

+971 4 423 7733

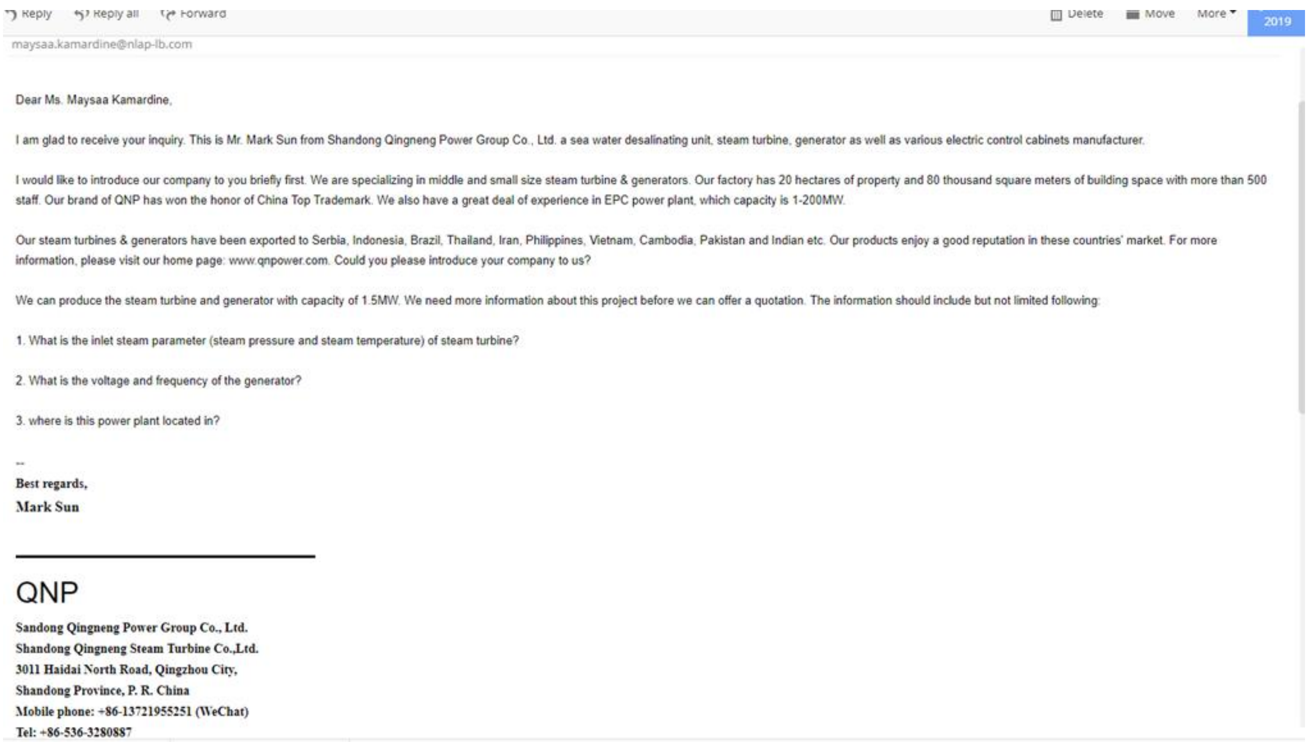
Direct +971 4 875 1011

Mobile +971 50 6537620

Fax +971 4 455 9071

Jihad.Aoun@man-es.com

3-Bio sun power/Turkish /habib.kacokaya@biosunpower.com


Reply Reply all Forward Delete Move More 2019

maysaa.kamardine@nlap-lb.com

Dear Ms. Maysaa Kamardine,

I am glad to receive your inquiry. This is Mr. Mark Sun from Shandong Qingneng Power Group Co., Ltd. a sea water desalinating unit, steam turbine, generator as well as various electric control cabinets manufacturer.

I would like to introduce our company to you briefly first. We are specializing in middle and small size steam turbine & generators. Our factory has 20 hectares of property and 80 thousand square meters of building space with more than 500 staff. Our brand of QNP has won the honor of China Top Trademark. We also have a great deal of experience in EPC power plant, which capacity is 1-200MW.

Our steam turbines & generators have been exported to Serbia, Indonesia, Brazil, Thailand, Iran, Philippines, Vietnam, Cambodia, Pakistan and Indian etc. Our products enjoy a good reputation in these countries' market. For more information, please visit our home page: www.qnpower.com. Could you please introduce your company to us?

We can produce the steam turbine and generator with capacity of 1.5MW. We need more information about this project before we can offer a quotation. The information should include but not limited following:

1. What is the inlet steam parameter (steam pressure and steam temperature) of steam turbine?

2. What is the voltage and frequency of the generator?

3. where is this power plant located in?

--

Best regards,
Mark Sun

QNP

Sandong Qingneng Power Group Co., Ltd.
Shandong Qingneng Steam Turbine Co.,Ltd.
3011 Haidai North Road, Qingzhou City,
Shandong Province, P. R. China
Mobile phone: +86-13721955251 (WeChat)
Tel: +86-536-3280887

To:
maysaa.kamardine@nlap-lb.com

Dear Maysaa,

Thank you for your email and interest in MAN Energy solutions.

With great pleasure I can inform you that we have steam turbine by MAN within the requested power range.

In order to understand the requirements of the project and to provide you with our best suitable solution, would you please provide the following information:

- § Name of the project:
- § Exact location of the Plant:
- § Owner of the project (end-user):
- § Name of the customer: North Lebanon Alternative Power
- § Power output required: 1.5 MW
- § Alternator input:
    - o Frequency:
    - o Voltage:
- § Ambient condition for the site of installation (Tmin, Tmax, wet bulb temperature, Altitude, Humidity):
- § What about the time line of the project (commencement, lead time):

Moreover if you please fill in following technical parameters, which are needed for setting of the requested steam turbine:

Loadpoint		Case 1	Case 2
Inlet Steam Condition from Steam Header			
Pressure	bar(a)		
Temperature	°C		
Enthalpy	kJ/kg		
Flow	t/h		
Extraction (if any)			
Flow	t/h		
Exhaust			
Pressure	bar(a)		
Temperature	°C		
Enthalpy	kJ/kg		
Flow	t/h		
Cooling Water Temperature at site	°C		

Should you have any questions to the above please let me know.

Looking forward to receive your kind feedback on the above.

With kind regards / Mit freundlichen Grüßen / و تفضلوا بقبول وافر التحية,

Jihad Aoun
Regional Sales Manager

MAN Energy Solutions Middle East LLC
SBU Power Plants
Maritime Business Centre, 9th Floor
Dubai Maritime City
P.O. Box 57091
Dubai, United Arab Emirates
www.man-es.com

Phone +971 4 423 7733
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Jihad.Aoun@man-es.com

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steam turbine

January 23, 2019 | 9:38 am | 11 KB

From:
maysaa.kamardine@nlap-lb.com

To:
habib.kocakaya@biosunpower.com

Salam alaikum,
I'm glad to connect with you .It's Maysaa kamardine from north lebanon alternative power .we are specialized in construction of thern
power plant .We use the municipality waste as a fuel of our plant.
Now, we need a 1.5 MW condensing steam turbine.
the steam with :
-pressure 40 bar
-temperature 250.3 °c
if it is available in your company let me know and give me a data sheet of it with an offer because we connect some others company .
best regards

ميساء قمرالدين
Maysaa Kamardine, *M.Sc.*
تصميم
Mechanical Development

Email: maysaa.kamardine@nlap-lb.com
Tel. +961 (0)6 612 004
Mobile: +961 71 796576

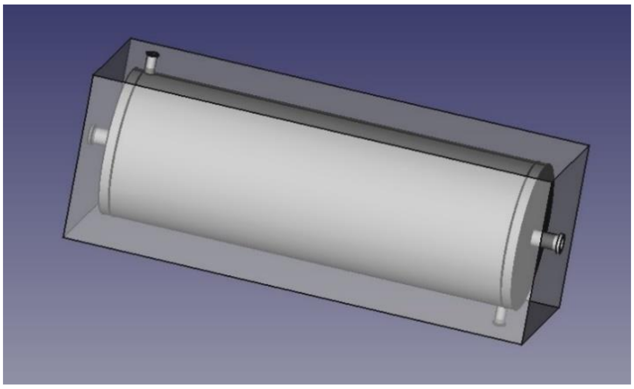
طاقة الشمال
North Lebanon Alternative Power
Mina Plaza Blg., 1st. floor
Tripoli-Mina
Lebanon - لبنان
www.nlap-lb.com

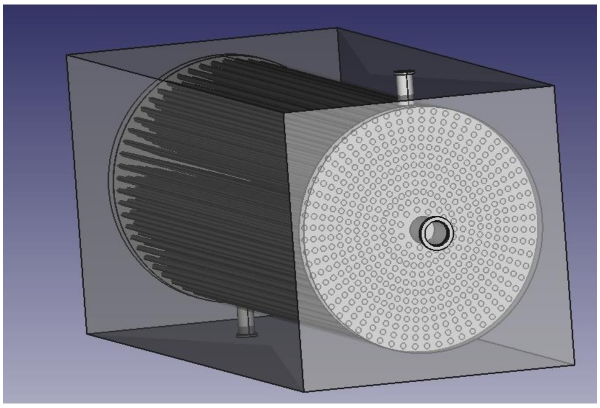
20 المكثف (Condenser)

20.1 Condenser Specification

- Length: 6 m, Number of tubes 530
- 1 inch tubes (50cm as rad 20'';6 m)
- Heat transfer between steam and water

20.2نموذج ببرنامج FreeCAD





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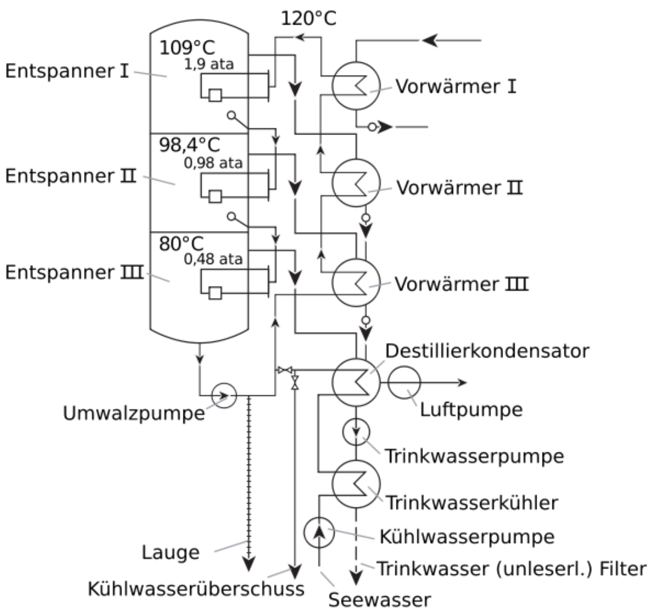
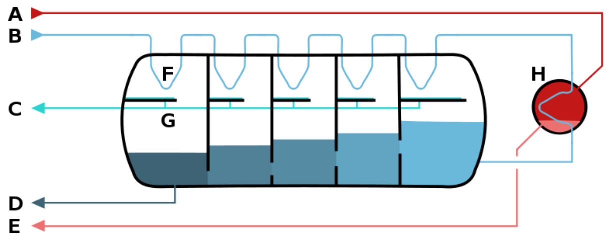
1.5MWel_condensor
27-11-2016.FCStd

20.3 Cooling of condenser

20.3.1 Sea water desalting unit for condenser cooling cycle (schema)

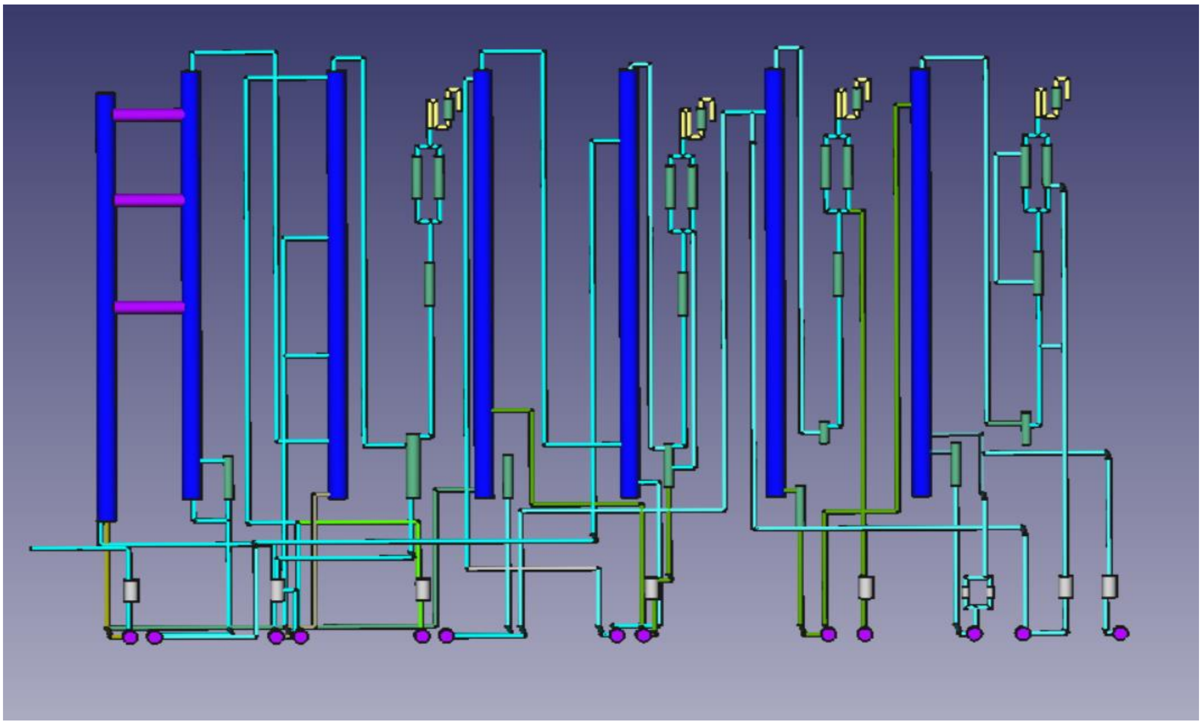


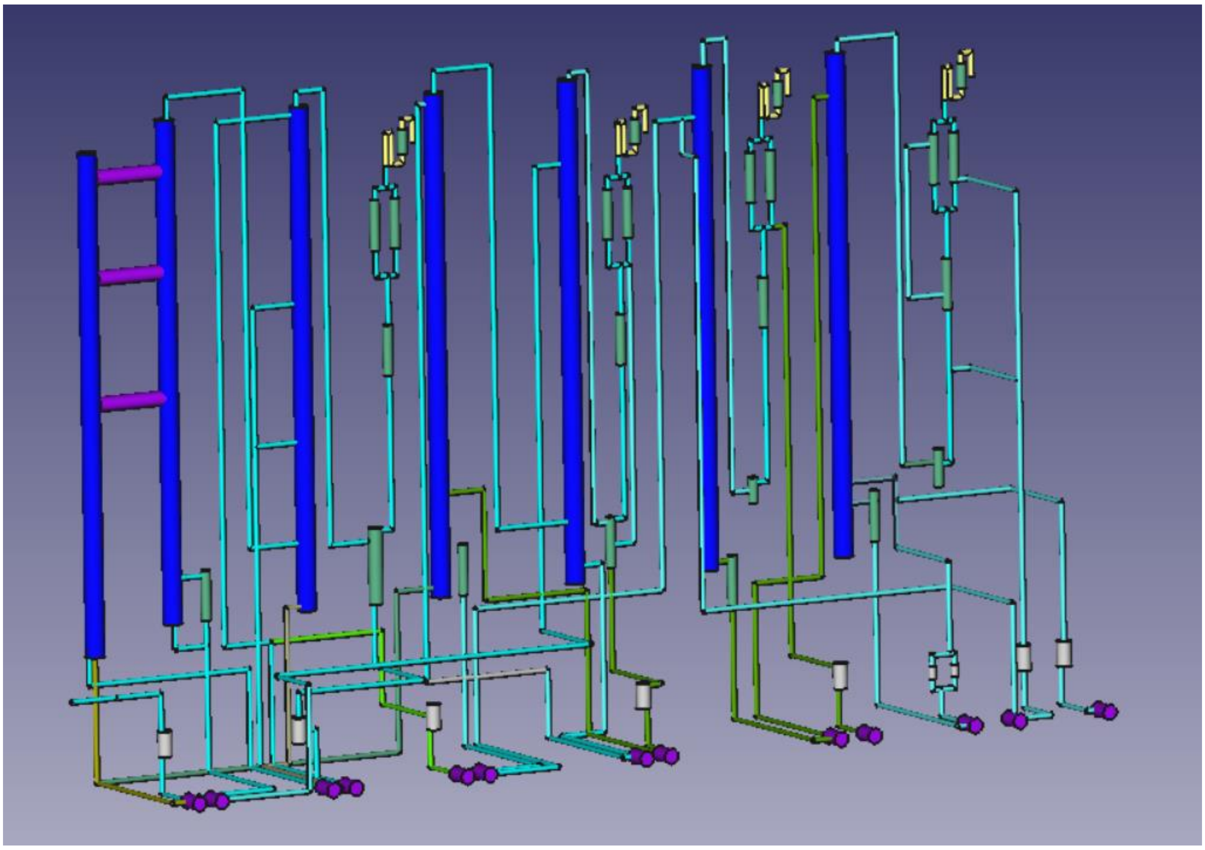


Schematic of a multistage flash desalinate

A – steam in, B – seawater in, C – potable water out, D – waste out, E – steam out , F – heat exchange, G – condensation collection, H – brine heater

20.3.2 نموذج ببرنامج FreeCAD





للتفصيل انظر الملف

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20.4 Cost for cooling with fresh sea water cycle (only with piping to sea)

500 متر بعيد من البحر: 1000 متر انابيب

Cooling						
	Length [m]	#قصتر 6 متر	Price per pipe element	Total price		
Pipes	1000	167	$30	$5,000		
		#Pumps	Price per pump			
Pumps		2	$200	$400		
					Total cooling	
					$5,400	

21 Water tank خزان المياه

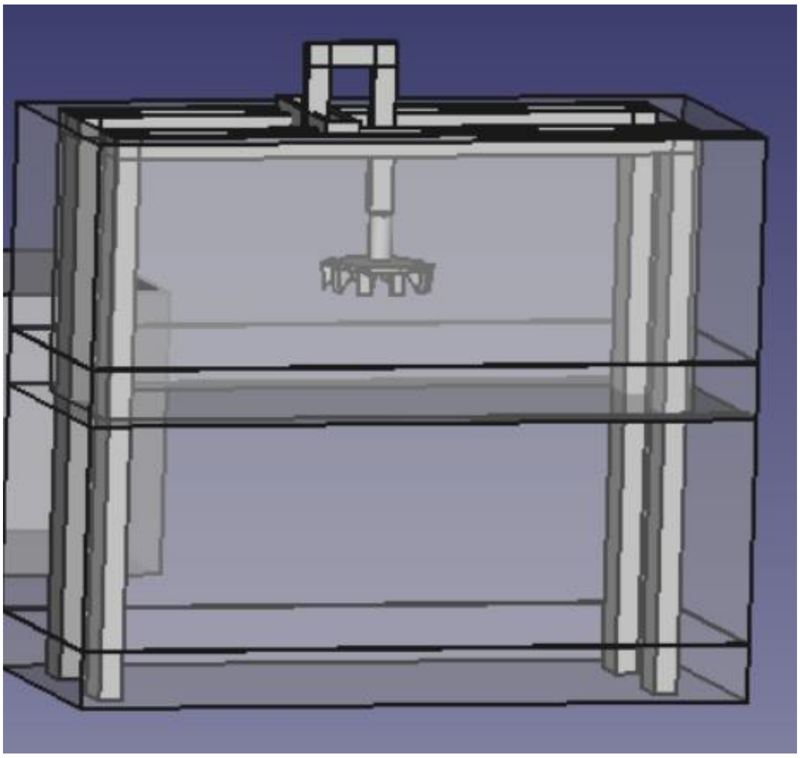
Length:6 m

Width:2 m

Hight:2 m

12 sheet of steel / (1:2m)/thickness :4 mm

22 مدخل النفايات



23 المحرقة والمبخر (Incinerator and vaporizer)

Climbing Tubes:

- vertical: 216 tubes (2 inch, 2.5 m)
- horizontal : 216 tubes (2 inch, 1 m)
- 4 tubes (4 inch, 12 m)
- 216 flosses (sheets) (2 inch)

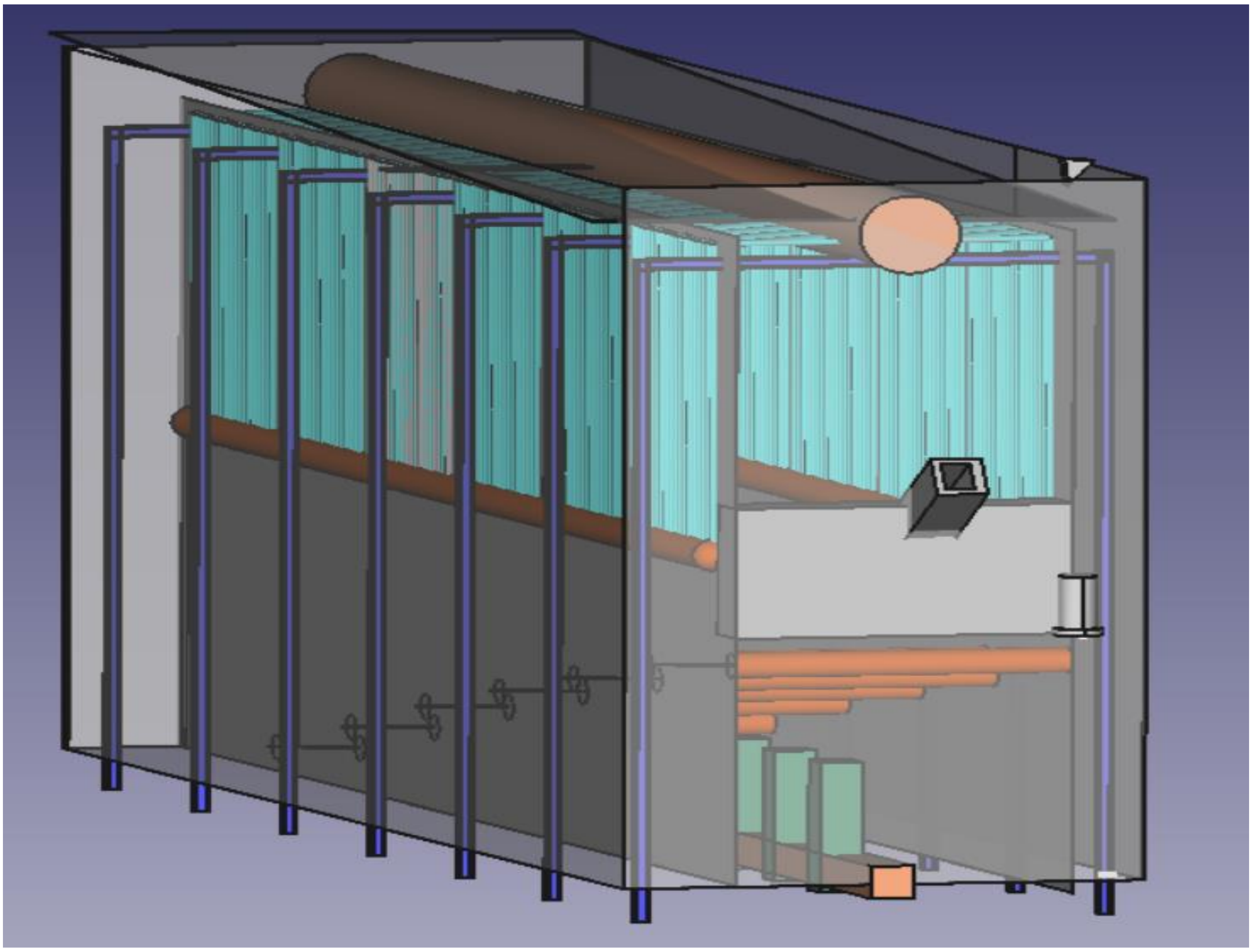
Sheets:

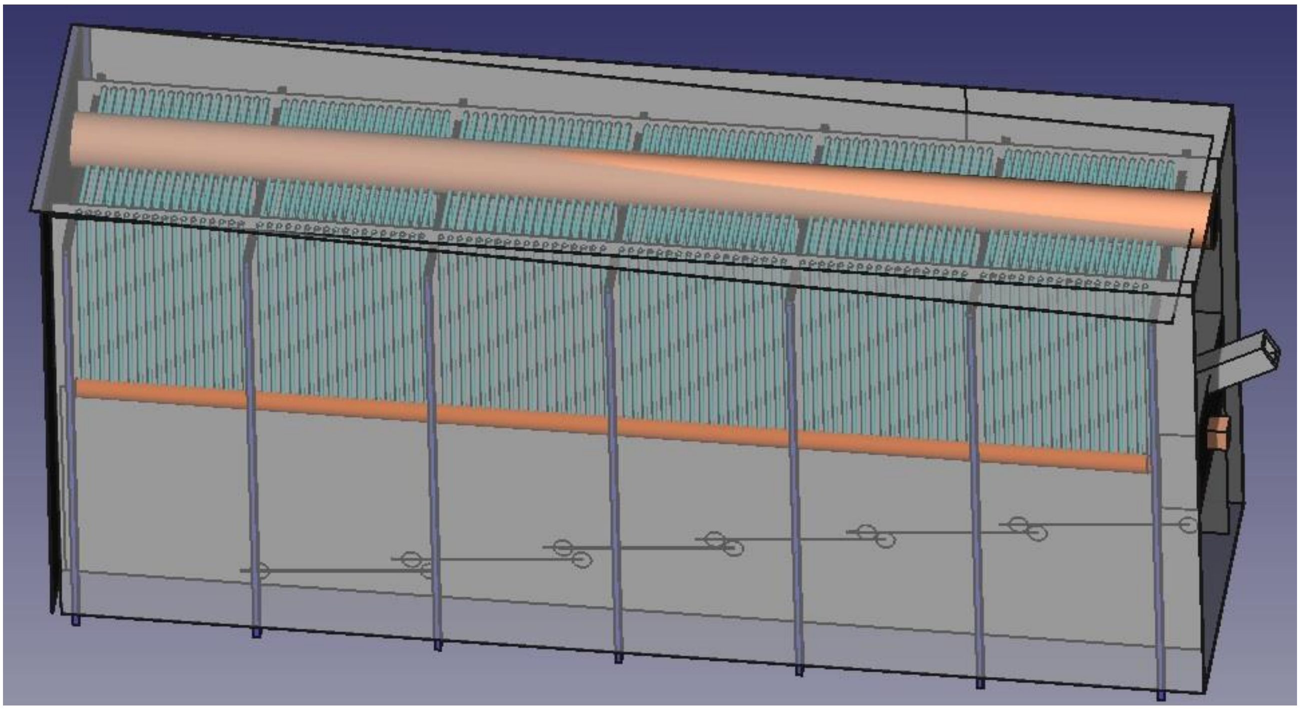
- 30 sheets (1:2 m) with thickness 4 mm
- 12 sheet (1:2 m) with thickness 4 mm
- 12 sheet (1:2 m) with thickness 4 mm to the incinerator
- sheet should be steel or stainless 306
- vaporiser : tube (rad=4‘‘, length 12 m)

Tube: between condenser and turbine :

2 tubes: length (6m), diameter: 4 inch
tube between pressure and turbine: length (6m), diameter (2 inch)

Pressure vessel: length: 12 m, diameter: 0,6 m, thickness: 16 mm (or more)





27-11-16_1.5MWel_incinerator.FCStd

24 Norms

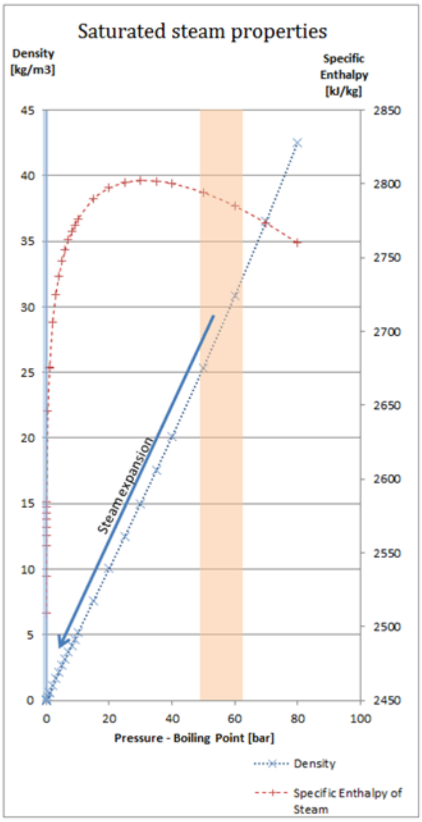
24.1 List of properties of saturated steam

Saturated Steam properties

Saturation Vapor Pressure - p -	Temperature (Boiling Point) - t -	Density - ρ -	Specific Volume - v -	Specific Enthalpy of Liquid - h_l -	Latent Heat of Vaporization - L -	Specific Enthalpy of Steam - h_s -	Specific heat
bar	°C	kg/m3	m3/kg	kJ/kg	kJ/kg	kJ/kg	kJ/kg.K
0.008	3.8	0.0063	159.7	15.9	2493	2509.00	1.87
0.02	17.5	0.0149	67.1	73.6	2460	2534	1.87
0.04	29.0	0.0290	34.5	122	2433	2555	1.87
0.05	32.9	0.0350	28.6	138	2424	2562	1.88
0.06	36.2	0.0420	23.8	152	2416	2568	1.88
0.07	39.0	0.0490	20.4	163	2410	2573	1.88
0.08	41.5	0.0550	18.2	174	2403	2577	1.89
0.09	43.8	0.0620	16.1	183	2398	2581	1.89
0.10	45.8	0.0680	14.7	192	2393	2585	1.89
0.5	81.4	0.309	3.24	341	2306	2646	1.97
1.0	99.6	0.590	1.69	418	2258	2675	2.03
1.0133	100.0	0.598	1.67	419	2257	2676	2.09
2	120.2	1.13	0.886	505	2201	2706	2.12
3	133.5	1.65	0.606	561	2163	2725	2.20
4	143.6	2.16	0.462	605	2133	2738	2.27
5	151.9	2.67	0.375	640	2108	2748	2.33
6	158.8	3.17	0.315	670	2085	2755	2.39
7	165.0	3.67	0.273	697	2065	2762	2.44
8	170.4	4.16	0.240	721	2046	2767	2.50
9	175.4	4.66	0.215	743	2030	2772	2.55
10	179.9	5.15	0.194	763	2013	2776	2.59
15	198.3	7.60	0.132	845	1945	2790	2.82
20	212.4	10.0	0.0995	909	1889	2797	3.02
25	223.9	12.5	0.0799	962	1839	2801	3.22
30	233.8	15.0	0.0666	1008	1794	2802	3.41
35	242.5	17.5	0.0570	1050	1752	2802	3.59
40	250.3	20.1	0.0497	1087	1713	2800	3.78
50	263.9	25.4	0.0394	1155	1640	2794	4.17
60	275.6	30.8	0.0324	1214	1571	2785	4.58
70	285.8	36.5	0.0274	1267	1506	2774	5.03
80	295.0	42.5	0.0235	1317	1443	2760	5.54

Typical properties in condenser of condensing turbines. These turbines exhaust steam at a pressure well below atmospheric, and in a partially condensed state, typically of a quality near 90%. (rows 0.04 – 0.10 bar)

Typical properties at the inlet of condensing turbines of PWRs. (rows 50 – 60 bar)



25 Standards

Reference of those informations: http://www.druckgeraete-online.de/seiten/anf_dampf.htm

25.1 General

No	Text of Annex I of the Pressure Equipment Directive	Water tube boiler EN 12952-1 to 17	Shell boiler EN 12953-1 to 14	Other standards
1.1	Pressure equipment shall be designed, manufactured, tested and, if necessary, equipped and installed in such a way as to ensure its safety when put into service in accordance with the manufacturer's instructions or under reasonably foreseeable conditions. [**Guideline E-03** | **Guideline H-07** | **Guideline H-15**] تصمم معدات الضغط وتصنع وتختبر ، وإذا لزم الأمر ، مجهزة ومركبة بطريقة تضمن سلامتها عند وضعها في الخدمة وفقاً لتعليمات الشركة الصانعة أو في ظروف معقولة بشكل معقول. [المبدأ التوجيهي E-03 | المبدأ التوجيهي H-07 | التوجيهي H-15]	**EN 12952-1** : 1.1	**EN 12953-1** : 1.1; 1.2;1.3	
1.2	When choosing the most appropriate solutions, the manufacturer must observe the following principles, in the order given: [**Guideline D-07** | **Guideline H-15**] - Elimination or reduction of hazards where reasonably possible; - application of appropriate protective measures against unavoidable hazards; - where appropriate, informing the user of the residual hazards and instructions on appropriate special measures to reduce the risks of installation and / or use. عند اختيار الحلول الأكثر ملاءمة ، يجب على الشركة المصنعة مراعاة المبادئ التالية ، بالترتيب المعطى: [**المبدأ التوجيهي D-07** | **التوجيهي H-15**] - القضاء أو الحد من المخاطر حيثما يكون ذلك ممكناً بشكل معقول ؛ - تطبيق تدابير الحماية المناسبة ضد المخاطر التي لا مفر منها ؛ - عند الاقتضاء ، إبلاغ المستخدم بالأخطار المتبقية وتعليمات بشأن التدابير الخاصة المناسبة للحد من مخاطر التركيب و / أو الاستخدام.			**EN 764-7** : 4;
1.3	If the possibility of improper use is known or foreseeable, the pressure equipment shall be designed to prevent the risk of such use or, if this is not possible, to adequately warn against the improper use of the pressure equipment.			**EN 764-7** : 6.6.2.1;6.6.2.3;

	[Guideline E-04 | Guideline H-07 | Guideline H-15] ذاكانت إمكانية الاستخدام غير السليم هو معروف أو يمكن التنبؤ بها، ويجب أن تصمم المعدات الضغط بحيث يتم منع خطر من هذا الاستخدام، أو إذا لم يكن ذلك ممكنا، وحذر من الاستخدام غير السليم للجهاز الطباعة بطريقة مناسبة.			
25.2 Interpretatin				
2.1	**General** pressure equipment must be designed professionally, taking into account all the factors that are critical to ensuring the safety of the equipment throughout its lifetime. The design incorporates appropriate safety factors using comprehensive methods that are known to consistently incorporate appropriate safety margins for all relevant types of failure. [Guideline E-03 | Guideline E-05] يجب تصميم معدات الضغط **العامة** بشكل احترافي ، مع الأخذ بعين الاعتبار جميع العوامل الهامة لضمان سلامة المعدات طوال عمرها. يتضمن التصميم عوامل السلامة المناسبة باستخدام أساليب شاملة معروفة باستمرار بإدراج هوامش السلامة المناسبة لجميع أنواع الفشل ذات الصلة. [	**EN 12952-3** : 5.1 to 5.9; 6.1 to 6.3; 8.4	**EN 12953-3** : 5..1 to 5.7;	**EN 764-7** : 6.1; 6.6.2;
2.2	**Design to the required load capacity**	**EN 12952-8** : 4.2.1;4.2.2; 4.2.3; 4.2.5;		
2.2.1	Pressure equipment shall be designed for loads appropriate to its intended use and other reasonably foreseeable operating conditions. In particular, the following factors should be considered: [Guideline A-42 | Guideline A-48 | Guideline A-56 |Guidelin صمم معدات الضغط للأحمال المناسبة للاستخدام المقصود وظروف التشغيل الأخرى المعقولة. على وجه الخصوص ، ينبغي النظر في العوامل التالية: e B-21 |Guideline H-07]	**EN 12952-3** : 3.1; 3.2	**EN 12953-3** : 6.1;	
-	Internal and external pressure;الضغط الداخلي والخارجي	**Internal** pressure: **EN 12952-3** : 5.2-1.Section.; 7.1; 7.2; 8.1;8.2; 8.3; 9.3; 10.2;10.3; 10.4; 11.2; 11.3;12.1; 12.2; Appendix A; External pressure: **EN 12952-3** : 5.6.3;		
-	ambient and operating temperatures;	**EN 12952-3** : 6.1; 6.2		

	درجات الحرارة المحيطة والتشغيلية		
-	Static pressure and filling weights under operating and test conditions; ضغط ثابت وملء الأوزان تحت ظروف التشغيل والاختبار	**EN 12952-3** : 5.7.2 (a); 7.3;	
-	Belastages from traffic, wind and earthquakes; خسائر من حركة المرور والرياح والزلازل -	**EN 12952-3** : 5.3;	
-	Reaction forces and moments related to supporting elements, fixings, piping, etc .; قوات رد الفعل واللحظات المتعلقة بدعم العناصر ، المثبتات ، الأنابيب ، وما إلى ذلك	**EN 12952-3** : 5.3;5.9; 7.4; 1 1.5;	
-	corrosion and erosion, material fatigue, etc .; التآكل والتآكل ، التعب المادية ، وما إلى ذلك ؛	**EN 12952-3** : 5.8;7.1.2; 10.2 .1.1; 13;Annex AA.3; Appendix B	
-	Decomposition of unstable fluids. تحلل السوائل غير المستقرة		
-	Different loads which can occur simultaneously must be taken into account, taking into account the probability of their simultaneous occurrence. يجب أن تؤخذ في الاعتبار الأحمال المختلفة التي يمكن أن تحدث في وقت واحد ، مع الأخذ بعين الاعتبار احتمالية حدوثها في وقت واحد.	**EN 12952-3** : 5.2;5.3; 6.2; 7. 3; 7.4; 7.5;	
2.2.2	The design for the required load capacity is based on the following procedures: يعتمد تصميم سعة الحمولة المطلوبة على الإجراءات التالية		**EN 12953-3** : 6 to 13
	-In general, a method of calculation according to 2.2.3, supplemented if necessary by an experimental design method in accordance with 2.2.4, [Guideline E-01 | Guideline E-07] or عمومًا ، طريقة حساب وفقًا لـ 2.2.3 ، تُستكمل إذا لزم الأمر بواسطة طريقة تصميم تجريبية	**EN 12952-3** : 7 to 11;8.4; 12.2; 7 .5;Appendix A; Annex B;	
	- an experimental design method without calculation, in accordance with 2.2.4, if the product of the maximum allowable pressure (PS) and the volume V is less than 6 000 bar • طريقة تصميم تجريبية بدون حساب ، وفقاً للمعيار 2.2.4 ، إذا كان ناتج الحد الأقصى المسموح به من الضغط (PS) والحجم V أقل من 6000 بار • l أو المنتج PS • DN أقل من 3000 بار.l or the product PS • DN is less than 3000 bar.	**EN 12952-3** : 12.1;	

2.2.3.	**calculation method**	**EN 12952-3** : 6.1;6.2; 6.3; 8. 4;	**EN 12953-3** : 6 to 13

a) Compressive strength and other loading aspects
For pressure equipment, the permissible loads shall be limited in terms of the reasonably foreseeable failure possibilities depending on the operating conditions. For this purpose, safety factors must be applied which make it possible to completely cover all uncertainties due to production, actual operation, load, calculation models, material properties and material behavior.
The calculation methods shall provide adequate safety margins according to the conditions of Section 7, if applicable.

In order to meet the above requirements, one of the following methods, which may be appropriate, may be used in addition or in combination:

طريقة الحساب

أ) احتواء الضغط وغيرها من الجوانب تحميل
للمعدات الضغط يجب المسموح الضغوط من حيث وسائط فشل متوقعة إلى حد معقول للحد تبعا لظروف التشغيل. يجب تطبيق هذه عوامل السلامة للقضاء تماما أي عدم اليقين الناجمة عن تصنيع والظروف الفعلية التشغيلية، الضغوط، ونماذج الحساب، والخصائص المادية والسلوك المادي.
يجب أن توفر طرق الحساب هوامش أمان كافية وفقًا لشروط القسم 7 ، إن وجدت.

من أجل تلبية المتطلبات المذكورة أعلاه ، يمكن استخدام إحدى الطرق التالية ، التي قد تكون مناسبة ، بالإضافة إلى ذلك أو في توليف

Interpretation according to formulas, — **EN 12952-3** : 7 to 11;8.4; 13; Appendix A;Annex B;

التفسير وفقا للصيغ ،

Design according to analysis method, — **EN 12952-3** : 5.2;5.4; 12.2;

تصميم وفقا لطريقة التحليل

Design according to fracture mechanics procedures.

تصميم وفقا لإجراءات الميكانيكا الكسر

b) Load capacity
Appropriate design calculations shall be carried out to demonstrate the load capacity of the pressure equipment concerned.

In particular, the following applies:

ب) سعة الحمولة
ب إجراء حسابات تصميم مناسبة لإظهار يجـ ***الحمولة*** لمعدات الضغط المعنية.

على وجه الخصوص ، ينطبق ما يلي:

- The calculation pressures must not be lower than the maximum allowable pressures, and the static and dynamic fluid pressures as well as the decay pressures of unstable fluids must be taken into account. If a container is divided into individual pressure chambers, the calculation of the partition wall between the pressure chambers must be based on the highest possible pressure in one pressure chamber and the lowest possible pressure in the adjacent pressure chamber. [**Guideline B-19**] يجب ألا تقل ضغوط الحساب عن الحد الأقصى المسموح به من الضغوط ، ويجب أن تؤخذ ضغوط السوائل الديناميكية والساكنة وكذلك ضغوط الانحلال في السوائل غير المستقرة في الاعتبار. إذا تم تقسيم الحاوية إلى غرف ضغط فردية ، فيجب أن يستند حساب جدار الفصل بين غرف الضغط إلى أعلى ضغط ممكن في غرفة ضغط واحدة وأقل ضغط ممكن في غرفة الضغط المجاورة . [**المبدأ التوجيهي ب -19**]	**EN 12952-3** : 5.7;
-The calculation temperatures must have reasonable safety margins. يجب أن تشتمل درجات الحرارة الحسابية على هوامش أمان معقولة.	**EN 12952-3** : 6.1;6.2;
- All sorts of temperature and pressure combinations, which may occur under reasonably foreseeable operating conditions of the equipment, must be considered in the design. يجب مراعاة جميع أنواع درجات الحرارة ومجموعات الضغط ، التي قد تحدث في ظروف تشغيلية معقولة للمعدات ، في التصميم.	**EN 12952-3** : 5.2;
-The maximum stress and stress concentrations must be within safe limits. - When calculating the pressure chamber, the material properties shall use appropriate values based on documented data, taking into account both the provisions of Section 4 and corresponding safety factors. The material properties to be considered include: يجب أن يكون الحد الأقصى للضغط وتركيز الإجهاد ضمن الحدود الآمنة. - عند حساب غرفة الضغط ، يجب أن تستخدم خواص المواد قيمًا مناسبة استنادًا إلى بيانات موثقة ، مع مراعاة كل من أحكام القسم 4 وعوامل السلامة المقابلة. وتشمل خصائص المواد التي يتعين النظر فيها ما يلي:	**EN 12952-3** : 13;Annex B;
- yield strength, 0.2% or 1% proof strength at the calculation temperature قوة الخضوع ، قوة مقاومة 0.2٪ أو 1٪ عند درجة الحرارة الحسابية	**EN 12952-3** : 6.3;
--Tensile strenght	**EN 12952-3** : 6.3;
- Time stability, e.g. Creep resistance; استقرار الوقت ، على سبيل المثال مقاومة الزحف	**EN 12952-3** : 6.3;
- fatigue data, e.g. B. fatigue strength;	**EN 12952-3** : 13;Annex B;
--Modulus of elasticity;	**EN 12952-3** : Annex D;
- adequate plastic deformation; تشوه مناسب من البلاستيك ؛	**EN 12952-3** : 8.4;
-On the material properties, suitable coupling factors shall be used, depending, for example, on the nature of the non-destructive tests, the properties of the material joints and the operating conditions considered.	**EN 12952-3** : 5.6 (g);11.2.4;
- When designing, all reasonably foreseeable wear mechanisms (especially corrosion, creep,	

fatigue) should be considered according to the intended use of the equipment.The operating instructions referred to in section 3.4 must indicate design features that are relevant to the life of the device, for example

For **creep** : design life in hours at specified temperatures;

For **fatigue** : design cycle number at specified voltage values;

-For **corrosion** : corrosion surcharge during design.

على طبيعة الاختبارات غير المدمرة ، وخصائص مفاصل المواد وظروف ، التشغيل قيد النظر.

عند التصميم ، ينبغي النظر في جميع آليات البلى (بما في ذلك التآكل ، الزحف ، - يجب أن تشير تعليمات (التعب) بشكل معقول وفقاً للاستخدام المقصود من المعدات التشغيل المشار إليها في القسم 3.4 إلى ميزات التصميم ذات الصلة بعمر الجهاز ، على سبيل المثال

زحف للحصول ،: الحياة التصميم في ساعات عند درجات حرارة محددة؛

التعب للحصول ،: تصميم عدد من الدورات في مستويات التوتر محددة.

التآكل للحصول ،: بدل تآكل في التصميم.

b) Stability
If the calculated wall thickness does not provide sufficient structural stability, the necessary measures must be taken, taking into account the hazards associated with transport and handling.

EN 12952-3 : 5.2;7.4; 7.5; 1 1.4; 11.5;

ج) الاستقرار
إذا كان سمك الجدار المحسوب لا يوفر الاستقرار الهيكلي الكافي ، يجب اتخاذ التدابير اللازمة ، مع الأخذ في الاعتبار المخاطر المرتبطة بالنقل والمناول

2.2.4 **Experimental Design Method**
[Guideline E-01 | Guideline E-05]
The design of the device may be tested in whole or in part by a test program carried out on a sample representative of the pressure equipment or of the pressure equipment series.
The test program must be clearly identified prior to the tests and, if a notified body is responsible for the design evaluation in the applied module, be recognized by the latter.
In this program the test conditions as well as the acceptance and rejection criteria shall be defined. The actual values of the essential dimensions and characteristics of the starting materials of the pressure equipment shall be established prior to the test.
During the tests, if necessary, the critical areas of the pressure equipment shall be monitored by means of appropriate instruments capable of measuring with sufficient accuracy deformations and stresses.

The test program must include:

طريقة التصميم التجريبي
[**التوجيهي E-01** | **المبدأ التوجيهي E-05**]
يمكن اختبار تصميم الجهاز كليًا أو جزئيًا من خلال برنامج اختبار تم إجراؤه على ممثل عينة من معدات الضغط أو من سلسلة معدات الضغط.
يجب تحديد برنامج الاختبار بوضوح قبل إجراء الاختبارات ، وإذا كانت الجهة المسؤولة مسؤولة عن تقييم التصميم في الوحدة النمطية المطبقة ، فيجب الاعتراف

بها من قبل الأخير.
يجب .في هذا البرنامج ، يتم تحديد شروط الاختبار وكذلك معايير القبول والرفض تحديد القيم الفعلية للأبعاد والخصائص الأساسية للمواد الأولية لمعدات الضغط قبل الاختبار.
خلال الاختبارات ، إذا لزم الأمر ، يجب مراقبة المناطق الحرجة لمعدات الضغط عن طريق الأدوات المناسبة القادرة على القياس بدقة وتشوهات كافية.

يجب أن يتضمن برنامج الاختبار:

a) A compressive strength test designed to verify that, in the event of pressure with a margin of safety above the maximum allowable pressure, the instrument will not show significant leakage or deformation beyond a specified limit. For the determination of the test pressure, the differences between the values measured under test conditions for the geometrical characteristics and the material properties on the one hand and the values permitted for the construction on the other hand shall be taken into account; the difference between test and design temperatures must also be considered.

EN 12952-3 : 12.1.2;12.1.3;

أ) اختبار مقاومة الضغط ليتم فحصها من قبل أنه فيما يتعلق الحد الأقصى لضغط هامش أمان محددة، يقوم الجهاز بعرض أي تسرب كبير أو تشوه تتجاوز عتبة عازمة تحت ضغط.

لتحديد الاختلافات ضغط الاختبار بين القيم المقاسة في ظروف الاختبار للخصائص الهندسية وخصائص المواد من ناحية والقيم المسموح بها للبناء من ناحية أخرى أن تؤخذ بعين الاعتبار. يجب أيضا النظر في الفرق بين درجات الحرارة واختبار التصميم

b) For creep or fatigue risk, appropriate tests determined according to the operating conditions intended for the equipment (eg operating time at certain temperatures, number of cycles for certain voltage values, etc.).

ب) بالنسبة لخطر الزحف أو التعب ، يتم تحديد الاختبارات المناسبة وفقًا لظروف التشغيل المعدة للمعدة (مثل وقت التشغيل في درجات حرارة معينة ، وعدد الدورات لقيم معينة من الجهد ، الخ).

c) If necessary, supplementary tests for other special effects according to section 2.2.1, such as corrosion, aggressive external influences, etc.

ج) عند الضرورة ، الاختبارات التكميلية للتأثيرات الخاصة الأخرى وفقا للقسم 2.2.1 ، مثل التآكل والتأثيرات الخارجية العدوانية ، إلخ.

2.3. **Precautions for Safety in Handling and Operation**

EN 12952-12 : 5; **EN 12953-7** : 4.2.7; **EN 12953-10** : 4; 5; **EN 764-7** : 8.1; 8.2.3;

The pressure equipment controls shall be such that their operation does not give rise to a reasonably foreseeable hazard. If applicable, the following points should be noted:

[Guideline B-21 | Guideline B-32 | Guideline E-03 |Guideline I-20]

- closing and opening devices;

الاحتياطات للسلامة في المناولة والتشغيل
يجب أن تكون أدوات التحكم في معدات الضغط بحيث لا يؤدي تشغيلها إلى حدوث خطر متوقع بشكل معقول. إذا أمكن ، تجدر الإشارة إلى النقاط التالية:

[المبدأ التوجيهي B-21 | الخط التوجيهي B-32 | المبدأ التوجيهي E-

03 | **الخط التوجيهي I-20**]

- إغلاق الأجهزة ؛ -

	- dangerous blow-off from pressure relief valves; تفجير خطير من صمامات تخفيف الضغط	**EN 12952-8** : 4.3.6;	**EN 12953-8** : 4.5 - 5th paragraph; **EN 12953-10** : 5;
	- devices to prevent physical access in case of overpressure or vacuum in the device; - surface temperatures taking into account the intended use; - decomposition of unstable fluids. In particular, pressure equipment with a removable closure device must be equipped with an automatic or manually operable device by which the operator can easily ensure that the device can be safely opened. If the device can be actuated quickly, the pressure device must also be equipped with a lock which prevents it from opening, as long as the pressure or the temperature of the fluid is a hazard. أجهزة لمنع الوصول المادي في حالة الضغط الزائد أو الفراغ في الجهاز ؛ - درجات حرارة السطح مع مراعاة الاستخدام المقصود ؛ - تحلل السوائل غير المستقرة. - على وجه الخصوص ، يجب أن تكون أجهزة الضغط المزودة بجهاز إغلاق قابل للإزالة مزودة بجهاز يعمل أوتوماتيكيًا أو يدويًا يمكن من خلاله للمشغل التأكد بسهولة من إمكانية فتح الجهاز بأمان. إذا كان من الممكن تشغيل الجهاز بسرعة ، يجب أن يكون جهاز الضغط مجهزًا بقفل يمنعه من الفتح ، طالما أن الضغط أو درجة حرارة السائل خطر.		
2.4.	**Precautions for Inspection** a) Pressure equipment shall be designed so that all required safety inspections can be carried out. **احتياطات التفتيش** أ) تصمم معدات الضغط بحيث يمكن إجراء جميع عمليات التفتيش على السلامة المطلوبة	**EN 12952-3** : 5.6.2;	**EN 12953-3** : 14;
	b) If necessary to ensure continuous equipment safety, provision must be made for detecting the internal condition of the printing equipment, such as openings for access to the interior of the printing equipment, so that appropriate inspections can be carried out safely and ergonomically. ب) إذا لزم الأمر لضمان سلامة المعدات المستمرة ، يجب توفير إمكانية الكشف عن الحالة الداخلية لمعدات الطباعة ، مثل الفتحات للوصول إلى داخل معدات الطباعة ، بحيث يمكن إجراء عمليات التفتيش المناسبة بأمان وراحة	**EN 12952-3** : 5.6.2;	

	c) Other means to ensure a safe condition of the pressure equipment can be used يمكن استخدام وسائل أخرى لضمان سلامة حالة معدات الضغط			
	- if these are too small for an entry; إذا كانت صغيرة جدًا بالنسبة للدخول	**EN 12952-3** : 5.6.2;		
	--When the opening of the printing device would adversely affect the interior of the device; عندما يؤثر فتح جهاز الطباعة سلبًا على الجزء الداخلي للجهاز			
	--When the ingredient has been shown to be unaffected by the material of which the printing device is made, nor is any other internal damage process reasonably foreseeable. عندما يتبين أن المكون غير متأثر بالمواد التي تم صنع جهاز الطباعة بها ، ولا توجد أي عملية ضرر داخلية أخرى يمكن توقعها بشكل معقول.	**EN 12952-3** : 5.6.2;		
2.5	**Draining and venting facilities** If necessary, suitable devices for draining and venting the pressure equipment must be provided,**مرافق التصريف والتنفيس** إذا لزم الأمر ، يجب توفير أجهزة مناسبة لتصريف وتنفيس معدات الضغط	**EN 12952-3** : 5.6.2; **EN 12952-7** : 5.2;5.3;	**EN 12953-6** : 5.3; 6.5;6.9 ;	**EN 764-7** : 8.1.4;8.1.5; 8.2.3 ; 8.5.6;
	- to avoid harmful effects such as water hammer, vacuum collapse, corrosion and uncontrolled chemical reactions; all operating and test conditions, in particular pressure tests, must be taken into account; لتجنب الآثار الضارة مثل مطرقة المياه ، وانهيار الفراغ ، والتآكل ، والتفاعلات الكيميائية غير المنضبط ؛ يجب أن تؤخذ جميع ظروف التشغيل والاختبار ، ولا سيما اختبارات الضغط ، في الاعتبار ؛	**EN 12952-3** : 5.6.3;		
	- to enable cleaning, inspection and maintenance without risk.	**EN 12952-3** : 5.6.3;		
	لتمكين التنظيف والتفتيش والصيانة بدون مخاطر.	**EN 12952-12** : 5;		
2.6	**Corrosion and other chemical influences** Where necessary, appropriate wall thickness allowances or adequate protection against corrosion or other chemical influences shall be provided, due account being taken of the intended and reasonably foreseeable use. **تآكل والتأثيرات الكيميائية الأخرى** اللازمة، لبدل المناسب أو الحماية الكافية ضد التآكل أو غيرها من هجوم كيماوي، مع النية والاعتبار الواجب استخدام المنظور إلى حد معقول.	**EN 12952-3** : 5.8;	**EN 12953-3** : 5.7;	
2.7	**Wear** Wherever severe erosion or wear can occur, appropriate measures must be taken to:**ارتداء** أينما يمكن أن يحدث تآكل أو تآكل شديد ، يجب اتخاذ التدابير المناسبة من أجل		**EN 12953-3** : 5.7;	
	-These phenomena by suitable design, for. B. wall thickness surcharges, or by the use of liners or coatings to minimize; هذه الظواهر عن طريق تصميم مناسب ، ل. ب رسوم إضافية على سمك الجدار ، أو عن طريق استخدام بطانات أو طبقات لخفض	**EN 12952-3** : 5.8.6;		
	-Make it possible to replace the most affected parts; جعل من الممكن استبدال الأجزاء الأكثر تضررا.			
	-Use the instructions given in section 3.4 to focus attention on the measures necessary for continuous safe operation. استخدام التعليمات الواردة في القسم 3.4 لتركيز الانتباه على التدابير اللازمة للتشغيل الآمن المستمر.			

2.8 **Assemblies**

Assemblies are to be designed so that

The interconnected components are reliable and suitable for their operating conditions;

-The proper installation of all components and their proper integration and assembly within the assembly is ensured.
[Guideline E-03 | Guideline E-05]

يتم تصميم المكونات بحيث

المكونات المترابطة موثوقة ومناسبة لظروف التشغيل الخاصة بها ؛

- ضمان التركيب الصحيح لجميع المكونات وتكاملها وتجميعها بشكل صحيح داخل المجموعة.

2.9 **Filling and emptying**

[Guideline E-04 | Guideline H-15]]
Where appropriate, the pressure equipment shall be so designed and equipped with equipment or prepared for appropriate equipment to ensure safe filling and emptying; particular attention must be paid to the following hazards:

a) when filling:

Overfilling or high pressure, in particular with regard to the degree of filling and the vapor pressure at the reference temperature;

- instability of the printing device;

b) during emptying: uncontrolled release of the pressurized fluid;

c) when filling and emptying: hazardous coupling and uncoupling.

ملء وتفريغ

عند [ ] [المبدأ التوجيهي E-04 | المبدأ التوجيهي H-15]
الاقتضاء ، يجب تصميم معدات الضغط بحيث تكون مجهزة ومجهزة بالمعدات أو المعدة للمعدات المناسبة لضمان الملء والتفريغ الأمنين ؛ يجب إيلاء اهتمام خاص للمخاطر التالية:

أ) عند الملء:

التعبئة الزائدة أو الضغط العالي ، خاصة فيما يتعلق بدرجة الملء وضغط البخار عند درجة الحرارة المرجعية ؛

- عدم ثبات جهاز الطباعة ؛

ب) أثناء التفريغ: إطلاق غير مضبوط للسائل المضغوط ؛

ج) عند التعبئة والتفريغ: اقتران خطي وفك

2.10	**Protection against exceeding the permissible limits of the pressure equipment** [guideline A-06 | Guideline A-20 | Guideline B-29 |Guideline E-04 | Guideline E-06 | Guideline H-15] In circumstances where reasonably foreseeable conditions could cause the allowable limits to be exceeded, the pressure equipment shall be	**EN 12952-7** : 4; 5.1;5.8; 6: 1; 6.2; **EN 12952-10** : 5;	**EN 12953-6** : 4; 5.1; 5.2; 5. 7; 5.8; 6.1; 6.2; 6. 10; 6.11;	**EN 764-7** : 5.1; 6.1.3;6.6.1; 7;

provided with appropriate protective devices or prepared for such equipment, unless the equipment is provided as part of an assembly by other means of protection is protected.
The suitable protection device or the combination of suitable protection devices is to be determined depending on the respective device or the respective assembly and the respective operating conditions.

Suitable protection devices and combinations of protection devices include:

الحماية من تجاوز الحدود المسموح بها لمعدات الضغط
[**المبدأ التوجيهي A-06** | **المبدأ التوجيهي A-20** | **الخط التوجيهي B-29** | **المبدأ التوجيهي E-04** | **المبدأ التوجيهي E-06** | **التوجيهي H-15**]
وفي الحالات التي يمكن توقعها في ظل ظروف معقولة، يمكن تجاوز الحدود المسموح بها، ومعدات الضغط يجب أن تكون مزودة وسائل وقائية مناسبة، أو توفير اعتماد لمن المناسب، إذا كان الجهاز كجزء من تجميع من قبل أجهزة وقائية أخرى محمي.
يتم تحديد جهاز الحماية المناسب أو مجموعة من أجهزة الحماية المناسبة وفقًا للجهاز المعني أو التجميع المعني وظروف التشغيل الخاصة به.

تشتمل أجهزة الحماية المناسبة ومجموعات الحماية على ما يلي:

	(a) safety accessories as defined in Article 2 (4) ; **Guideline A-43**])	**EN 12952-8** : 4.2.4;	**EN 12953-7** : 4.2.4;	
	ملحقات السلامة كما هي محددة في المادة 2 (4) ؛			
	(b) where appropriate, appropriate monitoring devices, such as indicators and / or warning devices, which allow either automatic or manually-measured measures to be taken to ensure compliance with the allowable limits of the pressure equipment. عند الاقتضاء ، أجهزة مراقبة مناسبة ، مثل المؤشرات و / أو أجهزة الإنذار ، التي تسمح إما باتخاذ تدابير تلقائية أو يدوية لقياس الامتثال للحدود المسموح بها لمعدات الضغط.			
2.11	**Safety accessories** [**Guideline A-06** | **Guideline A-20** | **Guideline B-29** | **Guideline E-04** | **Guideline E-06** | **Guideline H-15**] **إكسسوارات للسلامة**	**EN 12952-7** : 8; **EN 12952-10** : 5;	**EN 12953-6** : 6.10;	
2.11.1	For safety accessories the following applies:	**EN 12952-11** : 4; 5;	**EN 12953-9** : 4; 5;	**EN 764-7** : 4.3; 6.6;

- they must be designed and constructed to be reliable and suitable for the intended operating conditions, taking into account any maintenance and test requirements for the devices;

- they may not perform any other tasks unless their safety-related functions cannot be affected;

- they must comply with the appropriate design principles for adequate and reliable protection. In particular, these principles include fail safe, redundancy, diversity, and self-monitoring. لملحقات السلامة ينطبق ما يلي:

- يجب تصميمها وبناءها لتكون موثوقة ومناسبة لظروف التشغيل المزمعة ، مع مراعاة أي متطلبات صيانة واختبار للأجهزة ؛

- قد لا يقوموا بأي مهام أخرى ما لم تتأثر وظائفهم المتعلقة بالسلامة ؛

- يجب أن تلتزم بمبادئ التصميم المناسبة للحماية الكافية والموثوقة. على وجه

الخصوص ، تشمل هذه المبادئ الفشل الآمن ، التكرار ، التنوع ، والمراقبة الذاتية.

2.11.2	**Pressure limiting** devices These devices shall be designed such that the pressure does not exceed the maximum permissible pressure PS **during** operation; however, a short-term pressure overrun is permissible in accordance with Section 7.3, if applicable. [Guideline E-02 | Guideline E-09] **الحد من الضغط** يجبأجهزة أن يتم تصميم هذه الأجهزة بحيث لا يتجاوز الضغط الحد الأقصى للضغط الممكن السرطان (PS ومع ذلك ، يجوز تجاوز الضغط على المدى القصير وفقا للقسم 7.3 ، إذا كان ذلك ممكنا	**EN 12952-11** : 6;	**EN 12953-8** : 4; **EN 12953-9** : 6;	**EN 764-7** : 6.1; 6.2.2;6.2.3; 6.3.2; 6.4.2; 6.6;
2.11.3	**Temperature monitoring devices** These devices must have a safety-related response time appropriate to the measurement task **أجهزة مراقبة درجة الحرارة.** يجب أن يكون لدى هذه الأجهزة وقت استجابة متعلق بالسلامة يتناسب مع مهمة القياس	**EN 12952-10** : 7;	**EN 12953-9** : 7;	**EN 764-7** : 6.6; 9.2;
2.12	**External fire** Wherever possible, pressure equipment shall be designed and, where appropriate, equipped with appropriate equipment or equipped with suitable equipment to meet the damage limitation requirements in the event of an external fire, taking into account its intended use.**حريق خارجي** أين اللازمة، معدات الضغط يجب أن تكون مصممة خصيصا مع الأخذ بعين الاعتبار الغرض من استخدامها وذلك بشرط اختياريا مع الاكسسوارات المناسبة، أو توفير اعتماد لتركيب، وذلك في حال نشوب حريق خارجي، وتلبية الاحتياجات من حيث الحد من الضرر [Guideline E-02 | Guideline E-04]			**EN 764-7** : 6.2.3; 7.2;

3 25.3 production

3.1	**Manufacturing process** The manufacturer shall ensure the expert implementation of the measures taken at the design stage by applying appropriate techniques and procedures; this is especially true with regard to the following points: **عملية** التصنيع يجب على الشركة المصنعة التأكد من تنفيذ الخبراء للتدابير المتخذة في مرحلة التصميم من خلال تطبيق التقنيات والإجراءات المناسبة ؛ هذا صحيح بشكل خاص فيما يتعلق بالنقاط التالية [Guideline G-19 | Guideline I-21]	**EN 12952-5** : 6.1;	**EN 12953-2** : 4.4; 4.5;6; **EN 12953-4** : 5; **EN 12953-5** : 5.4;
3 . 1.1	**Preparing the components** When preparing the components (eg forming and welding edge preparation), there must be no damage, cracks or changes in the mechanical properties that could affect the safety of the printing device. **إعداد المكون** عند إعداد المكونات (على سبيل المثال. كما صب واللحام إعداد حافة) يجب أن لا يكون معطوبا أو شقوق أو تغيرات في الخواص الميكانيكية التي يمكن أن تؤثر على سلامة المعدات الضغط. [	**EN 12952-5** : 7.1;7.2; 7.3; 7. 4;	**EN 12953-4** : 5.15; **EN 12953-5** : 5.6;

	[Guideline F-03 | Guideline F-09 | Guideline F-14]		
3.1.2	**Durable material connections** [guideline C-15 | Guideline F-01 | Guideline F-03 |Guideline F-04 | Guideline F-05 | Guideline F-06|Guideline F-08 | Guideline F-09 | Guideline F-10 |Guideline F-11 | Guideline F-12 | Guideline F-14 |Guideline F-15 | Guideline F-16 | Guideline G-10 |Guideline G-25] The permanent joints of the material and adjacent areas shall not show defects on the surface or in the interior which could affect the safety of the equipment. **اتصالات المواد المعمرة** [المبدأ التوجيهي C-15 | المبدأ التوجيهي F-01 | المبدأ التوجيهي F-03 | المبدأ التوجيهي F-04 | الخط التوجيهي F-05 | المبدأ التوجيهي F-06 |المبدأ التوجيهي F-08 | الخط التوجيهي F-09 | المبدأ التوجيهي F-10 | المبدأ التوجيهي F-11 | المبدأ التوجيهي F-12 | المبدأ التوجيهي F-14 | المبدأ التوجيهي F-15 | المبدأ التوجيهي F-16 | المبدأ التوجيهي لمجموعة العشرون | المبدأ التوجيهي G-25] لا تظهر المفاصل الدائمة للمواد والمناطق المجاورة عيوبا على السطح أو في الداخل يمكن أن تؤثر على سلامة المعدات.	**EN 12952-5** : 7.1.2;7.3.11; 8 .4.1; **EN 12952-6** : 6; 7 to 8.2;	**EN 12953-4** : 5.12; **EN 12953-5** : 5.5; 5.6;
	The properties of the permanent joints shall be the same as the minimum properties specified for the materials to be joined, unless the design calculations take into account other specific values for such properties. تكون خصائص المفاصل الدائمة هي نفس الخصائص الدنيا المحددة للمواد الموضوعة ، ما لم تأخذ حسابات التصميم في الحسبان القيم المحددة الأخرى لهذه الخصائص	**EN 12952-5** : 8.1.1;8.7;	**EN 12953-4** : 5.12;
	In the case of pressure equipment, the permanent connections of the parts contributing to the compressive strength of the equipment and the parts directly connected thereto shall be carried out by qualified personnel with adequate qualifications and in accordance with a technically sound working procedure. لمعدات الضغط، دائم انضمام المكونات التي تساهم في مقاومة الضغط المعدات يجب، وتعلق مباشرة لهم من قبل موظفين مؤهلين من ذوي المؤهلات المناسبة وفقا لإجراءات التشغيل مناسبة مهنيا يتم تنفيذها.	**EN 12952-5** : 8.1.3;	
	The approval of work procedures and personnel for category II, III and IV pressure equipment shall be carried out by a competent independent authority; this is at the option of the manufacturer to تتم الموافقة على إجراءات العمل والأفراد لمعدات الضغط من الفئة الثانية والثالثة والرابعة من قبل سلطة مستقلة مختصة. هذا هو في اختيار الشركة المصنعة ل -A notified body, -A test laboratory recognized by a Member State in accordance with Article 20. مختبر اختبار معترف به من قبل دولة عضو وفقا للمادة 20. For the purpose of issuing such authorizations, the said independent body shall carry out or have carried out the examinations and tests provided for in the corresponding harmonized standards or equivalent examinations and tests. ولغرض إصدار هذه التراخيص ، تقوم الهيئة المستقلة المذكورة بإجراء أو إجراء الفحوص والاختبارات المنصوص عليها في المعايير المتوافقة المناظرة أو	**EN 12952-5** : 8.3.2;	

الاختبارات والفحوص المماثلة

3.1.3	**Non-destructive testing** For pressure equipment, non-destructive testing of permanent connections shall be carried out by qualified personnel with adequate qualifications. For pressure equipment of categories III and IV, the qualification of such personnel shall be approved by an independent inspection body recognized by a Member State in accordance with Article 13. [Guideline F-05 | Guideline F-07 | Guideline F-09 |Guideline F-13 | Guideline G-25]] **الاختبارات غير المدمرة** بالنسبة لمعدات الضغط ، يتم إجراء اختبارات غير متلفة للوصلات الدائمة بواسطة موظفين مؤهلين يتمتعون بمؤهلات مناسبة. بالنسبة لمعدات الضغط للفئتين الثالث والرابعة ، يجب أن تتم الموافقة على تأهيل هؤلاء الموظفين من قبل هيئة تفتيش مستقلة تعترف بها دولة عضو وفقاً للمادة 13	**EN 12952-6** : 9.2;	**EN 12953-5** : 5.2.2;5.5;
3.1.4	**Heat treatment** If there is a risk that the material properties will be changed so much by the manufacturing process that it will affect the safety of the pressure equipment, an appropriate heat treatment must be carried out at a suitable manufacturing stage. **المعالجة الحرارية** إذا كان هناك خطر أن تتغير خصائص المواد بدرجة كبيرة من خلال عملية التصنيع بحيث تؤثر على سلامة معدات الضغط ، يجب إجراء معالجة حرارية مناسبة في مرحلة التصنيع المناسبة	**EN 12952-5** : 7.3.8;7.3.9; 8.6; 8.7; 10;	**EN 12953-4** : 5.16;
3.1.5	**Traceability** Appropriate procedures shall be adopted and maintained to identify the materials of the parts of the equipment which contribute to the pressure resistance, by appropriate means, from the receipt of the material through the manufacturing process to the final acceptance of the manufactured pressure equipment. **التتبع يتم** اعتماد الإجراءات المناسبة والمحافظة عليها لتحديد المواد الخاصة بأجزاء المعدات التي تسهم في مقاومة الضغط ، بالوسائل المناسبة ، من استلام المادة خلال عملية التصنيع إلى القبول النهائي لمعدات الضغط المصنعة [Guideline G-04 | Guideline G-10]	**EN 12952-5** : 6.2;6.3; 6.4;	**EN 12953-4** : 5.2;
3.2	**Acceptance of** pressure equipment shall be subject to the acceptance described below يخضع **قبول** معدات الضغط للقبول الموضح أدناه		
3.2.1	**Final test** Pressure equipment shall be subjected to a final test to visually check and verify the relevant documentation to ensure that the requirements of this Directive are met. Here, tests that have been carried out during production can be taken into account. Insofar as required for reasons of safety, the final inspection is carried out on the inside and outside of all parts of the device, if necessary during the manufacturing process (eg if it is no longer possible to inspect at the final inspection). **الاختبار النهائي** يجب إخضاع أجهزة الضغط **لاختبار نهائي لفحص** الوثائق ذات الصلة والتحقق منها بصريًا لضمان استيفاء متطلبات هذا التوجيه. هنا ، يمكن أن تؤخذ في الاعتبار الاختبارات التي أجريت أثناء الإنتاج. بقدر ما يقتضي الأمر لأسباب تتعلق بالسلامة ، يتم إجراء الفحص النهائي داخل وخارج جميع أجزاء الجهاز ، إذا لزم الأمر أثناء عملية التصنيع (على سبيل المثال إذا لم يعد من الممكن فحصها في الفحص النهائي). [Guideline D-07 | Guideline D-13 | Guideline	**EN 12952-6** : 4.5;10.1;	

F-02 |Guideline G-29]

3.2.2	Pressure **test** The acceptance of pressure equipment shall include a compressive strength **test** , normally carried out in the form of a hydrostatic pressure test, which shall be at least equal to the value specified in 7.4, if applicable. For mass-produced category I equipment, this test may be carried out on a statistical basis. If the hydrostatic pressure test is disadvantageous or impracticable, other tests which have proved to be effective may be carried out. For tests other than the hydrostatic pressure test, additional measures such as non-destructive testing or other equivalent procedures must be used previously.	**EN 12952-6** : 10.2;	**EN 12953-5** : 5.7.2;

اختبار الضغط
خفض معدات الضغط يجب أن يتضمن اختبار الضغط والقوة، والتي تتم عادة في شكل اختبار الضغط الهيدروستاتيكي، حيث الضغوط على الأقل من القيمة المحددة في القسم 7.4 - يجب أن تمتثل - إن وجدت.
لمعدات الإنتاج الضخم من الفئة الأولى، يمكن إجراء هذا الاختبار على أساس إحصائي.
إذا كان اختبار الضغط الهيدروليكي هو ضار أو غير عملي، والاختبارات الأخرى لاختبارات أخرى من اختبار الضغط التي ثبت أن تكون فعالة، ينبغي القيام به الهيدروليكي قبل اتخاذ تدابير إضافية، مثل الاختبارات غير المدمرة أو غيرها من طريقة يعادل يجب أن تستخدم.

[Guideline C-06 | Guideline D-13 | Guideline F-16 |Guideline F-17 | Guideline H-02 | Guideline H-14 |Guideline H-16]

3.2.3 **Checking the safety devices**
For assemblies, acceptance also includes testing safety-related equipment that verifies that the requirements of section 2.10 are fully met. **التحقق من أجهزة السلامة**
بالنسبة للتجمعات ، يشمل القبول أيضًا اختبار المعدات المتعلقة بالسلامة التي تتحقق من استيفاء متطلبات القسم 2.10 بالكامل.

[Guideline E-04]

3.3	**Labeling and labeling**	**EN 12952-6** : 12;	**EN 12953-5** : 6.4;

In addition to the CE marking to be carried out in accordance with Articles 18 and 19, the following information shall be provided: (

a) For all pressure equipment

-The name and address of the manufacturer or other identifying material and, where applicable, that of his authorized representative established in the EU;

-Specifications that allow identification of the pressure equipment of its type, such as type, serial or lot identification, serial number;

Data on the essential upper / lower permissible limits. [Guideline B-19 | Guideline H-09]

b) Depending on the type of pressure equipment, further information is required to ensure safety during installation, operation, use and, if necessary, maintenance and periodic inspection; this information includes z. B.

The pressure device volume V in I;

- the nominal diameter DN for pipelines;

- the applied test pressure PT in bar and the date;

- the set pressure of the safety device in bar;

- The pressure equipment power in kW

- the mains voltage in volts;

- the intended use;

- the degree of filling in kg / l;

- the maximum filling mass in kg;

- the empty mass in kg;

- the product group.

c) If necessary, the pressure equipment shall be provided with warnings indicating cases of improper use which experience has shown to be possible.

The CE marking must be affixed to the pressure equipment or its nameplate affixed to it and provide the required information, with the following exceptions:

- Repeated labeling of individual parts, such as pipe parts intended for the same assembly, may be avoided by using appropriate documentation. This applies to the CE marking as well as other markings and labels in accordance with this Annex;

- if the pressure equipment is too small (eg equipment), the information listed under (b) may be made on a label affixed to the pressure equipment;

- Information on the filling material and the warnings referred to in (c) may be given on labels or in any other appropriate form provided that they remain legible for a reasonable period.

وضع العلامات ووضع العلامات

التي ستنفذ وفقا للمادتين 18 و 19 ، يجب توفير CE بالإضافة إلى علامة المعلومات التالية: (

أ) لجميع معدات الضغط

اسم وعنوان الشركة المصنعة أو غيرها من المواد التعريفية ، وعند الاقتضاء ، - اسم ممثله المفوض في الاتحاد الأوروبي ؛

-Herstellungsjahr.

المواصفات التي تسمح بتحديد معدات الضغط من نوعها ، مثل النوع ، أو الرقم التسلسلي أو تحديد الرقم ، الرقم المسلسل ؛

المبدأ التوجيهي ب] .بيانات حول الحدود المسموح بها الأساسية العليا / الدنيا
] **H-09 المبدأ التوجيهي** | **19**

ب) اعتمادا على نوع معدات الضغط ، هناك حاجة إلى مزيد من المعلومات لضمان السلامة أثناء التركيب والتشغيل والاستخدام ، وعند الضرورة ، الصيانة والتفتيش الدوري ؛ وتشمل هذه المعلومات ض .B

في V حجم جهاز الضغط I؛

- القطر الاسمي DN ؛ لخطوط الأنابيب

- ضغط الاختبار المطبق PT ؛ في الشريط والتاريخ

- الضغط المحدد لجهاز السلامة في الشريط ؛

- قوة معدات الضغط بالكيلووات

- التيار الكهربائي في فولت.

- الاستخدام المقصود ؛

- درجة الملء بالكيلو غرام / لتر ؛

- كتلة التعبئة القصوى بالكيلوجرام ؛

- الكتلة الفارغة بالكيلوجرام ؛

- مجموعة المنتجات.

ج) إذا لزم الأمر ، يجب تزويد أجهزة الضغط بتحذيرات تشير إلى حالات الاستخدام غير السليم والتي أثبتت التجربة أنها ممكنة.

على جهاز الضغط أو لوحة التعريف الملصقة عليها CE يجب وضع علامة وتقديم المعلومات المطلوبة ، مع الاستثناءات التالية:

- يمكن تجنب وضع علامات متكررة للأجزاء الفردية ، مثل أجزاء الأنابيب المخصصة لنفس التجميع ، وذلك باستخدام الوثائق المناسبة. ينطبق هذا على بالإضافة إلى علامات وتسميات أخرى وفقًا لهذا الملحق ؛ CE علامة

- إذا كانت معدات الضغط صغيرة جدا (مثل المعدات) ، يمكن أن تكون المعلومات المدرجة تحت (b) ؛ على ملصق مثبت بمعدات الضغط

- معلومات عن مواد التعبئة والتحذيرات المشار إليها في النقطة ج) يمكن أن يتم على ملصقات أو في أي غيرها من الوسائل الملائمة، شريطة أن يبقى مقروءا للفترة المناسبة.

3.4 **operating manual** **EN 764-7** : 4.3; 6.6.3;

[**Guideline A-03** | **Guideline D-07** | **Guideline H-03** |**Guideline H-05** | **Guideline H-15** | **Guideline H-19** |**Guideline I-21**]

(a) When placing on the market, a user manual shall be attached to the pressure equipment, if necessary, containing all safety information relating to:

Assembly including connection of various pressure equipment;

- commissioning;

- use;

- Maintenance including inspection by the user.

b) The operating instructions must contain the information to be affixed to the pressure equipment according to section 3.3 with the exception of the series marking; If necessary, the technical instructions and drawings and diagrams necessary for the correct understanding of this manual must be enclosed with the operating instructions.

c) If necessary, the instruction manual should also point out the dangers of improper use in accordance with section 1.3 and the special features of the design in accordance with section 2.2.3

تعليمات التشغيل

[**A-03 المبدأ التوجيهي** | **D-07 المبدأ التوجيهي** | **المبدأ التوجيهي H-03** | **H-05 المبدأ التوجيهي** | **H-15 المبدأ التوجيهي** | **المبدأ التوجيهي H-19** | **I-21 الخط التوجيهي**]

أ) عند وضعه في السوق ، يجب إرفاق دليل مستخدم بمعدات الضغط ، إذا لزم) الأمر ، يحتوي على جميع معلومات السلامة المتعلقة بما يلي:

الجمعية بما في ذلك توصيل معدات الضغط المختلفة ؛

- التكليف

- الاستخدام

- الصيانة بما في ذلك التفتيش من قبل المستخدم.

ب) يجب أن تحتوي تعليمات التشغيل على المعلومات الملصقة على معدات الضغط وفقًا للفقرة 3-3 باستثناء علامة السلسلة ؛ إذا لزم الأمر ، يجب إرفاق التعليمات الفنية والرسومات والرسوم البيانية اللازمة للفهم الصحيح لهذا الدليل مع تعليمات التشغيل.

ج) إذا لزم الأمر ، ينبغي أن يشير دليل التعليمات إلى مخاطر الاستخدام غير السليم وفقاً للبند 1-3 والسمات الخاصة بالتصميم وفقاً للقسم 2.2.3

25.4 materials

4 **materials**

[Guideline G-08 | Guideline G-09 | Guideline G-12 | Guideline G-23 | Guideline H-02 | Guideline I-12]

The materials used in the manufacture of pressure equipment, unless they are to be replaced, must be suitable for the entire intended service life.

Welding consumables and other joining materials need only comply with the relevant requirements of sections 4.1, 4.2 (a) and 4.3 first paragraph, both individually and in combination.

يجب أن تكون المواد المستخدمة في تصنيع معدات الضغط ، ما لم يتم استبدالها ، مناسبة لحياة الخدمة بأكملها.

يجب أن تلتزم المواد الاستهلاكية للحام ومواد الربط الأخرى فقط بالمتطلبات ذات الصلة في الفقرات 4.1 و 4.2 (أ) و 4.3 من الفقرة الأولى ، سواء بشكل فردي

أو في توليفة.

4.1	For materials of pressure-bearing parts, the following provisions apply: بالنسبة لمواد الأجزاء الحاملة للضغط ، تنطبق الأحكام التالية:		**EN 12953-2** : 3.2.2;4.2;
	[**Guideline G-18** | **Guideline G-22**]		
	(a) they must possess properties which are reasonably foreseeable for all reasonably foreseeable operating conditions and test conditions, and in particular have a sufficiently high ductility and toughness. If applicable, the properties of these materials shall comply with the provisions of Section 7.5. In particular, the materials must be selected so that it may not come to a brittle fracture; if, for certain reasons, a brittle material has to be used, appropriate measures must be taken; أ) يجب أن تمتلك الخصائص التي يمكن توقعها بشكل معقول) لجميع ظروف التشغيل المتوقعة بشكل معقول وظروف الاختبار ، وعلى وجه الخصوص لديها ليونة وقوة عالية بما فيه الكفاية. إذا كان ذلك ممكنًا ، يجب أن تمتثل خصائص هذه المواد لأحكام القسم 7.5. على وجه الخصوص ، يجب اختيار المواد بحيث لا تصل إلى كسر هش. إذا كان لا بد ، لأسباب معينة ، استخدام مادة هشة ، يجب اتخاذ التدابير المناسبة	**EN 12952-2** : 3.1; 3.3	
	[**Guideline G-10** | **Guideline G-13**] b) they must be sufficiently chemically resistant to the fluids carried in the pressure equipment; the chemical and physical properties required for operational safety must not be significantly impaired during the intended service life; c) they must not be significantly impaired by aging; ب) يجب أن تكون مقاومة كيميائياً بما فيه الكفاية للسوائل المنقولة في معدات الضغط ؛ يجب ألا تتعرض الخواص الفيزيائية والكيميائية اللازمة للسلامة التشغيلية إلى ضعف كبير خلال فترة الخدمة المقصودة ؛ ج) يجب ألا تتعرض للشيخوخة بشكل كبير ؛		
	(d) they must be suitable for the intended processing procedures; د) يجب أن تكون مناسبة لإجراءات المعالجة المقصودة ؛	**EN 12952-2** : 3.1; 3.2	
	E) they must be selected so that no material adverse effects occur when combining different materials.) يجب تحديدها بحيث لا تحدث أي آثار سلبية مادية عند الجمع بين المواد المختلفة.	**EN 12952-2** : 3.2	
4.2	(a) The parameters required for the calculation in relation to section 2.2.3, as well as the essential properties of the materials and their treatment as described in section 4.1, shall be specified by the pressure equipment manufacturer. أ) تحدد المعلمات اللازمة للحساب فيما يتعلق بالقسم 2.2.3 ، وكذلك (		

الخصائص الأساسية للمواد ومعالجتها على النحو المبين في القسم 1-4 ، من قبل الشركة المصنعة لمعدات الضغط

[Guideline G-10 | Guideline G-17]

(b) The manufacturer shall provide in the technical documentation information on compliance with the material requirements of the Directive in one of the following forms:
[Guideline G-15 | Guideline G-21]

EN 764-5: All sections

EN 12953-2 : 3.2.3;3.2.4;

EN 764-5: All sections

(ب) يجب على الشركة المصنعة أن تقدم في وثائق التوثيق المعلومات المتعلقة بالامتثال للمتطلبات المادية للتوجيه في أحد الأشكال التالية:

[

-Use of materials according to the harmonized standards;

EN 12952-2 : 4.1;

استخدام المواد وفقا للمعايير المنسقة

-Use of materials for which there is a European material approval for pressure equipment as referred to in Article 15;

-Single report on the materials.

[Guideline G-01 | Guideline G-05 | Guideline G-06 |Guideline G-07 | Guideline G-16 | Guideline G-19 |Guideline G-24 |Guideline G-25 |Guideline G-30]

(c) For category III and IV pressure equipment, the individual opinion referred to in point (b), third indent, shall be carried out by the notified body responsible for the conformity assessment of the pressure equipment.

[Guideline I-13 | Guideline I-14]

- استخدام المواد التي توجد لها الموافقة المادية الأوروبية لمعدات الضغط المشار إليها في المادة 15 ؛

تقرير واحد على المواد.

[المبدأ التوجيهي G-01 | المبدأ التوجيهي G-05 | المبدأ التوجيهي G-06 | المبدأ التوجيهي G-07 | المبدأ التوجيهي لمجموعة ال 16 | المبدأ التوجيهي مجموعة ال 19 |المبدأ التوجيهي G-24 | المبدأ التوجيهي G-25 |المبدأ التوجيهي G-30]

(ج) بالنسبة لمعدات الضغط من الفئتين الثالثة والرابعة ، يتم تنفيذ الرأي الفردي المشار إليه في النقطة (ب) ، البادئة الثالثة ، من قبل الهيئة المبلغة المسؤولة عن تقييم المطابقة لمعدات الضغط.

[المبدأ التوجيهي الأول - 13 | المبدأ التوجيهي الأول - 14]

4.3

The manufacturer of the pressure equipment must take the appropriate measures to ensure that the material used meets the specified requirements. In particular, all materials produced by the material manufacturer must be obtained for all materials and attesting compliance with a given rule.
[Guideline G-10 | Guideline G-27 | Guideline G-29]

EN 12952-2 : 6

EN 764-4: all sections

For the main pressure-bearing parts of Category II, III and IV pressure equipment, this shall take the form of a certificate of specific testing of the products.

When a material manufacturer applies a suitable quality management system, certified by a competent body established in the EU, which has undergone a specific assessment of the materials, it shall be considered that the certificates issued by the manufacturer demonstrate compliance with the relevant requirements of that body Offer section.
[Guideline G-02]

يجب على الشركة المصنعة لمعدات الضغط اتخاذ التدابير المناسبة للتأكد من أن على وجه الخصوص ، يجب الحصول .المواد المستخدمة تلبي المتطلبات المحددة على جميع المواد التي تنتجها الشركة المصنعة للمواد لجميع المواد والتأكد من الامتثال لقاعدة معينة.
[**التوجيهي لمجموعة العشرون المبدأ** | **G-27 المبدأ التوجيهي** | **التوجيهي E-29**]

للحصول على أجزاء ضغط الحاملة الرئيسية من المعدات في الفئتين الثانية والثالثة والرابعة، وهذا يأخذ شكل شهادة من منتجات محددة.

حيث الصانع المادي ومناسبة، مصدقة من قبل شركة تأسست في نظام إدارة الجودة السلطة المختصة في الاتحاد الأوروبي، الذي شهد فيما يتعلق مواد من تقييم معين، ثم يفترض أن الصادرة عن شهادة الشركة المصنعة لإثبات الامتثال للمتطلبات ذات الصلة في هذا قسم العرض.
[**G-02 المبدأ التوجيهي**]

25.5 Fired or otherwise heated overheating-prone pressure equipment in accordance with Article 4 (1)

[Guideline B-22 | Guideline C-04 | Guideline H-15]

EN 12953-2 :
4.4; 4.5;6;

These pressure devices are part of

Steam and hot water generators referred to in Article 4 (1) (b) such as: Fired steam and hot water boilers, superheaters and reheaters, waste heat boilers, waste incineration boilers, electrically heated boilers or electrode boilers and steam pressure pots, together with their equipment and, where appropriate, their feedwater treatment and fueling systems;

-Process heaters for non-steam and hot water media as referred to in Article 4 (1) (a) , such as: As heaters for chemical and similar processes and pressure equipment for the food industry. These pressure equipment shall be designed, designed and constructed to avoid or minimize the risk of significant failure of pressure-retaining parts due to overheating.

In particular, it must be ensured, where appropriate, that

أجهزة الضغط هذه جزء من

كما :مولدات البخار والماء الساخن المشار إليها في المادة 4 (1) (ب) مثل ، المرجل reheatersأطلقت البخار والمياه الساخنة المرجل، محمصات و حرارة النفايات، نفايات حرق المرجل، الغلايات الكهربائية للتدفئة أو المرجل الكهربائي، طناجر الضغط، جنبا إلى جنب مع قطع الغيار الخاصة بها وعند الاقتضاء أنظمتها لمعالجة الماء المغذي وإمدادات الوقود؛

- السخانات الحرارية للوسائط غير البخارية والماء الساخن المشار إليها في المادة 4 (1) (أ) ، مثل
كما سخانات للعمليات الكيميائية وما شابهها ومعدات الضغط
يجب تصميم وتصنيع وبناء معدات الضغط هذه لتجنب أو تقليل لصناعة الأغذية.
مخاطر الفشل الكبير لأجزاء الاحتفاظ بالضغط بسبب ارتفاع درجة الحرارة.

على وجه الخصوص ، يجب ضمان ذلك ، عند الاقتضاء ، ذلك

(a) appropriate safeguards are provided to limit operating parameters such as heat input, heat output and, where applicable, fluid level to avoid the risk of local or general overheating; أ) توفير ضمانات مناسبة للحد من بارامترات التشغيل مثل المدخلات الحرارية ، وخرج الحرارة ، وعند الاقتضاء ، مستوى السوائل لتجنب خطر حدوث سخونة محلية أو عامة)	**EN 12952-7** : 5.4 to 5.6; 6.5 to 6.9; **EN 12952-8** : 1;4.1.1; 4.1.2; 4.3; 5;6.1; **EN 12952-16** : 4-10;	**EN 12953-6** : 5.4 to 5.6; 6.6 to 6.8; **EN 12953-7** : 4.1.1;4.1.2; 4.3; 5; 6.1; **EN 12952-12** : 4 to 10;
(b) where necessary, provide sampling points so that the properties of the fluids can be assessed to avoid risks associated with deposits and / or corrosion; ب) عند الضرورة ، توفير نقاط لأخذ العينات بحيث يمكن تقييم خصائص السوائل لتجنب المخاطر المرتبطة بالودائع و / أو التآكل	**EN 12952-10** : 5.2;	
(c) reasonable precautions are taken to eliminate the risks of deposit damage; ج) اتخاذ احتياطات معقولة للقضاء على مخاطر تلف الودائع)	**EN 12952-8** : 1; **EN 12952-10** : 5;	**EN 12953-7** : 4.1.1;4.1.2; 4.3; 5; 6.1;
d) possibilities for the safe removal of residual heat after a shutdown are created; د) إمكانات الإزالة الآمنة للحرارة المتبقية بعد إنشاء إيقاف التشغيل		
e) measures are taken to prevent the dangerous accumulation of flammable mixtures of flammable substances and air and flashback. هـ) اتخذت تدابير لمنع التراكم الخطير للمزائج القابلة للاشتعال من المواد القابلة للاشتعال والهواء والاضطراب العكسي.)	**EN 12952-8** : 1.6.3; **EN 12952-9** : 4 to 9; **EN 12952-14** : 4 to 9;	**EN 12953-7** : 6.3;

6

25.6 Pipelines acc. Article 4 (1) (c)

By design and construction, the following must be ensured: a) The risk of overuse due to inadmissible movement or excessive forces z. As to flanges, connections, compensators or hose lines is to be prevented by support, attachment, anchoring, alignment or bias in a suitable manner; (b) where condensation may form inside pipelines for gaseous fluids, provision shall be made for drainage or debris removal from low-lying areas	**EN 12953-7** : 4.2.1;4.2.2; 4.2.3; 4.2. 6;

in order to prevent damage due to water hammer or corrosion;

c) due account shall be taken of the possibility of turbulence or vorticity damage. The corresponding provisions of section 2.7 apply;

d) the risk of fatigue caused by vibrations in pipes shall be duly taken into account;

(e) where the pipelines contain Group 1 fluids, it is appropriate to ensure that the branches of the pipes, which pose significant risks due to their dimensions, may be shut off;

(f) in order to minimize the risk of accidental removal, the sampling points on the permanent side of the joints shall be clearly marked, indicating the fluid contained;

(g) To facilitate maintenance, inspection and repair work, the location and course of buried pipelines and pipelines shall be specified, at least in the technical documentation.

حسب التصميم والبناء ، يجب ضمان ما يلي:

أ) خطر الإفراط في الاستخدام بسبب الحركة غير المقبولة أو القوات المفرطة بالنسبة للحافات والوصلات والمعوضات أو خطوط الخرطوم ، يجب منعها .ض عن طريق الدعم أو التعلق أو التثبيت أو الانحياز أو التحيز بطريقة مناسبة ؛

ب) في الحالات التي يمكن أن يتكون فيها التكثيف داخل خطوط أنابيب للسوائل) الغازية ، يجب إجراء الصرف على التصريف أو إزالة الأنقاض من المناطق المنخفضة لتجنب الضرر الناجم عن مطرقة المياه أو التآكل ؛

تنطبق الأحكام .ج) يجب مراعاة احتمالية حدوث اضطراب أو تلف في الدوامة المقابلة في القسم 2.7 ؛

د) يجب أن تؤخذ في الاعتبار مخاطر الإجهاد الناجم عن الاهتزازات في الأنابيب ؛

هـ) إذا كانت خطوط الأنابيب تحتوي على سوائل المجموعة 1 ، فمن المناسب) التأكد من أنه قد يتم إغلاق فروع الأنابيب التي تشكل مخاطر كبيرة بسبب أبعادها ؛

و) للحد من مخاطر الإزالة العرضية ، يجب أن يتم وضع علامات واضحة على) نقاط المعاينة على الجانب الدائم من المفاصل ، مما يدل على وجود السائل المتضمن ؛

ز) لتسهيل أعمال الصيانة والتفتيش والإصلاح ، يجب تحديد موقع وطرق) خطوط الأنابيب المدفونة وخطوط الأنابيب ، على الأقل

25.7 Special Quantitative Requirements for Specific Pressure Equipment

المتطلبات الكمية الخاصة لمعدات الضغط المحددة

7 Special Quantitative Requirements for Specific Pressure Equipment

المتطلبات الكمية الخاصة لمعدات الضغط المحددة

[Guideline H-06]
The following provisions are generally applicable. If they are not applied, including in the case where materials are not specifically mentioned and harmonized standards are not applied, the manufacturer must demonstrate that appropriate measures have been taken to achieve an equivalent overall level of safety.
This section is part of Annex I. Its provisions supplement the essential requirements of sections 1 to 6 for pressure equipment to which they apply.

الأحكام التالية قابلة للتطبيق بشكل عام.

لا يتم تطبيقها، بما في ذلك في حال أن المواد لا تشير تحديدا إلى وتطبق أية معايير موحدة، اتخذت الشركة المصنعة يجب إثبات أن التدابير المناسبة لتحقيق المستوى العام أي ما يعادل السلامة.
هذا القسم جزء من الملحق الأول. أحكامه تكمّل المتطلبات الأساسية للأقسام من 1 إلى 6 لمعدات الضغط التي تنطبق عليها.

7.1 Permitted loads الأحمال المسموح بها

7.1.1 symbols

Re, t (elastic limit) refers to the following values at the calculation temperature, depending on the case:

- upper yield strength for materials having a lower and upper yield strength;

- 1.0% proof strength for austenitic and unalloyed aluminum;

- 0.2% proof strength in the remaining cases.

Rm, 20 denotes the minimum value of tensile strength at 20 ° C.
Rm, t denotes the tensile strength at the calculation temperature.

حرف

تشير كلمة re ، t) حد المرونة) إلى القيم التالية عند درجة حرارة الحساب ، وفقًا للحالة:

-قوة إنتاجية أعلى للمواد التي لها قوة غلة منخفضة وأعلى ؛

-قوة مقاومة بنسبة 1.0٪ للألومنيوم الأوستني وغير المصقول ؛

-قوة مقاومة بنسبة 0.2 ٪ في الحالات المتبقية.

Rm، 20 يدل على القيمة الدنيا لقوة الشد عند 20 درجة مئوية .
Rm، tيدل على قوة الشد عند درجة حرارة الحساب.

7.1.2	The permissible general membrane stress shall not exceed the lower of the following values for predominantly static loads and at temperatures outside the range in which creep phenomena are significant, depending on the material used: Ferritic steel, including normally annealed (normalized rolled) steel, with the exception of fine grain steel and special heat treated steel: 2/3 of Re, t and 5/12 of Rm, 20; Austenitic steel: -If the elongation at break is greater than 30%: 2/3 of Re, t; Or alternatively, if the elongation at break is above 35%: 5/6 of Re, t and 1/3 of Rm, t; Unalloyed and low alloy cast steel: 10/19 of Re, t and 1/3 of Rm, 20; Aluminum: 2/3 of Re, t; Non-hardenable aluminum alloys: 2/3 of Re, t and 5/12 of Rm, 20. [**Guideline G-14**] يجب ألا يتجاوز ضغط الأغشية العامة المسموح به أقل القيم التالية للأحمال الساكنة في الغالب وعند درجات حرارة خارج النطاق الذي تكون فيه ظاهرة الزحف كبيرة ، تبعاً للمواد المستخدمة: فولاذ من الحديد ، بما في ذلك الصلب الملدن (الطبيعي المدلفن) ، باستثناء فولاذ الحبوب الناعم والصلب المعالج بالحرارة الخاصة: 3/2 من Re ،t و 12/5 من Rm 20 ، ؛ الفولاذ الأوستنيتي: - إذا كانت الاستطالة عند كسر أكبر من 30٪: 3/2 من Re ،t؛ أو بدلاً من ذلك ، إذا كانت الاستطالة عند كسر أعلى من 35٪: 6/5 من Re و t و 3/1 من Rm ،t؛ سبائك الصلب غير السبائكية وغير المنخفضة: 19/10 من Re و t و 3/1 من Rm؛20 ، الألومنيوم: 3/2 من Re ،t؛ سبائك الألومنيوم غير المتصلبة: 3/2 من Re و t و 12/5 من Rm 20 ،.	**EN 12952-3** : 6.3;	**EN 12953-3** : 6.2

7.2	**Connection** coefficients For welded **connections** , the connection coefficients must not exceed the following values: [Guideline F-09 | Guideline G-19] معاملات **الاتصال** بالنسبة للوصلات الملحومة ، يجب ألا تتجاوز معاملات الاتصال القيم التالية:		
	- For pressure equipment that undergoes destructive and nondestructive tests to verify that the joints are free from significant defects: **1,0** ; - بالنسبة لمعدات الضغط التي تخضع لاختبارات مدمرة وغير تدميرية للتحقق من خلو المفاصل من العيوب الكبيرة: **1.0**	**EN 12952-3** : All sections apply, except 11.2.4;	
	-For pressure equipment undergoing non-destructive random sampling: **0,85** ; لمعدات الضغط التي تخضع لأخذ عينات عشوائية غير مدمرة: **0.85**	**EN 12952-3** : 11.2.4;	
	-For pressure equipment which does not undergo non-destructive testing except for visual inspection: **0,7** . - لمعدات الضغط التي لا تخضع لاختبارات غير مدمرة باستثناء الفحص البصري: **0،7**		
	If necessary, the type of stress and the mechanical and technological properties of the connection must also be taken into account. إذا لزم الأمر ، يجب أيضًا أخذ نوع الإجهاد والخصائص الميكانيكية والتكنولوجية للربط في الاعتبار.	**EN 12952-3** : All sections apply;	
7.3	Pressure limiting **devices** , in particular for pressure vessels The temporary pressure exceeding specified in section 2.11.2 shall be limited to 10% of the maximum permissible pressure. [Guideline E-02] **أجهزة تحديد** الضغط ، خاصة لأوعية الضغط يجب أن يقتصر الضغط المؤقت المتجاوز في القسم 2.11.2 على 10٪ من الحد الأقصى للضغط المسموح به.	**EN 12952-10** : 5;	**EN 12953-8** : 4.2;
7.4	**Hydrostatic test pressure** For pressure vessels, the hydrostatic test pressure specified in section 3.2.2 shall be the higher of the following: - 1.25 times the maximum load of the pressure equipment in service, taking into account the maximum permissible pressure and the maximum permissible temperature, or -The 1.43-fold value of the maximum allowable pressure [Guideline C-06 | Guideline H-02 | Guideline H-16] **ضغط اختبار الهيدروستاتيكي** لأوعية الضغط ، يكون ضغط الاختبار الهيدروستاتيكي المحدد في القسم 3.2.2 أعلى مما يلي: - 1.25 أضعاف الحمل الأقصى لمعدات الضغط في الخدمة ، مع مراعاة الحد		**EN 12953-3** : 5.6

الأقصى المسموح به من الضغط ودرجة الحرارة القصوى المسموح بها ، أو

القيمة 1.43 أضعاف الحد الأقصى المسموح به من الضغط-

7.5 **Material**

properties Unless other criteria to be considered require other values, a steel shall be considered to be sufficiently ductile within the meaning of 4.1 (a) if its elongation at break is at least 14% in the standard tensile test and the notch impact work on an ISO-V sample at a temperature of not exceeding 20 ° C, but not exceeding 27 J at the intended lowest operating temperature.

[**Guideline G-13** | **Guideline G-17** | **Guideline G-18** |**Guideline G-22** | **Guideline G-28**]

خصائص المواد

ما لم تتطلب معايير مختلفة لتكون قيم أخرى، يعتبر الصلب لتكون الدكتايل بما فيه الكفاية كما هو محدد في القسم 4.1 إلكتروني أ) عندما استطالة عند الكسر في وضعها الطبيعي نفذت وفقا لاختبار الشد لا يقل عن 14٪، والطاقة تأثير على عينة ISO V عند درجة حرارة لا تتجاوز 20 درجة مئوية ، ولكن لا تتجاوز 27 J في أدنى درجة حرارة التشغيل المقصودة.

26 Reference 1: Water-tube boilers and auxiliary installations Part 3: Design and calculation for pressure parts

https://www.sis.se/api/document/preview/31887/

EN 12952-3:2001 (E)

26.1 Scope

This Part of this European Standard specifies the requirements for the design and calculation of water-tube boilers as defined in **EN 12952-1.**

26.1.1 Normative references

This Part of the European Standard incorporates by dated or undated reference, provisions from other publications.

These normative references are cited at the appropriate places in the text and the publications are listed hereafter.

For dated references, subsequent amendments to, or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest editions of the publication referred to applies (including amendments).

prEN 1092-1, Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 1: Steel flanges.

EN 1591, Flanges and their joints — Design rules for gasketed circular flange connections Calculation method.

prEN 1759-1, Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, class designated — Part 1: Steel flanges NPS ½ to 24.

EN 10025, Hot rolled products of non-alloy structural steels — Technical delivery conditions (includes amendment A1 : 1993).

prEN 10266, Steel tubes, fittings and structural hollow sections — Definitions and symbols for use in product standards.

prEN 12953-3, Shell boilers — Part 3: Design and calculation.

EN 12952 series, Water-tube boilers and auxilliary installations.

prEN 13445 series, Unfired pressure vessels.

prEN 13480 series, Metallic industrial piping.

ISO 7-1, Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designations.

ISO 4287, Geometrical Product Specification (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters.

26.1.2 Terms and definitions

For the purpose of this standard the terms and definitions given in EN 12952-1 apply.

26.1.3 Symbols and abbreviations

For the purposes of this standard, the symbols given in Table 4-1 of EN 12952-1 shall apply. Throughout this European Standard, additional terminology and symbols have been included where necessary to meet the requirements of the specific text concerned.

26.1.4 General

Water-tube boiler pressure parts shall be designed in accordance with the requirements of EN 12952-3. The resulting designs shall be reproduced in the form of approved drawings and specifications to ensure the proper application of the design requirements during the manufacturing and inspection stages.

26.2 Dimensions of pressure parts

The wall thickness and other dimensions of pressure parts sufficient to withstand the calculation pressure at calculation temperature for the design lifetime shall be determined in accordance with EN 12952-3 using materials in accordance with EN 12952-2.the design for loadings arising from the following situations shall also be determined in accordance with this part of EN 12952:

a) the bending of a drum or header as a beam under self weight and imposed loads;

b) local support loads on drums;

c) thermally induced forces and moments within or arising from systems of integral tubing;

d) local loading of tubes by structural attachments;

e) rapid and frequent changes of pressure and temperature.

Methods for calculating stresses caused by external loads applied to nozzles and to attachments shall be in accordance with prEN 13445.

NOTE The purpose of this part is to give specific design rules for common forms of loadings to which boiler parts are normally subjected to and general rules on how other loadings are to be considered. It does not give specific design rules for loadings other

than those described in a) to e). These design rules are adequate for boilers of established construction, installed and operated in accordance with the manufacturer's instructions.Determination of the dimensions of pressure parts shall be given special consideration not included in this standard, when abnormal conditions are present, such as:

f) abnormally high corrosive products of combustion;

g) highly pressurized products of combustion;

h) poor feedwater.

Deviations from the requirements of this standard by the use of alternative design methods shall be permitted, provided it can be shown that the adoption of such methods does not impair the safety of the component. A record of all deviations shall be recorded in the manufacturer`s dossier. See also clause 7 of EN 12952-1.

26.3 Strength of pressure parts

The strengths of the pressure parts shall be such as to withstand the following loads:

a) internal pressure

b) the weight of all pressure parts and their contents, the weight of components suspended from them and any

superimposed slag, fuel, ash or dust;

c) loads caused by gas pressure differentials over the boiler furnace and flue gas passes;

d) loads arising at connections between the boiler system and other parts.

If applicable, the pressure parts shall be adequate to withstand wind and earthquake loads. The conditions applicable for such loads shall be determined by the manufacturer.

26.4 Design by analysis

It shall be permissible to design by analysis provided the safety and functional requirements of the components are

not impaired.

The results of any stress calculations carried out for loadings not explicitly covered by equations in this clause shall be determined by using the criteria given in prEN 13445.

26.5 Cyclic loading

Boiler components are deemed to be exposed to cyclic loading if the boiler is designed for more than 500 cold start ups. Where cylindrical or spherical pressure parts with openings are subject to cyclic loading, the following calculation shall be carried out:

$$v_t = \left(550\ \text{N/mm}^2 - p_0\left(\frac{\alpha_m \times d_m}{n_s \times e_{ms}} - 0{,}5\right)\right)\frac{Z}{e_{ms}^2}$$

'

where

p_0 is the maximum operating pressure,

d_m is the mean diameter of the shell,

e_{ms} is the minimum wall thickness;

n_s = 2 for cylindrical shells or

n_s = 4 for spherical shells;

αm = 4 or if there is any doubt that this value is conservative, the exact value taken from Figure 13.4-5 or

Figure 13.4-7 shall be used;

Z = 2 K mm4/(N s) for ferritic steels or

Z = 1 K mm4/(N s) for austenitic and martensitic steels or

$$Z = - \frac{0,5 \ D_{\text{th}}}{\gamma_{\text{cyl sp}} \ \alpha_t \ \beta_t \ E/(1 - \nu)}$$

Where exact values Dth, βt, E, v may be taken from annex D, γcyl sp from Figure 13.4-6 or 13.4-9 and αt from Figure 13.4-8.

If the result of this calculation is smaller than the required temperature transient at start up, or if it is negative, then 13.4 shall apply.

For designs subject to cyclic loading, careful attention shall be paid to the design configuration in order to avoid stress raising features and to ensure good stress distribution. Stamping of materials shall not be done in critical areas.

In considering operating conditions, the design shall make adequate allowance for corrosion and fatigue.

The level of non-destructive testing adopted shall meet the acceptance criteria for main drum welds in EN 12952-6.

26.6 Other design requirements

26.6.1 General

In particular, cognizance shall be taken of the following requirements in EN 12952-5 and EN 12952-6:

a) the design shall be such that manufacturing and welding in accordance with EN 12952-5 and inspection in accordance with EN 12952-6 shall be possible;

b) where partial penetration welds are to be used, the depth of the required weld preparation groove shall be specified on the drawing;

c) the welds attaching branches, nozzles, stubs and supports to drums and headers shall not involve any combination of austenitic and ferritic steel;

d) the requirements covering the attachment of nozzles and branches to drums and headers without strength welding shall be to 9.3 of EN 12952-5;

e) the requirements covering tube connections to drums and headers without strength welding shall be to 9.4 of EN 12952-5;

f) limits of operation for cast iron valves and fittings;

g) where random NDE of welds is permitted by EN 12952-6, it shall be demonstrated that the welding is adequate for the imposed loading when a weld joint factor of 0,85 is applied;

h) the special requirements applicable to coil boilers are given in annex D of EN 12952-5;

i) the special requirements applicable to chemical recovery boilers are given in annex E of EN 12952-5. For major components operating in the creep range, facilities shall be provided for monitoring the creep in relation to operation.

26.6.2 Access

The boiler shall be designed to ensure adequate access is provided to facilitate the internal examination of the drums and headers. The examination may be either manual or remote in accordance with the physical size of the components. The requirements and limitations of access and inspection openings shall be in accordance with 9.2

of EN 12952-5.

26.6.3 Drainage and venting

The boiler shall be provided with adequate means of drainage and venting in order to avoid water hammer and

vacuum collapse, and to enable internal inspections to be carried out.

26.7 Design, calculation and test pressures

26.7.1 Design pressure

For the purpose of EN 12952-3 the design pressure pd shall be equal to/or greater than the maximum allowable pressure PS.For each compartment of the water-tube boiler, the design pressure shall be at least the highest set pressure of any safety valve mounted on that compartment.

NOTE A compartment is any pressurized section of plant which can be isolated by shut-off valves.

26.7.2 Calculation pressure

Each compartment might be divided into sections, each with its own calculation pressure pc and calculation temperature tc. The design of each section shall be based on one of the following.

a) For parts whose design stress has been derived from tensile strength Rm or minimum yield proof strength Rp 0,2 tc, the calculation pressure shall be the design pressure increased to the highest pressure possible when the plant is operating at the calculation temperature. Any difference between design pressure and calculation pressure might be caused by hydrostatic pressure and by pressure drop caused by fluid flow. Differences in hydrostatic height less than or equal to 0,05 MPa can be ignored;

b) For parts whose design stress has been derived from the creep rupture stress, the calculation pressure shall be the lowest set pressure of any safety valve at the superheater/reheater outlet, as appropriate, increased by the highest pressure difference possible under continuous rating at the calculation temperature. A check shall be made of the thickness calculated by method b), using the calculation pressure of

a) above with a design stress derived from tensile strength *R*m or minimum yield/proof strength *R*p 0,2/tc at the calculation temperature used in

b), and the greater thickness used.

If the minimum yield strength data at higher temperatures are not available, linear extrapolation may be allowed.

26.7.3 Calculation pressure for pressure differences

For parts with a design pressure not less than 1 N/mm2, which are simultaneously subject to both internal and external pressure, e.g. surface type attemperators in boiler drums, and where the design ensures that both pressures always occur together, the calculation pressure shall be the maximum pressure difference, but not less

than 1 N/mm2. The loading occurring during hydrostatic testing shall be taken into account.

26.7.4 Hydrostatic test pressure

26.7.4.1 General

In order to demonstrate, the strength and integrity of individual components and of the completely assembled watertube boiler, and to establish that no major error or defect has occurred, completely assembled water-tube boilers shall be hydrostatically tested to the test pressure specified in 5.7.4.3 and individual components shall be hydrostatically tested in accordance with 5.7.4.3 without any sign of weakness or defect. The hydrostatic tests shall be carried out on welded components or the completed water-tube boiler after all welding and heat treatment has been completed, but may be carried out prior to the drilling of holes for expanded tubes in

the boiler drum.

5.7.4.2 Hydrostatic tests on individual components

Boiler drums shall be hydrostatically tested to the test pressure specified in 5.7.4.3 before assembly into the watertube boiler, unless these devices are to be assembled into a water-tube boiler and the assembled water-tube boiler is then to be tested in the manufacturer's workshop to the test pressure specified in 5.7.4.3. All components which are not reasonably accessible for inspection after assembly into the water-tube boiler shall be individually hydrostatically tested to the test pressure specified in 5.7.4.3 before assembly into the water-tube boiler. Components other than those specified above shall not require to be individually tested before assembly in the water-tube boiler.

26.7.4.2 Test pressure

A boiler assembly comprises of a number of components each having its own specific calculation pressure and design temperature. The test pressure *p*t for components as defined in 5.7.4.2 shall be determined directly in accordance with 5.7.4.4.As there can only be one hydrostatic test pressure for a boiler assembly or separately isolated compartment as defined in 1.2 of EN 12952-1, it shall be necessary to carry out a series of individual calculations on selected components throughout the assembled boiler or isolated compartment, if applicable, in accordance with 5.7.4.4, to determine the individual apparent test pressure for each selected component. The hydrostatic test pressure for the whole assembly shall be the pressure which ensures that none of the components selected shall be subjected under test conditions to a stress greater than that given in 6.3.4.

26.7.4.3 Calculation of hydrostatic test pressure

The hydrostatic test pressure for a component or completely assembled boiler, shall be determined as follows:

$p_t = 1{,}43 \times PS$ or

$$p_t = 1{,}25 \times p_c \times \frac{R_{p0,2\ 20}}{K}$$

which ever is the greater, where

p_c is the calculation pressure of the component under consideration

p_t is the test pressure for the component under consideration The ratio $R_{p0,2\ 20}/K$ to be used shall be the highest of those permitted for the component under consideration, based on the material properties and the specific calculation temperature and should not be less than 1, see also 6.3.

26.8 Metal wastage

NOTE For the purpose of design in accordance with EN 12952-3 metal wastage includes oxidation, corrosion, erosion and abrasion.

26.8.1 Internal wastage

Internal wastage is normally small and shall not be considered for boilers operated with feedwater in accordance with EN 12952-12. For components exposed to risk of greater than normal wastage (e.g. erosion by turbulence),

appropriate countermeasures shall be provided.

The magnetite layer shall be protected in accordance with 13.4.1.1.

26.8.2 External wastage

External wastage of pressure parts not exposed to flue gases is normally small, and the thickness determined by this EN 12952-3 shall be adequate without further addition.

Tubes exposed to flue gases shall experience wastage to a varying extent. If the boiler design data indicates that wastage can be significant, the tubes shall be increased in thickness accordingly. Also other means of tube protection may occur. In this case the wall thickness allowance shall be specified by the manufacturer unless the purchaser has specified a higher allowance. In the special case of chemical recovery boilers, it shall be permitted to provide for wastage by means of metallurgically bonded, composite materials tubing with corrosion resistant layers.

26.8.3 Requirements

Where an allowance for wastage is made, the amount shall be specified in the design documents stipulating whether this allowance is "internal or external". Strength calculations shall use the dimensions after the wastage allowances are removed.

However, for tubes designed using design strengths derived from creep rupture properties, integration over time of the effects of creep and wastage shall be permitted, so that failure can be predicted at a time not less than the design lifetime. In such cases the tube thickness towards the end of the design life might be less than required by

equations (11.2-2 to -5).

26.8.4 Stress corrosion

With boiler water quality controlled in accordance with EN 12952-12, stress corrosion would not be expected to occur in ferritic tubing under normal boiler operating conditions. The risk of such corrosion in austenitic superheater materials can be satisfactorily reduced by ensuring no water droplets are carried over into the austenitic tubing.

Carry over can be considered to have been adequately restricted if the steam has an enthalpy of 2 900 kJ/kg or greater, or the enthalpy corresponds to a temperature of 425 °C or higher. Where it is predicted that exceptional conditions of chemical concentration may occur for prolonged periods of operation, the effects of stress corrosion and corrosion gouging shall be considered, and the materials selected

accordingly.

NOTE It is not possible to compensate for stress corrosion by increasing the thickness of components.

26.8.5 Mechanical requirements

Where there is a likelihood of in-service relative movement or fretting between a pressure part and a non-pressure part in contact with it, consideration shall be given to wastage of the components. If necessary wear pads shall be welded to the pressure part, or other equivalent means shall be employed.

26.9 Attachments on pressure parts

26.9.1 Load carrying attachments

Load-carrying attachments shall be defined by the design engineer and indicated as such on the drawing.

Load-carrying attachments are:

a) attachments designed for primary loads which are completely definable and are usually for support purposes,

or;

b) attachments which are usually provided for alignment and/or restraint purposes where the loading is not easily defined. Such attachments may be loaded by either primary or secondary loads.

Stresses caused by load-carrying attachments shall be calculated in accordance with prEN 13445.

26.9.2 Non-load-carrying attachments

Non-load-carrying attachments are attachments which carry no significant primary or secondary loads during manufacture, erection, testing or any operating condition.

Calculation temperature and nominal design stress 27

27.1 Calculation temperature

27.1.1 General

For the purpose of EN 12952 the maximum allowable temperature TS shall be that at the steam/hot water outlet.

The reference temperature *t*or shall the mean fluid operation temperature of the component under consideration, which is to be expected during use. Where steam or water flows through components in parallel, *t*or for each component shall take account of variations in heat transfer and fluid flow between the parallel parts. The calculation temperature *t*c of a component shall be calculated by taking account of variations in heat transfer and fluid flow in the boiler. If such calculations are not carried out then the calculation temperature *t*c shall be composed of the reference temperature *t*or and the temperature allowance in accordance with 6.1.2 to 6.1.10. The temperature allowances in Table 6.1-1 shall be regarded as minimum values, except where calculations of *t*c are carried out, and is allowed by 6.1.5.

Table 6.1-1 — Reference temperatures and temperature allowances

Physical state	Reference temperature	Temperature allowances			
		Unheated components[a]	Heated components[a]		Protected against radiation
			Heating mainly by radiation[b]	Heating mainly by convection	
Water or water/steam mixture	Saturation temperature at allowable (working gauge) pressure $p_{s\,1}$ or at allowable (total gauge) pressure $p_{s\,2}$	0 °C	50 °C For headers[c] (30 + 3 e_s) °C but not less than 50 °C	(15 + 2 e_s) °C but not more than 50 °C	20 °C
Superheated steam	Superheated steam, see also 6.1.3	15 °C, see also 6.1.5	50 °C	35 °C	20 °C

[a] For definitions of types of heating see 6.1.7 to 6.1.10

[b] Platen type superheaters are treated like convection type superheaters.

[c] For definition of header see 6.1.6

27.1.2 Circulation boilers

For circulation boilers, the reference temperature and the temperature allowance shall be in accordance with Table 6.1-1.

27.1.3 Once-through boilers, superheaters and reheaters

The calculation temperature *t*c shall be calculated taking into account of variations in heat transfer and fluid flow in the boiler. For once-through boilers, superheaters and reheaters the reference temperature shall be the mean temperature expected during service, of the fluid flowing through the various boiler parts.

27.1.4 Hot water generators

For the special case of hot water generators, where the temperature of the contained fluid is limited by thermostats1), the reference temperature of the components shall be the fluid temperature.

1) Temperature limiters manufactured and tested in accordance with EN 12952-11 are considered to be reliable .

27.1.5 Temperature allowances for unheated components

For unheated components carrying superheated steam, the temperature allowance of 15 °C given in Table 6.1-1 shall be reduced to 5 °C (measuring tolerance) if it shall be ensured that the temperature required by the design cannot be exceeded.

This can be achieved by:

a) temperature control upstream of the said components;

b) the arrangement of cooling or mixing points (e.g. by headers through which the fluid flows in a longitudinal direction) upstream of the said components;

c) connection measures for heating surface arrangement or the like.

27.1.6 Headers

Tubular hollow parts with a nominal external diameter greater than 76,2 mm, into which there are three or more non-axial tube entries, shall be considered as headers.

27.1.7 Unheated components

Components shall be considered to be unheated if

a) they are behind refractory brickwork, and an intermeditate space of at least 100 mm is between the brickwork and the components;

b) a gas-tight-welded waterwall is arranged between the components and the furnace or gas pass;

c) the components are protected by a layer of refractory bricks or refractory lining and this layer is not primarily subject to heat absorption due to radiative heat transfer2); in this case, the brickwork or refractory lining shall be attached to the suspended part by means of holding devices. In the case of headers, studding can be provided for this purpose;

d) the highest possible temperature of the flue gas is less than the reference temperature of the component.

27.1.8 Components protected against radiation

Components shall be considered to be protected against radiation2) if they are screened by closely spaced tubes (maximum clear distance 3 mm) and no substantial flow of flue gases can occur between the screening tubes and the components.

27.1.9 Components heated by convection

Components shall be considered to be primarily heated by convection if

a) they are not subject to radiation2);

b) the components are protected by a layer of refractory brickwork or refractory lining against radiative heat transfer1).

In this case, the bricks or refractory lining shall be attached to the suspended part by holding devices, which in the case of headers, can be studding;

c) the components are protected by a row of tubes with a ratio of

*P*Φ / *d*0 ≤ 1,3 *n*0,63 (6.1-1)

where

n is the number of rows;

*P*Φ is the tube pitch;

*d*o is the outside tube diameter.

This requires a value of

*P*Φ/*d*o ≤ 1,3 for one row of tubes in accordance with Figure 6.1-1;

*P*Φ/*d*o ≤ 2,0 for two rows of tubes in accordance with Figure 6.1-2;

*P*Φ/*d*o ≤ 2,6 for three rows of tubes in accordance with Figure 6.1-3.

d) the components are provided with closely spaced tubes in accordance with Figure 6.1-4 with a ratio of

$$\frac{P_0 \; P_{90}}{\pi \; l^2} \leq 0{,}1$$

where

*P*0 is the longitudinal pitch with ∅ = 0;

*P*90 is the circumferential tube pitch on the external surface with ∅ = 90;

l is the distance between component and furnace envelope.

27.1.10 Components heated by radiation

Unscreened components shall be considered to be primarily heated by radiation, if they are subject to radiation by flue gases with a temperature > 950 °C.

Figure 6.1-

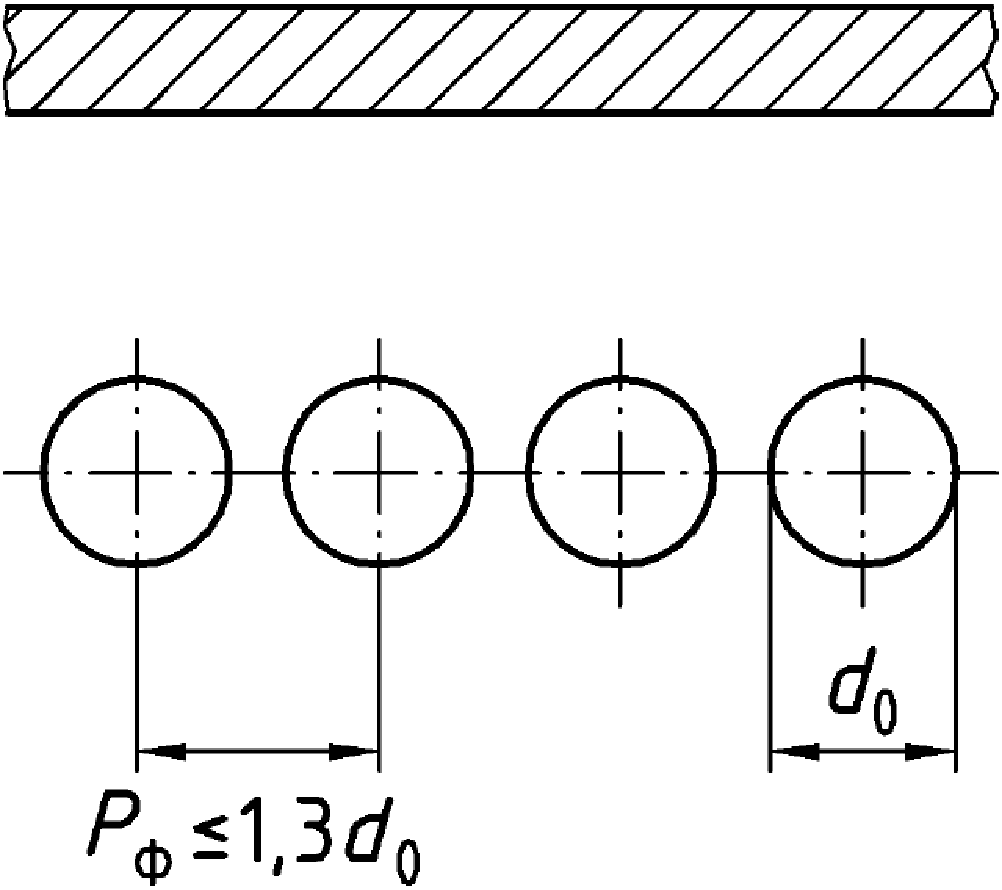


Figure 6.1-1 — Components protected by one row of tubes

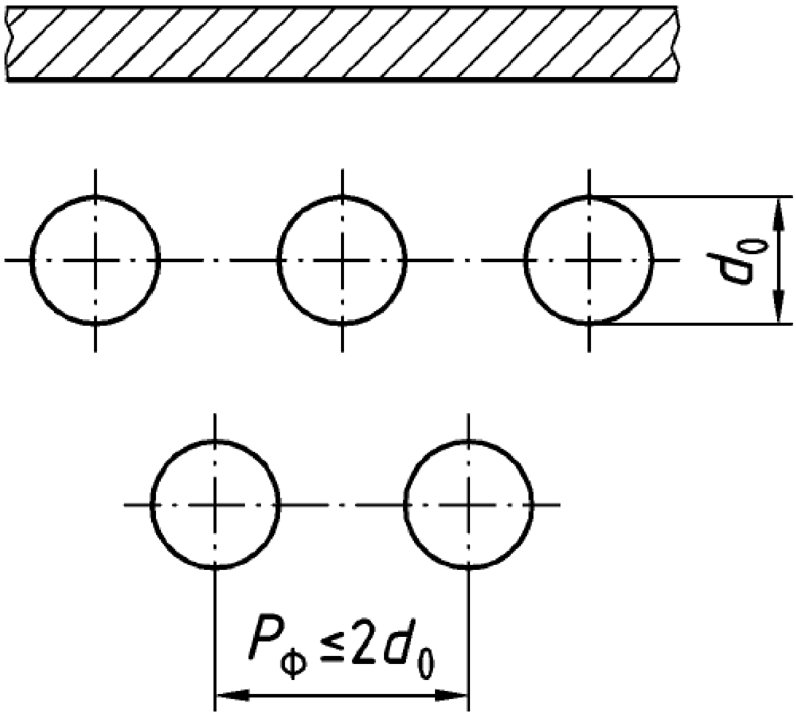


Figure 6.1-2 — Components protected by two rows of tubes

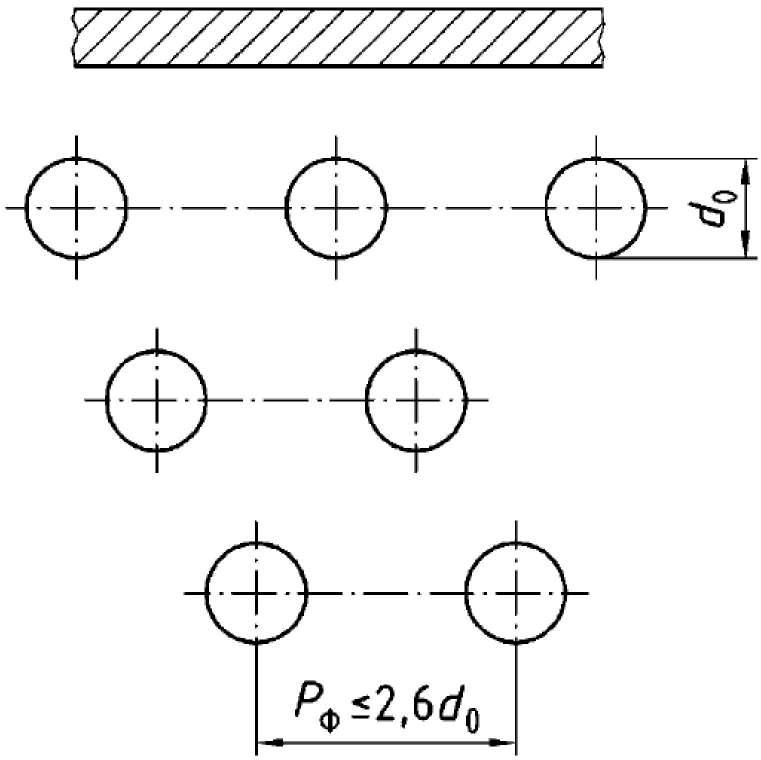
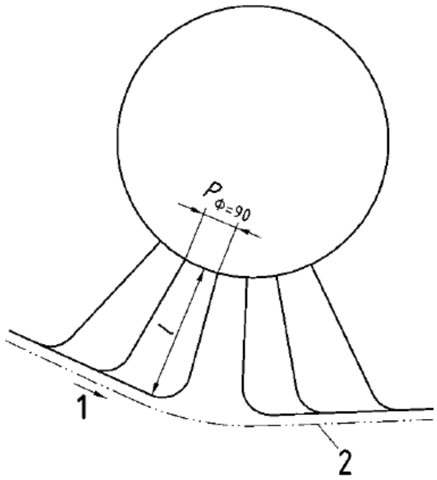


Figure 6.1-3 — Components protected by three rows of tubes



Key

1 flue gas flow
2 boundary of flue gas flow

Figure 6.1-4 — Components protected by closely spaced tubes

27.2 Maximum through-the-wall temperature difference and maximum flue gas temperature for heated drums and headers

27.2.1 Maximum through-the-wall temperature difference

The through-the-wall temperature difference (defined as outside wall temperature minus inside wall surface temperature) of heated drums and headers, shall not exceed 30 K.

NOTE Components made from ferritic steel not exceeding 32 mm wall thickness and exposed to a heat flux less or equal to 40 kW/m2 will meet this requirement.

27.2.2 Headers exposed to flue gases

Surfaces of superheater and reheater headers shall not be exposed to flue gas temperatures in excess of 500 °C.

27.2.3 Allowable deviations

In cases where it is necessary to deviate from 6.2.1 and 6.2.2 it shall be verified that unsteady and steady thermal stresses do not lead to unacceptable stresses in the component wall.

27.3 Design stress

27.3.1 Design stress for components

The design stress f to be used for the design of components primarily subjected to static loading shall be the lowest value obtained from equation (6.3-1)

$$f = \frac{K}{S}$$

where the material strength value K and the safety factor S are given in Tables 6.3-1 or 6.3-2.

27.3.2 Design stress for welded connections operating under creep condition

When the creep properties of the welded connection are known, the smallest of the design strengths of the welded connection and the two joined materials shall be used for loading at right angles to the weld seam.

When the creep properties of the welded connection are not known, but those of the filler material are known, the design strength for this loading shall be reduced by 20 % from the smaller of the design strengths of the joined materials. When the creep strength of the filler metal is not known, the joint strength shall be reduced by a further

20 %.

27.3.3 Design stress for austenitic steels

In the case of austenitic steels, the following shall be used:

– if its elongation after rupture exceeds 30 %, of *R*e t;

– or, alternatively, and if its elongation after rupture exceeds 35 %, 5/6 of *R*e t and of *R*m 20.

27.3.4 Design stress for test pressure

At the test pressure *p*' the design stress shall be

$$f' = \frac{K'}{S'}$$

where the material strength value *K*' and the safety factor *S*' are given in Table 6.3-3.

Table 6.3-1 — Material strength value *K* and related safety factor *S* for rolled and forged steels

Material strength value *K*	Safety factor *S* (parts under internal pressure)
R_m at 20 °C	2,4
$R_{p\ 0,2\ tc}$	1,5
R_{mTtc} [a, b]	1,25

[a] *T* is the minimum specified design lifetime with a minimum of 100 000 h. If no lifetime is specified 200 000 h shall be taken.

Should creep rupture strength values for times in excess of 100 000 h not be available, 100 000 h data may be used with *S* = 1,5 for internal pressure.

In exceptional cases, where pressure parts are operated in the creep range for short duration (less than 10 000 h) e.g. discharge, relief lines, *T* may be reduced to 10 000 h with the safety factor 1,25.

[b] Creep rupture strength values for intermediate lifetimes shall be obtained by linear interpolation in a double logarithmic system.

Table 6.3-2 — Material strength value K and related safety factor S for cast steel and nodular graphite cast iron

Material strength value K	Safety factor S		
	Cast steel	Nodular graphite cast iron	
		annealed	non-annealed
R_m at 20 °C	3,2	4,8	5,8
$R_{p\ 0,2\ tc}$	2,0	3,0	4,0
R_{mTtc} [a, b]	2,0	–	–

[a] T is the minimum specified design lifetime with a minimum of 100 000 h. If no lifetime is specified 200 000 h shall be taken.

Should creep rupture strength values for times in excess of 100 000 h not be available, 100 000 h data may be used with S = 1,5 for internal pressure.

In exceptional cases, where pressure parts are operated in the creep range for short duration (less than 10 000 h) e.g. discharge, relief lines, T may be reduced to 10 000 h with the safety factor 1,25.

[b] Creep rupture strength values for intermediate lifetimes shall be obtained by linear interpolation in a double logarithmic system.

Table 6.3-3 — Material strength value K' and related safety factor S' at test (gauge) pressure p'

Material strength value K'	Safety factors S'		
	Rolled and forged steel	Cast steel	Nodular graphite cast iron
$R_{p\ 0,2}$ at 20 °C	1,05	1,4	2,2

Cylindrical shells of drums and headers under internal pressure 28

28.1 Shell thickness

28.1.1 Requirements

The shell thickness after deduction of allowances, *e*rs = *e*s *c*1 *c*2 of drums and headers shall be the greatest of those required by the following:

a) a minimum of 9,5 mm for headers 300 mm outside diameter and above, and a minimum of 6 mm for headers below 300 mm outside diameter;

b) the requirements of 7.2 by applying 8.2 or 8.3.3 and 8.3.4;

c) the requirements of 7.3 and 7.4 (if applicable).

28.1.2 Required wall thickness including allowances

The required wall thickness including allowances shall be derived from

*e*s' = *e*cs + *c*1 + *c*2

28.2 Basic calculation

28.2.1 Required wall thickness without allowances

The required wall thickness without allowances *e*cs, in mm, of a cylindrical shell shall be determined by either of the following equations

$$e_{cs} = \frac{p_c\ d_{is}}{(2\ f_s - p_c)\ v} \qquad \text{if } d_{is} \text{ is given}$$

or

$$e_{cs} = \frac{p_c\ d_{os}}{(2\ f_s - p_c)\ v + 2p_c} \qquad \text{if } d_{os} \text{ is given}$$

where the following applies in addition to Table 4-1 of EN 12952-1:

– *v* is the minimum efficiency for isolated or adjacent branches *v*b or *v*m, respectively, isolated or adjacent openings in longitudinal, oblique or circumferential direction, determined in accordance with 8.2 by way of approximation or in accordance with 8.3.3 and 8.3.4. Cladding for the purpose of metal wastage resistance shall not be taken into account.The calculation of the required wall thickness of a main body reduced in strength by openings shall only be possible by iteration since strength reduction depends on the wall thickness.

The equivalent value of the stress in the shell shall be calculated using an inversion of equations (7.2-1) or (7.2-2).Thermal stress caused by through-the-wall-temperature-difference shall be taken into account in accordance with the requirements of clause 13.

Reference 2: Part 2: Materials for pressure parts of boilers and accessories EN 12952-2:2001/ 29

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies (including amendments).

EN 440, Welding consumables – Wire electrodes and deposits for gas shielded metal arc welding of non alloy and fine grain steels – Classification.

EN 499, Welding consumables – Covered electrodes for manual metal arc welding of non alloy and fine grain steels – Classification.

EN 756, Welding consumables – Wire electrodes and wire-flux combinations for submerged arc welding of non alloy and fine grain steels – Classification.

EN 758, Welding consumables – Tubular cored electrodes for metal arc welding with and without a gas shield of non alloy and fine grain steels – Classification.

EN 759, Welding consumables – Technical delivery conditions for welding filler metals – Type of product, dimensions, tolerances and marking.

prEN 764-4:1999, Pressure equipment – Part 4: Establishment of technical delivery conditions for materials.

prEN 764-5:1999, Pressure equipment – Part 5: Compliance and inspection documentation of materials.

prEN 1092-1:2001, Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 1: Steel flanges.

EN 1503-1, Valves – Materials for bodies, bonnets and covers – Part 1: Steels specified in European Standards.

EN 1503-2 , Valves – Materials for bodies, bonnets and covers – Part 2: Steels other than those specified in European Standards.

EN 1599, Welding consumables – Covered electrodes for manual metal arc welding of creep-resisting steels – Classification.

EN 1668, Welding consumables – Rods, wires and deposits for tungsten inert gas welding of non alloy and fine grain steels – Classification.

prEN 1759-1:2000, Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, class designated – Part 1: Steel flanges, NPS ½ to 24.

EN 10002-1, Metallic materials – Tensile testing – Part 1: Method of test at ambient temperature.

EN 10002-5, Metallic materials – Tensile testing – Part 5: Method of testing at elevated temperature. EN 10021, General technical delivery requirements for steel and iron products.

EN 10028-1, Flat products made of steels for pressure purposes – Part 1: General requirements. EN 10028-2, Flat products made of steels for pressure purposes – Part 2: Non alloy and alloy steels with specified elevated temperature properties.

EN 10028-3, Flat products made of steels for pressure purposes – Part 3: Weldable fine grain steels, normalized.

EN 10045-1, Metallic materials – Charpy impact test – Part 1: Test method. EN 10160, Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflection method).

EN 10164, Steel products with improved deformation properties perpendicular to the surface of the product – Technical delivery conditions. EN 10204, Metallic products – Types of inspection documents.

EN 10213-1, Technical delivery conditions for steel castings for pressure purposes – Part 1: General.

EN 10213-2, Technical delivery conditions for steel castings for pressure purposes – Part 2: Steel grades for use at room temperature and elevated temperatures.

prEN 10216-1:1995, Seamless steel tubes for pressure purposes – Technical delivery conditions – Part 1: Non alloy steel tubes with specified room temperature properties. prEN 10216-2:1998, Seamless steel tubes for pressure purposes – Technical delivery conditions – Part 2: Non alloy and alloy steel tubes with specified elevated temperature properties.

prEN 10216-3:1998, Seamless steel tubes for pressure purposes – Technical delivery conditions – Part 3: Non alloy and alloy fine grain steel tubes.

prEN 10216-5:1998, Seamless steel tubes for pressure purposes – Technical delivery conditions – Part 5: Stainless steel tubes.

prEN 10217-2:1998, Welded steel tubes for pressure purposes – Technical delivery conditions – Part 2: Electric welded non alloy and alloy steel tubes with specified elevated temperature properties.

prEN 10217-3:1998, Welded steel tubes for pressure purposes – Technical delivery conditions – Part 3: Alloy fine grain steel tubes.

EN 10222-2, Steel forgings for pressure purposes – Part 2: Ferritic and martensitic steels with specified elevated temperature properties.

EN 10222-3, Steel forgings for pressure purposes – Part 3: Nickel steels with specified low temperature properties.

EN 10222-4, Steel forgings for pressure purposes – Part 4: Weldable fine grain steels with high proof strength.

EN 10222-5, Steel forgings for pressure purposes – Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels.

EN 10228-1, Non-destructive testing of steel forgings – Part 1: Magnetic particle inspection.

EN 10228-2, Non-destructive testing of steel forgings – Part 2: Penetrant testing. EN 10228-3, Non-destructive testing of steel forgings – Part 3: Ultrasonic testing of ferritic or martensitic steel forgings.

EN 10236, Metallic materials – Tube – Ring expanding test.

EN 10246-6, Non-destructive testing of steel tubes – Part 6: Automatic full peripheral ultrasonic testing of seamless steel tubes for the detection of transverse imperfections

29.1 Materials covered by European Material Standards

- Pressure parts

Pressure parts of water-tube boilers covered by this European Standard shall be constructed from steel products in accordance with table A-1.

Steel products shall be of the types listed in the European Standards, see clause 2, manufactured in accordance with these standards, and which comply in all respects with the minimum requirements of this Part.

- Fittings

Non-alloy and alloy steel butt-welding fittings shall be in accordance with ISO 3419;

Stainless steel butt-welding fittings shall be in accordance with ISO 5251.

- Flanges

Steel flanges shall be in accordance with prEN 1092-1, EN 1759-1 or ISO 7005-1 as appropriate.

- Valves

Metal valves for use in flanged tubing systems shall be in accordance with EN 1503-1 or EN 1503-2.

Table A.1 — List of European standardised steels grouped according to product forms

Product form	EN standard	Material description	Grade	Restrictions			Material group to CR ISO 15608
				Heat treatment	Thickness mm min.	Thickness mm max.	
plate and strip	EN 10028-2	elevated temperature properties	P235GH	N	0	150	1.1
plate and strip	EN 10028-2	elevated temperature properties	P265GH	N	0	150	1.1
plate and strip	EN 10028-2	elevated temperature properties	P295GH	N	0	150	1.2
plate and strip	EN 10028-2	elevated temperature properties	P355GH	N	0	150	1.2
plate and strip	EN 10028-2	elevated temperature properties	16Mo3	N	0	150	1.1
plate and strip	EN 10028-2	elevated temperature properties	13CrMo4-5	NT	0	60	5.1
plate and strip	EN 10028-2	elevated temperature properties	13CrMo4-5	NT Q	60	100	5.1
plate and strip	EN 10028-2	elevated temperature properties	13CrMo4-5	Q	100	150	5.1
plate and strip	EN 10028-2	elevated temperature properties	10CrMo9-10	NT	0	60	5.2
plate and strip	EN 10028-2	elevated temperature properties	10CrMo9-10	NT Q	60	100	5.2
plate and strip	EN 10028-2	elevated temperature properties	10CrMo9-10	Q	100	150	5.2
plate and strip	EN 10028-2	elevated temperature properties	11CrMo9-10	NT Q	0	60	5.2
plate and strip	EN 10028-2	elevated temperature properties	11CrMo9-10	Q	60	100	5.2
plate and strip	EN 10028-3	fine grain steel	P275NH	N	0	150	1.1
plate and strip	EN 10028-3	fine grain steel	P355NH	N	0	150	1.2
plate and strip	EN 10028-3	fine grain steel	P460NH	N	0	150	2.1
tube, seamless	prEN 10216-2	elevated temperature properties	P195GH	N	0	16	1.1
tube, seamless	prEN 10216-2	elevated temperature properties	P235GH	N	0	60	1.1
tube, seamless	prEN 10216-2	elevated temperature properties	P265GH	N	0	60	1.1
tube, seamless	prEN 10216-2	elevated temperature properties	8MoB5-4	N	0	16	5.1
tube, seamless	prEN 10216-2	elevated temperature properties	16Mo3	N	0	60	1.2
tube, seamless	prEN 10216-2	elevated temperature properties	X11CrMo9-1+I	I	0	60	5.4
tube, seamless	prEN 10216-2	elevated temperature properties	X11CrMo9-1+NT	NT	0	60	5.4
tube, seamless	prEN 10216-2	elevated temperature properties	X11CrMo5+I	I	0	100	5.3
tube, seamless	prEN 10216-2	elevated temperature properties	X11CrMo5+NT1	NT	0	100	5.3
tube, seamless	prEN 10216-2	elevated temperature properties	X11CrMo5+NT2	NT	0	100	5.3
tube, seamless	prEN 10216-2	elevated temperature properties	13CrMo4-5	NT	0	60	5.1
tube, seamless	prEN 10216-2	elevated temperature properties	10CrMo9-10	NT	0	60	5.2
tube, seamless	prEN 10216-2	elevated temperature properties	11CrMo9-10	QT	0	60	5.2
tube, seamless	prEN 10216-2	elevated temperature properties	X10CrMoVNb9-1	NT	0	120	6.4
tube, seamless	prEN 10216-2	elevated temperature properties	15NiCuMoNb5-6-4	NT	0	80	2.1
tube, seamless	prEN 10216-2	elevated temperature properties	X2OCrMoV11-1	NT	0	80	6.4
tube, seamless	prEN 10216-2	elevated temperature properties	10CrMo5-5	NT	0	60	5.1

Table A.1 — List of European standardised steels grouped according to product forms *(continued)*

Product form	EN standard	Material description	Grade	Restrictions			Material group to CR ISO 15608
				Heat treatment	Thickness mm min.	Thickness mm max.	
tube, seamless	prEN 10216-3	fine grain steels	P355NH	N	0	100	1.2
tube, seamless	prEN 10216-3	fine grain steels	P460NH	N	0	100	2.1
tube, welded	prEN 10217-2	elevated temperature properties	PH195	N	0	16	1.1
tube, welded	prEN 10217-2	elevated temperature properties	PH235	N	0	16	1.1
tube, welded	prEN 10217-2	elevated temperature properties	PH265	N	0	16	1.1
tube, welded	prEN 10217-2	elevated temperature properties	16Mo3	N	0	16	1.1
tube, welded	prEN 10217-3	fine grain steels	P355NH	N	0	40	1.2
tube, welded	prEN 10217-3	fine grain steels	P460NH	N	0	40	2.1
forging	prEN 10222-2	elevated temperature properties	X16CrMo5 1	A	0	300	5.3
forging	prEN 10222-2	elevated temperature properties	X16CrMo5 1	NT QT	0	300	5.3
forging	prEN 10222-2	elevated temperature properties	X20CrMoV11-1	QT	0	330	6
forging	prEN 10222-2	elevated temperature properties	X10CrMoVNb9-1	NT	0	130	6
forging	prEN 10222-2	elevated temperature properties	14MoV6-3	NT QT	0	500	4.1
forging	prEN 10222-2	elevated temperature properties	11CrMo9-10	N	0	200	5.2
forging	prEN 10222-2	elevated temperature properties	11CrMo9-10	NT QT	200	500	5.2
forging	prEN 10222-2	elevated temperature properties	16Mo3	N	0	35	1.2
forging	prEN 10222-2	elevated temperature properties	16Mo3	QT	35	100	1.2
forging	prEN 10222-2	elevated temperature properties	16Mo3	QT	100	500	1.1
forging	prEN 10222-2	elevated temperature properties	13CrMo4-5	N NT QT	0	70	5.1
forging	prEN 10222-2	elevated temperature properties	13CrMo4-5	N NT QT	70	500	5.1
forging	EN 10222-4	fine grain steel, high proof strength	P285NH	N	0	70	1.2
forging	EN 10222-4	fine grain steel, high proof strength	P285QH	QT	70	400	1.2
forging	EN 10222-4	fine grain steel, high proof strength	P355NH	N	0	70	1.2
forging	EN 10222-4	fine grain steel, high proof strength	P355QH	QT	70	400	1.2
forging	EN 10222-4	fine grain steel, high proof strength	P420NH	N	0	70	2.1
forging	EN 10222-4	fine grain steel, high proof strength	P420QH	QT	70	400	2.1

A annealed
AT annealed and tempered
I isothermally annealed
N normalized
NT normalized and tempered
Q quenched
QT quenched and tempered

Annex B (normative)

Establishment of creep rupture strength values for new materials

The establishment of creep rupture strength values for new materials shall be done in two steps as described in table B.1.

Table B.1 — Establishment of creep rupture strength values

	Available Test Data	Procedure for evaluation	Further tests
First step for preliminary data in data sheets (EMDS)	Creep tests (3 samples each) for 3 casts at min. 2 test temperatures (Δt = 50°C – 100 °C) for more than 10 000 h (rupture). where embrittlement may occur, for each cast and temperature 1 notched sample for more than 10 000 h (rupture).	For scatter bands not greater than ± 10 % extrapolation factor < 3 for time. Max. application temp. ≤ max. test temperature. For scatter bands greater than ± 10 % no extrapolated values in data sheets. In this case the calculation values shall be defined in each case.	From each manufacturer creep tests for (min. 5 samples) min. 1 cast with min. 2 test temperatures for more than 30 000 h (rupture). Where necessary for each test temperature min. 2 notched samples for more than 30 000 h (rupture).
Second step for final data in data sheets (EMDS)	Creep tests (min., 5 samples each) for min. 6 casts at test temperatures with $\Delta t \leq$ 50 °C up to 35 % max. intended operating time. where necessary for notched creep tests (min. 2 samples) at min. 2 temperatures in embrittlement range up to more than 30 000 h (rupture).	For scatter bands not greater than ± 20 % extrapolation factor < 3 for time. Max. application temperature ≤ 25 °C above max. test temperature.	New manufacturers of such materials shall test samples at least at one test temperature for more than 30 000 h (rupture). In the case of extension of the application range of the data sheet creep tests (min. 5 samples each) for one cast at min. 2 test temperatures more than 30 000 h (rupture).

29.2 Materials for pressure parts

29.2.1 Materials covered by harmonized European material Standards for pressure purposes

- Flat products, forgings, castings, tubes, fittings, flanges and valve bodies

The material shall be ordered and delivered in accordance with annex A and the relevant European Standards EN 10028-2, EN 10028-3, EN 10213-1, EN 10213-2, prEN 10216-2, prEN 10216-3, prEN 10217-2, prEN 10217-3, EN 10222-2, EN 10222-5, EN 10253-1, EN 10254 and EN 10273. The additional requirements given in this Part shall be taken into account. Harmonized supporting standards are prEN 1092-1, EN 1503-1, EN 1503-2, prEN 1759-1.

- Cast iron

Nodular cast iron shall not be used in the construction of pressure parts, except for valves and fittings as indicated in prEN 12952-7, within the design limits specified in EN 12952-3. The use or other types of cast iron shall not be permitted.

- Studs, bolts and nuts

Studs, bolts and nuts shall be ordered and delivered in accordance with the requirements of EN 12952-3.

- Welding consumables

The welding consumables (electrodes, filler wires, filler rods, fluxes, fusible inserts) shall be selected so that the mechanical properties of the weld metal are compatible with the relevant requirements of the base materials from EN 440, EN 499, EN 756, EN 758, EN 759, EN 1599, EN 1668, EN 12070, EN 12071, EN 12074 and EN 12536. The welding consumables shall be ordered and delivered according to specifications approved in accordance with EN 12074 and prEN 13479-1.

- Verification of properties

The properties shall conform to the requirements of the European material Standards. Compliance with the delivery requirements shall be documented in the inspection document.

- Requirements for non-destructive examination

The non-destructive examination (NDE) requirement for various forms of material shall be as given below.

a) plates: NDE in accordance with EN 10160 class S1.

b) tubes – seamless: Seamless tubes shall be tested in accordance with prEN 10216 (Series) test category II . For unalloyed seamless tubes with design temperatures below 450 °C and design pressures below 42 bar, it is permitted to perform category 1 in accordance with prEN 10216-2. 9

1) longitudinal imperfections: NDE in accordance with EN 10246-7 Acceptance level: U2 sub-category B for cold finished and machined tubes U2 sub-category C for all other conditions

2) transverse imperfection: NDE in accordance with prEN 10246-6 Acceptance level: U2 sub-category C for all headers with outside diameters > 142 mm.

3) tube ends: NDE in accordance with annex B of EN 10246-7; Acceptance level: U2 sub-category B or C as for longitudinal imperfections. NOTE: This is only mandatory for fixed length tubes. When the tubes are in close end to end contact, it can be accepted that 100 % (full length) ultrasonic examination has taken place, and therefore no additional tube end examination is required.

c) tubes - welded: Welded tubes of test category II in accordance with prEN 10217- 2 For unalloyed welded steel tubes with design temperatures below 450 °C and design pressures below 42 bar, it is permitted to perform category I in accordance with prEN 10217-2. However, the longitudinal weld shall be subject to ultrasonic examination.

1) longitudinal imperfections: NDE in accordance with EN 10246-7 Acceptance level: U2 sub-category C

2) transverse imperfection: NDE in accordance with prEN 10246-6 Acceptance level: U2 sub-category C for all headers with outside diameter > 142 mm.

3) tube ends: NDE in accordance with annex B of EN 10246-7; Acceptance level: U2 sub-category C as for longitudinal imperfections.

NOTE: This is only mandatory for fixed length tubes. When the tubes are in close end to end contact, it can be assumed that 100 % (full length) ultrasonic examination has taken place, and therefore no additional tube end examination is required. The requirements annex I, 3.1.2. and 3.1.3 of Pressure Equipment Directive 97/23/EC should be taken into account.

d) forgings: Forgings produced in accordance with EN 10222-2, EN 10222-3, EN 10222-4, prEN 10222-5 and solid bars produced in accordance with EN 10222-2 required for the production of tubular sections by machining, shall be tested in accordance with the requirements for tubes taking into consideration EN 10228-1 to EN 10228-3, steel closed die forgings shall be delivered in accordance with EN 10254.

e) steel castings: Steel castings shall be delivered and tested in accordance with EN 10213-1 and EN 10213-2.

30 Reference 3: Water-tube boilers and auxiliary installations - Part 5: Workmanship and construction of pressure parts of the boiler EN 12952-5:2001

30.1 Tube bending procedure tests

30.1.1 General

- The requirements to be met by procedure tests covering the bending and forming of tubular components, as defined in 7.3.2 are given in the following clauses. Procedure tests for tubular products are divided into three groups, depending on outside diameter and the forming processes employed, as follows:

– A.2 Hot or cold formed bends in tubes with outside diameter Š 142 mm

– A.3 Cold formed bends in tubes with outside diameter > 142 mm

– A.4 Hot formed bends in tubes with outside diameter > 142 mm

- Procedure tests carried out within the material groups defined in table A.1 of EN 12952-2 qualify other lower

alloyed or softer materials (lower ultimate tensile strength) in the same group, in particular materials in steel group 1.2 cover 1.1 and 5.2 cover 5.1.

- The validity ranges of the tube bending procedure tests are defined in A.2.3, A.3.3 and A.3.4.
- Procedure test bends shall be bent to an angle of at least 90°. This shall be deemed to represent the minimum requirements for all bend angles. The thickness and DFC measurements shall be taken at 30° intervals from within this bend angle. Thickness determination shall normally be by sectioning but, for tubes above 80 mm nominal outside diameter, thickness may be determined by ultrasonic means. Any mechanical test specimens required shall, where possible, be taken from within this bend angle. However, where this is not possible, required specimens shall be taken from the straight tube adjacent to the commencement of the bend, which has been subject to the same heat treatment, if any, as the bend.
- The manufacturer shall prepare documented records of all tube bend procedure tests.A.2 Hot or cold formed bends in tubes with outside diameter Š 142 mm
- Types of bending processes The bending process is normally characterised by specific machines using different forms of tooling. A change to a similar machine, of different load capacity, using the same tooling shall not require requalification.

The following shall be permitted types of tube bending processes, but these are not to be considered as limiting:

– rotary draw bend (without mandrel);

– rotary draw bend (with mandrel);

– boost bending (without mandrel);

– boost bending (with mandrel);

– press or squeeze bending;

– roll bending;

– any of the above in conjunction with local automatic strip heating on the intrados of the bend;

– gang bending for water wall panels.

Other than for local automatic strip heating on the intrados of the bend, where hot bending is employed, heating shall be by an induction process or by heating in a gas fired or other form of furnace/muffle.

- Post-bending heat treatment (PBHT)

Bends shall be subject to PBHT in accordance with 7.3.8 and 7.3.9 prior to testing.

Separate qualification shall be required for:

a) cold bend (without PBHT);

b) cold bend (with PBHT);

c) hot bend (without PBHT);

d) hot bend (with PBHT).

Any test bends made using controlled local automatic strip heating on the intrados of the bend, except those in steel group 1.1 and 1.2, shall be normalised, or normalised and tempered, as appropriate, in accordance with the requirements of the base material specification or data sheet.

A.2.3 Validity range of tests

A.2.3.1 Any combinations of tube outside diameter, wall thickness and bend radius for a given material grouping

(see A.1.2) and given types of bending process shall be acceptable, provided the requirements for the tube forming ratio (TFR) given in A.2.3.2 are met.

A.2.3.2 The TFR shall be determined by a particular set of bending test parameters dO, e and rb in accordance with

A.2.3.3. Any other combination of parameters, within a given steel group and bending process up to a TFR of 110 %

of the one determined in the test, shall be covered.

A.2.3.3 TFR shall be:

$$T_{FR} = \frac{d_0^2}{e \times r_b}$$

where

$$T_{FR} = \frac{d_0^2}{e \times r_b} \qquad \text{(A.1)}$$

-e

dO = tube outside diameter, in mm;

e = nominal tube wall thickness, in mm;

rb = radius of bend measured to the centre-line of the tube, in mm.

The following example illustrates how TFR shall be applied:

Dimensions of test bend:

Outside diameter of tube dO 51

Nominal tube thickness e 5

Radius of bend rb 150.

Steel group: 1

Bending process: Cold rotary draw.

$$T_{FR} = \frac{d_0^2}{e \times r_b} = \frac{51^2}{5 \times 150} = 3{,}468 \qquad \text{validity range: } 3{,}468 \times 110\ \% = 3{,}815$$

Other tube bends made with the same bending process in the same steel group would be compared for qualification

within the validity range of the test bend in accordance with table A.2-1:

Table A.2-1 — Validity range for different bends

d_0	e	r_b	TFR	Within Validity Range
44,5	4	133	3,772	Yes
44,5	5	133	2,978	Yes
51	4	150	4,335	No – New qualification required
51	6	200	2,168	Yes
63,5	5	190	4,244	No – New qualification required
63,5	8	150	3,360	Yes
70	6	210	3,889	No – New qualification required
70	8	250	2,450	Yes
76,1	7	228	3,628	Yes
76,1	8	190	3,810	Yes

Table C-1 — Limits for weld imperfections in fin to tube welds

Identification of imperfection			Maximum permitted	
EN 26520 Group No.	EN 26520 Defect No.	Type of imperfection	EN 25817 level*	Definition of maximum permitted
1	100	Cracks (all)	B	Not permitted
2	200	Cavities (all)	"S"	When occurring at the surface, – diameter Š 2 mm, with the additional condition that: – it does not occur at a stop or restart
3	301X 302X 3031 304X	Slag inclusions (all) Flux inclusions (all) Oxide inclusions Metallic inclusions (all)	"S"	Not permitted when occurring at the surface (shall be removed by grinding for example) Local oxide layers due to GTAW or GMAW are not defined as inclusions and are acceptable.
4	401X	Lack of fusion (all)	B	Not permitted in the fusion welds, but see C.4.2.2.
5	5011 5012	Undercut	B	Depth Š 0,5 mm (whatever the length is), a smooth transition is required
5	503	Excessive convexity	"S"	Weld shape should not be more than 30° convex; see figure C-4
5	507	Misalignment	"S"	6 Š 2 mm, see figure C-3a
5	508	Angular misalignment	"S"	6 Š 3 mm, see figure C-3b
5	510	Burn through	"S"	Not permitted. Unmelted remaining wall required: Š 2 mm; see C.4.2.2a)
5	517	Poor restart	B	Not permitted
6	601	Stray flash or arc strike	"S"	Not permitted, grinding is required plus DPI or MPI to ensure that no crack is left
6	602	Spatter	"S"	Shall normally be removed; isolated spatter may however be permitted
6	604	Grinding mark	"S"	Not permitted; shall be flushed by grinding; a smooth transition is required
6	605	Chipping mark	"S"	Not permitted; shall be flushed by grinding; a smooth transition is required
6	606	Underflushing	"S"	Not permitted; minimum wall thickness required by design

* The requirements of this standard have been supplemented to reflect current European boiler manufacturing practice. Where this has been done an identifying letter "S" has been utilized in the table.

31 Water-tube boilers and auxiliary installations - Part 4: In-service boiler life expectancy calculations EN 12952-4

31.1 Calculation of in-service creep damage

31.1.1 General

This annex describes a procedure for calculating the creep damage of a boiler and its major components during operation. It is based on measured values of pressure and temperature, from which the actual primary stress and the expected lifetime at these conditions may be determined. Design lifetime is not necessarily identical with the operating lifetime. It is therefore necessary to make projections at various stages throughout the operating lifetime of the boiler to determine its expected lifetime.

31.1.2 Symbols and abbreviations

In addition to the symbols given in EN 12952-1:2001, Table 4-1, the symbols given in Table A.1 apply.

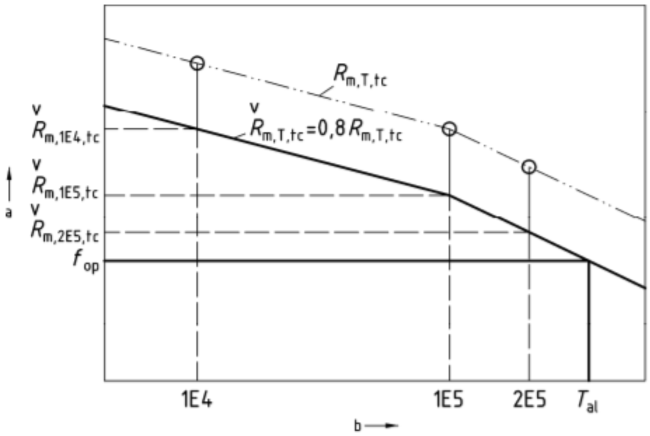
Table A.1 — Symbols

Symbol	Description	Unit
f_{op}	Membrane stress at operating conditions	N/mm^2
T_{op}	Operated time at operating conditions	h
T_{al}	Time to reach the theoretical rupture by creep	h
D_c	Creep damage	–

31.2 Calculation of in-service lifetime and creep damage

31.2.1 General

The calculation of the usage factor due to creep is a method that retrospectively takes into consideration the previous modes of operation. It is carried out for highly loaded components on the basis of the measured operating temperatures and gauge pressures. In order to limit the number of the required calculations and to more clearly present the results, the pressure and temperature range over which the component has been operated, shall be broken down into increments. The membrane stress fop at the highest loaded point in the component shall be obtained by transposing the design formula using the mean pressure of each pressure increment. If the operating pressure is not measured continuously during operation the separation into increments is not valid and under such circumstances the operating pressure for 100 % load may be used, thus resulting in more conservative predictions. If available, the measured minimum wall thickness may be used. If this was not measured, the guaranteed minimum wall thickness of the material as delivered shall be used. The theoretical lifetime Tal shall be calculated for each rating temperature/pressure. According to Figure A.1, Tal is obtained at the intersection of the stress line fop and the lower limit curve of the scatter band of the creep rupture strength (= 0,8 Rm T tc) at the mean temperature of each temperature increment. The respective portion of the creep damage ΔDci k for each incremental temperature/pressure is obtained by the ratio of the operating time Top for this increment divided by the theoretical lifetime Tal for the same increment.



Key

a) lg (R_m)

b) lg (T), h

Figure A.1 — Diagram for the determination of T_{al}

The operating times in the temperature/pressure increment shall be summarized, taking into account the temperature allowances for measuring uncertainties and for temperature asymmetries in due consideration at this classification. The usage portion for each increment is given by

$$\Delta D_{ci\,k} = \frac{T_{op}}{T_{al}} \qquad \text{A.1}$$

The creep damage Dc during the evaluated period shall be obtained from the linear damage rule by summing up the values ΔDci k for all temperature increments and, if any, pressure as follows:

$$D_c = \sum_i \sum_k \Delta D_{ci\,k} \qquad \text{(A.2)}$$

31.2.2 Online computerized data storage

In the case of on-line data storage by means of a data processing system a separation into increments may be waived. For calculation of the theoretical lifetime Tal the on-line measured values of pressure and temperature including the above mentioned allowances shall be used instead of the mean values of the increments. The increase of creep damage is obtained in this case from the measured time divided by the theoretical lifetime (see Tables A.2 and A.3). The computer programme used shall permit the results to be verified by at least a random test.

Water-tube boilers and auxiliary installations –Part 7: Requirements for equipment for the boiler-12952-7 32

General requirements for steam boilers and hot water generators

32.1 Safeguards against excessive pressure

Each steam boiler and hot water generator shall be equipped with safeguards against excessive pressure in accordance with prEN 12952-10.

32.2 Heat supply system

- For the heat supply of steam boilers and hot water generators the following Parts of this European Standard shall apply:

◎ EN 12952-8 for firing systems for liquid and gaseous fuels;

◎ prEN 12952-9 or prEN 12952-16 for solid fuels.

- The heat supply shall be adapted to the allowable heat output as well as to the intended mode of operation.

32.3 Ash removal plants

Ash removal plant shall be in accordance with prEN 12952-9 or prEN 12952-16.

32.4 Flue-gas cleaning plants

Flue-gas cleaning plants shall be in accordance with prEN 12952-13 and prEN 12952-14.

32.5 Requirements for limiting devices and safety circuits

- All limiters and their installation shall be in accordance with prEN 12952-11. The electrical safety circuits shall correspond to prEN 50156-1 (see safety levels given in Table 4.6.1 and Annex B).
- Functional testing of limiters shall be possible at any time for any operating condition, e.g. by simulation where appropriate. If any part of the functional test involves delaying the cut-off and lock-out of the heat supply, then the time delay shall not exceed a value specified by the manufacturer. For boilers fitted with water level limiter, the time delay shall not exceed the time for the water level to fall from the lowest controlled water level to LWL at MCR:

a) for steam boilers in the case of complete loss of feedwater supply and at maximum steam output, i.e.

$$t = \frac{V}{Q_{St} \cdot v_{St}}$$

b) for hot water generators in the case of interrupted feeding and recirculation and at the allowable heat output,i.e.

$$t = \frac{V}{Q_{HW} \cdot v_{HW}}$$

where

QHW is the equivalent steam generation calculated according to the allowable heat output, in kg/s;

QSt is the maximum continuous rating, in kg/s;

t is the sinking time, in s;

V is the water volume between HHS and LWL, in m3;

*v*HW is the specific water volume, m3/kg;

*v*St is the specific water volume at saturated steam temperature, in m3/kg.

- The result of each limiter check shall be clearly recognizable to the boiler operator, e.g. by the lighting of a signal.

32.6 Cleaning, access and inspection openings

- Steam boilers and hot water generators shall be provided with openings to permit cleaning and inspection of the boiler interior. Sufficient space shall be provided to permit access to the steam and water spaces and the combustion chamber as well.
- Water or steam-containing components with an inside diameter of more than 1 200 mm and components with a diameter of more than 800 mm and a length of 2 000 mm shall be so designed as to permit internal inspection.

Internals shall be of such a design as not to obstruct inspection of the component walls, or it shall be possible to remove them.

- Headers and similar components shall be provided with adequate access for inspection of their inner surface as follows:

◎ for inside diameters in excess of 80 mm where mud deposits can accumulate;

◎ for inside diameters in excess of 150 mm for any other cases.

Inspection access shall be designed as head, hand or inspection holes where manual inspection methods are to be used or, as inspection nozzles where inspection devices are used e.g. endoscopes.

- Sizes of openings in water and steam spaces shall be:

a) Manholes shall not be smaller than 320 mm × 420 mm or have an inside diameter of at least 420 mm. The nozzle or ring height shall not exceed 300 mm, and 350 mm in the case of a tapered design. For structural or design reasons, the openings of manholes may be reduced to 300 mm × 400 mm clear width or to 400 mm inside diameter. In such cases, the nozzle or ring height shall not exceed 150 mm, or 175 mm in the case of a tapered design. For minimum number of openings see table 4.6-1;

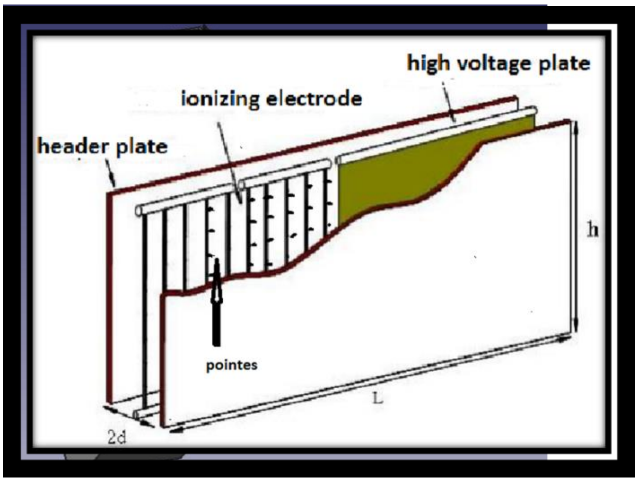
b) Head holes shall not be smaller than 220 mm × 320 mm or have an inside diameter of at least 320 mm. The nozzle or ring height shall not exceed 100 mm, or 120 mm in the case of a tapered design. For minimum number of openings (see table 4.6-1);

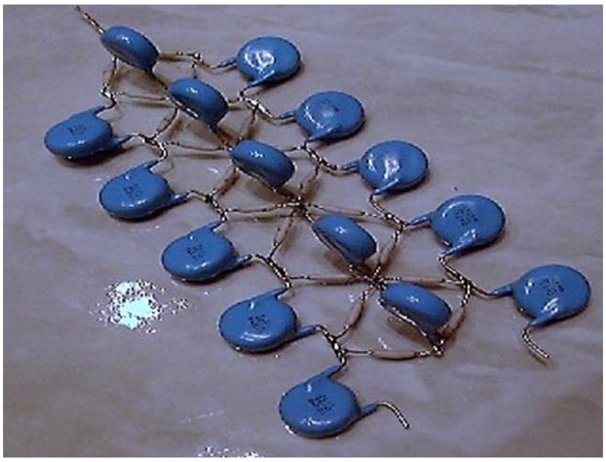
c) Hand holes shall not be smaller than 100 mm × 150 mm or have an inside diameter of at least 120 mm. The nozzle or ring height shall not exceed 65 mm, or 95 mm in the case of a tapered design. For minimum number of openings (see table 4.6-1);

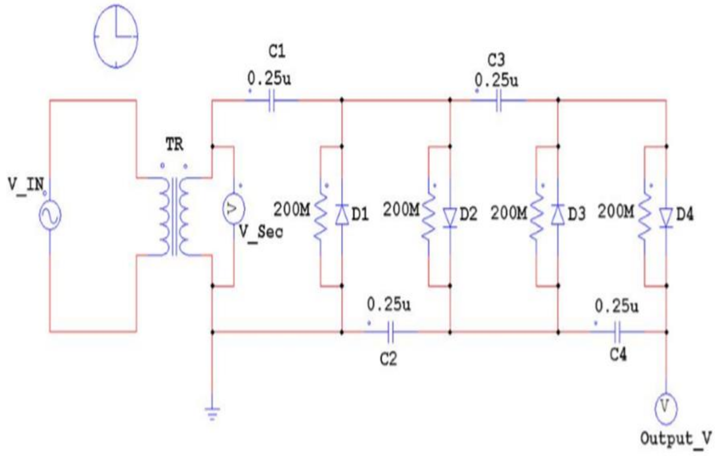
d) Inspection holes shall have a diameter of 50 mm. However, they shall be provided only where a hand hole is not possible for design reasons. For minimum number of openings see Table 4.6-1;

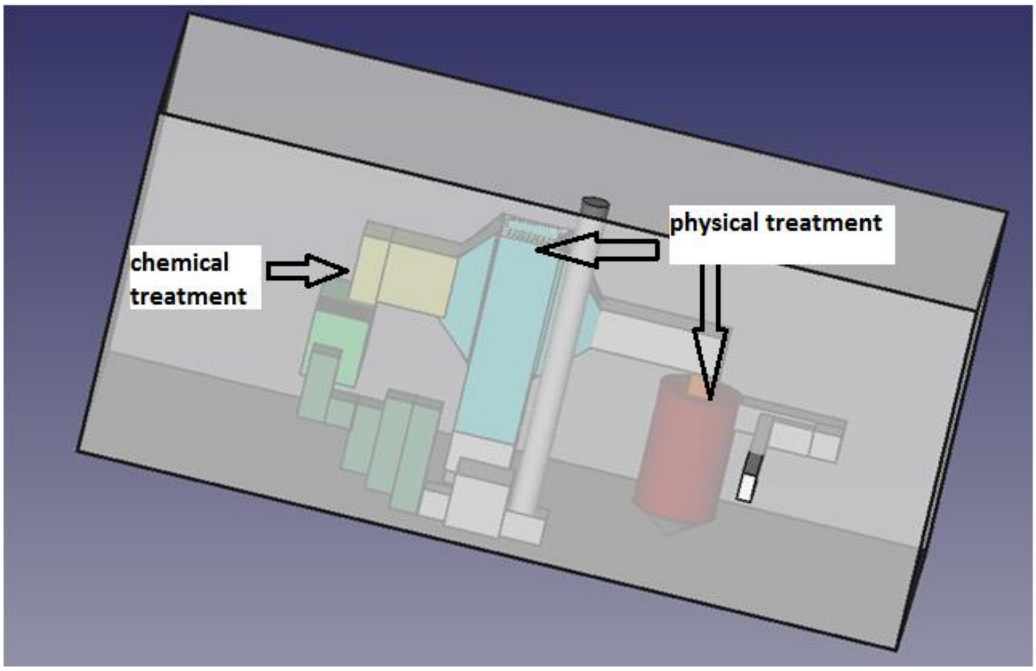
e) Inspection nozzles shall have an inside diameter of approximately 50 mm. They may be arranged in axial and/or radial direction as shown in Figure 4.6-1. Radial inspection nozzles may be omitted, if connecting tubes can be used in lieu of such nozzles.

33 تنقية الدخان









انظر "Master Thesis Maysaa Kamareddine, 2016"

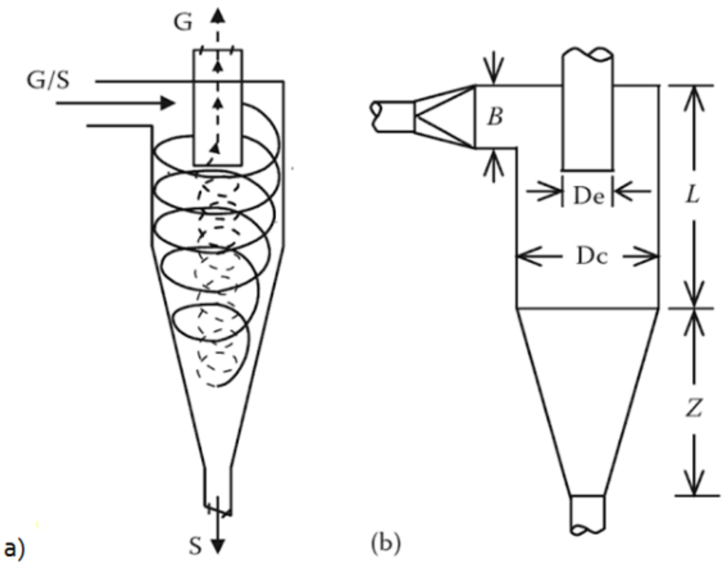
33.1 ESP[16]

Quality	عرض(متر) Width	طول (متر) Length	العدد Quantity	السماكة (مم) thickness
حديد مزيبق Iron quicksilver	**1**	**2**	**6**	**0.5**
فولاذ steel	**1**	**2**	**1**	**5**
قضيب نحاس Copper rod	**قطر 6 مم**	**0.8**	**43**	–

Inlet, outlet of ESP: 2 sheet (1:2m)

Chimney: 2 sheet (1:2m)

Cyclone: 2 sheet (1:2m) iron quicksilver



a) Flow pattern in cyclone separator. (b) Standard cyclone dimensions. S, solids; G, air; Dc, cyclone diameter; 2Dc; B = De = Dc/2.

33.2 Incineration Tests[17]

- Incineration without plastic

- [16] Electrostatic preceptor
- [17] Master Thesis Maysaa Kamareddine, 2016, see www.aecenar.com/publications

Figure 39: beginning of combustion

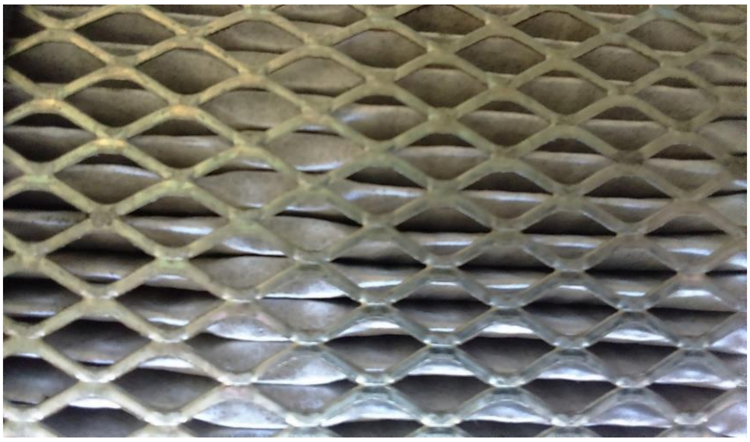


Figure 40: filter media after treatment

Figure 41: chimney during incineration

Calculation of emissions

V2 = V1 * (P1/P2) * (T2/T1) * (Z2/Z1)

Converting to uniform units

V1 = 314.000 Nm^3/h

P1 = 1.000 atm

T1 = 273.150 °K

T2 = 323.150 °K

P2=1.000 atm

P1, T1 normal conditions

P2, T2 specification for exhaust

Z1=1 (ideal), Z2=1.01(at 1 atm): Compressibility Factor

Calculation for V2

V2 = 314.000*(1.000/1.000) *(323.150/273.150)*(1.100/1.100)

V2 = 375 m^3/h

Or mass of filter before treatment =1300 g

Mass after treatment =1364

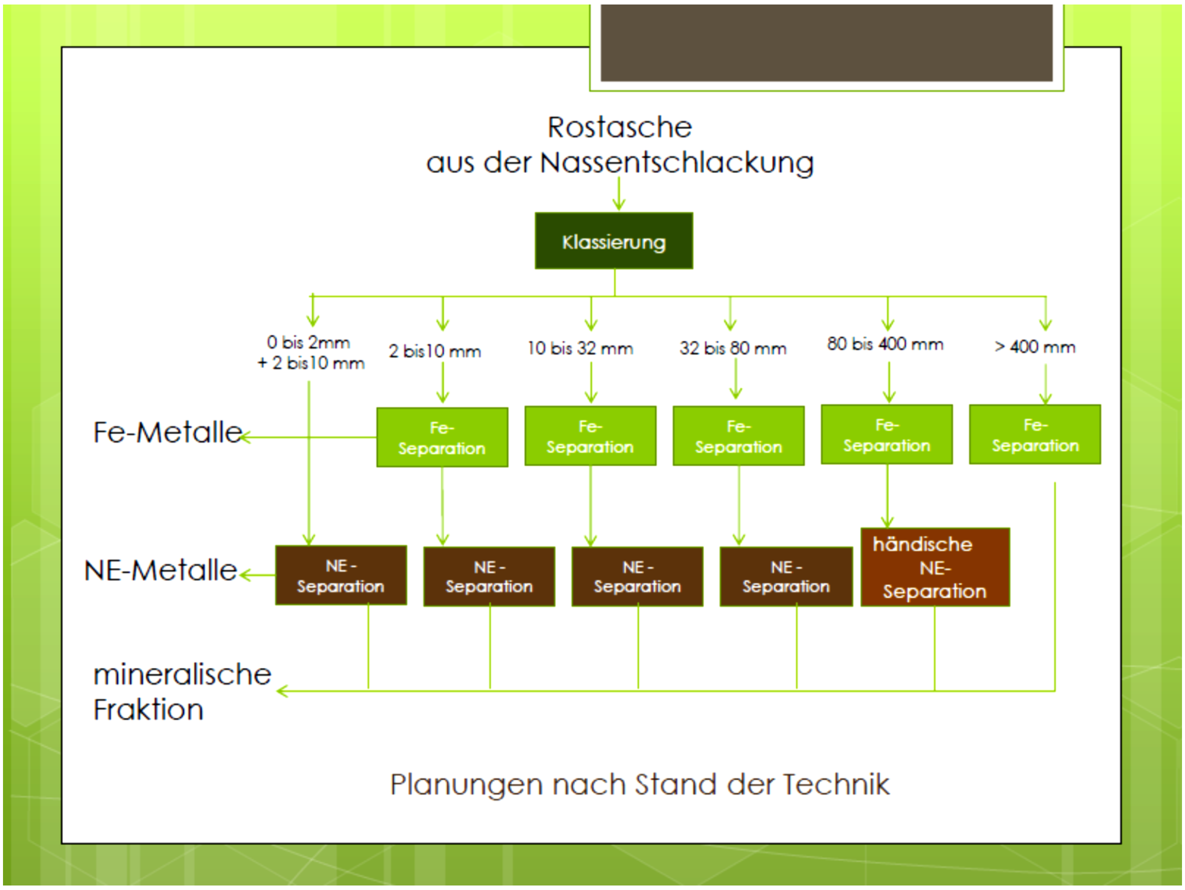
The total mass of particulate =1364-1300=64 g

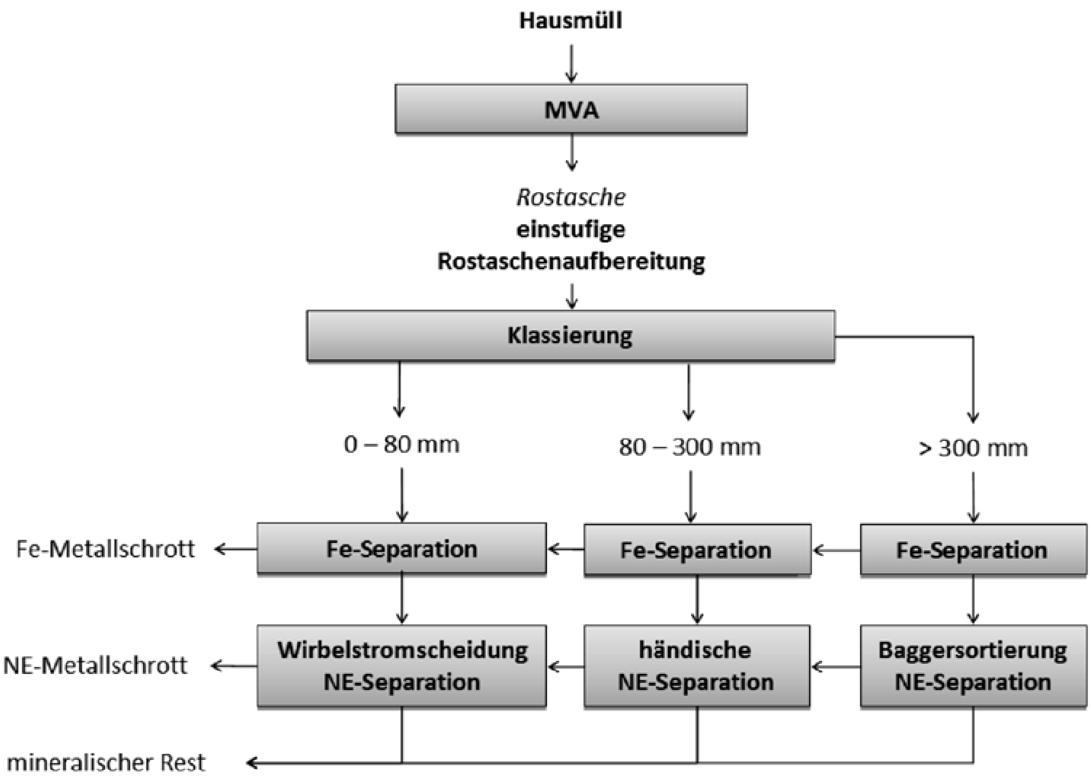
375 m^3/h correspond to 64 g

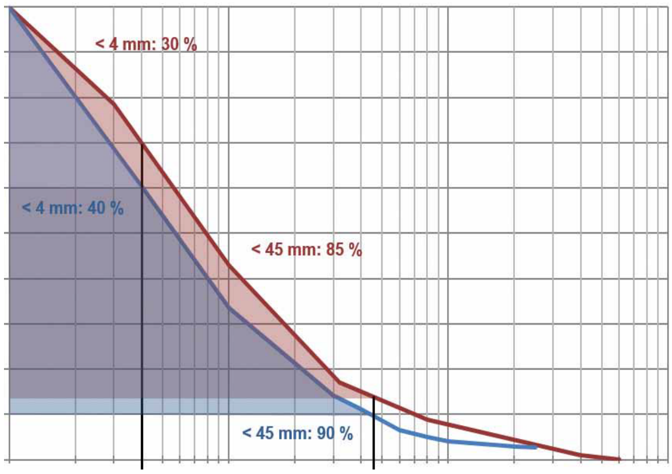
معالجة**Thus 170 mg / m^3 <200 mg/ m^3 confirm to Lebanese standard (annex D)** positive results

34 الرماد بعد حرق النفايات المنزلية والاستفادة منه (Preparation of rost ash)

34.1 نظرة عامة







Schadstoffe (Alwast)	
Parameter	**Wertebereich**
Arsen	3 bis 15 mg/kg
Blei	1.000 bis 3.500 mg/kg
Cadium	2 bis 20 mg/kg
Chrom ges.	200 bis 1.000 mg/kg
Kupfer	1.000 bis 10.000 mg/kg
Nickel	100 bis 500 mg/kg
Wertstoffe	
Parameter	**Verwertbare Anteile**
Fe-Metall	8 %
NE-Metall	2 %
VA-Metall	1 %

توزيع حجم الجسيمات من الرماد: ما بين 0 و 45 ملمتر تشكل 90% من الرماد

Die Metalle sind ferner in die Fraktionen Eisenmetalle (Fe) und Nichteisenmetalle (NE) zu unterteilen.

drei Hauptbestandteile der Rostasche

المكونات الرئيسية الثلاثة للرماد

84% معادن(minerals)

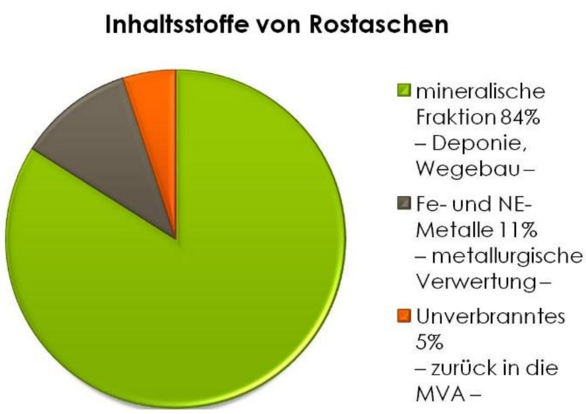
(وما لم تغيره عملية الحرق مثل بطون ، حجر، ارميد، ...)

10% حديد (و الومينيوم، نحاس)

(Unter den Metallen sind eisenhaltiger Schrott, Aluminium, Kupfer und Messing vorhanden)

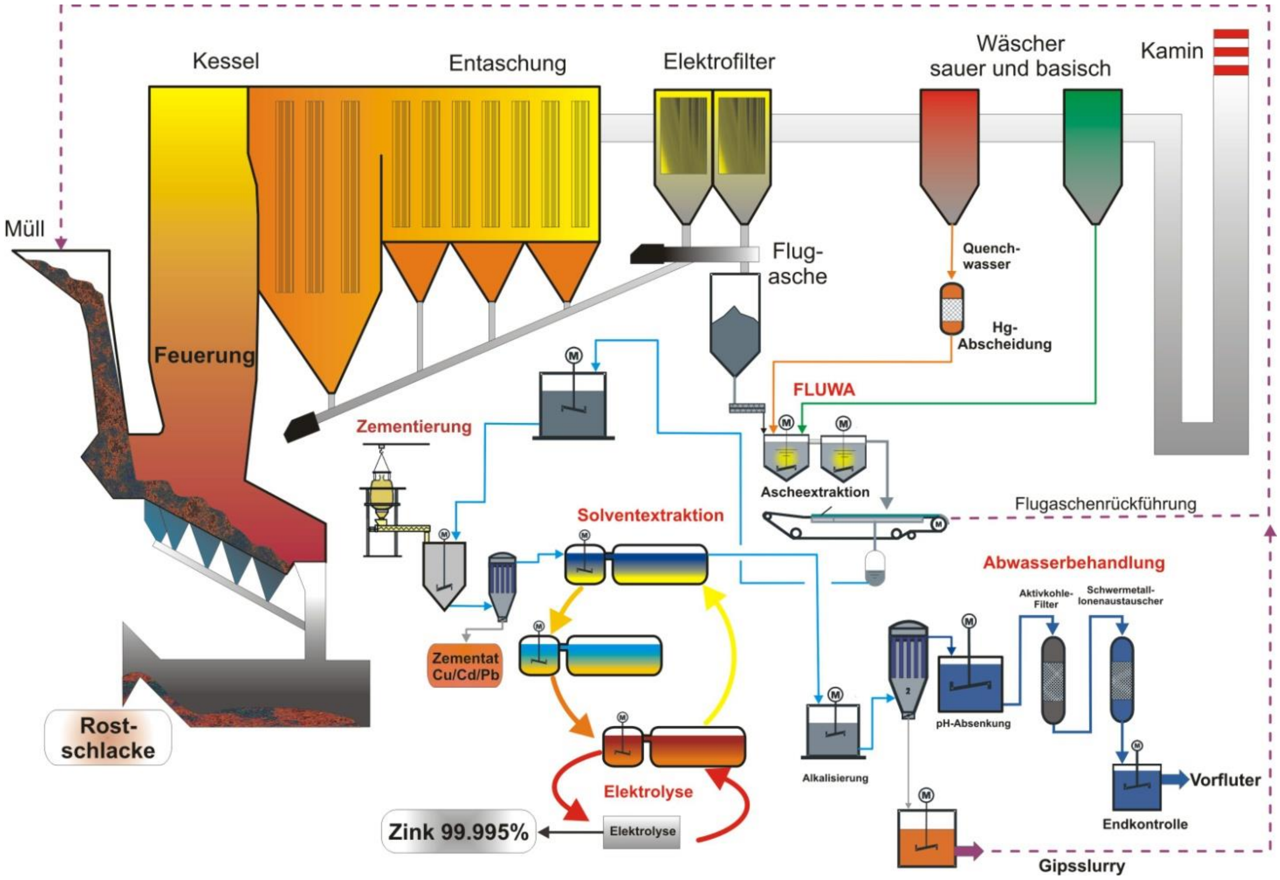
Im Hinblick auf eine spätere verfahrenstechnische Aufbereitung ist Rostasche in drei Hauptbestandteile aufzuteilen. Hierbei können aufgrund der Inhomogenität der Inputmaterialien nur Schwankungsbreiten angegeben werden. Das Bild 2 zeigt die beispielhafte Zusammensetzung aus uns vorliegenden Materialansprachen.

VA-Metall = Rostfreier Stahl (stainless steel)



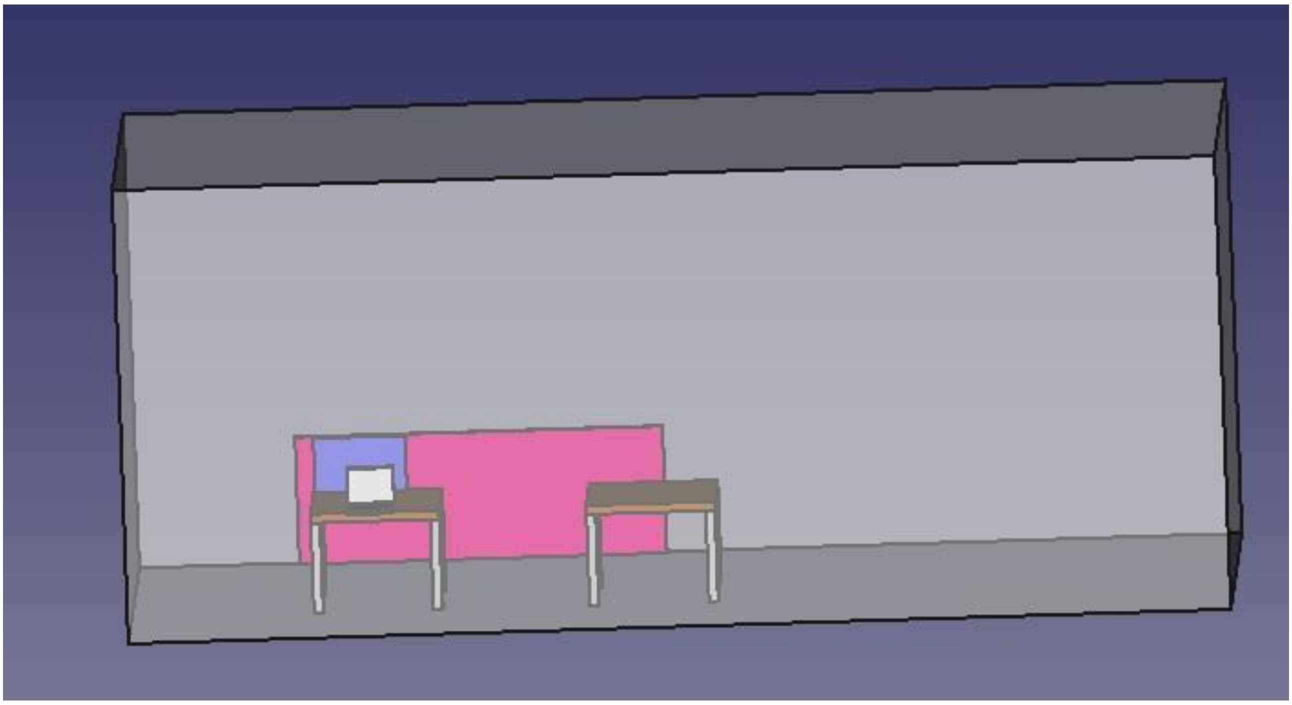
5%) لم يحرق ولكن قابل للحرق و يعاد الى المحرقة (مثل خشب، ورق، ثياب، ...)	

34.2 FLUREC/FLUWA

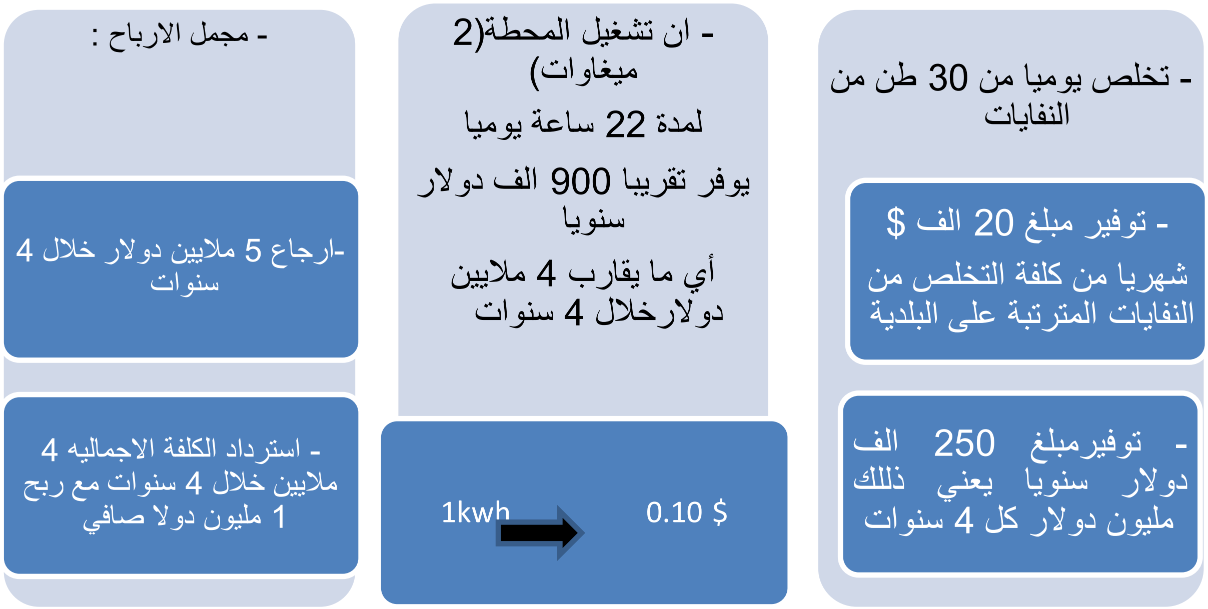


Chemical ash recycling

35 غرفة التحكم



36 ارقام مالية وايجابيات لمشروع بناء وتشغيل محطة طاقة 1.5MW عن طريق حرق النفايات



37 المواد الاولية التي نحتاجها لبناء محطة 1.5MW

incinerator	number	rad(inch)	length	prix($/6m) stainless 306	steel($/6m)	total ($)
vertical tubes	216	2	2.5		50	$4,500
horizontal tubes	216	2	1			
sheet for v.tubes	30	4 mm thic	(1:2 m)		70	$2,100
sheet for h.tubes	12	4 mm thic	(1:2m)		70	$840
sheet for inciner	12	6 mm thic	(1:2m)		70	$840
tube for vaporiser	1	4	12		100	$100
condenser						
tubes	530	1	6 m	120		$63,600
tube	1	12	6 m			
water tank						

37.1 Costs of Building the 1.5 MW plant

NLAP 1.5 MW Mobile Incineration Plant, total installation costs				
Material Costs (including workers for manufatoring)				
Part	Number of pieces		Total	Supplier
Steam filter	1		$ 1.000,00	
Condensor	1		$ 35.000,00	
condensor cooling	1		$ 1.500,00	
tubes (Stainless)	10m 1 inch		$ 45.000,00	
Generator	1		$ 32.500,00	Jamal&Chaban, Omar M. Mohamad
diesel burner including fuel feed	1		$ 2.000,00	
safety valve 15 bar	1		$ 1.000,00	
pressure sensors	5		$ 15.000,00	
fresh water tank (stainless)	1		$ 2.000,00	
incineration burning chamber (including transportation band)&vaporizer (climbing tubes...)	1		$ 200.000,00	
fume purification (incl. filter for CO, SO2, NH3)	1		$ 50.000,00	Costs All in all
Turbine 1.5 MW	1		$ 857.500,00	$1.555.500
Hardware Control System (Including Instrumentation)			$ 25.000,00	**x 1.3 (with overhead)**
Water antioxidant system			$ 3.000,00	**$2.022.150**
Sorting House			$ 15.000,00	
mobile platform			$ 30.000,00	
Total Material			**$1.315.500**	
Engineering Staff Costs				
Task	MM	Qualifikation	Salary/MM	Total Salary
Integration with Test Vaporizer				
Integration with Incineration V	30	Eng.	$3.000	$90.000
Integration Turbine Electrics	7	Eng.	$3.000	$21.000
Integration Process Control system	5	Eng.	$3.000	$15.000
Control System	18	Eng.	$3.000	$54.000
Project Management	20	Eng.	$3.000	$60.000
Total Man Power Costs	**80**			**$240.000**

37.1.1.1 Funding utilization and milestones

		Milestone		Funding need
2017	كانون الثاني	Steam Control Valve Testrig finished, Waste inlet control finished	Basic Development	20k$
	شباط	TEMO-IPP Demonstration plant at Qalamoun site in operation	Marketing	30k$

المواد الاولية التي نحتاجها لبناء محطة 1.5MW

	آدار	Ground for production facility ready	Infrastructure	50k$
	نيسان	NLAP production plant at Ras Nhache site installed (Hangar)	Infrastucture	20k$
	أيار	Ground for 1.5 MW is aquisited and prepared Detailed Specification&Design according to customers wish finished	1.5 MW plant project	280k$
	حزيران	Start of manufactoring &installation	1.5 MW plant project	0.5Mio$
	تموز	Manufactoring of Condensor finished	1.5 MW plant project	
	آب	Manufactoring of Incinerator & Vaporizer finished	1.5 MW plant project	0.5Mio$
	أيلول	Manufactoring of Turbine finished	1.5 MW plant project	
	تشرين الاول	all mechanical devices installed, piping finished	1.5 MW plant project	
	تشرين الثاني	Process control system installed and tested	1.5 MW plant project	0.5Mio$
	كانون الاول	wohle plant integration tested	1.5 MW plant project	
2018	كانون الثاني	Delivery of plant	1.5 MW plant project	0.5Mio$
2019		Operation of 1.5 MW plant		96k$
2020				96k$
2021				96k$
2022				96k$
2023				96k$

Suppliers 38

(…CNC and others instruments) تصنيع قطع

Company	Phone number	Description	Address	E-mail web site
CNC LAB	06 412 895 03 476 916	Manufacture 3D design in plastic & open source hardware	Tripoli,Lebanon Bahsas,Behind Haykalieh Hospital, Harba Bld.	www.cnclab.com info@cnclablb.com
Hasan Al Baba	03 828 256	Manufacture and casting	Tripoli, Lebanon Mina, Industry and Commerce street	
HI-Tech fabrication Fawaz Abdel Hadi	06 442 787 70 751 522	Precision mechanical parts manufacturing brass & steel marking heads maker	Tripoli, Lebanon Mahjar suhi P.O. Box 1274	www.hitechfabrication.com info@hitechfabrication.com sirfawaz@yahoo.com
Hannuf mechanical 'Corporation for casting and art construction	06 387 723 03 717 107	Manufacture and casting	Tripoli, Lebanon Al Badawi	
GPS Steel	03 196 225	Uses electric discharge machining process to shape any metal material rapidly by using desired modeled electrodes	Beirut, Lebanon Burj Hammoud	Gps.steel.co@gmail.com
Riyako factory	79 118 779 03 302 869	3D CNC machine, manufacture cupboard for cars	Tripoli, Lebanon Badawi, behind Al Ridani bakery	Zaher23357@gmail.com

Environment Impact Assessment of Waste to Incineration Power Plant NLAP-IPP in Srar (Akkar/North Lebanon)

Waste incinerator 450 ton/day, 25 MW electricity

تقييم الاثر البيئي لمحطة طاقة كهربائية تعمل على التفكك الحراري للنفايات

Authors:

Dr. Samir Mourad

Maysaa Kamaraeddine

Initial Document: 07.11.2018
Last update: 1.1.2019

Content

39 Introduction

This document is the first document concerning the process to get permission from Lebanese Government to operate NLAP-IPP.

الخطوات لإجراء المشروع:

1. طلب إذن من التنظيم المدني على اجراء المشروع في ارض معينة. سيعطي الإذن اذا كانت الارض مصنفة لهذا الغرض

2. لما يوجد الإذن من التنظيم المدني: طلب سماح تقديم تقييم أثر بيئي من وزارة البيئة.

3. كتابة تقييم الأثر البيئي (Environment Impact Assessment - EIA)

The EIA Report includes[18]:

- Description of the Project
- Baseline scenario
- Environmental factors affected
- Effects on the environment
- Assessment of Alternatives
- Mitigation or Compensation Measures
- Monitoring
- Non-Technical Summary
- Quality of the EIA Report

[18] ( ).

40 Laws

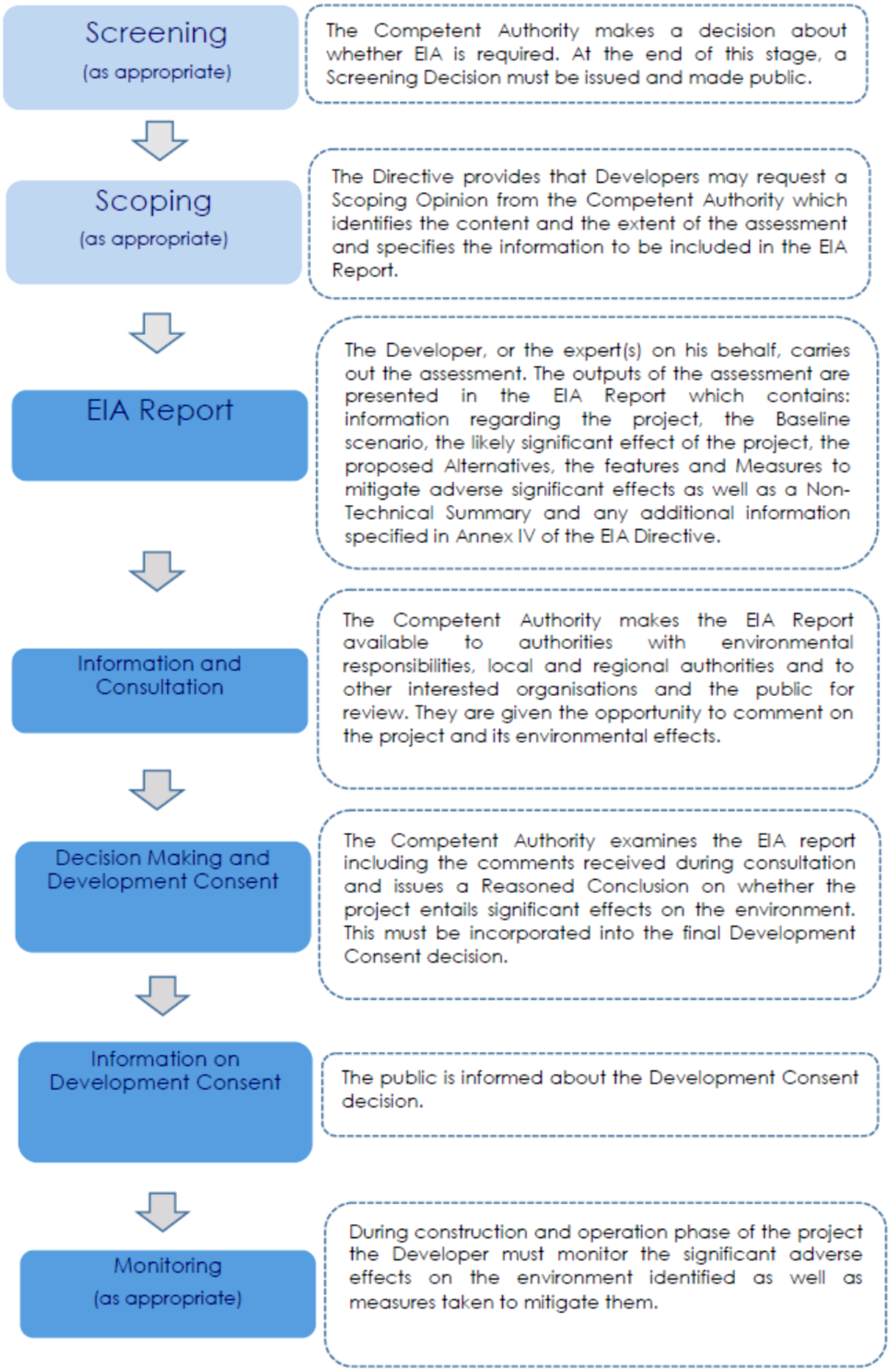
40.1 Description to write an Environment Impact Assessment

http://ec.europa.eu/environment/eia/eia-support.htm

EU Commission guidance documents:

- (2017)
- (2017)
- (2017)

40.1.1 Steps of EIA



40.1.2 The review checklist

SECTION 1 DESCRIPTION OF THE PROJECT				
No.	Review Question	Relevant?	Adequately Addressed?	What further information is needed?
The Objectives and Physical Characteristics of the Project				
1.1	Are the Project's objectives and the need for the Project explained?			
1.2	Is the programme for the Project's implementation described, detailing the estimated length of time (e.g. expected start and finish dates) for construction, operation, and decommissioning? (this should include any phases of different activity within the main phases of the Project, extraction phases for mining operations for example)			
1.3	Have all of the Project's main characteristics been described? (for assistance, see the Checklist in Part C of the Scoping Guidance Document in this series)			
1.4	Has the location of each Project component been identified, using maps, plans, and diagrams as necessary?			
1.5	Is the layout of the site (or sites) occupied by the Project described? (including ground levels, buildings, other physical structures, underground works, coastal works, storage facilities, water features, planting, access corridors, boundaries)			
1.6	For linear Projects, have the route corridor, the vertical, and horizontal alignment and any tunnelling and earthworks been described?			
1.7	Have the activities involved in the construction of the Project (including land-use requirements) all been described?			
1.8	Have the activities involved in the Project's operation (including land-use requirements and demolition works) all been described?			
1.9	Have the activities involved in decommissioning the Project all been described? (e.g. closure, dismantling, demolition, clearance, site restoration, site re-use, etc.)			
1.10	Have any additional services, required for the Project, been described? (e.g. transport access, water, sewerage, waste disposal, electricity, telecoms)			
1.11	Are any developments likely to occur as a consequence of the Project identified? (e.g. new housing, roads, water or sewerage infrastructure, aggregate extraction)			
1.12	Have any existing activities that will alter or cease as a consequence of the Project been identified?			

SECTION 2 DESCRIPTION OF ENVIRONMENTAL FACTORS LIKELY TO BE AFFECTED BY THE PROJECT				
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
Baseline: Aspects of the Environment				
2.1	Have the existing land uses on the land to be occupied by the Project and the surrounding area described and are any people living on or using the land been identified? (including residential, commercial, industrial, agricultural, recreational, and amenity land uses and any buildings, structures or other property)			
2.2	Have the topography, geology and soils of the land to be occupied by the Project and the surrounding area been described?			
2.3	Have any significant features of the topography or geology of the area described and are the conditions and use of soils been described? (including soil quality stability and erosion, agricultural use and agricultural land quality)			
2.4	Has the biodiversity of the land/sea to be affected by the Project and the surrounding area been described and illustrated on appropriate maps?			
2.5	Have the species (including their populations and habitats), and the habitat types that may be affected by the Project been described? (Particular attention should be paid to any species and habitats protected under the Habitats and Birds Directives (Directives 92/43/EEC and 2009/147/EC).			
2.6	Have the Natura 2000 sites that may be affected by the Project been described?			
2.7	Has the water environment of the area been described? (including reference to any River Basin Management Plans/Programme of Measures under the WFD, running and static surface waters, groundwaters, estuaries, coastal waters and the sea and including run off and drainage. N.B. not relevant if water environment will not be affected by the Project)			
2.8	Have the hydrology, water quality, and use of any water resources that may be affected by the Project been described? (including any River Basin Management Plans/Programme of Measures under the WFD, use for water supply, fisheries, angling, bathing, amenity, navigation, effluent disposal)			
2.9	Have local climatic and meteorological conditions in the area been described? (N.B. not relevant if the atmospheric environment will not be affected by the Project)			
2.10	Has existing air quality in the area been described, including, where relevant, limit values set out by Directives 2008/50/EC and 2004/107/EC as well as relevant Programmes adopted under this legislation? (N.B. not relevant if the ambient air will not be affected by the Project)			

…

SECTION 3 DESCRIPTION OF THE LIKELY SIGNFICANT EFFECTS OF THE PROJECT				
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
Scoping of Effects				
3.1	Has the process by which the scope of the information for the EIA Report defined been described? (for assistance, see the Scoping Guidance Document in this series)			
3.2	Is it evident that a systematic approach to Scoping has been adopted?			
3.3	Was consultation carried out during Scoping?			
3.4	Have the comments and views of consultees been presented?			
Prediction of Direct Effects				
3.5	Have the direct, primary effects on land uses, people, and property been described and, where appropriate, quantified?			
3.6	Have the direct, primary effects on geological features and characteristics of soils been described and, where appropriate, quantified?			
3.7	Have the direct, primary effects on biodiversity been described and, where appropriate, quantified? (if relevant, are references made to Natura 2000 sites? (Directive 2009/147/EC and Directive 92/43/EEC))			
3.8	Have the direct, primary effects on the hydrology and water quality of water features been described and, where appropriate, quantified?			
3.9	Have the direct, primary effects on uses of the water environment been described and, where appropriate, quantified? (if relevant, are references made for River Basin Management Plans/Programmes of Measures under the WFD (2000/60/EC))			
3.10	Have the direct, primary effects on air quality been described and, where appropriate, quantified? (if relevant, are references made to Air Quality Plans under Directives 2008/50/EC and 2004/107/EC))			
3.11	Have the direct, primary effects on climate change been described and, where appropriate, quantified?			
3.12	Have the direct, primary effects on the acoustic environment (noise or vibration) been described and, where appropriate, quantified? (if relevant, are references made to Action Plans/Programme under the Environmental Noise Directive (2002/49/EU))			
3.13	Have the direct, primary effects on heat, light or electromagnetic radiation been described and, where appropriate, quantified?			

…

SECTION 4	CONSIDERATION OF ALTERNATIVES			
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
4.1	Have the different Alternatives suggested during Scoping been considered and assessed, and if not has justification been provided?			
4.2	Have the Developer and practitioners, who are preparing the EIA Report, identified and assessed additional Alternatives (to the ones suggested during Scoping)?			
4.3	Have the process by which the Project was developed been described and are the Alternatives to the design of the Project considered during this process been described? (for assistance, see also the guidance on types of Alternatives which may be relevant in the Scoping Guidance Document in this series)			
4.4	Have the Alternatives to the design considered during this process been described? (for assistance, see also the guidance on types of alternatives which may be relevant in the Scoping Guidance Document in this series)			
4.5	Have the Alternatives to technology been considered during this process? (for assistance, see also the guidance on types of Alternatives which may be relevant in the Scoping Guidance Document in this series)			
4.6	Have the Alternatives to the location considered during this process been described? (for assistance, see also the guidance on types of alternatives which may be relevant in the Scoping Guidance Document in this series)			
4.7	Have the Alternatives to the size considered during this process been described (for assistance, see also the guidance on types of alternatives which may be relevant in the Scoping Guidance Document in this series)			
4.8	Have the Alternatives to the scale considered during this process been described? (for assistance, see also the guidance on types of alternatives which may be relevant in the Scoping Guidance Document in this series)			
4.9	Has the Baseline situation in the 'do-nothing' scenario been described?			
4.10	Are the Alternatives realistic and genuine Alternatives to the Project? (i.e. feasible Project options that meet the objectives)			

...

SECTION 5 DESCRIPTION OF MITIGATION				
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
5.1	Where there are significant adverse effects on any aspect of the environment, has the potential for the mitigation of these effects been discussed?			
5.2	Have the measures that the Developer has proposed to implement, in order to mitigate effects, been clearly described and is their effect on the magnitude and significance of impacts clearly explained?			
5.3	Have any proposed mitigation strategy's negative effects been described?			
5.4	If the effect of Mitigation Measures on the magnitude and significance of impacts is uncertain, has this been explained?			
5.5	Is it clear if the Developer has made a binding commitment to implement the mitigation proposed or acknowledged that the Mitigation Measures are just suggestions or recommendations?			
5.6	Do the Mitigation Measures cover both the construction and operational phases of the Project?			
5.7	Have the Developer's reasons for choosing the proposed mitigation been explained?			
5.8	Have the responsibilities for the implementation of mitigation including roles, responsibilities, and resources been clearly defined?			
5.9	Where the mitigation of significant adverse effects is not practicable, or where the Developer has chosen not to propose any mitigation, have the reasons for this been clearly explained?			
5.10	Is it evident that the practitioners developing the EIA Report and the Developer have considered the full range of possible approaches to mitigation, including measures to avoid, prevent or reduce and, where possible, offset impacts by alternative strategies or locations, changes to the Project design and layout, changes to methods and processes, 'end of pipe' treatment, changes to implementation plans and management practices, measures to repair or remedy impacts and measures to compensate impacts?			
Other Questions on Mitigation				

SECTION 6 DESCRIPTION OF MONITORING MEASURES				
No.	Review Question	Relevant?	Adequately Addressed?	What further information is needed?
6.1	Where adverse effects on any aspect of the environment are expected, has the potential for the monitoring of these effects been discussed?			
6.2	Are the measures, which the Developer proposes implementing to monitor effects, clearly described and has their objective been clearly explained?			
6.3	Is it clear whether the Developer has made a binding commitment to implement the proposed monitoring programme or that the Monitoring Measures are just suggestions or recommendations?			
6.4	Have the Developer's reasons for choosing the monitoring programme proposed been explained?			
6.5	Have the responsibilities for the implementation of monitoring, including roles, responsibilities, and resources been clearly defined?			
6.6	Where monitoring of adverse effects is not practicable, or the Developer has chosen not to propose any Monitoring Measures, have the reasons for this been clearly explained?			
6.7	Is it evident that the practitioners developing the EIA Report and the Developer have considered the full range of possible approaches to monitoring, including Monitoring Measures covering all existing environmental legal requirements, Monitoring Measures stemming from other legislation to avoid duplication, monitoring of Mitigation Measures (ensuring expected significant effects are mitigated as planned), Monitoring Measures capable of identifying important unforeseen effects?			
6.8	Have arrangements been proposed to monitor and manage residual impacts?			
Other Questions on Monitoring Measures				

SECTION 7 QUALITY				
No.	**Review Question**	**Relevant?**	**Adequately Addressed?**	**What further information is needed?**
Quality of presentation				
7.1	Is the EIA Report available in one or more clearly defined documents?			
7.2	Is the document(s) logically organised and clearly structured, so that the reader can locate information easily?			
7.3	Is there a table of contents at the beginning of the document(s)?			
7.4	Is there a clear description of the process that has been followed?			
7.5	Is the presentation comprehensive but concise, avoiding irrelevant data and information?			
7.6	Does the presentation make effective use of tables, figures, maps, photographs, and other graphics?			
7.7	Does the presentation make effective use of annexes or appendices to present detailed data that is not essential to understanding the main text?			
7.8	Are all analyses and conclusions adequately supported with data and evidence?			
7.9	Have all sources of data been properly referenced?			
7.10	Has terminology been used consistently throughout the document(s)?			
7.11	Does it read as a single document, with cross referencing between sections used to help the reader navigate through the document(s)?			
7.12	Is the presentation demonstrably fair and, as far as possible, impartial and objective?			
Non-Technical Summary				
7.13	Does the EIA Report include a Non-Technical Summary?			
7.14	Does the Summary provide a concise but comprehensive description of the Project, its environment, the effects of the Project on the environment, the proposed Mitigation Measures, and proposed monitoring arrangements?			
7.15	Does the Summary highlight any significant uncertainties about the Project and its environmental effects?			
7.16	Does the Summary explain the Development Consent process for the Project and the EIA's role in this process?			
7.17	Does the Summary provide an overview of the approach to the assessment?			

...

40.1.3 Example section: Waste Framework Directive

Name used	Formal name
WasteFD	■ Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain directives
Relevant EU guidance:	■ Application of EIA Directive to the rehabilitation of landfills.

The WasteFD establishes a legal framework for the management and treatment of most waste types. The Directive sets out a waste hierarchy that ranges from prevention to disposal. Waste management under the Directive must be implemented without endangering human health and without harming the environment (e.g. without risk to water, air, biodiversity, and without causing nuisance). It also sets out rules for extended producer responsibility, effectively adding to the burdens of manufacturers to manage products returned after use.

Opportunities for synergy
The WasteFD requires the adoption and implementation of Waste Management Plans and Waste Prevention Programmes at the national and local levels. These plans and programmes should analyse the current situation with regards to waste treatment, as well as identify the measures needed to carry out waste management in the context of the WasteFD's objectives. This includes existing and planned waste management installations, which are likely to constitute Projects subject to the EIA Directive. As waste installations should be provided for under Waste Management Plans, they are also subject to the requirements of the SEA Directive (see above).

The EIA Directive may also bear relevance for any Project with regard to the waste produced not only during the construction and operation of the Project, but also, in particular, with regard to the decommissioning and/or rehabilitation of the site.

During the preparation of the EIA Report, the waste produced and returned to the Project location must be taken into consideration in assessing the Project's significant effects on the environment, and would be relevant for the establishment of Alternatives and Mitigation as well as Compensation Measures.

40.2 Incineration of Waste Directive 2000/76/EC[19]

40.2.1 Summary of Directive 2000/76/EC on the incineration of waste (the WI Directive)

entered into force on 28 December 2000. It repealed former directives on the incineration of hazardous waste (Directive 94/67/EC) and household waste (Directives 89/369/EEC and 89/429/EEC) and replaced them with a single text. The aim of the WI Directive is to prevent or to reduce as far as possible negative effects on the environment caused by the incineration and co-incineration of waste. In particular, it should reduce pollution caused by emissions into the air, soil, surface water and groundwater, and thus lessen the risks which these pose to human health.

This is to be achieved through the application of operational conditions, technical requirements, and emission limit values for incineration and co-incineration plants within the EU.

The WI Directive sets emission limit values and monitoring requirements for pollutants to air such as dust, nitrogen oxides (NOx), Sulphur dioxide (SO_2), hydrogen chloride (HCl), hydrogen

[19] http://ec.europa.eu/environment/archives/air/stationary/wid/legislation.htm

fluoride (HF), heavy metals and dioxins and furans. The Directive also sets controls on releases to water resulting from the treatment of the waste gases. Most types of waste incineration plants fall within the scope of the WI Directive, with some exceptions, such as those treating only biomass (e.g. vegetable waste from agriculture and forestry). Experimental plants with a limited capacity used for research and development of improved incineration processes are also excluded.

The WI Directive makes a distinction between:

a) incineration plants (which are dedicated to the thermal treatment of waste and may or may not recover heat generated by combustion) and

b) co-incineration plants (such as cement or lime kilns, steel plants or power plants whose main purpose is energy generation or the production of material products and in which waste is used as a fuel or is thermally treated for the purpose of disposal).

The WI Directive provides for public consultation, access to information and participation in the permitting procedure.

Transposition into national legislation was necessary by 28 December 2002. From this date on new incinerators have had to comply with the provisions of the WI Directive. The deadline to bring existing plants into compliance was 28 December 2005.

40.2.2 Legislation Summary - Waste incineration [20]

The European Union (EU) has introduced measures to prevent or reduce air, water and soil pollution caused by the incineration or co-incineration of waste, as well as the resulting risk to human health. These measures specifically require a permit be obtained for incineration and co-incineration plants, and emission limits for certain pollutants released to air or to water.

40.2.2.1 ACT

Directive of the European Parliament and of the Council of 4 December 2000 on the incineration of waste [**See amending act(s)**].

40.2.2.2 SUMMARY

Incineration of both hazardous and harmless wastes may cause emissions of substances which pollute the air, water and soil and have harmful effects on human health. In order to limit these risks, the European Union (EU) shall impose strict operating conditions and technical requirements on waste incineration plants * and waste co-incineration plants *.

40.2.2.3 Plants

This Directive not only applies to solid or liquid waste incineration plants, but also to co-incineration plants.

[20] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM:l28072

Experimental plants which aim to improve the incineration process and which treat less than 50 tons of waste are excluded from the scope of the Directive, as are plants which only treat:

- vegetable waste from agriculture and forestry;
- vegetable waste from food processing, if the heat generated is recovered;
- certain fibrous vegetable waste from pulp paper or paper production if it is co-incinerated at the place of production and the heat generated is recovered;
- certain wood waste;
- cork waste;
- radioactive waste;
- animal carcasses;
- waste resulting from the exploration of oil and gas and incinerated on board off-shore installations.

40.2.2.4 Permits

All incineration or co-incineration plants must have a permit to carry out their activities. The permit will be issued by the competent authority on the condition that the requirements defined in this Directive are complied with. The permit specifies the categories and quantities of waste which may be treated, the plant's incineration or co-incineration capacity and the procedures for sampling and measuring air and water pollutants to be used.

40.2.2.5 Delivery and reception of waste

During delivery and reception of waste, the operator of the incineration plant or co-incineration plant shall take all necessary precautions to prevent or limit negative effects on the environment and risks to people.

Furthermore, prior to accepting hazardous waste at the incineration plant or co-incineration plant, the operator of the plant must have at their disposal the administrative information on the generating process, the physical and chemical composition of the waste, as well as on the hazardous characteristics of the waste.

40.2.2.6 The operating conditions

In order to guarantee complete waste combustion, the Directive requires all plants to keep the incineration or co-incineration gases at a temperature of at least 850°C for at least two seconds. If hazardous waste with a content of more than 1 % of halogenated organic substances, expressed as chlorine, is incinerated, the temperature has to be raised to 1 100 °C for at least two seconds.

The heat generated by the incineration process has to be put to good use as far as possible.

40.2.2.7 Air emissions limit values

The limit values for **incineration plant** emissions to air are set out in Annex V to the Directive. They concern heavy metals, dioxins and furans, carbon monoxide (CO), dust, total organic carbon (TOC), hydrogen chloride (HCl), hydrogen fluoride (HF), Sulfur dioxide (SO_2) and the nitrogen oxides (NO and NO_2).

The determining of limit values for **co-incineration plant** emissions to air is set out in Annex II. In addition, special provisions are laid down relating to cement kilns and combustion plants which co-incinerate waste.

40.2.2.8 Water discharges from the cleaning of exhaust gases

Incineration and co-incineration plants must have a permit which authorizes them to discharge used water caused by exhaust-gas clean-up. This permit will ensure that the emission limit values set out in Annex IV to the Directive are complied with.

40.2.2.9 Residues

Incineration or co-incineration residues must be reduced to a minimum and, as far as possible, recycled. When dry residues are transported, precautions must be taken to prevent their dispersal in the environment. Tests must be carried out to establish the physical and chemical characteristics, and polluting potential, of residues.

40.2.2.10 Monitoring and surveillance

The Directive requires the installation of measurement systems to monitor the parameters of an installation and relevant emissions. Emissions to air and to water must be measured continuously or periodically in accordance with Article 11 and Annex III of the Directive.

40.2.2.11 Access to information and public participation

Applications for new permits must be made accessible to the public so that the latter may comment before the competent authority reaches a decision.

For plants with a nominal capacity of two tonnes or more per hour, the operator must provide the competent authority with an annual report on the functioning and monitoring of the plant, to be made available to the public. A list of plants with a nominal capacity of less than two tonnes per hour must be drawn up by the competent authority and made available to the public.

40.2.2.12 Implementation reports

By 31 December 2008, the Commission must report to Parliament and the Council on the application of the Directive, progress achieved in emission control techniques and experience with waste management. This report has been included in the Communication .

Other reports on the implementation of the Directive will also be produced.

40.2.2.13 Penalties

The Member States must determine the penalties applicable to breaches of the Directive.

40.2.2.14 Content

This Directive aims to integrate into existing legislation technical progress in terms of monitoring emissions from incineration processes and to ensure compliance with the international commitments made by the Community with regard to reducing pollution, specifically concerning the setting of emissions limit values for dioxides, mercury and dust produced by waste incineration. The Directive is based on an integrated approach: limits relating to water discharges have been introduced alongside value limits set for emissions into air.

40.2.2.15 Key Terms of the Act

- Incineration plant: any stationary or mobile technical unit and equipment dedicated to the thermal treatment of wastes with or without recovery of the combustion heat generated. This includes the incineration by oxidation of waste as well as other thermal treatment processes such as pyrolysis, gasification or plasma processes in so far as the substances resulting from the treatment are subsequently incinerated.
- Co-incineration plant: any stationary or mobile plant whose main purpose is the generation of energy or production of material products and:

References

Act	Entry into force	Deadline for transposition in the Member States	Official Journal
Directive	28.12.2000	28.12.2002	OJ L 332 of 28.12.2000

Amending act	Entry into force	Deadline for transposition in the Member States	Official Journal
Regulation (EC) No	11.12.2008	-	OJ L 311 of 21.11.2008

The successive amendments and corrections to Directive have been incorporated in the original text. This is of documentary value only.

40.2.2.16 RELATED ACTS

of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) [Official Journal L 334 of 17.12.2010].Commission Decision of 20 February 2006 laying down a questionnaire to be used for reporting on the implementation of Directive on the incineration of waste [Official Journal L 121 of 06.05.2006].See also

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40.3 Laws and Guidance Issues Implemented in Srar EIA

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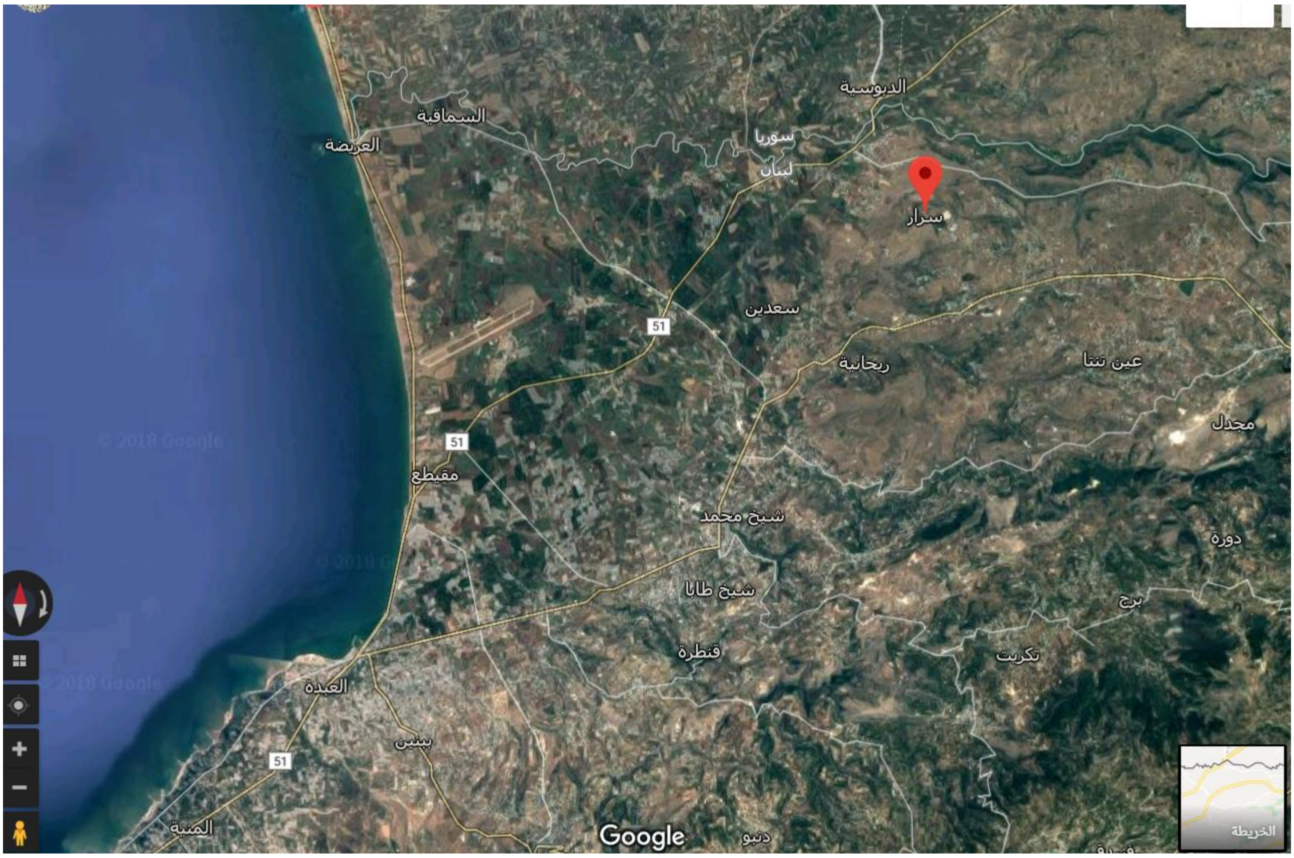
41 Description of the Environment

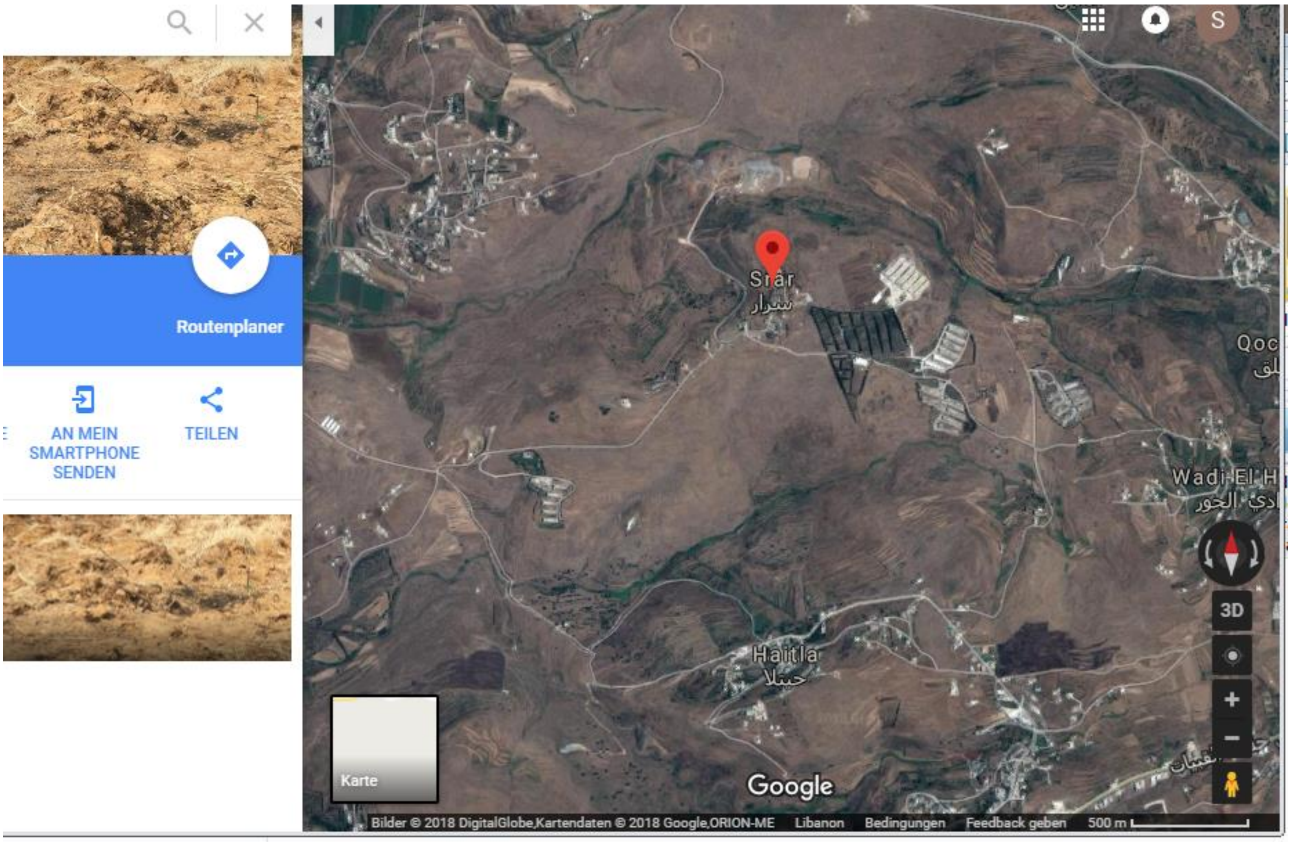
41.1 Introduction

tbd

41.2 Description of the Area



Coordinates: 34.6166278,36.124453,15



41.3 Environmental Components in Srar

41.3.1 Physical Resources

Description of Existing Environment

A. Physical Environment

<table>
<tr><td>Components/ Parameters</td><td>☐ Yes</td><td>☐ No</td><td>Remarks</td></tr>
<tr><td>1. What is the general elevation of the proposed gasoline station project site?
<100 m
100-300
301-500
501-1,000
1,000-1,500
>1,500
(To determine elevation, refer to the topographic map where the elevation per contour line is indicated)</td><td>200m</td><td></td><td></td></tr>
<tr><td>2. Slope and Topography of the area (within 50-meter radius from center of site)
☐ Terrain is flat or level (0-3% slope)
☐ Gently sloping to undulating (3-8% slope)
☐ Undulating to rolling (8-18% slope)
☐ Rolling to moderately steep (18-30% slope)
☐ Steeply rolling (30-50% slope)
☐ Very steep to mountainous (>50% slope)</td><td>☐ Terrain is flat or level (0-3% slope)</td><td></td><td></td></tr>
<tr><td colspan="4">Do you know of any land sliding occurring or that has occurred in the site? NO
Cause of Landslide:</td></tr>
</table>

<table>
<tr><td>Has the area experienced any flooding during the wet season?</td><td></td></tr>
</table>

<table>
<tr><td>Soil type of the area</td><td>☐ Clayey soil</td><td>☐ Sandy loam soil</td><td>☐ Sandy soil</td><td>☐ Other soil types:</td></tr>
</table>

<table>
<tr><td>Is there an access road going to the project site?
If yes, what is its distance to the site _______km.</td><td>Type of access road:
public road</td></tr>
<tr><td>Does the site conform to the approved land use of the municipality? Yes</td><td></td></tr>
<tr><td>Are there existing structures or developments around the project site? If yes, please list them</td><td>Electricity
Water</td></tr>
</table>

Project Activities Affecting the Physical Environment	☐ **Yes**	☐ **No**
Cooling water cycle Waste input management Aches management Waste water management Are there any structures on the proposed site? Will there be demolition of existing structures? If yes, what types of structures will be demolished? Types of Structures:		
11. Is there a need to construct an access road going to the site? NO If Yes, what type of access road: [ ] all weathered road, length _____(m) width ____, [ ] concrete, [ ] asphalt		

B. Biological Environment	☐ **Yes**	☐ **No**
Are there any trees and other types of vegetation in the *project site*? If yes, please *identify*.		NO
Are there birds and other forms of wildlife found in the area? Please *identify*.		NO
Is the site near or within a watershed or forest reservation area? If near, only, how near? ______1km_____ If within, indicate name of the watershed or forest reservation area		
Are there any reserved forests or protected area within 1,000 m of the proposed site?		NO

What is the present land use in the vicinity (roughly a radius of 500m) of the proposed site?

Coastal/ Marine	Residential	Forest	Mangrove	Grassland	Agriculture

Project Activities Affecting the Biological Environment	**Yes**	**No**
Type of vegetation on site		
1. Will there be vegetation clearing?		NO
2. Will clearing activities affect any critical wildlife habitats?		NO
3. Will clearing activities affect any rare, threatened or endangered plant and animal species?		NO
4. Will there be trees to be affected (e.g. cut down; remove) during clearing? If yes, how many and what are these species of trees?		NO

Will the project cause an increase in traffic or disrupt traffic in major routes due to the entry and exit of construction equipment?	YES	
Is the available domestic water supply enough to meet the maximum projected water consumption of the petrol station?		NO
C. Socio-Economic Environment		
1. Are there existing settlements in the proposed station? If yes, indicate the number of: (within 50m radius) Yes Households/Families:3 families ___		

Project Activities Affecting the Socio-Cultural and Economic Environment	**Yes**	**No**
Will the project cause or increase traffic in the areas?	Yes	
Are there existing transport services/facilities routing the areas?	yes	
Will the project cause an increase in traffic or disrupt traffic in major routes due to the entry and exit of construction equipment?	yes	
Is there a prevailing water shortage or water supply problem in the area?		No
Are there already existing commercial establishments within the vicinity of the project area?	yes	

41.3.2

41.3.3 Socio-Cultural and Economic Activities

In Srar, that is a sanitary landfill, does not exist a social and cultural activities.

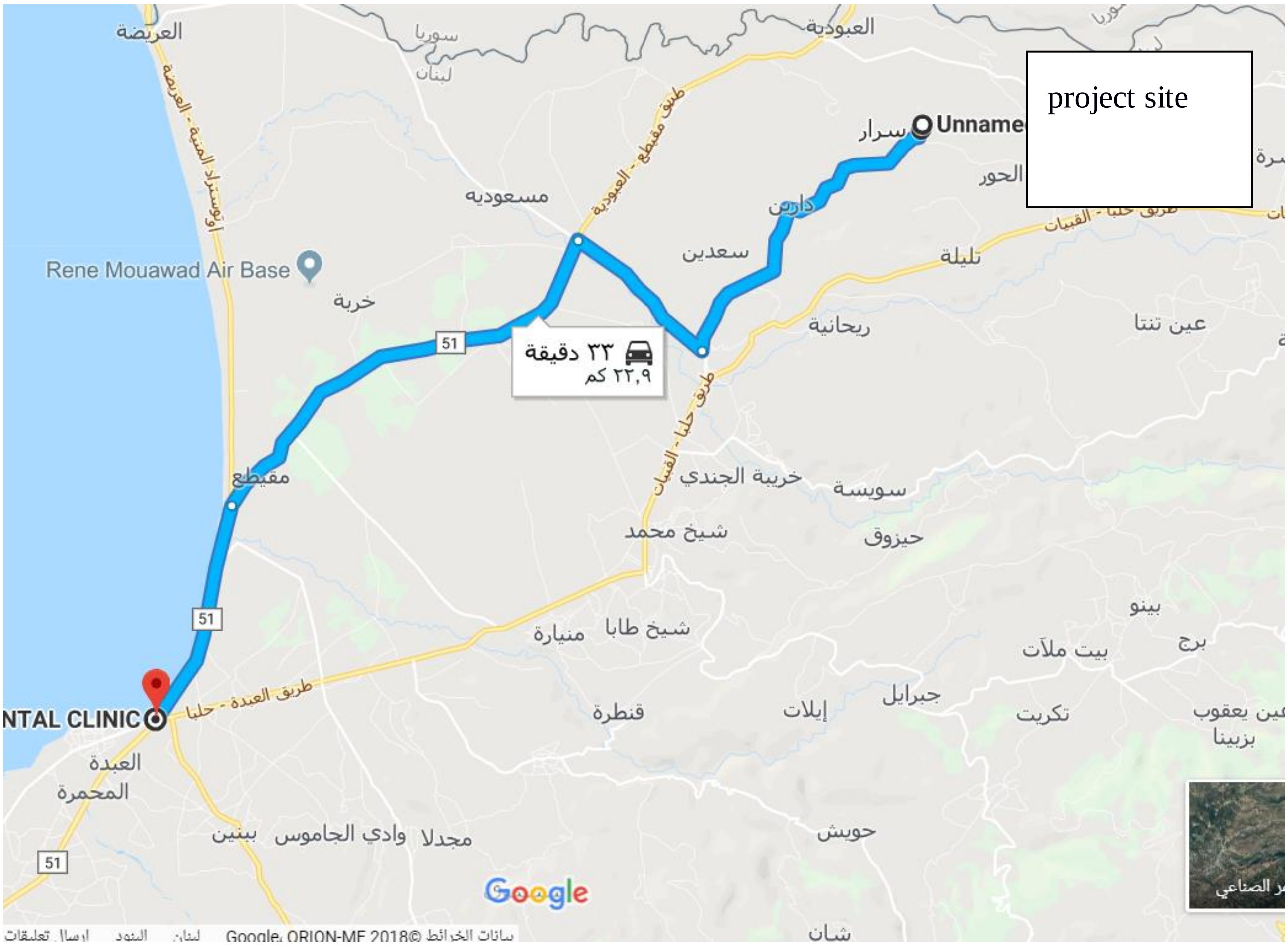
41.3.4 Education and Literacy

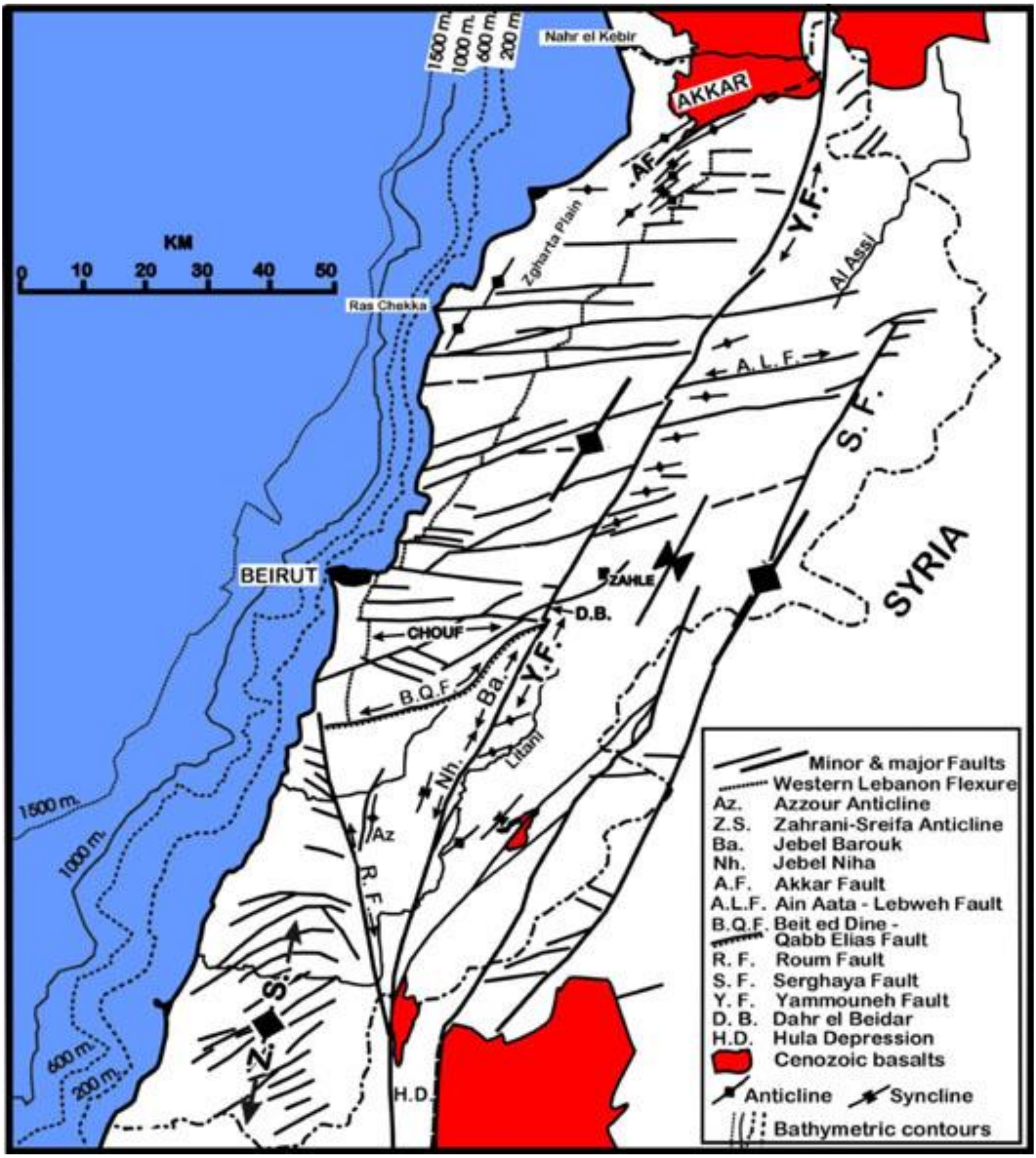
41.3.5 Environment, Archaeological Sites and Cultural Heritage

41.3.6 Cultural Facilities

42 Description of the Project

42.1 Location of the Project





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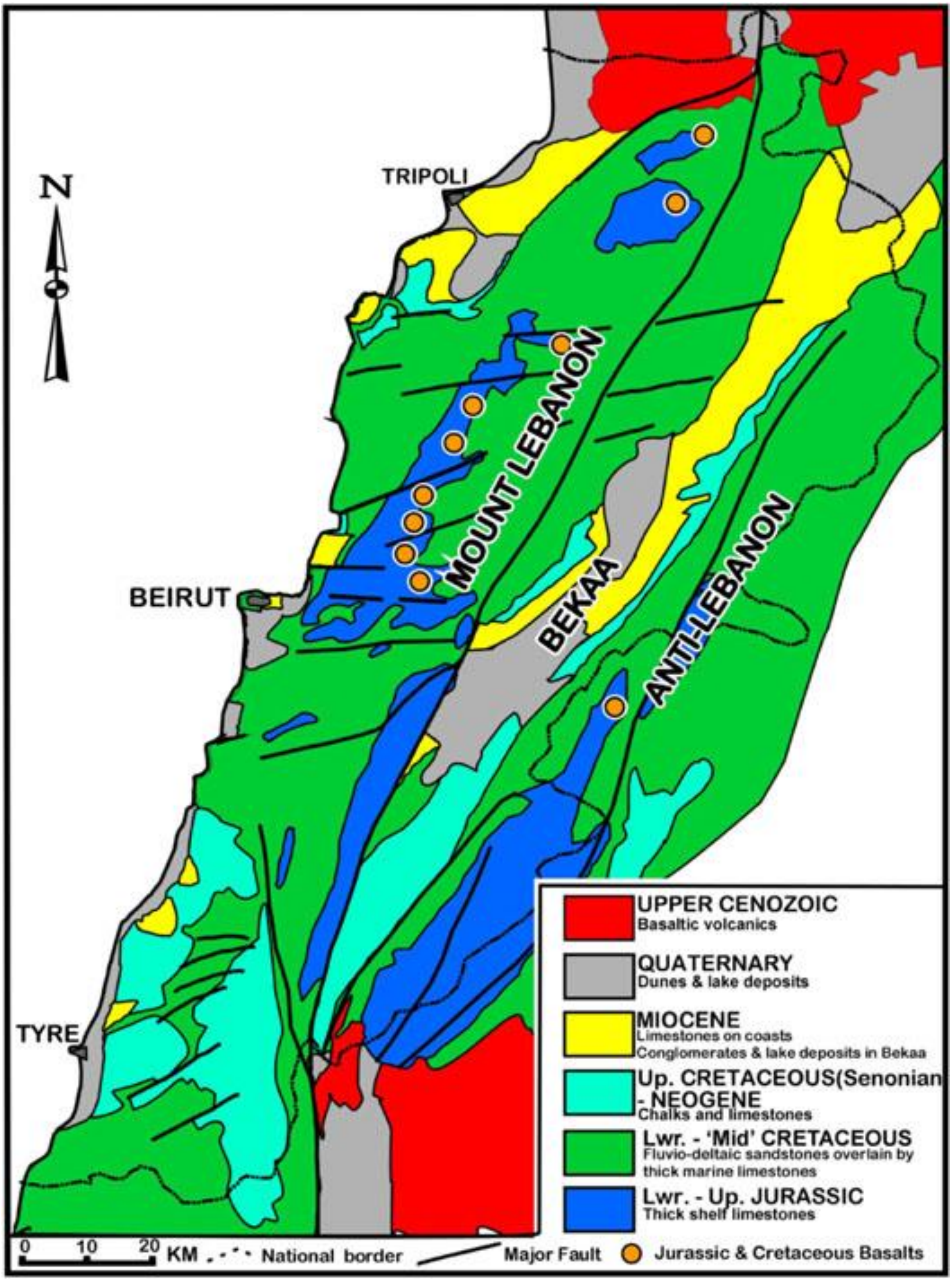
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TRIPOLI
BEIRUT
TYRE
MOUNT LEBANON
BEKAA
ANTI-LEBANON
UPPER CENOZOIC
Basaltic volcanics
QUATERNARY
Dunes & lake deposits
MIOCENE
Limestones on coasts
Conglomerates & lake deposits in Bekaa
Up. CRETACEOUS(Senonian - NEOGENE
Chalks and limestones
Lwr. - 'Mid' CRETACEOUS
Fluvio-deltaic sandstones overlain by thick marine limestones
Lwr. - Up. JURASSIC
Thick shelf limestones
0 10 20 KM
National border
Major Fault
Jurassic & Cretaceous Basalts

42.2 Type of Project (Size and Magnitude of the Project)

In Srar 100 of 130 municipalities of Akkar put their waste. This is 400 t per day. It is planned to build a WtE facility. It is an industrial project composed in particular of an incinerator and a system of turbine plus generator to transform the heat of steam to electricity.

In the following picture we observe the details of the sanitary landfill in srar

WORKS CONTRACT NOTICE

Construction of Solid Waste Management Facilities in Baalbek, Srar-Akkar and Joub Janine in four (4) lots

Location - Lebanon

1. **Publication reference**

   EuropeAid/138647/DH/WKS/LB

2. **Procedure**

   Open

3. **Programme title**

   Upgrading Solid Waste Management capacities in Bekaa and Akkar regions in Lebanon (SWAM)

   Upgrading Solid Waste Management capacities in Lebanon (SWAM II)

4. **Financing**

   Financing agreement No. ENPI/2013/024-977 and No. ENI/2014/025-014

5. **Contracting Authority**

   The Office of the Minister of State for Administrative Reform

CONTRACT SPECIFICATIONS

6. **Description of the contract**

   OMSAR intends to implement the following works:

   - a sanitary landfill in Baalbek, Lebanon with a capacity of 1 million m^3 including lining for Phase A;
   - a steel hangar to house the sorting plant in Baalbek, Lebanon (about 3,400 m^2);
   - a sanitary landfill in Srar, Akkar, North Lebanon with a capacity of 280,000 m^3;
   - a steel hangar to house the sorting plant in Srar, Akkar (about 2,800 m^2);
   - concrete platform for composting and maturation (about 5,000 m^2) part of the Srar, Akkar

42.3 Need of the Project & Project Objective

To solve the both problems waste and shortage of electricity in Akkar. In Srar 100 of 130 municipalities of Akkar put their waste. This is 400 t per day.

42.4 Data Collection and Preparation of Maps

During commissioning and operation emissions data shall be measured and collected.

42.5 Methodologie

After commissioning the plant shall be operated for 8 hours a day. During operation the exact waste volume per day needed to generate the power that will be known insha Allah.

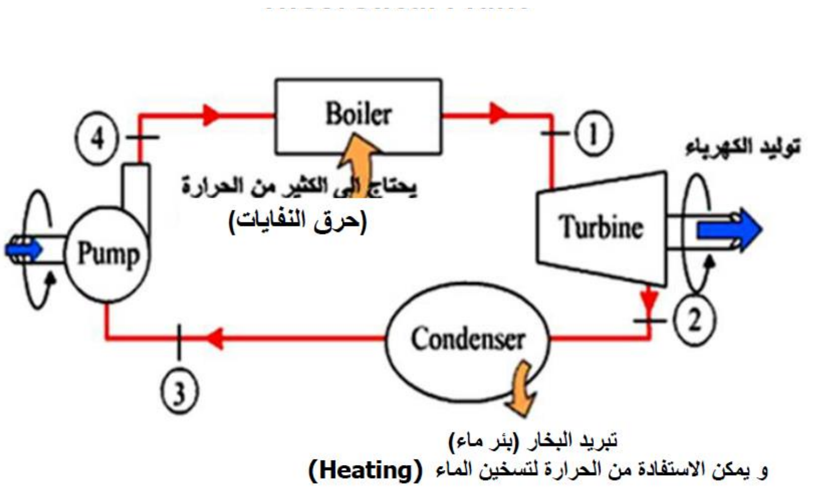
42.6 Description the of the installation

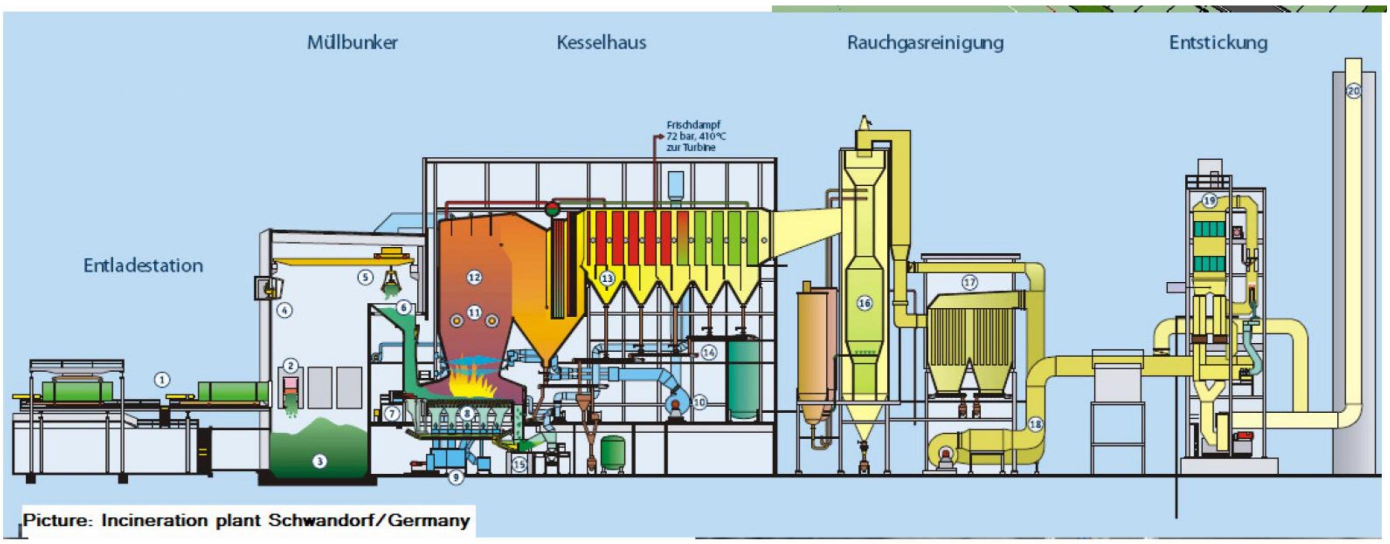
The operation is planned for 16 hours a day. All waste of the partner municipalities of Srar waste facility is treated. The generated electricity shall be offered for public or in cooperation with Lebanese Governmental Electricity Company.

- The plant has the possibility to eliminate about **400 (tons/day)** of camp waste (depending on their type).
- The plant includes a **filtration system** to fulfill the Lebanese and International requirements and norms concerning smoke emissions

42.6.1 Incineration remnant (Smoke and Ashes) are recycled. Waste water is treated.

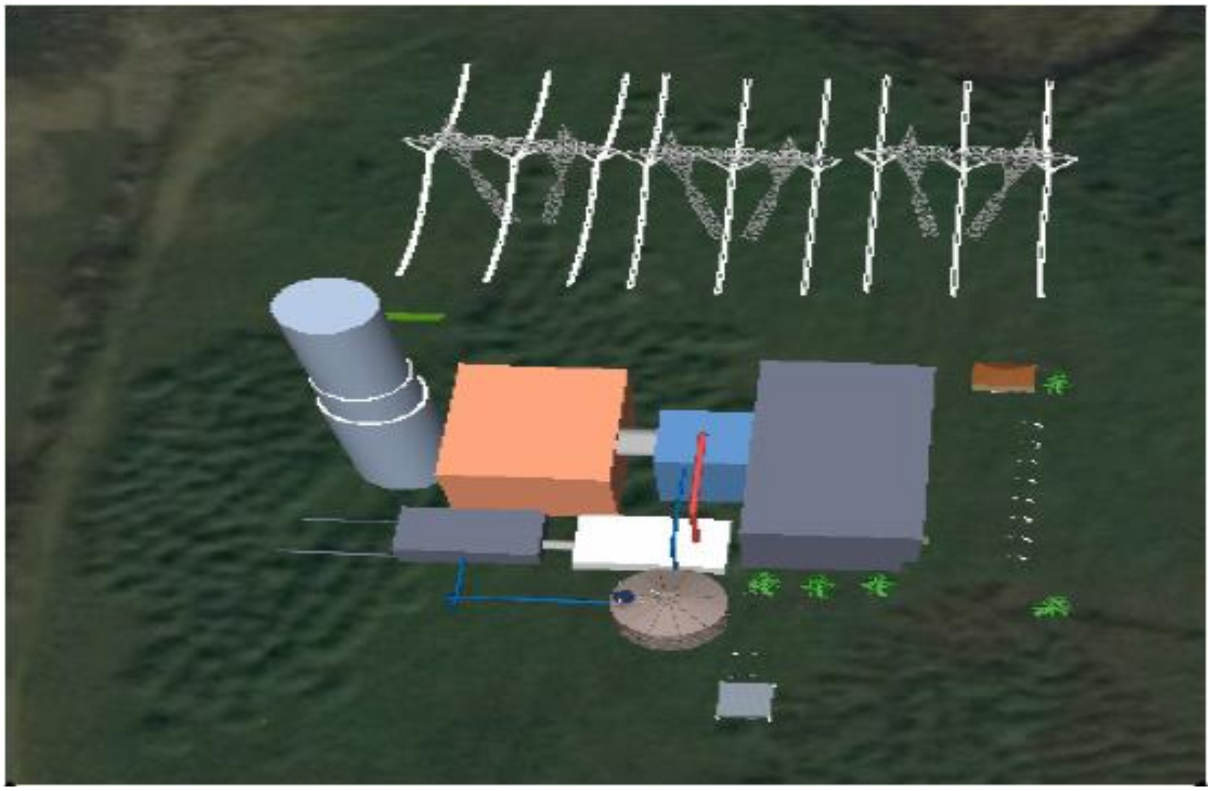
Schema of kernel power plant (without waste input treatment and waste material output treatment)



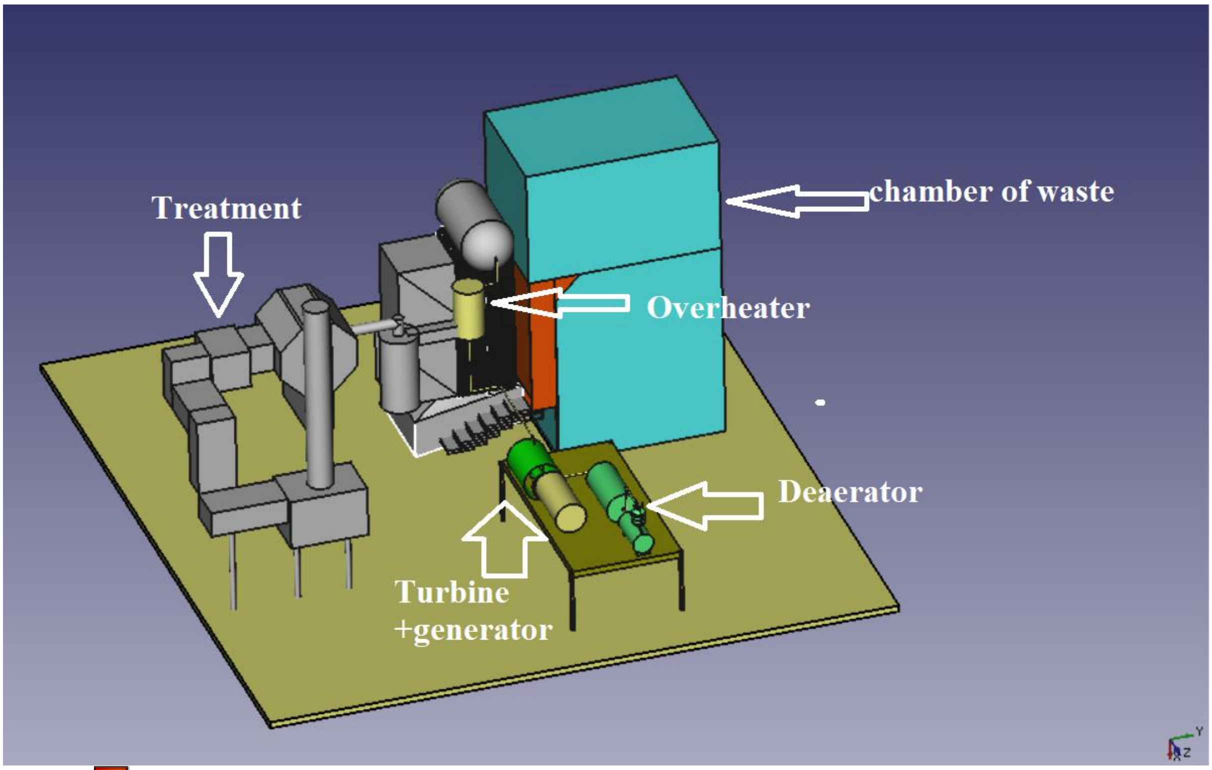


Picture: Incineration plant Schwandorf/Germany

42.6.2 The planned facility



42.6.2.1 Power plant 15 MW



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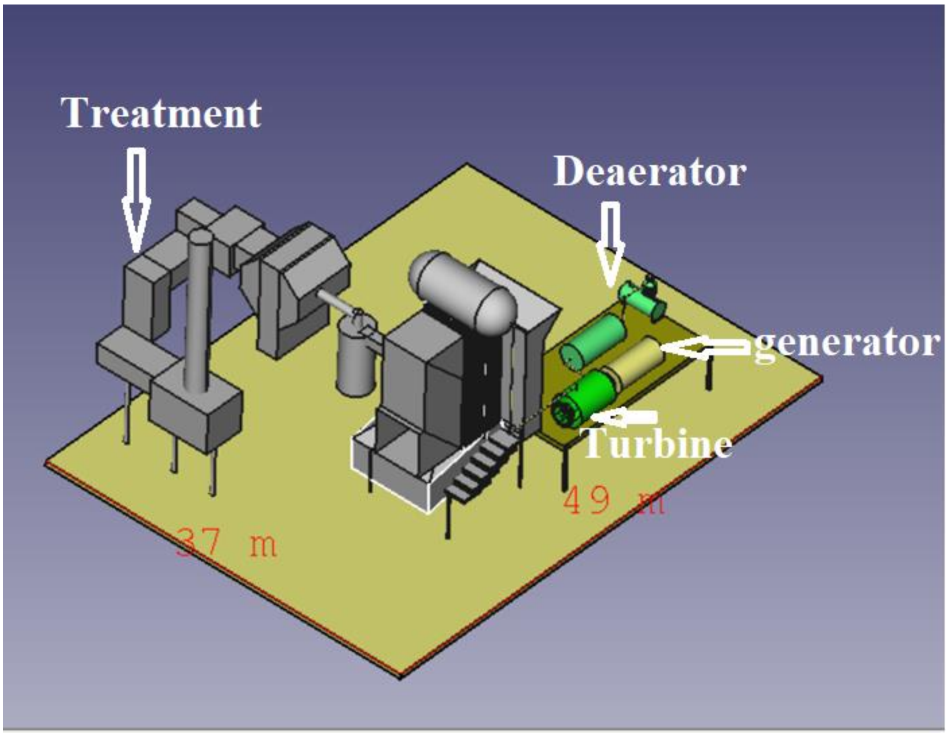
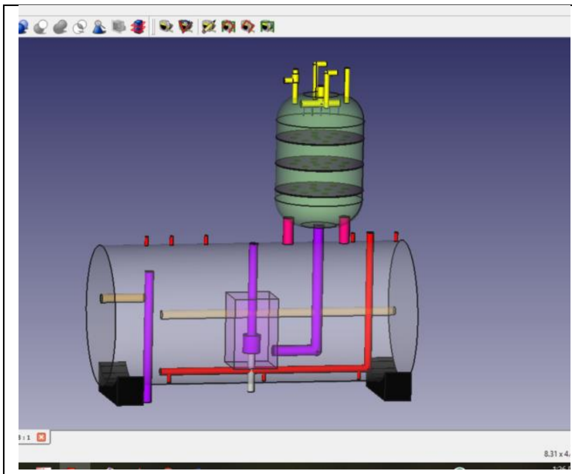
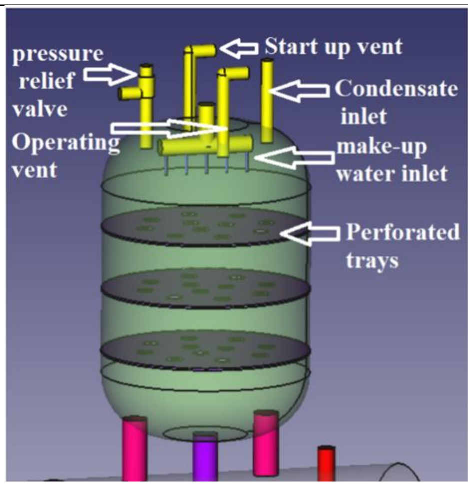
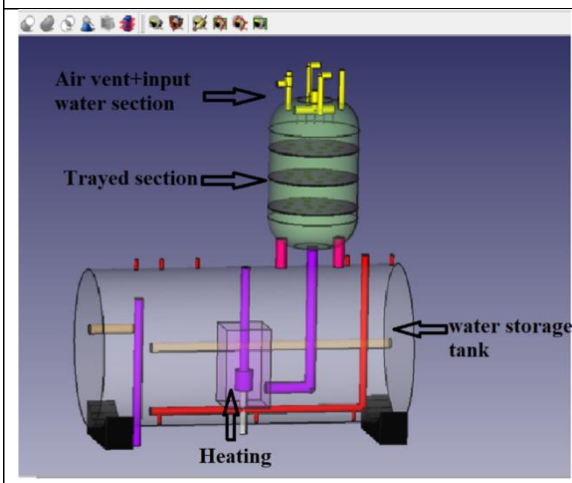
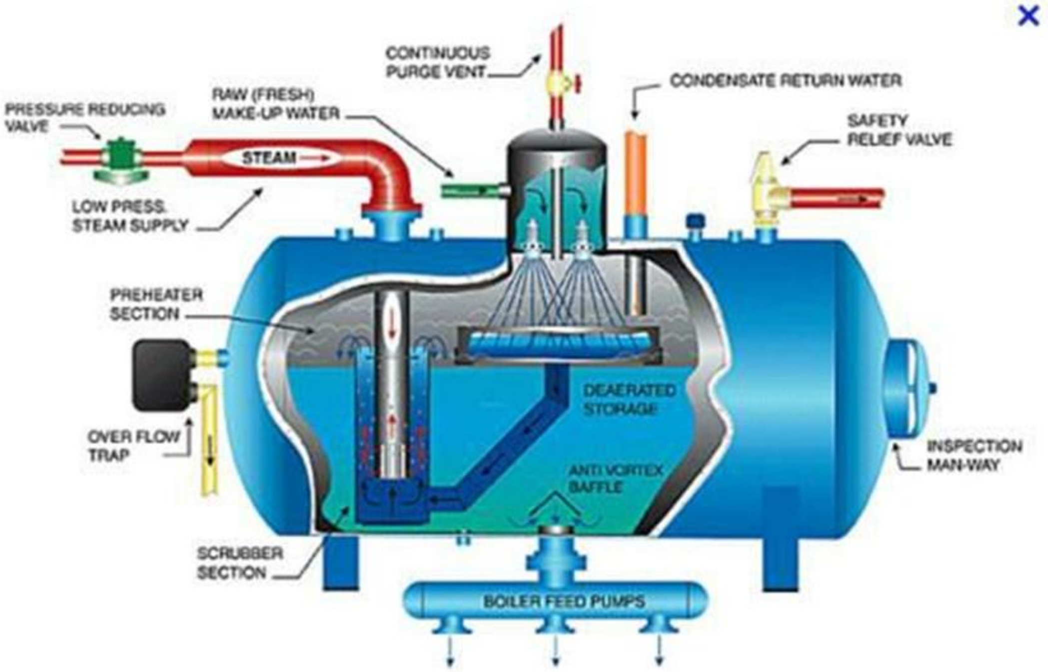
42.6.2.2 Turbine 15 MW



42.6.2.3 Deaerator

		
 		dearator031218.FCStd


CONTINUOUS PURGE VENT
CONDENSATE RETURN WATER
RAW (FRESH) MAKE-UP WATER
PRESSURE REDUCING VALVE
SAFETY RELIEF VALVE
STEAM
LOW PRESS. STEAM SUPPLY
PREHEATER SECTION
DEAERATED STORAGE
OVER FLOW TRAP
INSPECTION MAN-WAY
ANTI VORTEX BAFFLE
SCRUBBER SECTION
BOILER FEED PUMPS

42.6.2.4 Offer from alibaba :Deaerato

Product name	Thermal de-aerator with Water Tank	
Product information		
Unit price	USD 25000/Sets	
Min. order quality	1 Sets	
Payment terms	T/T	
Quotation valid time	2018-12-28	
Product description	Place of Origin:China Type:Tanks Brand Name:LSBiotech Working Pressure:0.2MPa Working Temperature:104 degree Cel. Water Tank:Include. 25 CMB Water Flowrate: 50 ton per hour Arrangment:Horizontal tank Valves & Instruments: without	
Supplier background		
Business type	✓ Trading Company	
Main products	BOILER,BOILER PARTS,BOILER ISLAND	
Product certification		

-

SHANDONG LONGSHENG BIOTECHNOLOGY CO., LTD.

山 东 龙 升 生 物 科 技 股 份 有 限 公 司

E-2-102, Shidaizongbujidi, No.15 Lanxiang Road,
Tianqiao District, Jinan Shandong 250032, China
Tel:[+86-531-83156209] Fax:[+86-531-58530859]

QUOTATION

CUSTOMER	SHIPMENT	DETAILS	
Mayssa Kamarredine	FOB CHINA	Date	31 January, 2019
Lebanon	CIF xxxx	Quotation No.	LS-Q-20181203
		Valid	3 December, 2018
		Currency	USD

A. PRICE & SCOPE

Item	Type No.	Description	Qty.	Unit Price	Total Price
1	XMC-250	**Deaerator**	10 set	**97,500**	**975,000**
1.1	/	**Deaerator Dome** Capacity 250 tph Working Temperature 104 °C Working Pressure 0.2 MPa (g) Diameter 1,650mm Height 3,550mm	1 pcs	/	/
1.2	/	**Water Tank** Diameter 3,250mm Length 15,850mm Eff. Volume > 125 CBM	1 pcs	/	/
1.3	/	**Steam Balance Main Pipe** DN273 Steam balance pipe system between tanks Length 5 meter Material Mild Steel	1 set	/	/
1.4	/	**Water Balance Main Pipe** DN219 Water balance main pipe system between tanks Length 5 meter Material Mild Steel	1 set	/	/
2	/	**Instrument & Valves (Option)**	10 set	**27,900**	**279,000**

2.1	/	**Level Gauge (on Tank)**	1 set	**16,000**	**16,000**
2.1.1	B43H1.6-G	Local Glass Level Gauge with LED backlight	1 pcs	/	/
2.1.2	LHCF2-F	Magnetic Float Level Gauge with transmitter	1 pcs	/	/
2.1.3	LHPR1.6-S	Double Chamber Balance Container with transmitter	1 pcs	/	/
2.2	/	**Pressure Gauge (on Dome & Tank)**	1 set	**1,800**	**1,800**
2.2.1	Y-150	Local Pressure Gauge	2 pcs	/	/
2.2.2	ST3000	Pressure Transmitter	2 pcs	/	/
2.3	/	**Temperature Gauge (on Dome & Tank)**	1 set	**800**	**800**
2.3.1	WSS511	Local Temperature Gauge	2 pcs	/	/
2.3.2	WRP-431	Temperature Transmitter	2 pcs	/	/
2.4	/	**Valves (on Dome & Tank)**	1 set	**9,300**	**9,300**
2.4.1	J41H-1.6	Direct mounted hand valves on Dome & Tank	1 set	/	/
2.4.2	A48Y-16C	Safety valve on Dome & Tank on Dome & Tank (DN150)	2 pcs	/	/
2.4.3	ZPH-80	DN 80 Vacuum Breaker Valve on Tank	1 pcs	/	/
2.4.4	YLF-100	DN 100 Overflow Valve on Tank	1 pcs	/	/
2.4.5	T947H-1.6	Heating steam control valve with motorized actuator	1 set	/	/
2.4.6	T947H-1.6	Make up water control valve with motorized actuator	1 set	/	/
2.5	/	**Flanges**	1 set	/	free
2.5.1	/	Flanges and counter-flanges for instruments and valves	1 set	/	/
2.5.2	/	Bolt, nut, washer, and gasket	1 set	/	/
3	/	**Packing**	1 set	//	free
	TOTAL PRICE (EXW)		**USD1,254,000**		

•

	SAY USD ONE MILLION TWO HUNDRED FIFTY FOUR THOUSAND ONLY.
	Exclusion: 1. All insulation and cladding materials 2. All steel structure, platform, ladder, handrail, and walkway for deaerator dome and tank 3. All support, hanger, and clamp for pipe lines and valves 4. All cables for instruments and control valves 5. Any other instruments or valves which is not specified in above sheet

B. DEAERATOR TECHNICAL DATA

Description	**Value**
Medium	Steam and Water
Medium Property	Non-hazardous
Design Life Time	10 years
Deaerator Capacity (single unit)	250 tph
Working Temperature	104 °C
Design Temperature	230 °C
Working Pressure	0.02 MPa (g)
Design Pressure	0.04 MPa (g)
Dome Dimension	1,650 D x 3,550 H
Tank Capacity	> 125 m^3
Tank Full Volume	130 m^3
Tank Dimension	3,250 D x 15,850 L
Dome Material	SUS 304
Tank Material	Q345R (GB713-2014)
Corrosion Allowance	1.6 mm
Welding Joint Coefficient	0.85/0.85

C. SHIPMENT

Item	Description	Price
1	China Inland - China inland transportation to FOB port - China Custom Clearance - THC	USD16,000
2	Ocean Transportation	to be confirmed later

	- Marine Insurance (ICC(A) term) - Ocean Freight by Loose Cargo Vessel - Ocean Time: est. 60 days	
	TOTAL PRICE (CIF = EXW + 1 + 2)	to be confirmed later

D. PAYMENT TERMS

- 50% of total price as down payment shall be made by T/T after PO signing.
- 50% of total price shall be made through irrevocable L/C against shipment documents.

E. DESIGN AND FABRICATION CODE

1. GB150-2011 《Pressure Vessel》
2. GB713-2014 《Steel Plates for Boilers and Pressure Vessels》 (eqv to ISO9328-2:2011, Steel flat products for pressure purposes - Technical delivery conditions – Part 2: Non-alloy and alloy steels with specified elevated temperature properties, NEQ)
3. TSG R0004-2009 《Stationary Pressure Containers Safety Technology Supervision Regulation》

F. QC

1. 100% PT (Hydraulic Pressure Test) is taken on domes & tanks
2. 100% RT (Radiography Test) is taken on all tube joint welding seams
3. 100% PT (Penetrant Test) is taken on all tube joint welding seams and tank connection welding seams
4. 10% RT (Radiography Test) is taken on tank connection welding seams
5. 2 layers of bottom rust-proof painting and 2 layers of surface painting

G. DELIVERY SCHEDULE

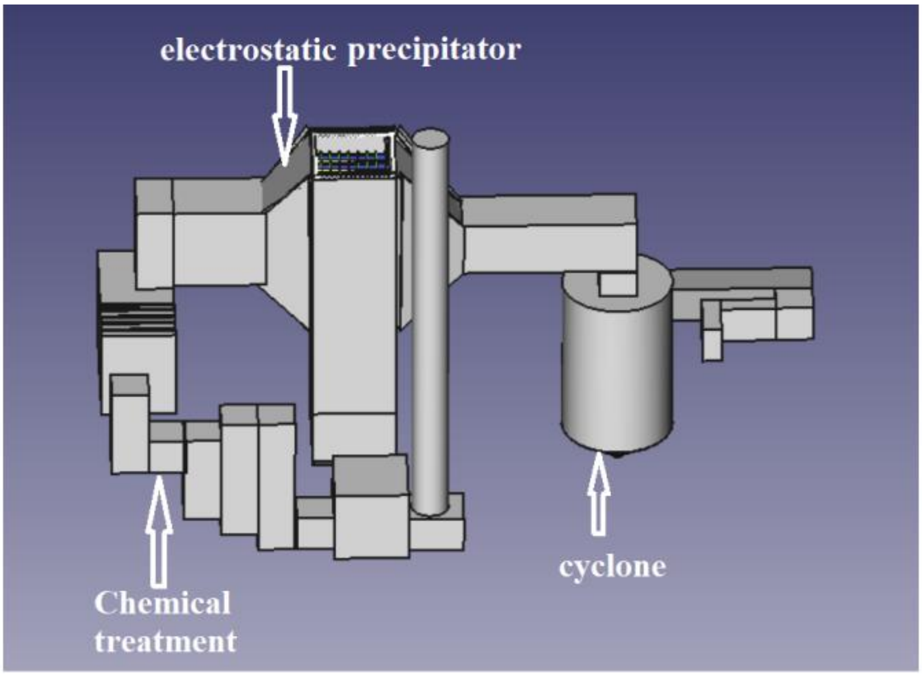
26 weeks to FOB port on receipt of DP.
Partial shipment could be started from 10th week.

H. ADDITIONAL INFORMATION

Port of Embarkation : TIANJIN / QINGDAO / SHANGHAI, CHINA
Port of Discharge : to be informed

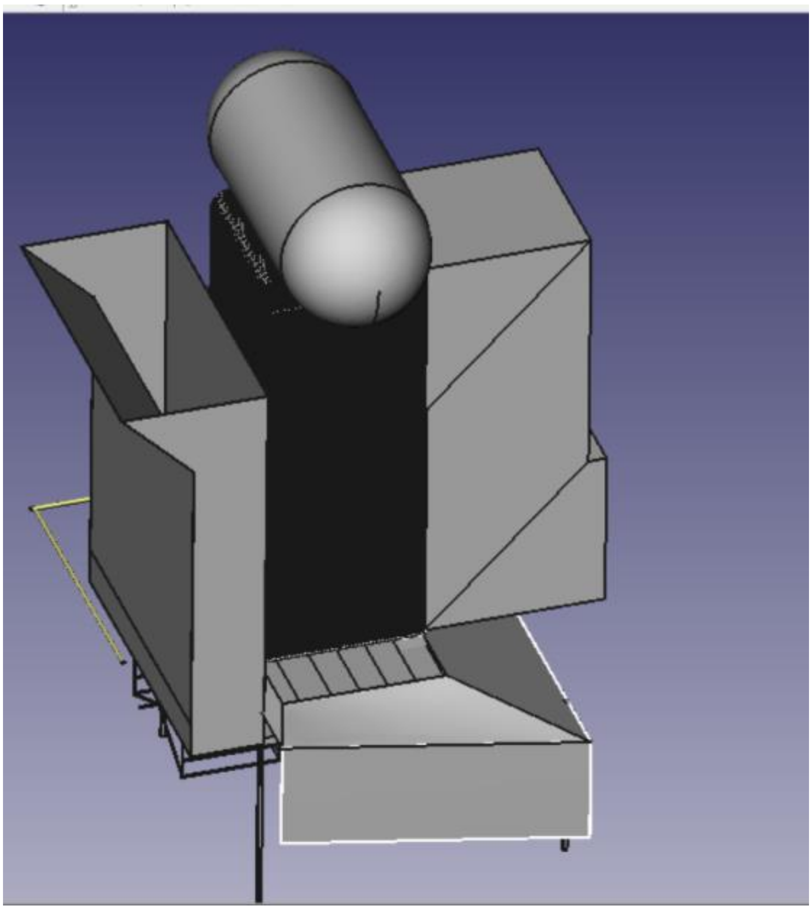
-

42.6.2.5 Treatment's system



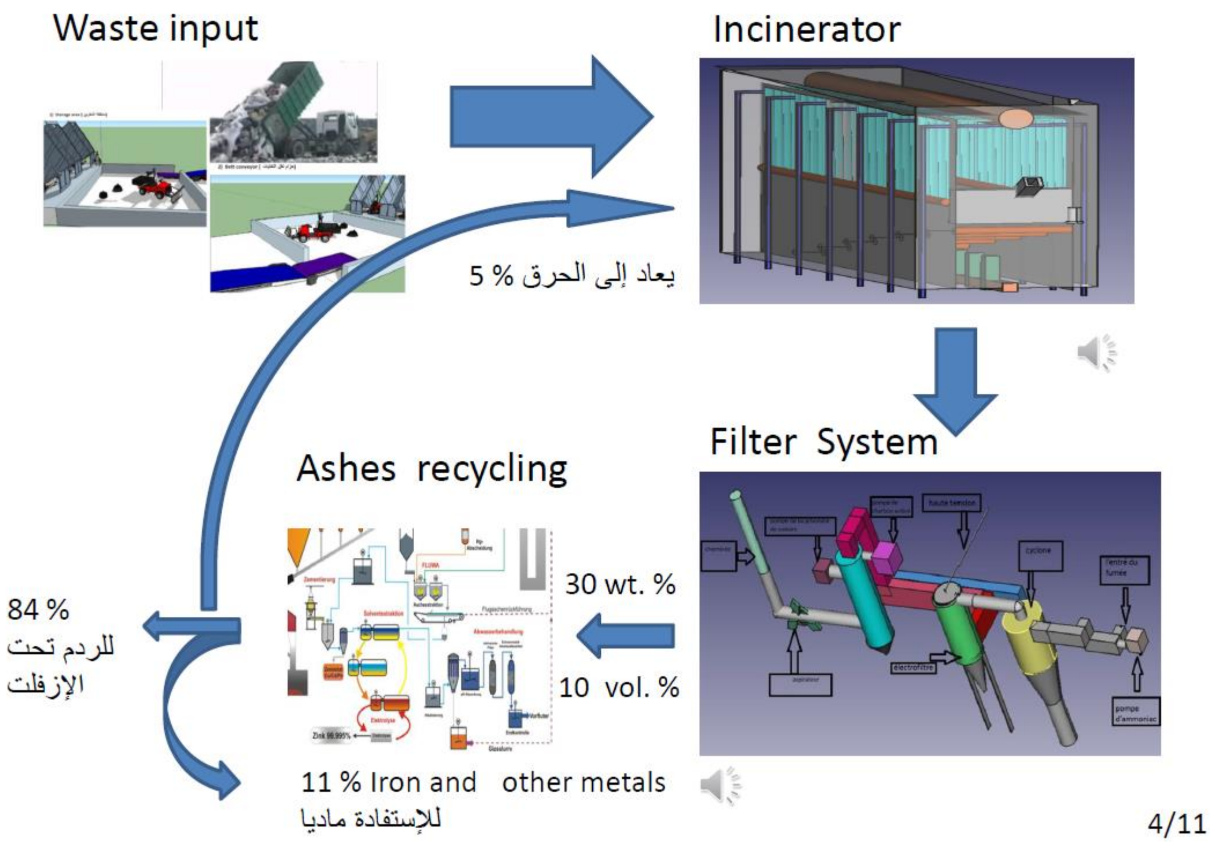
filtrage101218.FCStd

42.6.2.6 Boiler

- 

boiler111218.FCStd

42.6.3 Waste material cycle



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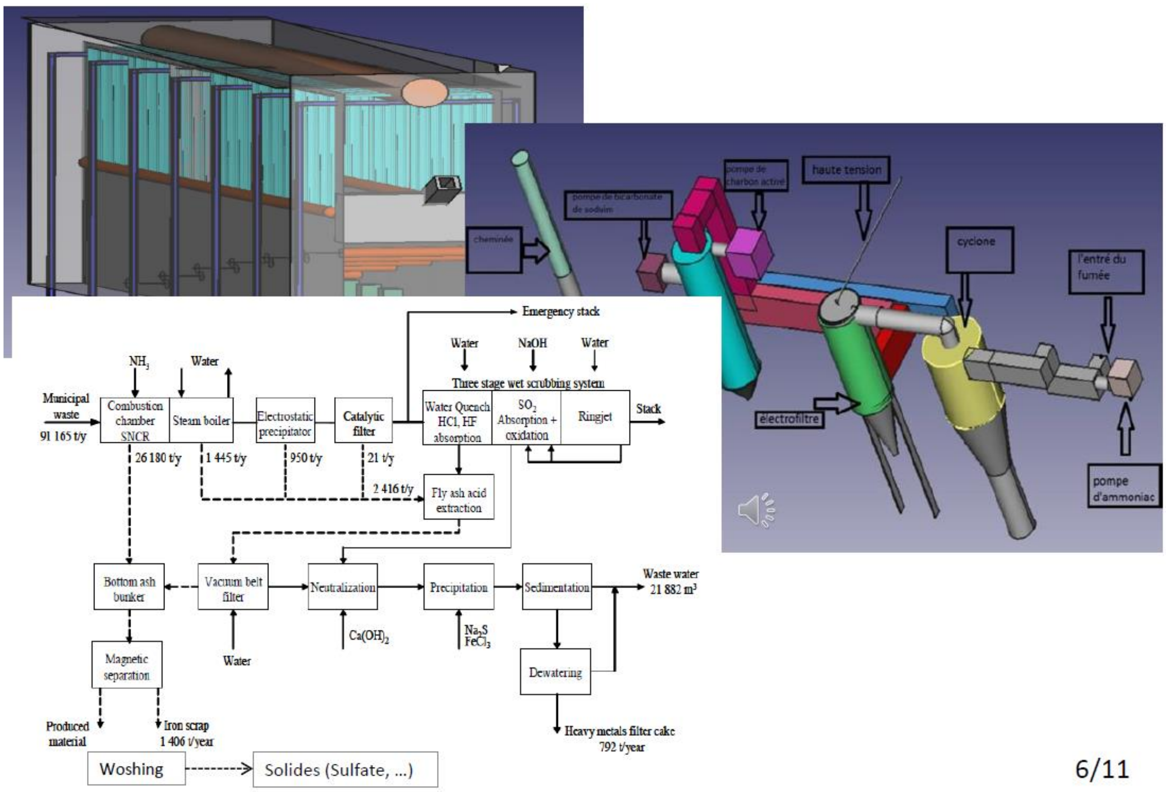
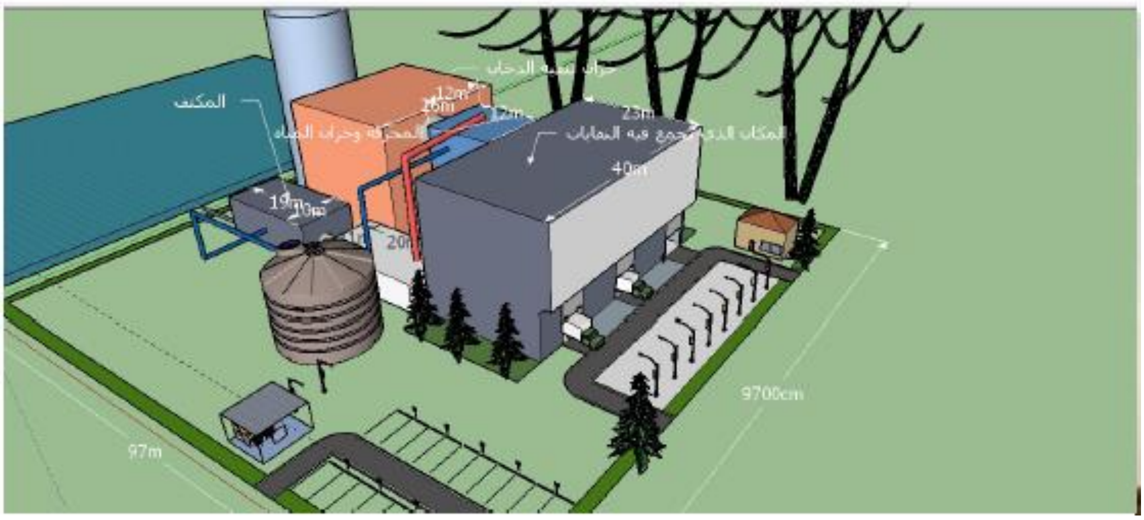
42.6.4 Incinerator (Burning chamber) and filters



- In Srar, the mass of waste that will be treating is 40**0 t**/day.

42.7 Layout Specifications

- مساحة الأرض المطلوبة



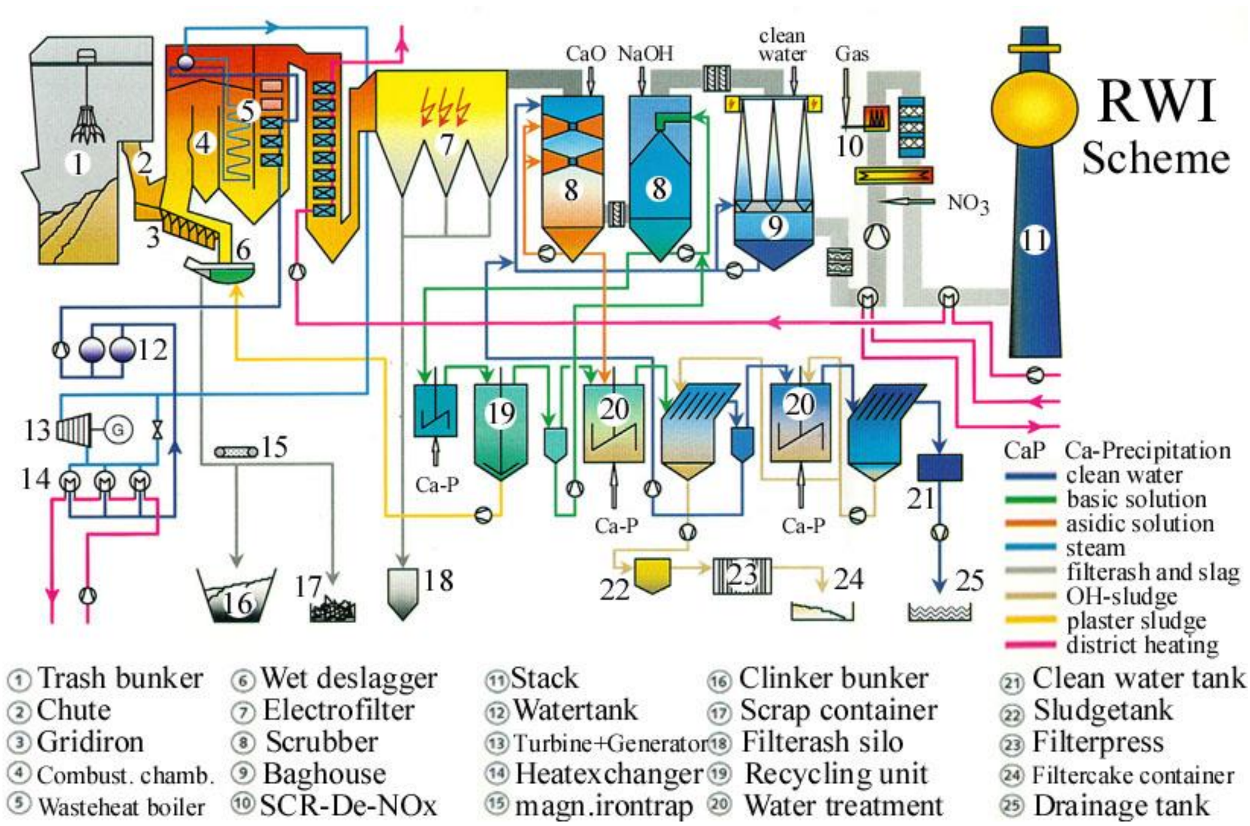
30 m x 30 m = 900 m.square

Mostly steel/stainless steel

42.7.1 Construction Equipment

- Equipment is available at site.

42.7.2 Construction of the sewage collection network



42.7.2.1 Water discharges from the cleaning of exhaust gases

- Incineration and co-incineration plants must have a permit which authorizes them to discharge used water caused by exhaust-gas clean-up. This permit will ensure that the emission limit values set out in **Annex IV** of the Directive we are complying with.
-

42.7.2.2 Residues

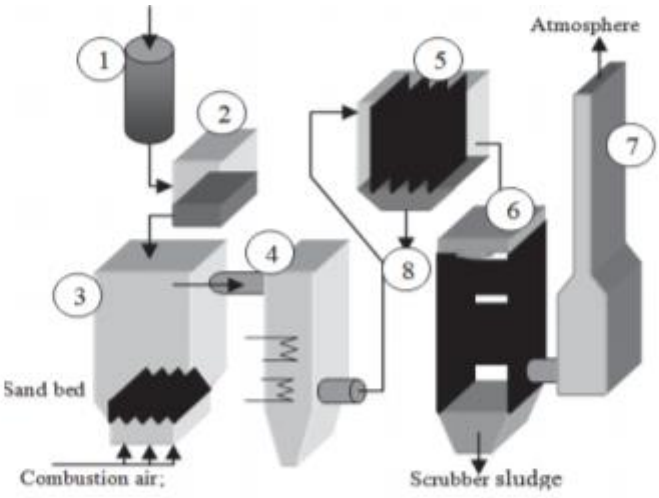
- Incineration or co-incineration residues must be reduced to a minimum and, as far as possible, recycled. When dry residues are transported, precautions must be taken to prevent their dispersal in the environment. Tests must be carried out to establish the physical and chemical characteristics, and polluting potential, of residues.

- **Annex IV announce that the description of project part must include:**
-
- **(d)**
  - **an estimate, by type and quantity, of expected residues and emissions (such as water, air, soil and**
  - **subsoil pollution, noise, vibration, light, heat, radiation) and quantities and types of waste produced**
  - **during the construction and operation phases.**
- **Then we apply to this technique of treatment of water:**

42.7.2.3 THE INCINERATION AND COCOMBUSTION OF THE SLUDGE

a. Sludge incineration Methods for thermal treatment of sewage sludge include:

- - combustion or monoincineration using multiplehearth furnace, fluidized bed, combined MHF-FBC, cyclone furnace, smelting furnace, rotary furnace; - co-combustion with coal in power plants, with coal in FBC power plants, with other fuels, with MSW; - alternative processes such as wet oxidation, pyrolysis, oil from sludge, fuel from sludge, gasification; An important argument in favour of combustion and co-combustion is complete mastery of the basics of processes, including purification techniques resulting products.
- Simple incineration of sludge from wastewater treatment can only be used as a method of destroying them but without producing additional energy due to the lower heating value of sludge. A simple sludge incineration scheme is shown in Figure 1. The sludge with a solid content of about 1-4% is introduced into the mixing and homogenization tank. Next a thickening stage where sludge settles and the supernatant is removed. In this stage the solid content increases to 3-8%. Thickened sludge is then dewatered typically using plate or belt presses. Organic and inorganic additives introduced in this process increase the calorific value of the sludge and reduce the content of inorganic ash. The solid content varies from 18 to 35%.

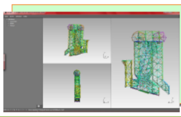


- A simple sludge incineration scheme. 1- sludge mixing tank; 2- belt press, plate press, centrifuge; 3- fluidised bed incinerator; 4- waste heat boiler; 5- electrostatic precipitator; 6-

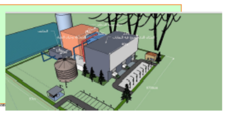
wet scrubber; 7 - stack; 8 - inorganic incinerated sewage sludge ash. In the combustion chamber the sludge is burned with compressed combustion air introduced with a temperature of 500-600o C. Because fluidized sand layer an overhead freeboard zone at 800–900o C is created. Water is evaporated, volatile metals vaporise and organic compounds are combusted completely to gases. The remaining inorganic material is carried out of the chamber as fine particulates with the exhaust gases. After assigns an important amount of heat in the waste heat boiler ash gases are cleaned in an electrostatic precipitator and crosses the wet scrubber. Remaining particles in the gas generates important quantities of scrubber sludge and then clean gases are discharged to the stack.

42.8 Plan (Project Cost)

- 60 t waste per day is needed for a 2 MW.
- 480 t waste per day is needed to produce 8x2 MW = 16 MW.
- There are two possibilities:
- - 8 blocks of NLAP-2MW devices.
- - 1 block of 15 MW plant; Installation Cost: 7 Mio. $
-
-
-



4 MW تكاليف محطة طاقة



Installation cost

Time span
12 month (Oct. 2015 – Sept. 2016)

Material

4 MW Turbine&Generator	1,500,000 $
Heat exchanger, condensor, Pipes, pumps, …	500,000 $
Icineration including incoming silo and filters	4,000,000 $

Personal
Project Management & Leadership
5 Engineers
About 50 technicians and workers
Personnel costs: 1,500,000 $

Total installation cost: ~ *7,500,000 $*

Operational cost per year
20 years (Sept. 2016 – 2036)

Maintance
500,000 $

Personal
(3 Engineers, 3 technicians,20 workers)
400,000 $

Total operational cost per year:
~ **900,000 $**

***Income per year (for* 20 years)**
Icineration Material from region
85t x 353 = 30,000 t
Electricity 353x20hx4MW=28,000,000 kWh
Total income per year:
~ **3,000,000 $**

Actual Partners and Roles for installation

Germany	TEMO Consulting e.K. www.temo-ek.de	-Supplier management
Germany	SIEMENS	Turbine, Generator
Germany	EVT	Incineration chain
Germany	N.N.	Filter system
Lebanon	طاقة الشمال North Lebanon Alternative Power	-Project Management - Vaporizer - Superheater - Condenser -Piping and Integration -Control System

•

NLAP 1.5 MW Mobile Incineration Plant, total installation costs				
Material Costs (including workers for manufatoring)				
Part	Number of pieces		Total	Supplier
Steam filter	1		$ 1.000,00	
Condensor	1		$ 35.000,00	
condensor cooling	1		$ 1.500,00	
tubes (Stainless)	10m 1 inch		$ 45.000,00	
Generator	1		$ 32.500,00	Jamal&Chaban, Omar M. Mohamad
diesel burner including fuel feed	1		$ 2.000,00	
safety valve 15 bar	1		$ 1.000,00	
pressure sensors	5		$ 15.000,00	
fresh water tank (stainless)	1		$ 2.000,00	
incineration burning chamber (including transportation band)&vaporizer (climbing tubes...)	1		$ 200.000,00	
fume purification (incl. filter for CO, SO2, NH3)	1		$ 50.000,00	Costs All in all
Turbine 1.5 MW	1		$ 857.500,00	$1.555.500
Hardware Control System (Including Instrumentation)			$ 25.000,00	**x 1.3 (with overhead)**
Water antioxidant system			$ 3.000,00	**$2.022.150**
Sorting House			$ 15.000,00	
mobile platform			$ 30.000,00	
Total Material			**$1.315.500**	
Engineering Staff Costs				
Task	MM	Qualifikation	Salary/MM	Total Salary
Integration with Test Vaporizer				
Integration with Incineration V	30	Eng.	$3.000	$90.000
Integration Turbine Electrics	7	Eng.	$3.000	$21.000
Integration Process Control system	5	Eng.	$3.000	$15.000
Control System	18	Eng.	$3.000	$54.000
Project Management	20	Eng.	$3.000	$60.000
Total Man Power Costs	**80**			**$240.000**

42.9 Infrastructure Services (Proposed Infrastructure/Utilities and layout)

42.9.1 Environmental Aspects

- Not relevant because of filters and internal heavy metal recovery plant.

42.9.2 Power Supply

- No external power supply needed

42.9.3 Water Supply

- 2000 t/ day cooling water, to be taken from local water supply pipe.
- Alternative: Cooling tower.

42.9.4 Sewerage Services

- 1 time per week about 2 tons solid waste remnant has to be taken to final destination.

42.9.5 Solid and Liquid Waste Management

- Heavy Metals recovering plant under development and construction

42.9.6 Proposed Wastewater Treatment Plant

- tbd

43 Screening for with Ministry of Environment

43.1 Screening application for the installation of a power plant unit in Srar in north Lebanon

43.1.1 ملحق رقم 4: نموذج التصنيف لتقييم الأثر البيئي

•

1. اسم المشروع: محطة طاقة لتوليد الطتقة الكهربائية عن طريق التفكك الحراري للنفايات

•

2. صاحب المشروع:

❑ الاسم: سمير مراد

❑ العنوان: راسنحاش–البترون

❑ رقم الهاتف: 76341526 ❑ رقم الفاكس:

❑ البريد الإلكتروني: smourad69googlemail.com •

•

3. صنف المشروع:

❑ عام ❑ زراعي:

❑ خاص ❑ صناعي (مع تحديد رقم ISIC):

❑ ❑ سياحي (مع التحديد):

• ❑ خدماتي (مع التحديد):

• ❑ غيره:

•

• طبيعة المشروع:

❑ مشروع جديد ❑ مشروع قائم أو حائز على ترخيص أو موافق عليه

• ❑ تعديل

• ❑ إضافة

- ❑ توسيع
- ❑ إعادة تأهيل
- ❑ إقفال
-

4. أهداف المشروع:التخلص من النفايات و توليد الطاقة الكهربائية
5. الكلفة المقدرة للمشروع:

❑ إنشاء:16 مليون دولار6

❑ تجهيز:

6. البرنامج الزمني للمشروع:

- 6 اشهر

•	• البداية	• النهاية
• التخطيط والتصميم		
• الإنشاء		
• التشغيل		

7خريطة تبين موقع المشروع – مقياس 1/20,000 (مرفقة)

1. خريطة مساحة مع إفادة عقارية
2. إفادة ارتفاق وتخطيط والشروط الخاصة للمنطقة
3. الاحداثيات الجغرافية للعقار (GPS coordinates)
4. . مستندات أخرى مرفقة (تصميم المشروع ووصف المشروع وتفاصيل أكثر

43.1.2 Project Information

1. Project Name:power plant incineration
2. Project Owner:
3. Land Ownership:
4. Full Address:
5. Phone:
6. Fax:
7. Email address:
8. Lot number:
9. Petroleum brand: usual
10. Project Cost:
11. Operation:
12. One shift per day?
13. Any days for maintenance: 1
14. Working days: 7
15. Man power operating the process:

• **Position**	• **No. Required**
• Manager	•
• **Total**	•

16. The number of vehicles arriving the site: 2 / week
17. Type of equipment
18. Population size of village: ca
19. Proximity to Waste Generation Center
20. Proximity to Energy Distribution Networks
21. **Project Category**
22. **General Land Classification**

☐ Agricultural	☐ Residential	☐ Tourism
☐ Industrial	☐ Forest Land	☐ Institutional
☐ Commercial	☐ Open Spaces	☐ Others, Pls. Specify:

•

23. **Project Components**

• **Services**				
• **Facility**		• **No. of Unit**	• **Area (m^2)**	• **Capacity**
• Access? Originating from? To?		•		

• Area of the incineration	•	•	•
• Total area of the site	•	•	•
• Shape of the site (Length, width)	•	•	•
• Maximum height of infrastructure	•	•	•
• Type of incineration	•	•	•
• Furnace	•	•	•
• Type of Byproducts	•	•	•
• Ash and clinker removal system	•	•	•
• Energy recovery system	•	•	•
• Air pollution control (APC) system	•	•	•
• Stack height	•	•	•
• Any produced Leachate?	•	•	•
• Source and Composition of municipal wastes to be incinerated	•	•	•
• Fuel Storage Area	•	•	•
• Parking Area	•	•	•
• Office Bldg.	•	•	•
• *Public Toilets*			
• Others, Pls. Specify			
• **Logistics and Principles of Sampling and Analysis of Waste Data**			
• **Design and Layout of the Mass Burning Incineration System**			

•

24. Water Resources and Infrastructure

• Water Supply Source	•	•	• Remarks
• Existing Public Water	•	•	•
• Estimated daily water requirements of the proposed incineration?			

•

- **Deep Well (Underground tanks)**

• Water Source	• No. Wells/Hand Pump/Tanks	• Location	• Depth (m)	• Discharge • (liter / sec)
• Deep Well w/ Manual Hand Pump	•	•	•	•
• Deep Well w/ Electric or Motor Pump	•	•	•	•

•

- **Stormwater Management System (collector pipe, where to?, site drain) Drainage System**

☐ Rainwater will be collected in storage tank
☐ Rainwater will be collected in Reservoir
☐ Rainwater will be collected in collector pipe, where to?
☐ Rainwater will be connected to public drainage system
☐ Rainwater will be connected to natural outfall / water body

•

- **Drainage System**

- Type of drainage:

a) Major Road:
b) Other road (street):

- **Is there any surface water body (river, canal, stream, lake, wetland) within 1,000m of the proposed site?**

☐ **Yes** ☐ **No**

- **If yes, describe each surface water body close to site**

Water Source	Name of Water Body	Location	Distance
1. Creek			
2. Spring			
3. Stream			
4. River			
5. Others			

25. Power Supply (Source of Power)

☐ Local Electric
☐ Own Generator:
☐ Others, pls. specify

26. Wastewater (Sewage) Disposal System

- Sewage System:

☐ Individual Septic Tank	☐ Communal Septic Tank

- Sewage Design:

☐ 2 chamber septic tank with leaching	☐ 2 chamber septic tank without leaching
☐ 3 chamber septic tank w/ leaching **X**	☐ 3-chamber septic tank w/o leaching
☐ On site wastewater treatment plant, pls. specify	

-
- **Sewage Disposal**
- discharge to an existing public sewerage system
- Treatment in individual septic tanks with disposal by absorption field or leaching pit
- Others: (Specify)_________________________________
-
- **Wastewater Treatment Facility**:
- Attach Flowchart on liquid waste management
- Attach lay-out / detailed plan
- Liquid waste facility-main component
- Wastewater treatment facilities (which one? Name is needed)
-

27. Solid Waste Disposal System

- Bottom ash
- Bly ash
- Others, (specify):
- Will there be a waste sorting/segregation system to be employed prior to incineration?
- YES NO
- **Disposal System**
- Burning at open dumpsite in the project site
- Open dumpsite outside of the project site (where?)
- Others, specify:________________________
- Location of the waste disposal site:

44 Environmental factors affected

- The environmental impact assessment shall identify, describe, and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on the following factors:

- population and human health (such as health effects caused by the release of toxic substances to the environment, health risks arising from major hazards associated with the Project, effects caused by changes in disease vectors caused by the Project, changes in living conditions, effects on vulnerable groups, exposure to traffic noise or air)
- biodiversity, with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC;

land, soil, water, air and climate;
material assets, cultural heritage and the landscape
the interaction between the factors referred to in points (a) to (d).

- A description of the factors specified in Article 3(1) likely to be significantly affected by the project: population, human health, biodiversity (for example fauna and flora), land (for example land take), soil (for example organic matter, erosion, compaction, sealing), water (for example hydro-morphological changes, quantity and quality), air, climate (for example greenhouse gas emissions, impacts relevant to adaptation), material assets, cultural heritage, including architectural and archaeological aspects, and landscape.

- A description of the likely significant effects of the project on the environment resulting from, inter alia: -

a the construction and existence of the project, including, where relevant, demolition works; -

b the use of natural resources, in particular land, soil, water and biodiversity, considering - as far as possible the sustainable availability of these resources;

c the emission of pollutants, noise, vibration, light, heat and radiation, the creation of - nuisances, and the disposal and recovery of waste;

d the risks to human health, cultural heritage or the environment (for example due to - accidents or disasters);

e the accumulation of effects with other existing and/or approved projects, taking into - account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources;

f the impact of the project on climate (for example the nature and magnitude of - greenhouse gas emissions) and the vulnerability of the project to climate change;

g the technologies and the substances used. -

The description of the likely significant effects on the factors specified in Article 3(1) should cover the direct effects and any indirect, secondary, cumulative, trans boundary, short-term, medium-term and long-term, permanent and temporary, positive and negative effects of the project. This description should take into account the environmental protection objectives established at Union or Member State level which are relevant to the project.

45 Significant Effects on the environment

45.1 The concept of significance

- The concept of significance considers whether or not a Project's impact could be determined to be unacceptable in its environmental and social contexts. The assessment of significance relies on informed, expert judgment about what is important, desirable acceptable with regards to changes triggered by the Project in question. common approach used in EIA is the application of a multi-criteria analysis. Common criteria used to evaluate significance include the magnitude of the predicted effect and the sensitivity of the receiving environment:
- _ **Magnitude** considers the characteristics of the change (timing, scale, size, and duration of the impact) which would probably affect the target receptor as a result of the proposed Project;
- _ **Sensitivity** is understood as the sensitivity of the environmental receptor to change, including its capacity to accommodate the changes the Projects may bring about.

45.2 Cumulative effects

- It is important to consider effects not in isolation, but together; that is, cumulatively. They can arise from:
- the interaction between all of the different Projects in the same area;
- the interaction between the various impacts within a single Project

45.3 Example of significant effects

- A description of the likely significant effects of the project on the environment resulting from, inter alia:

(a) the construction and existence of the project, including, where relevant, demolition works;

(b) the use of natural resources, in particular land, soil, water and biodiversity, considering as far as possible the sustainable availability of these resources;

(c) the emission of pollutants, noise, vibration, light, heat and radiation, the creation of nuisances, and the disposal and recovery of waste;

(d) the risks to human health, cultural heritage or the environment (for example due to accidents or disasters);

(e) the accumulation of effects with other existing and/or approved projects, taking into account any existing environmental problems relating to areas of particular environmental importance likely to be affected or the use of natural resources;

(f) the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change;

(g) the technologies and the substances used.

- The description of the likely significant effects on the factors specified in Article 3(1) should cover <u>the direct</u> effects <u>and any indirect,</u> secondary, cumulative, trans-boundary, <u>short-term, medium-term and long-term, permanent and temporary</u>, <u>positive and negative effects</u> of the project. This description should take into account the environmental protection objectives established at Union or Member State level which are relevant to the project.

46 Assessment of Alternatives

Identifying and considering Alternatives can provide a concrete opportunity to adjust the project design in order to minimize environmental impacts and, thus, to minimize the project's significant effects on the environment. Additionally, the proper identification and consideration of alternatives

from the outset can reduce unnecessary delays in the EIA process, the adoption of the EIA decision,

or the implementation of the Project that mentioned in Annex IV point 2.

A description of the reasonable alternatives, those alternatives studied by the developer, which are relevant to the proposed project and its specific characteristics. Annex IV to the Directive gives some examples of the types of Alternatives to be considered and which include:

- project design,
- technology,
- location,
- size ,
- scale,
- the main reasons for selecting the chosen option,
- including a comparison of the environmental effects.
  - This list serves as inspiration for a multitude of other Alternatives. These roughly relate to the
  - categories above. Some such Alternatives are listed below:
  - _ the nature of Project;
  - _ time frames for construction ;
  - _ process by which the Project is constructed;
  - _ equipment used either in the construction or running of the Project;
  - _ site layout (e.g. location of buildings, waste disposal, access roads);
  - _ operating conditions (e.g. working schedule, timing of emissions);
  - _ physical appearance and design of buildings, including the materials to be used;
  - _ means of access, including principal mode of transport to be used to gain access to the Project.
  - In our case, we have 2 options to build this plant::
- - 8 Blocks of NLAP-2MW devices.
- 1 block of 15 MW plant.

47 Mitigation or Compensation Measures

- Annex IV point 7 states that:
- 'A description of the measures envisaged to avoid, prevent, reduce, or if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements (for example the preparing of a post-project analysis). That description should explain the extent, to which significant adverse effects on the environment are avoided, prevented, reduced or offset, and should cover by the construction and operational phases.'

• Type of measure	• How it works
• **Measures to prevent**	• Impact avoidance by: • Changing means or techniques, not undertaking certain Projects or • components that could result in adverse impacts. • changing the site, avoiding areas that are environmentally • sensitive. • putting in place preventative measures to stop adverse effects from occurring
• **Measures to reduce**	• Impact minimization by: • Scaling down or relocating the Project. • Redesign elements of the Project. • Using a different technology. • Taking supplementary measures to reduce the impacts either at the • source or at the receptor (such as noise barriers, waste gas treatment, type of road surface).
• **Measures to offset**	• Offset or compensate for residual adverse impacts that cannot be avoided or further reduced in one area with improvements elsewhere with: • Site remediation / rehabilitation / restoration. • Resettlement-Monetary compensation

47.1 Mitigation and Compensation Measures: In a nutshell

- Mitigation and Compensation Measures should be considered when assessing Alternatives, both with a view to strengthening the feasibility of Projects, and to improving the Project's design.
- Both Mitigation and Compensation Measures may be costly, and may influence the choice of Alternatives
- Mitigation and Compensation Measures may apply to both the construction and operational phases of the Project.
- A description of Mitigation and Compensation Measures for significant adverse effects must be incorporated in the decision to grant Development Consent for a Project (see section 3.2. decisions-making: Reasoned Conclusion and Development Consent' of this Guidance Document).

48 Monitoring

Article 8a also states:

- In accordance with the requirements referred to in paragraph 1(b), Member States shall ensure that the features of the project and/or measures envisaged to avoid, prevent or reduce and, if possible, offset significant adverse effects on the environment are implemented by the developer, and shall determine the procedures regarding the monitoring of significant adverse effects on the environment. The type of parameters to be monitored and the duration of the monitoring shall be proportionate to the nature, location and size of the project and the significance of its effects on the environment. Existing monitoring arrangements resulting from Union legislation other than this Directive and from national legislation may be used if appropriate, with a view to avoiding duplication of monitoring.
- Monitoring Measures for Projects with significant adverse effects must be incorporated in the decision to grant Development Consent for a Project and, as such, should generally be included in the EIA Report. Monitoring Measures may be linked to other legal requirements, such as those stemming from the IED, WFD or the Habitats Directive. Care must be taken to avoid duplication in Monitoring Measures in this regard. Requirements on Monitoring Measures were added to the EIA Directive as part of the 2014 amendments (Article 8a and Annex IV).
- Generally, Monitoring Measures can help to ensure that Projects meet all existing environmental legal requirements, and that impacts are in line with EIA Report Projections. They should also ensure that any Mitigation or Compensation Measures for expected significant effects are carried out as planned.
- Monitoring Measures can also provide insight into the quality of the EIA procedure carried out, and can generate lessons learned and good practices for future EIAs.
- Practitioners should first check which Monitoring Measures are required by other legislation. If these are not sufficient or appropriate for monitoring the expected environmental impacts or proposed Mitigation Measures, then additional measures may be proposed within the EIA Report. Monitoring Measures should always strive to be proportionate to the nature of the environmental impacts in terms of the time, costs, and other resources involved.
- Monitoring Measures should be specific and detailed enough to ensure their implementation, including defining roles, responsibilities, and resources. In some cases,

economies of scale can be achieved through the joint monitoring of related Projects. Measures should also be capable of identifying important unforeseen effects.

49 Non-Technical Summary

49.1 The qualities of a good Non-Technical Summary

- The Non-Technical Summary is easily identifiable and is accessible within the EIA Report;
- The Non-Technical Summary provides a concise, but comprehensive description of the Project, its environment, the effects of the Project on the environment, the proposed Mitigation Measures, and the proposed monitoring arrangements;
- The Non-Technical Summary highlights any significant uncertainties about the Project and its environmental effects;
- The Non-Technical Summary explains the Development Consent process for the Project and the role of the EIA in that process;
- The Non-Technical Summary provides an overview of the approach to the assessment;
- The Non-Technical Summary is written in non-technical language, avoiding technical terms, detailed data and scientific discussion;
- The Non-Technical Summary is comprehensible to a lay member of the public.

50 Quality of the EIA Report

50.1 The qualities of a good EIA Report

- A clear structure with a logical sequence that describes, for example, existing Baseline conditions, predicted impacts (nature, extent and magnitude), scope for mitigation, proposed Mitigation/Compensation Measures, significance of unavoidable/residual impacts for each environmental factor;
- A table of contents at the beginning of the document;
- A description of the Development Consent procedure and how EIA fits within it;
- Reads as a single document with appropriate cross-referencing;
- Is concise, comprehensive and objective;
- Is written in an impartial manner without bias;
- Includes a full description and comparison of the Alternatives studied;
- Makes effective use of diagrams, illustrations, photographs and other graphics to support the text;
- Uses consistent terminology with a glossary;
- References all information sources used;
- Has a clear explanation of complex issues;
- Contains a good description of the methods used for the studies of each environmental factor;
- Covers each environmental factor in a way which is proportionate to its importance;
- Provides evidence of effective consultations (if some consultations have already taken place)
- Provides basis for effective consultations to come;
- Makes a commitment to mitigation (with a programme) and to monitoring;
- Contains a Non-Technical Summary which does not contain technical jargon;
- Contains, where relevant, a reference list detailing the sources used for the description and assessments included in the report.annex

51 Annex

51.1 Appendix A: Projects listed in Annex I of Directtive 97/11/EC

APPENDIX A
PROJECTS LISTED IN ANNEX I OF DIRECTIVE 97/11/EC

Article 4(1) of Directive 97/11/EC requires that the following types of projects must be subject to EIA.

Annex I Projects

1. Crude-oil refineries (excluding undertakings manufacturing only lubricants from crude oil) and installations for the gasification and liquefaction of 500 tonnes or more of coal or bituminous shale per day.

2. Thermal power stations and other combustion installations with a heat output of 300 megawatts or more, and nuclear power stations and other nuclear reactors including the dismantling or decommissioning of such power stations or reactors (*) (except research installations for the production and conversion of fissionable and fertile materials, whose maximum power does not exceed 1 kilowatt continuous thermal load).

3. (a) Installations for the reprocessing of irradiated nuclear fuel
   (b) Installations designed:
   - for the production or enrichment of nuclear fuel,
   - for the processing of irradiated nuclear fuel or high-level radioactive waste,
   - for the final disposal of irradiated nuclear fuel,
   - solely for the final disposal of radioactive waste,
   - solely for the storage (planned for more than 10 years) of irradiated nuclear fuels or radioactive waste in a different site than the production site.

4. (a) Integrated works for the initial smelting of cast-iron and steel
   (b)Installations for the production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes.

5. Installations for the extraction of asbestos and for the processing and transformation of asbestos and products containing asbestos: for asbestos-cement products, with an annual production of more than 20 000 tonnes of finished products, for friction material, with an annual production of more than 50 tonnes of finished products, and for other uses of asbestos, utilization of more than 200 tonnes per year.

6. Integrated chemical installations, i.e. those installations for the manufacture on an industrial scale of substances using chemical conversion processes, in which several units are juxtaposed and are functionally linked to one another and which are:
   (i) for the production of basic organic chemicals;
   (ii) for the production of basic inorganic chemicals;
   (iii) for the production of phosphorous-, nitrogen- or potassium-based fertilizers (simple or compound fertilizers);
   (iv) for the production of basic plant health products and of biocides;
   (v) for the production of basic pharmaceutical products using a chemical or biological process;
   (vi) for the production of explosives.

7. (a) Construction of lines for long-distance railway traffic and of airports (1) with a basic runway length of 2 100 m or more;
(b) Construction of motorways and express roads (2);
(c) Construction of a new road of four or more lanes, or realignment and/or widening of an existing road of two lanes or less so as to provide four or more lanes, where such new road, or realigned and/or widened section of road would be 10 km or more in a continuous length.

8. (a) Inland waterways and ports for inland-waterway traffic which permit the passage of vessels of over 1 350 tonnes;
(b) Trading ports, piers for loading and unloading connected to land and outside ports (excluding ferry piers) which can take vessels of over 1 350 tonnes.

9. Waste disposal installations for the incineration, chemical treatment as defined in Annex IIA to Directive 75/442/EEC (3) under heading D9, or landfill of hazardous waste (i.e. waste to which Directive 91/689/EEC (4) applies).

10. Waste disposal installations for the incineration or chemical treatment as defined in Annex IIA to Directive 75/442/EEC under heading D9 of non-hazardous waste with a capacity exceeding 100 tonnes per day.

11. Groundwater abstraction or artificial groundwater recharge schemes where the annual volume of water abstracted or recharged is equivalent to or exceeds 10 million cubic metres.

12. (a) Works for the transfer of water resources between river basins where this transfer aims at preventing possible shortages of water and where the amount of water transferred exceeds 100 million cubic metres/year;
(b) In all other cases, works for the transfer of water resources between river basins where the multi-annual average flow of the basin of abstraction exceeds 2 000 million cubic metres/year and where the amount of water transferred exceeds 5 % of this flow.
In both cases transfers of piped drinking water are excluded.

13. Waste water treatment plants with a capacity exceeding 150 000 population equivalent as defined in Article 2 point (6) of Directive 91/271/EEC (5).

14. Extraction of petroleum and natural gas for commercial purposes where the amount extracted exceeds 500 tonnes/day in the case of petroleum and 500 000 m3/day in the case of gas.

15. Dams and other installations designed for the holding back or permanent storage of water, where a new or additional amount of water held back or stored exceeds 10 million cubic metres.

16. Pipelines for the transport of gas, oil or chemicals with a diameter of more than 800 mm and a length of more than 40 km.

17. Installations for the intensive rearing of poultry or pigs with more than:

    (a) 85 000 places for broilers, 60 000 places for hens;
    (b) 3 000 places for production pigs (over 30 kg); or
    (c) 900 places for sows.

18. Industrial plants for the
    (a) production of pulp from timber or similar fibrous materials;
    (b) production of paper and board with a production capacity exceeding 200 tonnes per day.

19. Quarries and open-cast mining where the surface of the site exceeds 25 hectares, or peat extraction, where the surface of the site exceeds 150 hectares.

20. Construction of overhead electrical power lines with a voltage of 220 kV or more and a length of more than 15 km.

21. Installations for storage of petroleum, petrochemical, or chemical products with a capacity of 200 000 tonnes or more.

51.2 Appendix B: Projects listed in Annex II of Directtive 97/11/EC

APPENDIX B
PROJECTS LISTED IN ANNEX II OF DIRECTIVE 97/11/EC

Article 4(2) of Directive 97/11/EC requires that the following types of projects must be subject to EIA if it is determined, either by case-by-case examination or on the basis of thresholds and criteria set by the Member State, that they are likely to have significant effects on the environment.

Annex II Projects

1. Agriculture, silviculture and aquaculture
   (a) Projects for the restructuring of rural land holdings;
   (b) Projects for the use of uncultivated land or semi-natural areas for intensive agricultural purposes;
   (c) Water management projects for agriculture, including irrigation and land drainage projects;
   (d) Initial afforestation and deforestation for the purposes of conversion to another type of land use;
   (e) Intensive livestock installations (projects not included in Annex I);
   (f) Intensive fish farming;
   (g) Reclamation of land from the sea.

2. Extractive industry
   (a) Quarries, open-cast mining and peat extraction (projects not included in Annex I);
   (b) Underground mining;
   (c) Extraction of minerals by marine or fluvial dredging;
   (d) Deep drillings, in particular:
   - geothermal drilling,
   - drilling for the storage of nuclear waste material,
   - drilling for water supplies,

   with the exception of drillings for investigating the stability of the soil;
   (e) Surface industrial installations for the extraction of coal, petroleum, natural gas and ores, as well as bituminous shale.

3. Energy industry
   (a) Industrial installations for the production of electricity, steam and hot water (projects not included in Annex I);
   (b) Industrial installations for carrying gas, steam and hot water; transmission of electrical energy by overhead cables (projects not included in Annex I);
   (c) Surface storage of natural gas;
   (d) Underground storage of combustible gases;
   (e) Surface storage of fossil fuels;
   (f) Industrial briquetting of coal and lignite;
   (g) Installations for the processing and storage of radioactive waste (unless included in Annex I);
   (h) Installations for hydroelectric energy production;
   (i) Installations for the harnessing of wind power for energy production (wind farms).

4. Production and processing of metals
   (a) Installations for the production of pig iron or steel (primary or secondary fusion) including continuous casting;
   (b) Installations for the processing of ferrous metals:
   (i) hot rolling mills;

(b) Installations for the processing of ferrous metals:
- (i) hot-rolling mills;
- (ii) smithies with hammers;
- (iii) application of protective fused metal coats;

(c) Ferrous metal foundries;
(d) Installations for the smelting, including the alloyage, of non-ferrous metals, excluding precious metals, including recovered products (refining, foundry casting, etc.);
(e) Installations for surface treatment of metals and plastic materials using an electrolytic or chemical process;
(f) Manufacture and assembly of motor vehicles and manufacture of motor-vehicle engines;
(g) Shipyards;
(h) Installations for the construction and repair of aircraft;
(i) Manufacture of railway equipment;
(j) Swaging by explosives;
(k) Installations for the roasting and sintering of metallic ores.

5. Mineral industry
(a) Coke ovens (dry coal distillation);
(b) Installations for the manufacture of cement;
(c) Installations for the production of asbestos and the manufacture of asbestos-products (projects not included in Annex I);
(d) Installations for the manufacture of glass including glass fibre;
(e) Installations for smelting mineral substances including the production of mineral fibres;
(f) Manufacture of ceramic products by burning, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain.

6. Chemical industry (Projects not included in Annex I)
(a) Treatment of intermediate products and production of chemicals;
(b) Production of pesticides and pharmaceutical products, paint and varnishes, elastomers and peroxides;
(c) Storage facilities for petroleum, petrochemical and chemical products.

7. Food industry
(a) Manufacture of vegetable and animal oils and fats;
(b) Packing and canning of animal and vegetable products;
(c) Manufacture of dairy products;
(d) Brewing and malting;
(e) Confectionery and syrup manufacture;
(f) Installations for the slaughter of animals;
(g) Industrial starch manufacturing installations;
(h) Fish-meal and fish-oil factories;
(i) Sugar factories.

8. Textile, leather, wood and paper industries
   (a) Industrial plants for the production of paper and board (projects not included in Annex I);
   (b) Plants for the pretreatment (operations such as washing, bleaching, mercerization) or dyeing of fibres or textiles;
   (c) Plants for the tanning of hides and skins;
   (d) Cellulose-processing and production installations.

9. Rubber industry - Manufacture and treatment of elastomer-based products.

10. Infrastructure projects
   (a) Industrial estate development projects;
   (b) Urban development projects, including the construction of shopping centres and car parks;
   (c) Construction of railways and intermodal transshipment facilities, and of intermodal terminals (projects not included in Annex I);
   (d) Construction of airfields (projects not included in Annex I);
   (e) Construction of roads, harbours and port installations, including fishing harbours (projects not included in Annex I);
   (f) Inland-waterway construction not included in Annex I, canalisation and flood-relief works;
   (g) Dams and other installations designed to hold water or store it on a long-term basis (projects not included in Annex I);
   (h) Tramways, elevated and underground railways, suspended lines or similar lines of a particular type, used exclusively or mainly for passenger transport;
   (i) Oil and gas pipeline installations (projects not included in Annex I);
   (j) Installations of long-distance aqueducts;
   (k) Coastal work to combat erosion and maritime works capable of altering the coast through the construction, for example, of dykes, moles, jetties and other sea defence works, excluding the maintenance and reconstruction of such works;
   (l) Groundwater abstraction and artificial groundwater recharge schemes not included in Annex I;
   (m) Works for the transfer of water resources between river basins not included in Annex I.

11. Other projects
   (a) Permanent racing and test tracks for motorised vehicles;
   (b) Installations for the disposal of waste (projects not included in Annex I);
   (c) Waste-water treatment plants (projects not included in Annex I);
   (d) Sludge-deposition sites;
   (e) Storage of scrap iron, including scrap vehicles;
   (f) Test benches for engines, turbines or reactors;
   (g) Installations for the manufacture of artificial mineral fibres;
   (h) Installations for the recovery or destruction of explosive substances;
   (i) Knackers' yards.

12. Tourism and leisure
   (a) Ski-runs, ski-lifts and cable-cars and associated developments;

51.3 Appendix C: Projects listed in Annex IV of Directtive 97/11/EC

APPENDIX C
ANNEX III SCREENING SELECTION CRITERIA

Article 4(3) of Directive 97/11/EC requires that Competent Authorities must take into account the selection criteria set out in Annex III of the Directive when making screening decisions on a case-by-case basis and when setting thresholds and criteria for projects requiring EIA.

1. Characteristics of Projects

The characteristics of projects must be considered having regard, in particular, to:

- the size of the project,
- the cumulation with other projects,
- the use of natural resources,
- the production of waste,
- pollution and nuisances,
- the risk of accidents, having regard in particular to substances or technologies used.

2. Location of Projects

The environmental sensitivity of geographical areas likely to be affected by projects must be considered, having regard, in particular, to:

- the existing land use,
- the relative abundance, quality and regenerative capacity of natural resources in the area,
- the absorption capacity of the natural environment, paying particular attention to the following areas:
  - wetlands;
  - coastal zones;
  - mountain and forest areas;
  - nature reserves and parks;
  - areas classified or protected under Member States' legislation;
  - special protection areas designated by Member States pursuant to Directive 79/409/EEC and 92/43/EEC;
  - areas in which the environmental quality standards laid down in Community legislation have already been exceeded;
  - densely populated areas;
  - landscapes of historical, cultural or archaeological significance.

3. Characteristics of the Potential Impact

The potential significant effects of projects must be considered in relation to criteria set out under 1 and 2 above, and having regard in particular to:

- the extent of the impact (geographical area and size of the affected population),
- the transfrontier nature of the impact,
- the magnitude and complexity of the impact,
- the probability of the impact,
- the duration, frequency and reversibility of the impact.

51.4 Appendix D: Projects listed in Annex IV of Directtive 97/11/EC

APPENDIX D
ENVIRONMENTAL INFORMATION REQUIREMENTS SET OUT IN ANNEX IV OF DIRECTIVE 97/11/EC

Article 5(1) of Directive 97/11/EC requires the Developer to provide to the Competent Authority the information set out below in so much as the information is relevant to the given stage of the consent procedure and to the specific characteristics of the project and of the environmental features likely to be affected, and the developer may reasonably be required to compile the information having regard *inter alia* to current knowledge and methods of assessment.

Environmental Information Requirements for EIA
1. Description of the project, including in particular: - a description of the physical characteristics of the whole project and the land-use requirements during the construction and operational phases, - a description of the main characteristics of the production processes, for instance, nature and quantity of the materials used, - an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting from the operation of the proposed project.
2. An outline of the main alternatives studied by the developer and an indication of the main reasons for this choice, taking into account the environmental effects.
3. A description of the aspects of the environment likely to be significantly affected by the proposed project, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and the inter-relationship between the above factors.
4. A description of the likely significant effects of the proposed project on the environment resulting from: - the existence of the project, - the use of natural resources, - the emission of pollutants, the creation of nuisances and the elimination of waste, and the description by the developer of the forecasting methods used to assess the effects on the environment.
5. A description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment.
6. A non-technical summary of the information provided under the above headings.
7. An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information.

References

http://ec.europa.eu/environment/eia/eia-support.htm

Conference in Chamber of Commerce, Industry and Agriculture Tripoli, Lebanon (2MW plant Build-Operation-Transfer (BOT))

52 Meeting Organization

52.1 Request

بسم الله الرحمن الرحيم

جانب رئيس غرفة التجارة والصناعة في الشمال السيد توفيق دبوسي المحترم

الموضوع: حجز قاعة بغرفة التجارة والصناعة

السلام عليكم ورحمة الله وبركاته،

نحن مؤسسة **طاقة الشمال NLAP** رقم سجل تجاري 3010736 بالتعاون مع **الجمعية العلمية اللبنانية LSA والجمعية العلمية الألمانية AECENAR** نتوجّه إليكم بهذا الكتاب لحجز القاعة الزجاجيّة بمبنى الغرفة بتاريخ 2019/03/13 من الساعة 4:30 مساءً إلى الساعة 6:30 مساءً لعددٍ يتراوح بيْن 200 و 300 شخص بهدف الاعلان عن مبادرتنا وعرض لمشروع توليد طاقة كهربائية تعمل على نظام التفكك الحراري وذلك بالتنسيق مع رئيس بلدية طرابلس الأستاذ أحمد قمر الدين

وتفضلوا بقبول فائق الاحترام.

م. زياد ملك
مدير بـرامـج مؤسسة طاقة الشمال

د. سمير مراد
رئيس LSA و AECENAR ومدير مؤسسة طاقة الشمال

53 Speeches

53.1 Opening Speech

بسم الله الرحمن الرحيم

طرابلس 13.3.2019

الحمد لله الذي تتم بنعمته الصالحات، والحمد لله الذي هدى إلى هذا العمل بلطفه وأعان على إنجازه بكرمه ومعروفه. والصلاة والسلام على المبعوث رحمة للعالمين نبينا محمد وعلى صحبه أجمعين.

حضرة رئيس بلدية طرابلس احمد قمر الدين

حضرة رئيس غرفة التجارة والصناعة د. توفيق الدبوسي

حضرة العميد كرم مراد

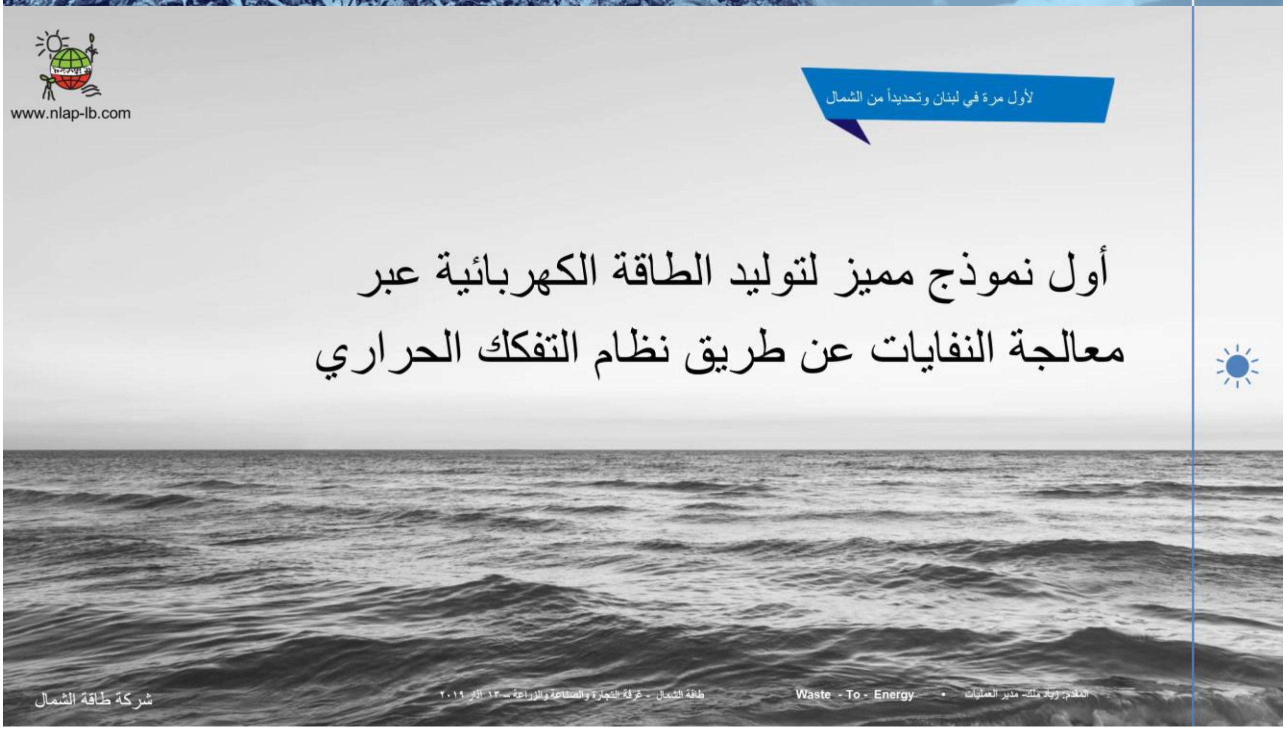
حضرة رؤساء اتحادات بلديات الشمال ورؤساء البلديات

حضرات الدكاترة الأفاضل، ممثلي الجامعات اللبنانية

حضرات **الضيوف والزملاء الكرام، الاخوة والاخوات، الذين نتشرف بوجودهم جميعا معنا اليوم في هذا اللقاء الهام :**

يسرني، غاية السرور،كرئيس لجمعية AECENARو لمؤسسة طاقة الشمال ان أرحب بكم جميعا فأهلا وسهلاً بكم.

53.2 Presentation



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المقدمة

بالتزامن مع اشتداد أزمة النفايات المتنقلة بين المناطق اللبنانية والقلق الدائم من استحداث مطامر العوادم التي تشكل عشرين الى ثلاثين في المئة من النفايات،تطرح شركة طاقة الشمال بالتعاون مع عدد من الخبراء والاختصاصيين حلولا علمية لمعالجة النفايات.

شركة طاقة الشمال

طاقة الشمال - غرفة التجارة والصناعة والزراعة – ١٣ آذار ٢٠١٩

Waste - To - Energy • المقدم: زياد ملك- مدير العمليات


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تاريخ الشركة
2005-2013
دراسات هندسية لصناعة محطة طاقة تجاربية محلية
2014
صناعة أول محطة تجاربية ولدت الكهرباء في رأسنحاش
2015
دراسات هندسية لزيادة القدرة الإنتاجية للمحطة وتفعيلها في طرابلس وبعض المدن الأخرى
2016
• انشاء وتشغيل اول نموذج لمحطة متنقلة مستوفية للشروط البيئية المعمول بها في لبنان
• مكتب للمؤسسة في طرابلس
المقدمة
2019
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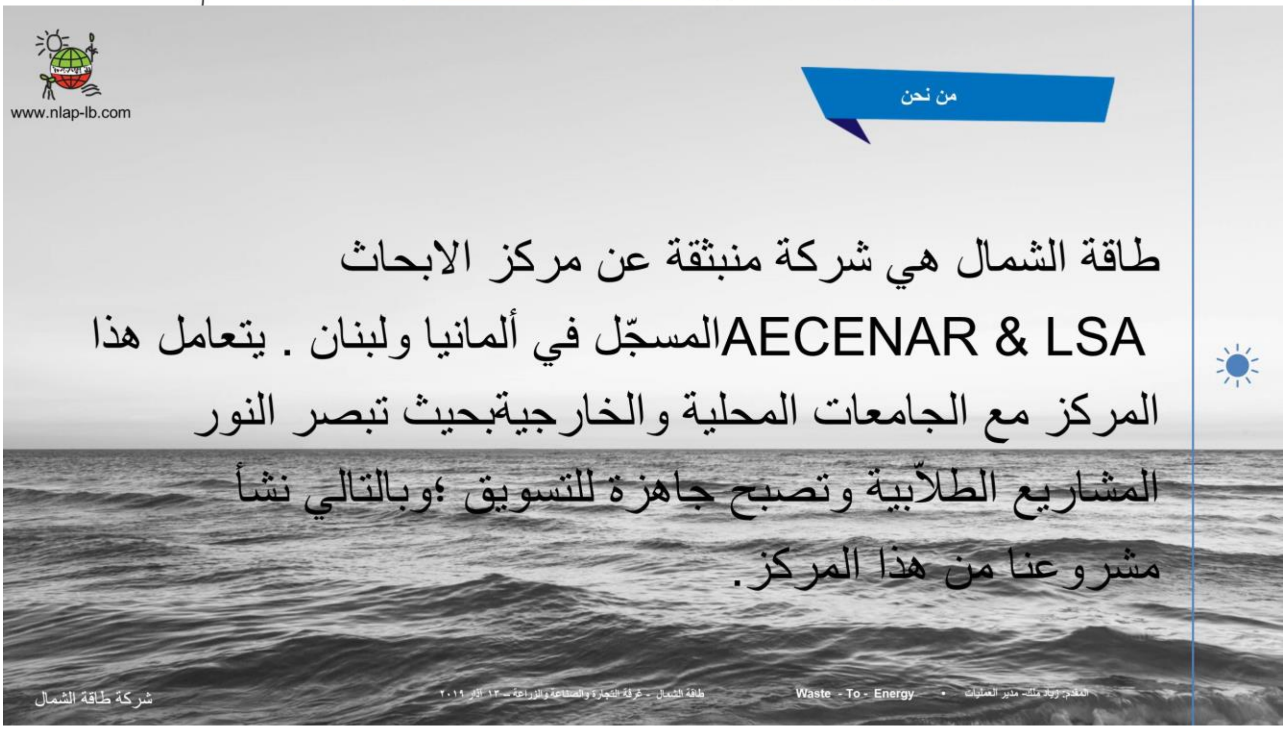
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طاقة الشمال هي شركة منبثقة عن مركز الابحاث
AECENAR & LSAالمسجّل في ألمانيا ولبنان . يتعامل هذا
المركز مع الجامعات المحلية والخارجيةبحيث تبصر النور
المشاريع الطلاّبية وتصبح جاهزة للتسويق ؛وبالتالي نشأ
مشروعنا من هذا المركز.
شركة طاقة الشمال
طاقة الشمال - غرفة التجارة والصناعة والزراعة ـ ١٣ آذار ٢٠١٩
Waste - To - Energy
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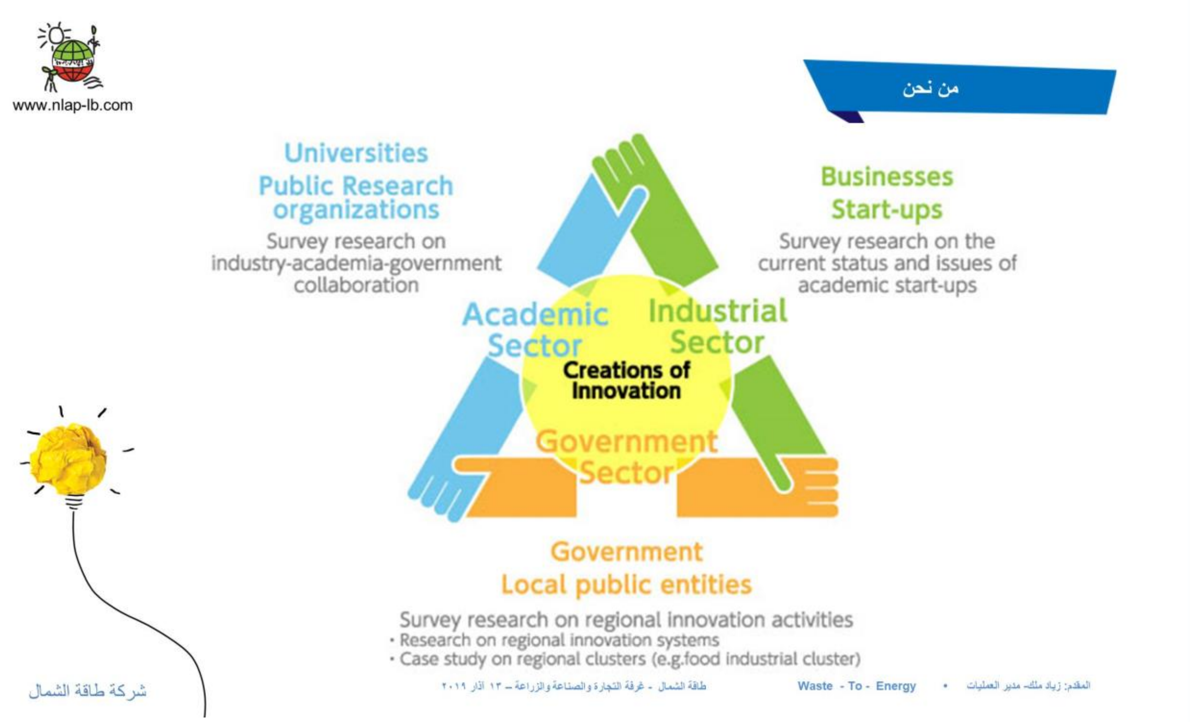
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Survey research on industry-academia-government collaboration
Businesses
Start-ups
Survey research on the current status and issues of academic start-ups
Academic Sector
Industrial Sector
Creations of Innovation
Government Sector
Government
Local public entities
Survey research on regional innovation activities
• Research on regional innovation systems
• Case study on regional clusters (e.g.food industrial cluster)
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Waste - To - Energy


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ابحاث تطبيقية لتطوير المجتمع والصناعة
ابحاث لزيادة المعرفة
الصناعة
(الإنتاج)
• ايجاد فرص عمل
• تقوية الاقتصاد
• الخروج من التبعية
التعليم
اعداد الطلاب نظريا
ISSIR
http://aecenar.com/partners/issir
يضع الخطط لتطور المجتمع تكنولوجيا
LASeR
TECDA Research Center
PhD thesis opportunities
LU École Doctorale
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المركز الوطني للفضاء
TEMO Soft-, Hardware & Consulting e.K., Germany
www.temo-ek.de, Owner: Samir Mourad
TECDA Technology Center
انشاء المشاريع
تدريب الطلاب
تأسيس شركات
practical work (stage), bachelor&master thesis opportunities
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الجامعة العربية
BAU (Beirut Arab Univ.)
LIU (Lebanese International Univ.)
ULF (Université Libanais-Francais)
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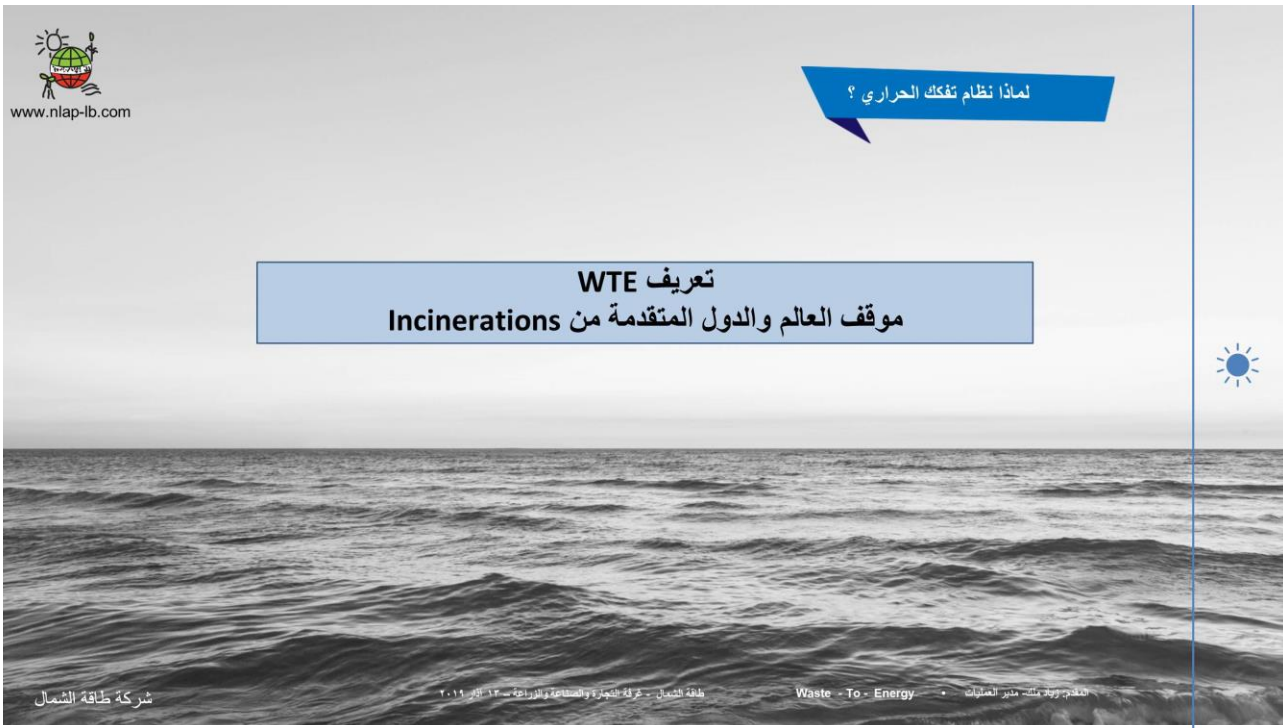
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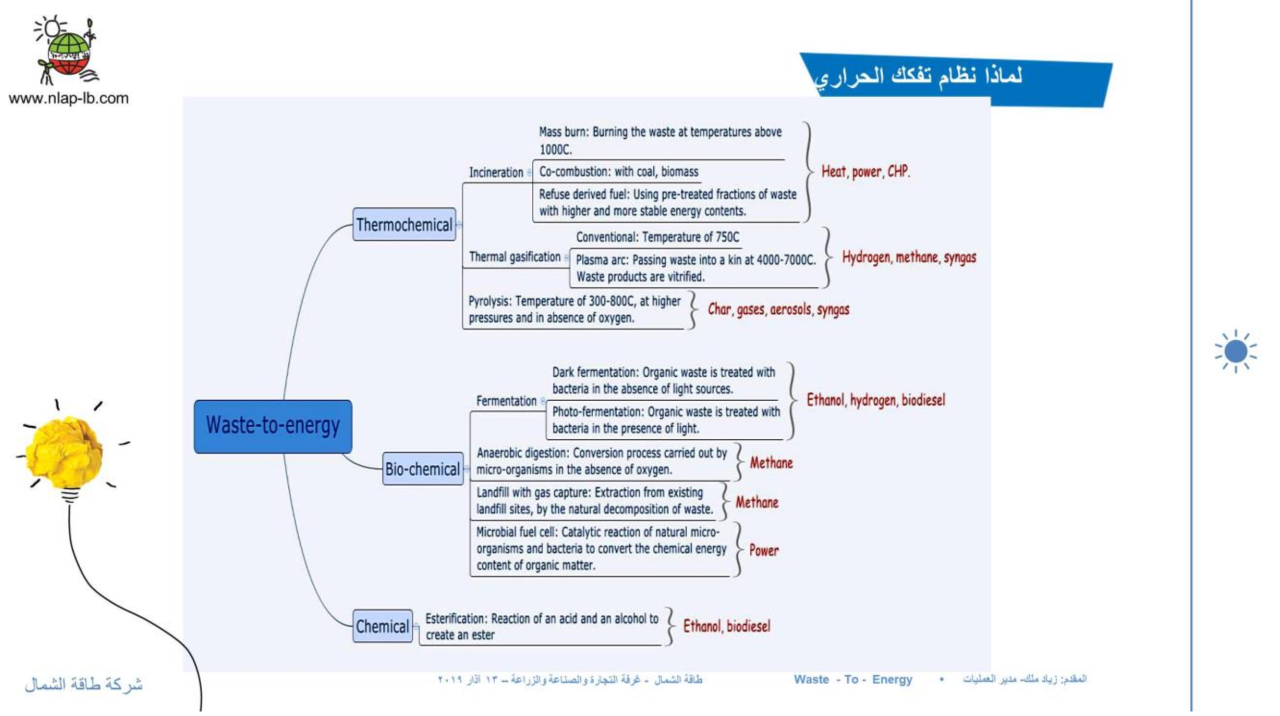
لماذا نظام تفكك الحراري ؟
تعريف WTE
موقف العالم والدول المتقدمة من Incinerations
شركة طاقة الشمال
Waste - To - Energy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لماذا نظام تفكك الحراري
Waste-to-energy
Thermochemical
Incineration
Mass burn: Burning the waste at temperatures above 1000C.
Co-combustion: with coal, biomass
Refuse derived fuel: Using pre-treated fractions of waste with higher and more stable energy contents.
Heat, power, CHP.
Thermal gasification
Conventional: Temperature of 750C
Plasma arc: Passing waste into a kin at 4000-7000C. Waste products are vitrified.
Hydrogen, methane, syngas
Pyrolysis: Temperature of 300-800C, at higher pressures and in absence of oxygen.
Char, gases, aerosols, syngas
Bio-chemical
Fermentation
Dark fermentation: Organic waste is treated with bacteria in the absence of light sources.
Photo-fermentation: Organic waste is treated with bacteria in the presence of light.
Ethanol, hydrogen, biodiesel
Anaerobic digestion: Conversion process carried out by micro-organisms in the absence of oxygen.
Methane
Landfill with gas capture: Extraction from existing landfill sites, by the natural decomposition of waste.
Methane
Microbial fuel cell: Catalytic reaction of natural micro-organisms and bacteria to convert the chemical energy content of organic matter.
Power
Chemical
Esterification: Reaction of an acid and an alcohol to create an ester
Ethanol, biodiesel
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Waste - To - Energy

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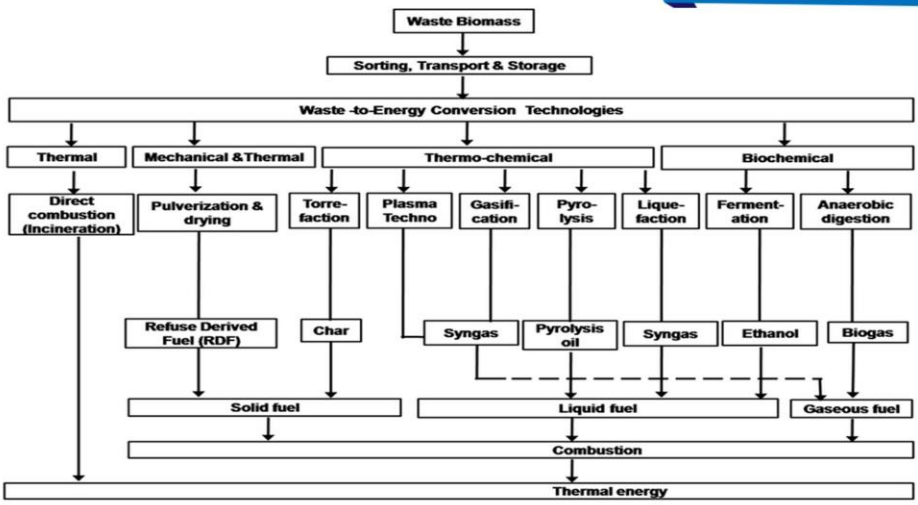

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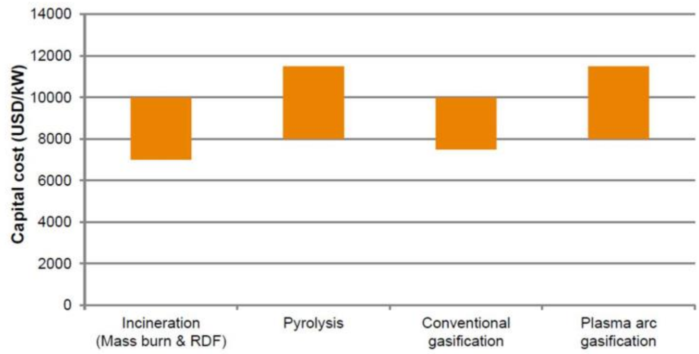
لماذا نظام تفكك الحراري

CAPITAL COSTS FOR THERMAL WTE POWER GENERATION TECHNOLOGIES IN THE UNITED STATES (15 MW OUTPUT)

The capital investments for the construction and implementation of these technologies, and the costs needed to operate them for the entire lifetime of a chosen project can influence decisions.

As of today, incineration of MSW still presents the most desirable economic conditions on the market, and is therefore the preferred option in most markets.



Source: Stringfellow (2014)

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BIOMASS AND WASTE POLICY TARGETS IN SELECTED COUNTRIES

Country	Biomass and waste targets
China	30 GW by 2020
Germany	14% of heating by 2020
Indonesia	810 MW by 2025
Norway	14 TWh annual production by 2020
Philippines	267 MW by 2030
United States	Contained in state-level Renewable Portfolio Standards

Source: Navigant Research (2014)

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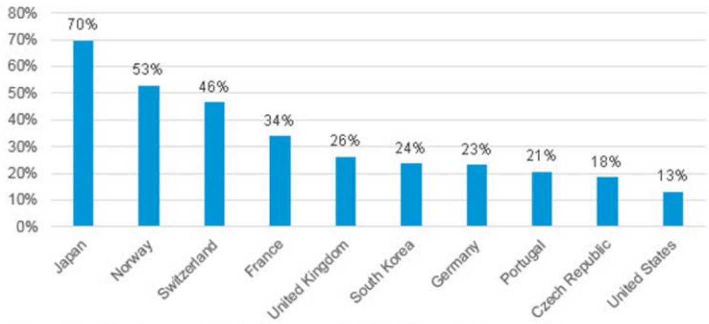
Percent of total municipal sold waste that is burned with energy recovery in selected countries



Note: Data for Japan and South Korea are for 2013. Data for other countries are for 2014.
Source: U.S. Environmental Protection Agency for the United States, Organization for Economic Cooperation and Development for other countries

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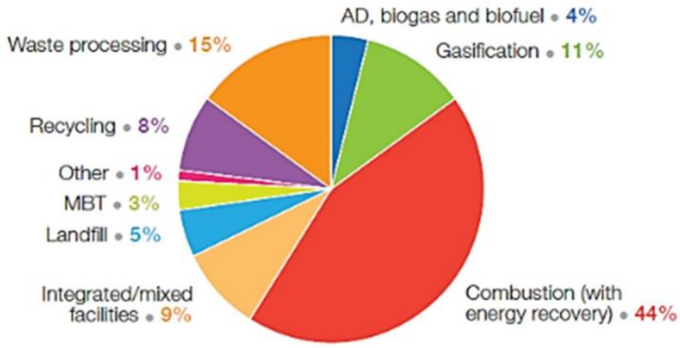
Utility Scale Plants existing according to the technology used.

(Data from 93 countries in 2013-2014 (total of 2723 facilities)).



*(Mechanical

Biological Treatm
-MBT)

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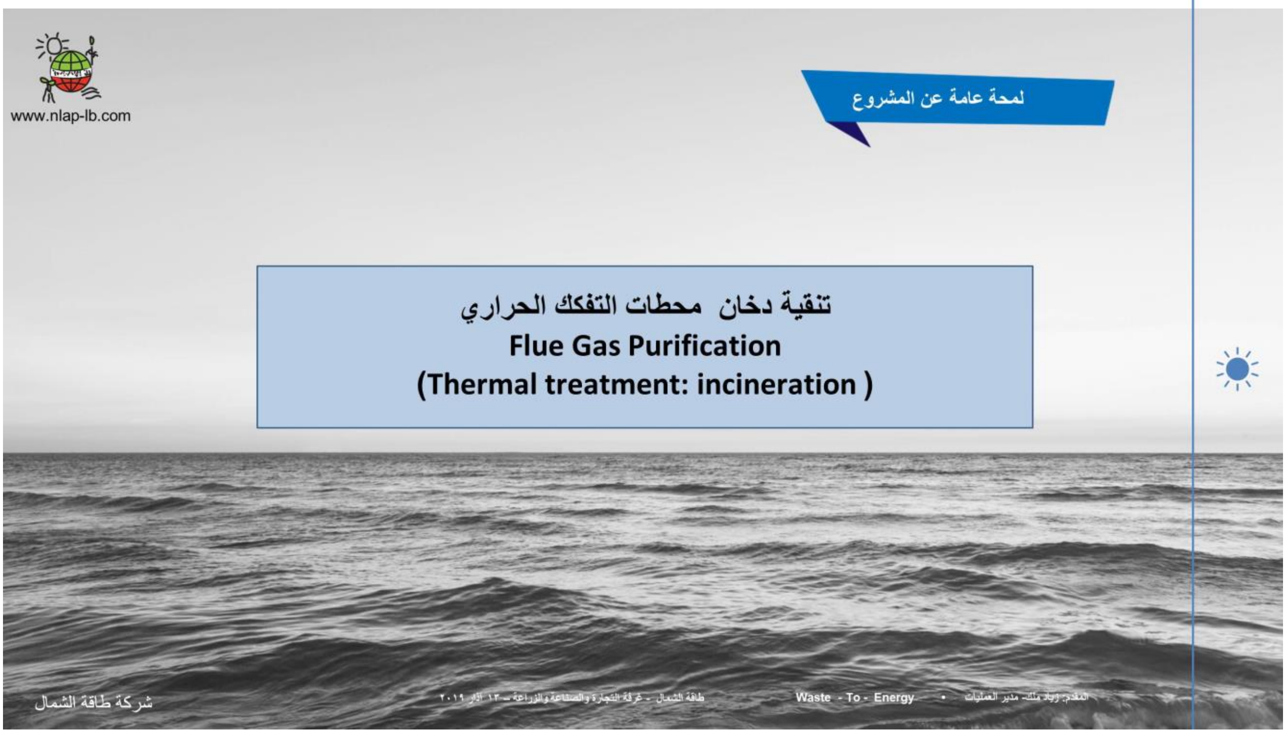
Incinerator in world
لماذا نظام تفكك الحراري
The largest scale plant with the capacity to handle 4,320t/day was built in Singapore in only 38months
Source: Mitsubishi Heavy Industries, Environmental & Chemical Engineering Co., Ltd.
In Thailand, an industrial waste incinerator has been operating from 2006. Its treatment capacity is 100t/day.
Source: JFE Engineering Corporation
Waste - To - Energy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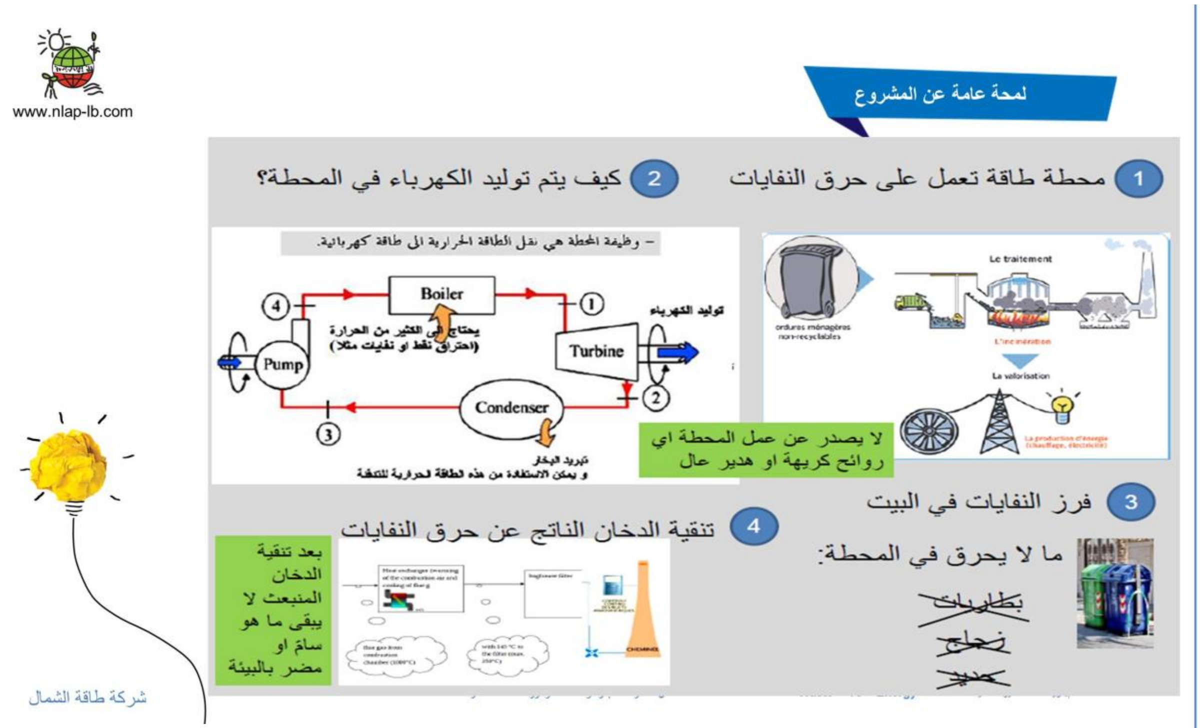
لمحة عامة عن المشروع
تنقية دخان محطات التفكك الحراري
Flue Gas Purification
(Thermal treatment: incineration)
شركة طاقة الشمال
Waste - To - Energy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لمحة عامة عن المشروع
1 محطة طاقة تعمل على حرق النفايات
2 كيف يتم توليد الكهرباء في المحطة؟
- وظيفة المحطة هي نقل الطاقة الحرارية الى طاقة كهربائية.
Boiler
Pump
Turbine
Condenser
توليد الكهرباء
يحتاج الى الكثير من الحرارة (احتراق نفط او نفايات مثلا)
تبريد البخار
و يمكن الاستفادة من هذه الطاقة الحرارية للتدفئة
Le traitement
L'incinération
La valorisation
لا يصدر عن عمل المحطة اي روائح كريهة او هدير عال
3 فرز النفايات في البيت
ما لا يحرق في المحطة:
بطاريات
زجاج
حديد
4 تنقية الدخان الناتج عن حرق النفايات
بعد تنقية الدخان المنبعث لا يبقى ما هو سام او مضر بالبيئة
شركة طاقة الشمال


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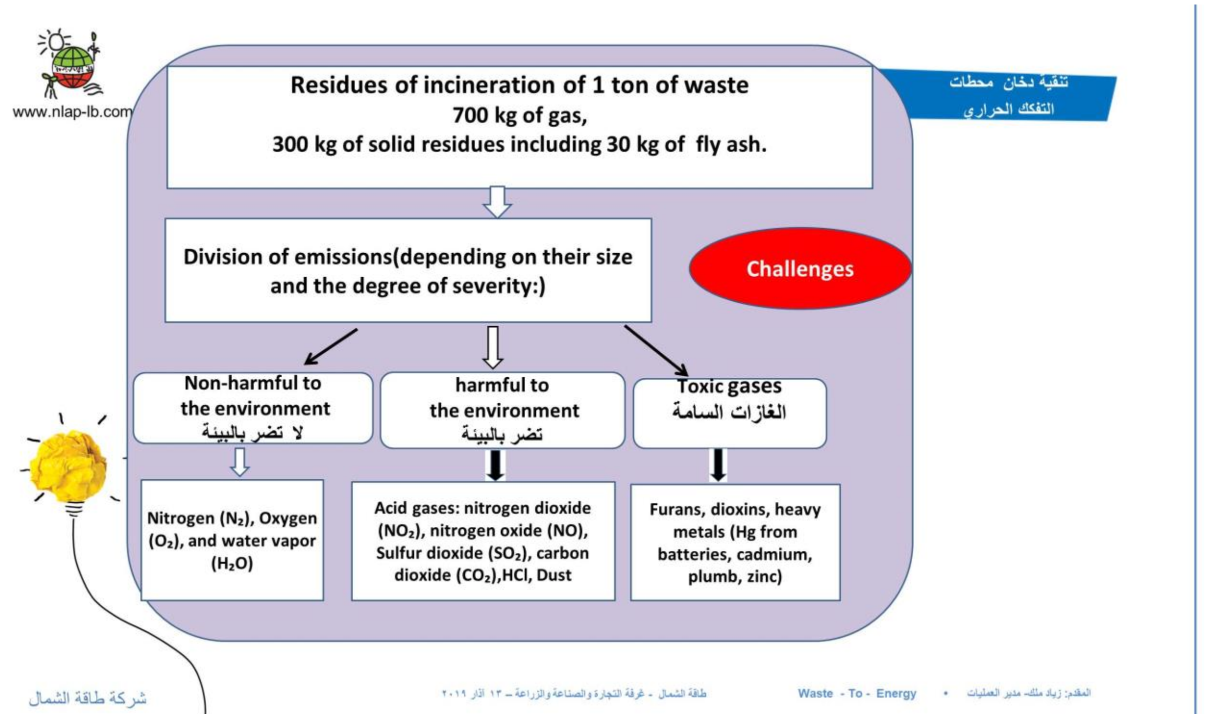
لمحة عامة عن المشروع
Fraction | Net Calorific Value (MJ/kg)
Paper | 16
Organic material | 4
Plastics | 35
Glass | 0
Metals | 0
Textiles | 19
Other materials | 11
Source: ISWA (2013)
شركة طاقة الشمال
Waste - To - Energy
21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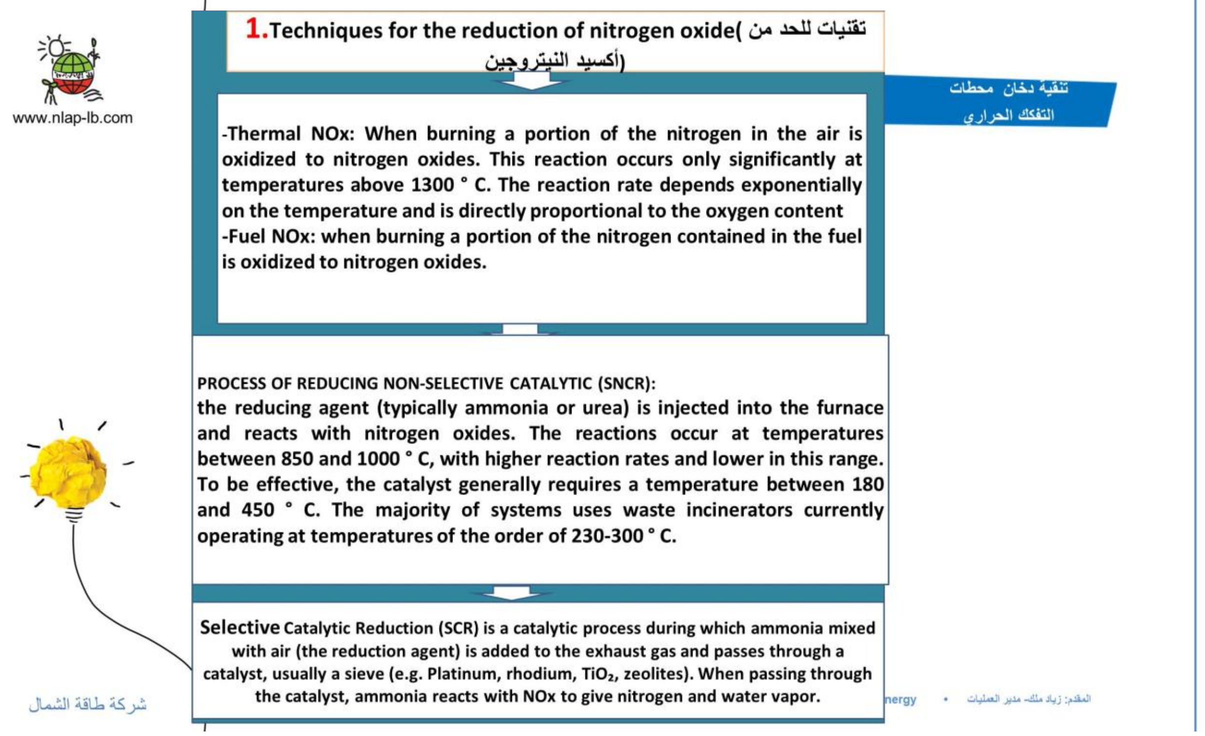
تنقية دخان محطات التفكك الحراري
Residues of incineration of 1 ton of waste
700 kg of gas,
300 kg of solid residues including 30 kg of fly ash.
Division of emissions(depending on their size and the degree of severity:)
Challenges
Non-harmful to the environment لا تضر بالبيئة
harmful to the environment تضر بالبيئة
Toxic gases الغازات السامة
Nitrogen (N_2), Oxygen (O_2), and water vapor (H_2O)
Acid gases: nitrogen dioxide (NO_2), nitrogen oxide (NO), Sulfur dioxide (SO_2), carbon dioxide (CO_2),HCl, Dust
Furans, dioxins, heavy metals (Hg from batteries, cadmium, plumb, zinc)
شركة طاقة الشمال
Waste - To - Energy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تنقية دخان محطات التفكك الحراري
1.Techniques for the reduction of nitrogen oxide(تقنيات للحد من أكسيد النيتروجين)
-Thermal NOx: When burning a portion of the nitrogen in the air is oxidized to nitrogen oxides. This reaction occurs only significantly at temperatures above 1300 ° C. The reaction rate depends exponentially on the temperature and is directly proportional to the oxygen content
-Fuel NOx: when burning a portion of the nitrogen contained in the fuel is oxidized to nitrogen oxides.
PROCESS OF REDUCING NON-SELECTIVE CATALYTIC (SNCR):
the reducing agent (typically ammonia or urea) is injected into the furnace and reacts with nitrogen oxides. The reactions occur at temperatures between 850 and 1000 ° C, with higher reaction rates and lower in this range. To be effective, the catalyst generally requires a temperature between 180 and 450 ° C. The majority of systems uses waste incinerators currently operating at temperatures of the order of 230-300 ° C.
Selective Catalytic Reduction (SCR) is a catalytic process during which ammonia mixed with air (the reduction agent) is added to the exhaust gas and passes through a catalyst, usually a sieve (e.g. Platinum, rhodium, TiO_2, zeolites). When passing through the catalyst, ammonia reacts with NOx to give nitrogen and water vapor.
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2.Treatment of dioxin and furans and mercury Hg & CO_2(علاج الديوكسين والفيوران)

By activated carbon(can be also called "lignite Coke for odorous compounds.)
Activated carbon is in the form of a fine black talc. Its elementary particles are made porous by a suitable heat treatment so as to create therein pores having dimensions of affinity with the molecules to be filtered. So there are formulations of active carbon adapted to different molecules that one wishes to retain.

The Environmental Protection Agency (EPA) showed that dioxins broke down easily when exposed to temperatures in excess of 1,200 °C.

To obtain a minimum feeding rate (F(min)) of activated carbon (AC), It was found that dioxin removal efficiency(eta) increased with an increase in AC feeding concentration. This had an almost linear function to F/Q when F/Q was less than 65 g/Nm(3), where F was the AC feeding rate (mg/min), and Q was the volumetric flow rate of flue gas (Nm(^{3})/min). However, it did not seem to be affected by F/Q, when F/Q was larger than 150 mg/Nm(^{3}). On the basis of the experimental data obtained in this study, the removal efficiency of dioxins by the application of AC could be correlated as eta (%)=100/[1.0+(40.2/(F/Q)(3))]. It is valid in appropriate conditions (F/Q=10-300 mg/Nm(^{3})) suggested by the study with a statistical error of +/-18%.

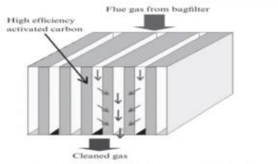
Measurement :The Intelligent Gravimetric Analyzer (IGA)
The system is an ultra-high vacuum (UHV) system and allows measurement of isotherms and accurate determination of the adsorption and desorption kinetic profiles for each pressure step. The system consists of a fully computer controlled microbalance, pressure admit system and temperature regulation system

Dioxins concentrations at activated carbon adsorber

	Dioxins concentrations ($ng\text{-}TEQ/m^3$-norm.)		Removal-efficiency (%)
	Inlet	Outlet	
Electric furnace for steel	5.5	0.009 3	99.83
Ash melting furnace	1.8	0.000 80	99.96
Waste furnace	1.1	0.000 16	99.99

Hg concentrations at activated carbon adsorber

	Inlet (mg/m^3-norm.)	Outlet (mg/m^3-norm.)
Waste furnace	0.065	<0.005 (Under determination limit)
Ash melting furnace	0.57	<0.005 (Under determination limit)



Cartridge packed with activated carbon

JFE TECHNICAL REPORT No. 19 (Mar. 2014)

Ref:Minimum feeding rate of activated carbon to control dioxin emissions from a large-scale municipal solid waste incinerator, Article in Journal of Hazardous Materials 161(2-3):1436-43 · June 2008 with 289 Reads DOI: 10.1016/j.jhazmat.2008.04.128 · Source: PubMed

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3.Acid gas treatment technologies(HF, HCl and SO_2)تقنيات معالجة الغاز الحمضي

Depending on the concentrations, temperature, size of the flow to be treated and of further parameters, can be used different technologies for the treatment of acid gas emissions. Being a quick summary we can mention:

Bag filters with reagent injection(calcium hydroxide ($Ca(OH)_2$) or sodium bicarbonate))

The filters in flat bags are successfully used for the chemical absorption of acid gases such as HF, HCl and SO_2 in addition to the adsorption of other pollutant compounds. Generally it is used, among others, calcium hydroxide and sodium bicarbonate ($Ca(OH)_2$) of typical commercial quality, which is injected in the gas stream before entering the filter. To achieve proper compliance with the emission limits required, the additive should be added in amounts over-stoichiometric (from 1.5 to 3 times).
at least 130-200 ° C

تنقية دخان محطات
التفكك الحراري

- Treatment by $Ca(OH)_2$:

$Ca(OH)_2 + 2HCl \leftrightharpoons CaCl_2 + 2H_2O$

$Ca(OH)_2 + 2HF \leftrightharpoons CaF_2 + 2H_2O$

$Ca(OH)_2 + SO_2 \leftrightharpoons CaSO_3 + H_2O$

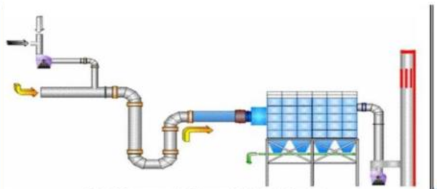
$CaSO_3 + 1/2\ O_2 \rightarrow CaSO_4$

- Treatment by $NaHCO_3$:

$NaHCO_3 + HCl \leftrightharpoons NaCl + CO_2 + H_2O$

$NaHCO_3 + HF \leftrightharpoons NaF + CO_2 + H_2O$

$2NaHCO_3 + SO_2 + 1/2O_2 \rightarrow Na_2SO_4 + 2CO_2 + H_2O$


Typical dry process (solid reagent injection in the pipe) With downstream de-duster

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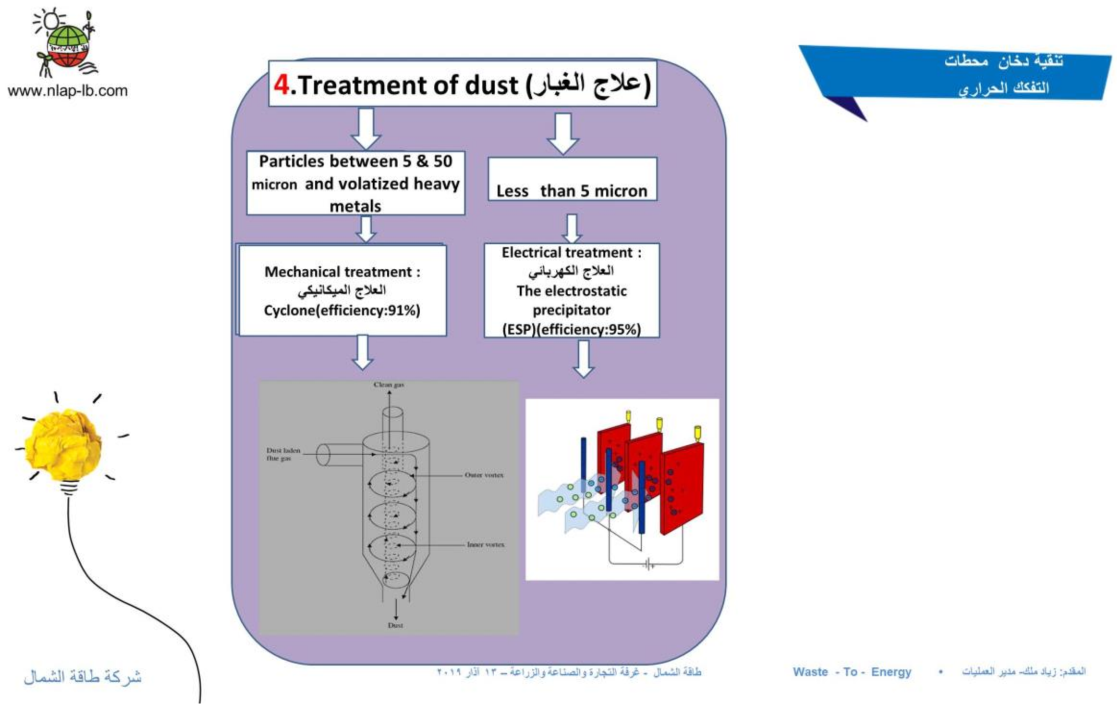

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تنقية دخان محطات التفكك الحراري

Bottom & flying ashes: heavy metals recovery

Heavy Metals Recycling Unit for NLAP-IPP Demonstration Plant

Lists of metals (mg/kg)

Element bottom ash	Bottom ash	Fly ash	Dry / quasi-dry	wet
Al	22.000-73.000	49.000 - 90.000	12.000-83.000	21.000-39.000
Cd	0.3-70	50-450	140-300	150-1.400
Cu	190-8.200	600-3.200	16-1.700	440-2.400
Fe	4.100-1500	12.000 - 44.000	2.600-71.000	20.000-97.000
Hg	0,02-8	0,7-30	0,1-51	2,2-2.300
Mo	2-280	15-150	9-29	2-44
Pb	100-13.700	5.300-26.000	2.500-10.000	3.300-22.000
Zn	61-7.800	7.000-70.000	7.000-20.000	8.100-53.000

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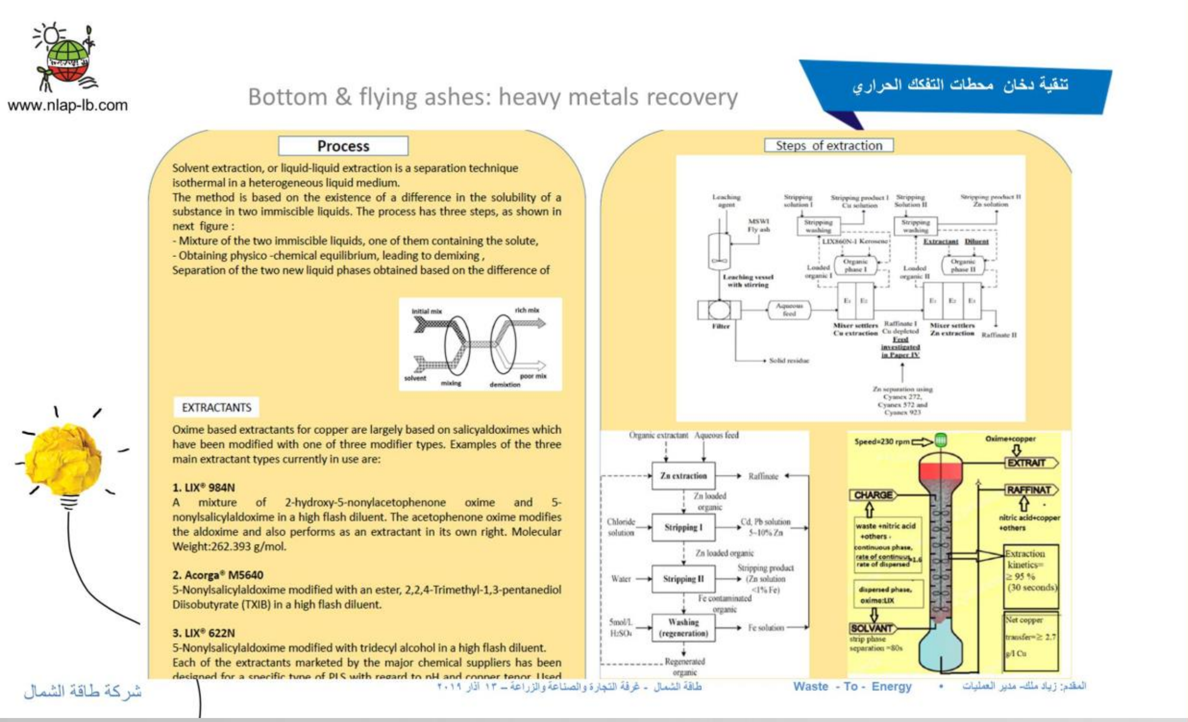
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تنقية دخان محطات التفكك الحراري
Bottom & flying ashes: heavy metals recovery
Process
Solvent extraction, or liquid-liquid extraction is a separation technique isothermal in a heterogeneous liquid medium.
The method is based on the existence of a difference in the solubility of a substance in two immiscible liquids. The process has three steps, as shown in next figure :
- Mixture of the two immiscible liquids, one of them containing the solute,
- Obtaining physico -chemical equilibrium, leading to demixing ,
Separation of the two new liquid phases obtained based on the difference of
initial mix
rich mix
solvent
mixing
demixtion
poor mix
EXTRACTANTS
Oxime based extractants for copper are largely based on salicyaldoximes which have been modified with one of three modifier types. Examples of the three main extractant types currently in use are:
1. LIX® 984N
A mixture of 2-hydroxy-5-nonylacetophenone oxime and 5-nonylsalicylaldoxime in a high flash diluent. The acetophenone oxime modifies the aldoxime and also performs as an extractant in its own right. Molecular Weight:262.393 g/mol.
2. Acorga® M5640
5-Nonylsalicylaldoxime modified with an ester, 2,2,4-Trimethyl-1,3-pentanediol Diisobutyrate (TXIB) in a high flash diluent.
3. LIX® 622N
5-Nonylsalicylaldoxime modified with tridecyl alcohol in a high flash diluent.
Each of the extractants marketed by the major chemical suppliers has been
Steps of extraction
Zn extraction
Stripping I
Stripping II
Washing (regeneration)
Raffinate
CHARGE
EXTRAIT
RAFFINAT
SOLVANT
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طاقة الشمال - غرفة التجارة والصناعة والزراعة – ١٣ آذار ٢٠١٩
Waste - To - Energy
المقدم: زياد ملك- مدير العمليات


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نظام التحكم في العمليات
Processing Control Unit (PCU)
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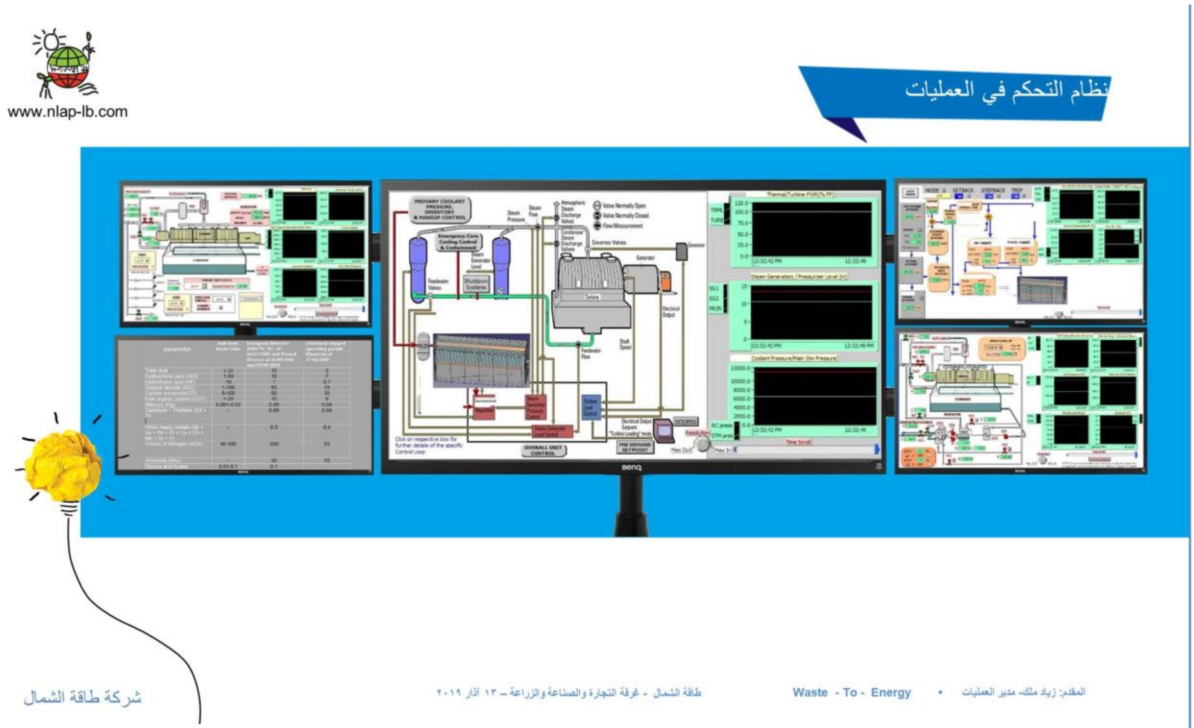
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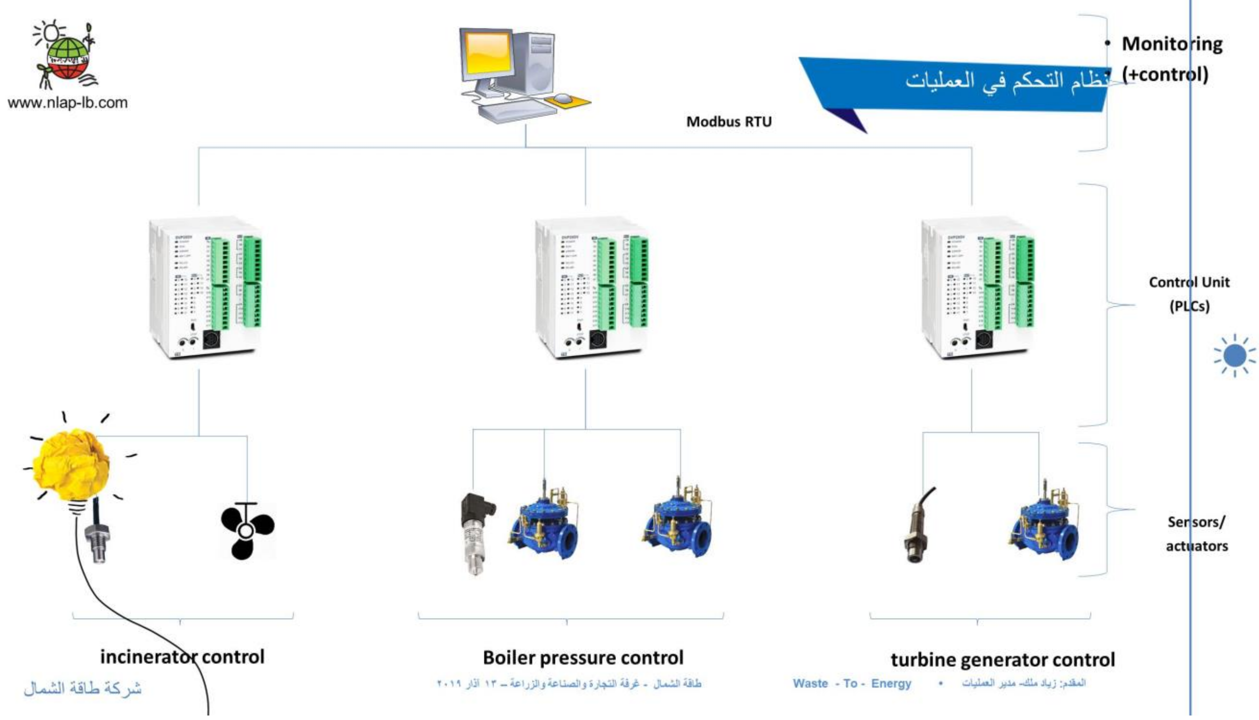
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نظام التحكم في العمليات
Monitoring (+control)
Modbus RTU
Control Unit (PLCs)
Sensors/ actuators
incinerator control
Boiler pressure control
turbine generator control
شركة طاقة الشمال
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لمحة عامة عن المشروع
نظام مراقبة تلوث الهواء على الانترنت
Air Pollution Monitoring Online System
شركة طاقة الشمال
طاقة الشمال - غرفة التجارة والصناعة والزراعة – ١٣ آذار ٢٠١٩
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Air Quality
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EPD ASG
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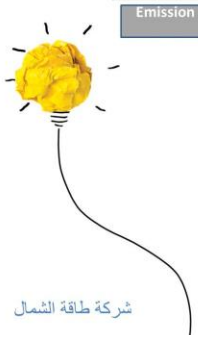
معايير السلامة و البيئة

parameter	half-hour mean value	European Directive 2000/76 / EC of 04/12/2000 and French Decrees of 20/09/2002 and 03/08/2010	refectural stopped operating permit Flamoval of 17/06/2009
Total dust	1-20	10	3
Hydrochloric acid (HCl)	1-50	10	7
Hydrofluoric acid (HF)	10	1	0.7
Sulphur dioxide (SO_2)	1-150	50	15
Carbon monoxide(CO)	5-100	50	30
total organic carbon (COT)	1-20	10	8
Mercury (Hg)	0.001-0.03	0.05	0.04
Cadmium + Thallium (Cd + Tl)	-	0.05	0.04
Other heavy metals (Sb + As + Pb + Cr + Cu + Co + Mn + Ni + V)	-	0.5	0.4
Oxides of Nitrogen (NOx)	40-300	200	50
Ammonia (NH_3)	-	30	10
Dioxins and furans	0.01-0.1	0.1	-

Emission limit values in mg / Nm 3 to 11% O_2 dry gas According to EC 20/09/2010 to an incinerator >6 ton/h



	<1 ton/h	1-3 ton/h	>3 ton/h
Elements (polluants)	Maximum value(mg/m^3)	Maximum value(mg/m^3)	Maximum value(mg/m^3)
Dust	200	100	30
Pb+Cr+Cu+Mn	-	5	5
Ni+As	-	1	1
Cd+Hg	-	0.2	0.2
Cl (HCl)	250	100	50
F (HF)	-	4	2
SO_2	-	300	300

Emission limit values in mg /m^3 to respected (Lebanese environmental ministry

شركة طاقة الشمال

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Waste - To - Energy • المقدم: زياد ملك- مدير العمليات


Pressure equipment shall be designed, manufactured, tested and, if necessary, equipped and installed in such a way as to ensure its safety .
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معايير السلامة و البيئة
Special Quantitative Requirements for Specific Pressure Equipment (Guideline H-06)
Waste - To - Energy
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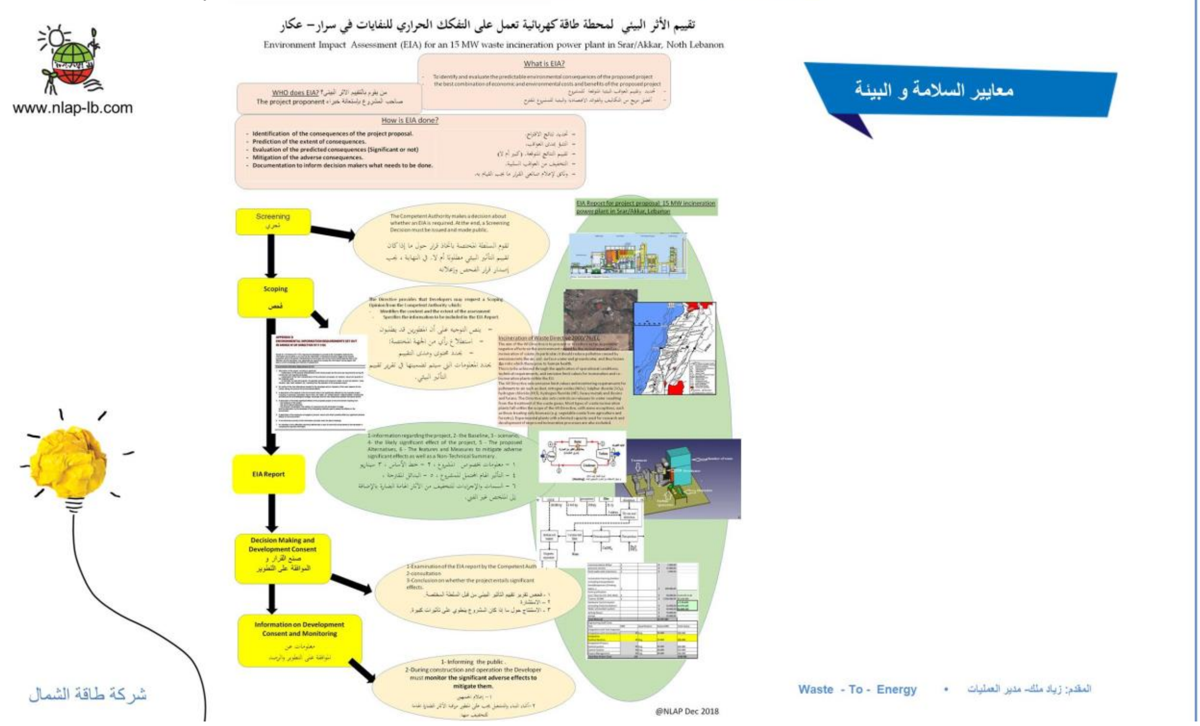
تقييم الأثر البيئي لمحطة طاقة كهربائية تعمل على التفكك الحراري للنفايات في سرار– عكار
Environment Impact Assessment (EIA) for an 15 MW waste incineration power plant in Srar/Akkar, Noth Lebanon
www.nlap-lb.com
معايير السلامة و البيئة
What is EIA?
WHO does EIA?
How is EIA done?
Screening
Scoping
EIA Report
Decision Making and Development Consent
Information on Development Consent and Monitoring
Waste - To - Energy
شركة طاقة الشمال
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طرق العمل
شركة طاقة الشمال
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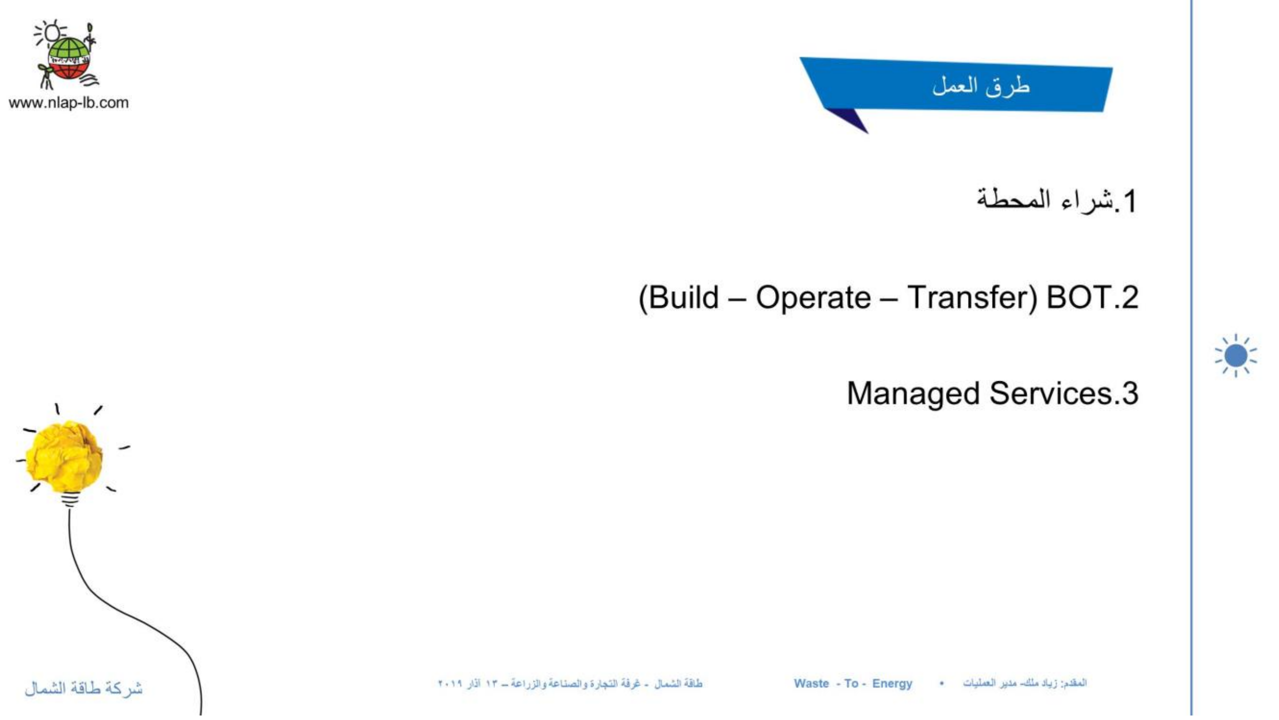
www.nlap-lb.com
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1.شراء المحطة
(Build – Operate – Transfer) BOT.2
Managed Services.3
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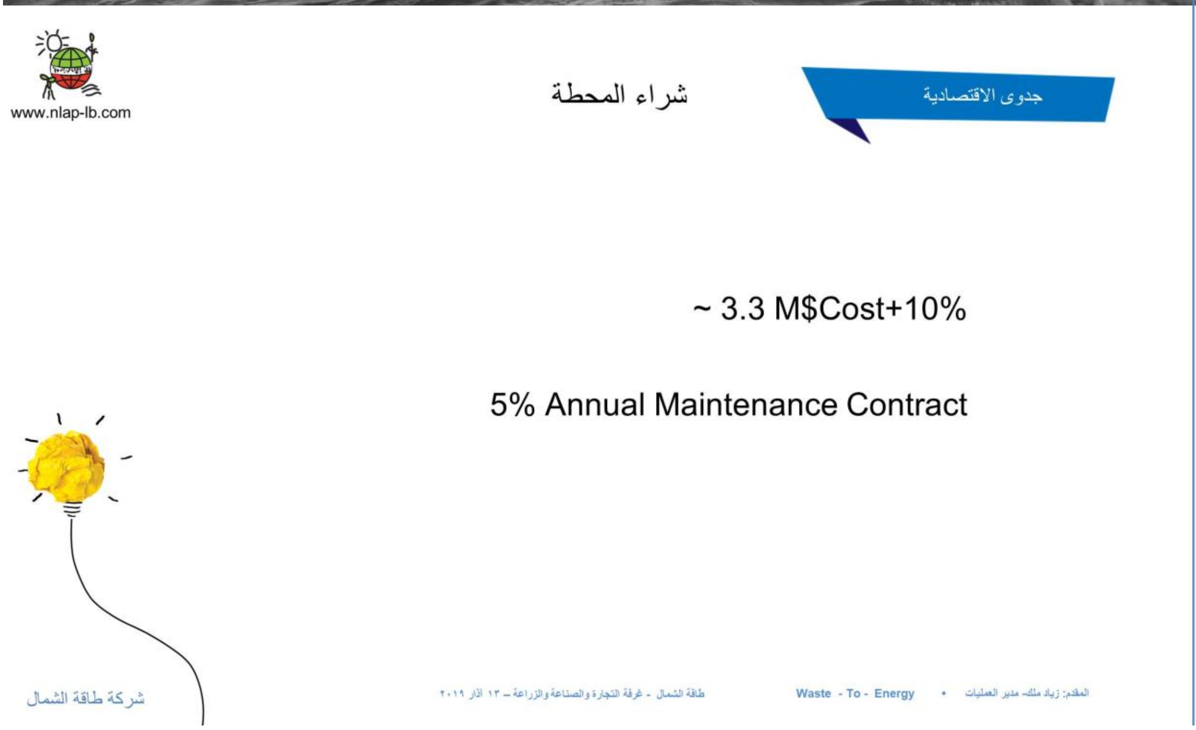
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شراء المحطة
جدوى الاقتصادية
~ 3.3 M$Cost+10%
5% Annual Maintenance Contract
شركة طاقة الشمال
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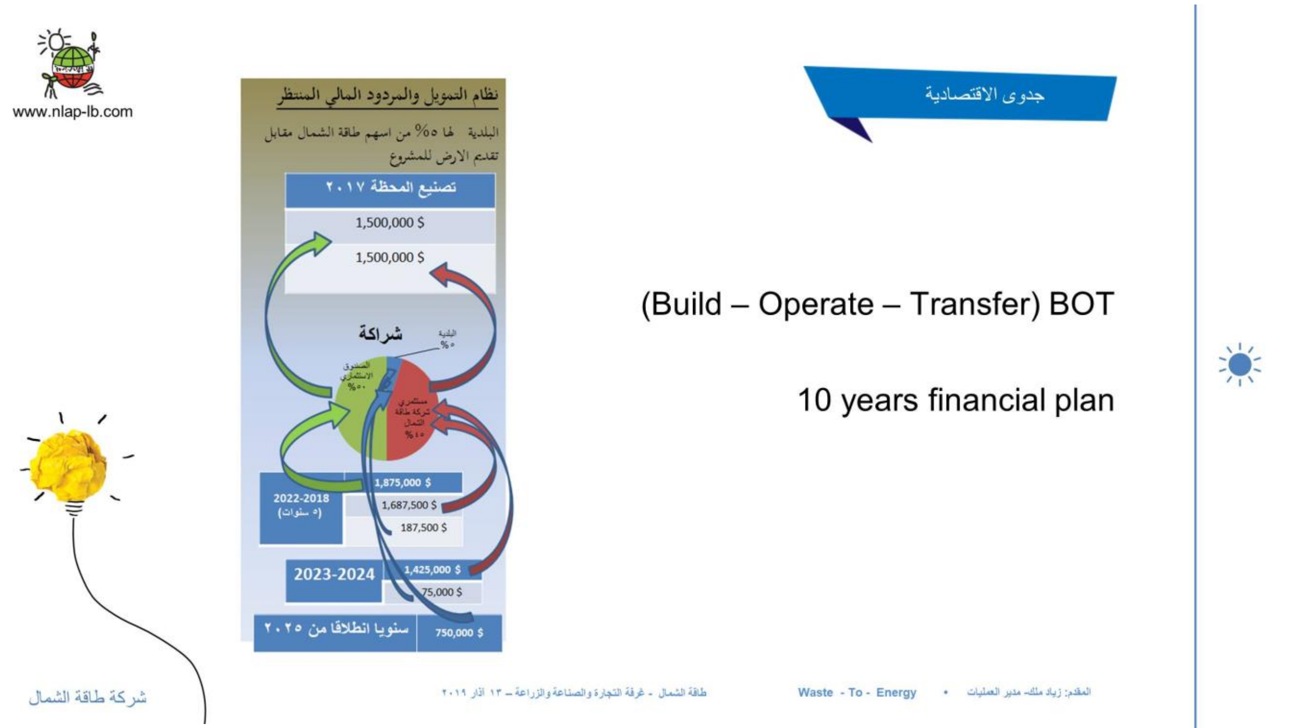
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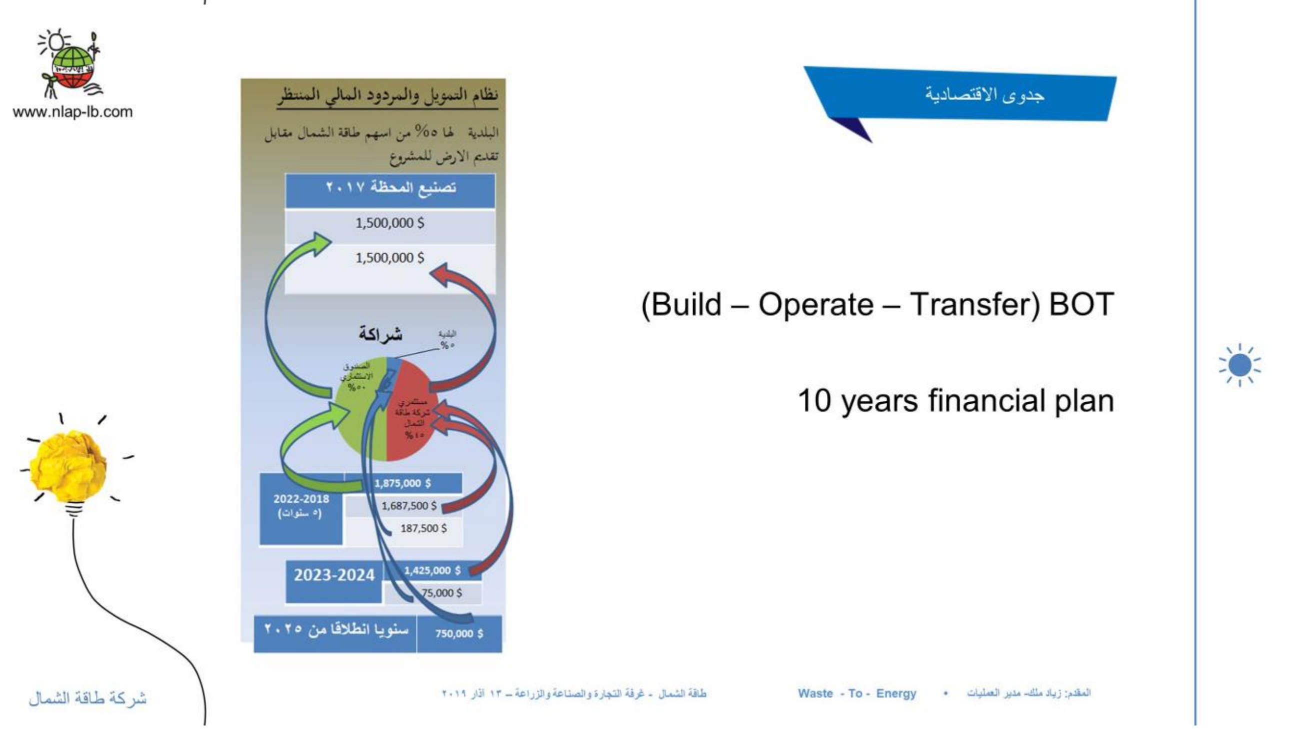
جدوى الاقتصادية
نظام التمويل والمردود المالي المنتظر
البلدية لها ٥% من اسهم طاقة الشمال مقابل تقديم الارض للمشروع
تصنيع المحطة ٢٠١٧
1,500,000 $
1,500,000 $
شراكة
1,875,000 $
2022-2018
1,687,500 $
187,500 $
2023-2024
1,425,000 $
75,000 $
سنويا انطلاقا من ٢٠٢٥
750,000 $
(Build – Operate – Transfer) BOT
10 years financial plan
شركة طاقة الشمال
Waste - To - Energy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10 years financial plan
شركة طاقة الشمال
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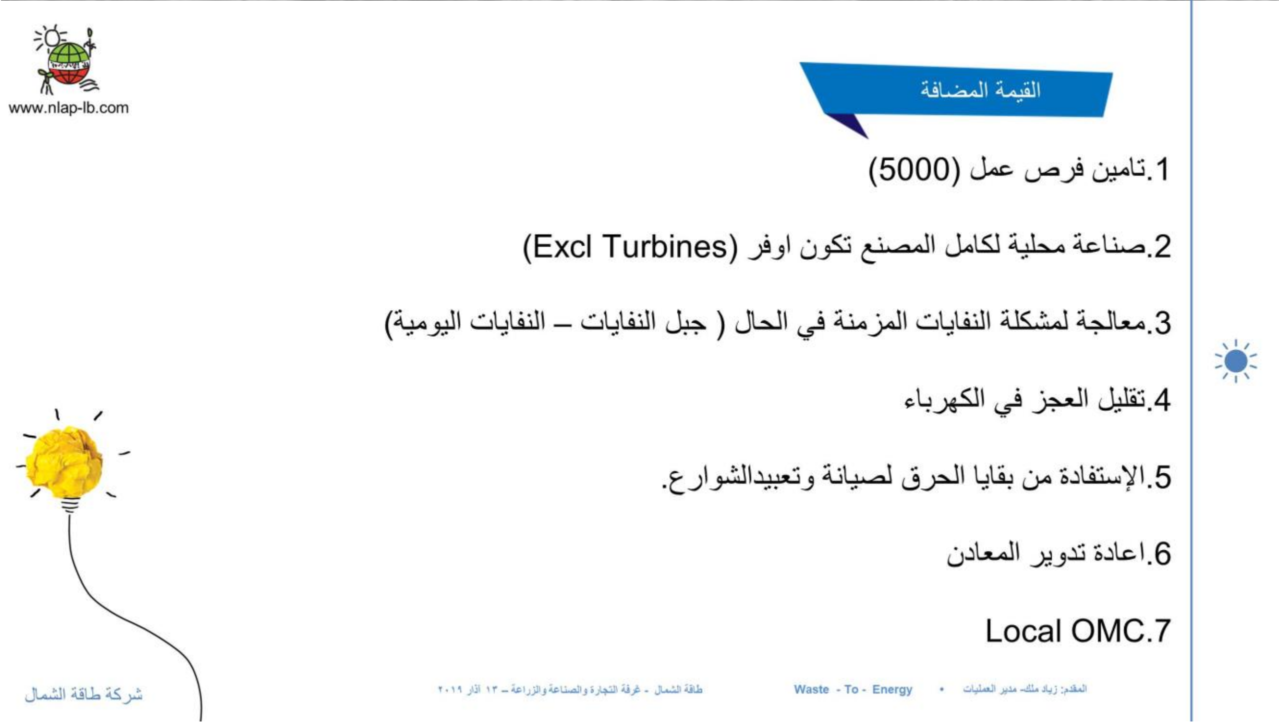
المقدم: زياد ملك- مدير العمليات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القيمة المضافة
1.تامين فرص عمل (5000)
2.صناعة محلية لكامل المصنع تكون اوفر (Excl Turbines)
3.معالجة لمشكلة النفايات المزمنة في الحال (جبل النفايات – النفايات اليومية)
4.تقليل العجز في الكهرباء
5.الإستفادة من بقايا الحرق لصيانة وتعبيدالشوارع.
6.اعادة تدوير المعادن
Local OMC.7
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MOVIE


طاقة الشمال
North Lebanon Alternative Power
وشكراً
AECENAR
Waste - To - Energy
المقدم: زياد ملك- مدير العمليات
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1. نظام التحكم في العمليات
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Waste - To - Energy
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NLAP 2 MW Mobile Incineration Plant, total installation costs

Material Costs (including workers for manufatoring)

Part	Number of pieces		Total
Steam filter	1		$ 1,000.00
Condensor	1		$ 35,000.00
condensor cooling	1		$ 1,500.00
tubes (Stainless)	10m 1 inch		$ 50,000.00
Generator	1		$ 55,500.00
diesel burner including fuel feed	1		$ 3,000.00
safety valve 15 bar	1		$ 4,000.00
pressure sensors	5		$ 15,000.00
fresh water tank (stainless)	1		$ 12,000.00
incineration burning chamber (including transportation band)&vaporizer (climbing [illegible]	1		$ [illegible]

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Turbine 2MW	1		$ 1,500,500.00
Hardware Control System (Including Instrumentation)			$ 50,000.00
Water antioxidant system			$ 7,000.00
Sorting House			$ 30,000.00
mobile platform			$ 30,000.00
Total Material			$1,887,500

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Engineering Staff Costs

Task	MM	Qualifikati on	Salary/MM	Total Salary
Integration with Test Vaporizer				
Integration with Incineration Vaporizer	30	Eng.	$3,000	$90,000
Integration Turbine Electrics	7	Eng.	$3,000	$50,000
Integration Process Control system	5	Eng.	$3,000	$30,000
Control System	18	Eng.	$3,000	$54,000
Project Management	20	Eng.	$3,000	$60,000
Total Man Power Costs	80			$284,000
Total cost (Staff+construction)				$2,171,500

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Operation cost

- Employees : -3 persons to each time /2 times per day
  -800$/month
- Monitoring : Dr.Mirvat el hoz

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54 Conference Report

(Conference at Chamber of Commerce, Industry & Agriculture of Tripoli & North Lebanon, 13.03.2019, 16.30-18.30)

Presentation Eng. Ziad Malak (as pdf)

Report:

بحضور رئيس بلدية طرابلس السيد أحمد قمر الدين والعقيد عميد حمود والنقيب محمد عوض ممثل العميد كرم مراد رئيس فرع المخابرات في الشمال وعدد من الاساتذة الجامعيين من مختلف الجامعات في الشمال، واختصاصيين بيئيين، وعدد من الطلاب الجامعيين، وفعاليات اجتماعية وسياسية.

تم اطلاق مبادرتنا "نوّر البلد بمعالجة النفايات" يوم أمس في غرفة التجارة والصناعة والزراعة في طرابلس.

Conference in Chamber of Commerce, Industry and Agriculture Tripoli, Lebanon (2MW plant Build-Operation-Transfer (BOT))

بدأ الكلام مدير شركة طاقة الشمال المهندس الدكتور سمير مراد مرحبا بالحضور طارحاً اشكالية الأزمة المزدوجة التي تعاني منها طرابلس وسائر مدن وقرى لبنان "غرق في النفايات وعجز في الكهرباء"، ثم قدم المهندس زياد ملك عرضاً مفصلاً لنموذج محطة الطاقة التي تستخدم النفايات كوقود لإنتاج الطاقة الكهربائية الموجودة حاليا في رأس مسقا، شارحاً أبعاد المشروع ومبيناً قيمته المادية والبيئية وفعاليته ومساهمته مع الأفكار والمشاريع المقترحة بإنقاذ طرابلس من أزمتها.

وقد تخلل العرض مداخلات واستفسارات الحاضرين .

بارك الله بمن حضر ونفع الله بنا وبكم.

Dr. Eng. Samir Mourad (CEO NLAP)

Eng.Ziad Malak (COO NLAP)

Ziad Malak (left),

Mr. Ahmad Kamareddine, Major of Tripoli

54.1 Comments

الزمان: الجمعة 15 .03 .2019

المكان: مركز الشركة في راسمسقا

الحضور: د. سمير مراد، المهندس زياد ملك، الآنسة ميساء قمر الدين، الآنسة مريم عبد الكريم، السيدة رلى مراد، الآنسة سهام عيشة، الآنسة آسيا مراد

وكانت الآراء على الشكل التالي:

. الآنسة ميساء: نجح المؤتمر بكونه منبراً لطرح المشروع وشرحه للرأي العام

. الآنسة سهام: الرأي العام السائد ضد فكرة المحارق قد يحملنا إلى تغيير المشروع بالكامل أو التخلي عن فكرته إلى تقنيات أخرى . التنظيم كان جيداً

. السيدة رلى: . كانت الإجابةالعلمية على بعض التساؤلات غير كافية أو مقنعة . الحضور كان متنوعاً وهذا دليل إيجابي على تفاعل شتى شرائح المجتمع مع هذه الإشكالية وطرق حلها . عدم تقبل الجمهور لفكرة تسليم المنشأة للدولة تحملنا إلى تعديل هذا الطرح.

. الدكتور سمير: أشاد بالمحاضرة العلمية ونبه إلى أن فكرة عدم إقصاء الحلول والطرق الأخرى في معالجة النفايات قرَّبت كثيراً وجهات النظر وأسهمت في إرساء جو التعاون والتفاهم.

. المهندس زياد: نسبة نجاح المؤتمر رآها 60% وذلك للأسباب التالية:

. توزيع الدعوات الشخصية لم يُتابع كما يجب

. الحضور كان موزعاً كالآتي: سياسيين: لم يكن هناك حضور بإستثناء رئيس بلدية طرابلس

ذوي الإختصاص: كان حضورهم ضعيفاً

الشباب : حضور قوي وهذا يحمل على التفاؤل

. التوقيت : الزماني: إذ تزامن مع انعقاد 3 مؤتمرات أخرى مما شتت الحضور

مدة المحاضرة لم تكن مدروسة تماماً مما أدى إلى عدم التوفيق في رسم برنامج المؤتمر خصوصاً فيما يتعلق بفرصة الصلاة، إذ إنسحب أكثر المدعوين بعد الإستراحة

. تجهيز القاعة: . الصوتيات كانت رديئة

. عدد الكراسي لم يكن حسب الإتفاق

. الأماكن الأمامية لم تكن محجوزة للمدعوين الأساسيين

. الهدف من المؤتمر: ما لم يتم: . القيام بالتوصيات التالية:

. لجنة مراقبة لأعمال المحارق ولكل المشاريع البديلة الأخرى.

. العمل على تبديد المخاوف الشائعة حول عملية التفكك الحراري.

دروس وعبر

قرر المجتمعون الإستفادة من الأخطاء الحاصلة في سبيل تصويب العمل مستقبلاً وتم تسمية النقاط التالية:

. المتابعة الإعلامية على وسائل التواصل الإجتماعي كي يبقى المشروع حياً على الساحة.

. إصدار النشرات العلمية التي من شأنها تصحيح المفاهيم الخاطئة حول الآثار البيئية للمشروع.

. تشكيل لجان للمتابعة من الرأي العام وذوي الإختصاص.

. إعتماد آلية عمل شفافة فيما يتعلق بالإنبعاثات.

. إرسال رسائل شكر للحاضرين، خاصة وعامة.

. فريق العمل الخاص بالشركة يجب ان يكون منتشراً بشكل أوسع بين الحاضرين ليتمكنوا من التعرف عليه ولتسهيل طرح الأسئلة ومناقشتها.

. الإستفادة من دورات في الإدارة والتنظيم تقيمها بعض الجمعيات مثل BIAT - TIC

. الإتقان في العمل الفردي والجماعي.

والله ولي التوفيق

54.2 Attendees

كريم ميقاتي	50 سنة	مهندس طاقة	71202833
محمد هزيم	65 سنة	مهندس ميكانيك . رئيس بلدية حرار	03188541
عبد الغني الأيوبي	80 سنة	مهندس زراعي . المستشار البيئي لبلدية طرابلس	70972927
محمد القيسي	56 سنة	مهندس ميكانيك	70117873
نظيرة صافي ملك	64 سنة	اجازة في اللغة الإنكليزية	70434138
سناء صافي غنام	66 سنة	إجازة في الرياضيات	71709199
محمد مصطفى برغل	45 سنة	مهندس	03180144
عبد الحميد كريمة	36 سنة	صيدلي	03809480
نغم محمد السيد	17 سنة	طالبة	78989197
سناء محمد عزام	17 سنة	طالبة	71650285
زهية محمود السيد	18سنة	طالبة	03915524

إيمان عاصم لوياني	16 سنة	طالبة	70008185
سيل خليل موعد	16 سنة	طالبة	03947343
هديل جمال قاسم	16 سنة	طالبة	70367300
فاطمة محمد وهبة	17 سنة	طالبة	71901762
مريم علي موعد	17 سنة	طالبة	70907662
نور الهدى علي الحاج	17 سنة	طالبة	76421151
وفا الرز	28 سنة	مهندس داخلي وادارة اقتصادية واجتماعية	76467682
أحمد الحج أسعد	17 سنة	طالب	03035456
ربيع غنيم	17 سنة	طالب	03569319

Proposal Maschha BOT

بسم الله الرحمن الرحيم

2019

Proposal Mashaa

طاقة الشمال

North Lebanon Alternative Power

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4/10/2019

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55 نبذة عن شركة طاقة الشمال Preface

بالتزامن مع اشتداد أزمة النفايات المتنقلة بين المناطق اللبنانية والقلق الدائم من استحداث مطامر العوادم التي تشكل عشرين الى ثلاثين في المئة من النفايات،تطرح شركة طاقة الشمال بالتعاون مع عدد من الخبراء والاختصاصيين حلولا علمية لمعالجة النفايات.

طاقة الشمال هي شركة منبثقة عن مركز الابحاث AECENAR & LSA المسجّل في ألمانيا ولبنان . يتعامل هذا المركز مع الجامعات المحلية والخارجية بحيث تبصر النور المشاريع الطلاّبية وتصبح جاهزة للتسويق ؛وبالتالي نشأ مشروعنا من هذا المركز .

رؤيتنا Vision:

No waste problem anymore in Middle East, supply of electricity 24/24 hours for all in Middle East, giving the youth in the region an opportunity of work.

رسالتنا Mission

To provide municipalities and customers in North Lebanon and in the region with power plants at low cost to solve their waste and electricity problems.

56 Introduction

NLAP_2MWPP is a waste to energy mobile power plant that works on INCINERATION technology. It is a waste treatment technology that involves burning commercial, residential and hazardous waste. Incineration converts discarded materials, including paper, plastics and food scraps into bottom ash, fly ash, combustion gases, air pollutants, wastewater, wastewater treatment sludge and heat. See figure1 below:

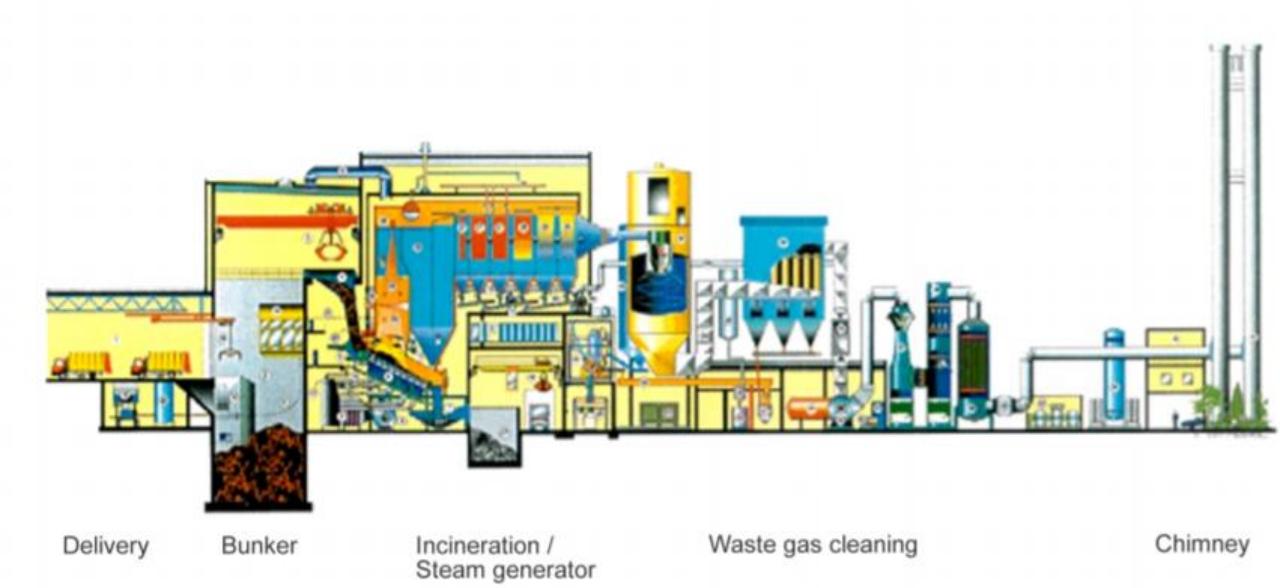


Figure 42:typical WTE diagram

Waste to Energy (WtE) is now an available and well-known procedure to treat a very wide range of waste. The WtE sector has undergone a rapid technological development over the last 10 to 15 years. This change has been driven in order to control industries' policies, and in particular, imposing limits on pollutants produced by individual installation. A continual process development is ongoing: at the moment, the sector is exploiting techniques which aim to limit costs and to improve environmental performance. The intention of waste incineration is to treat wastes so as to reduce their volume and hazard, destroying potentially harmful substances that are, or may be, released during incineration. Incineration processes allow not only recovering energy, but also mineral and/or chemical content from waste. Basically, waste incineration is the oxidation of the combustible materials contained in the waste. Waste is generally a highly heterogeneous material, consisting essentially of organic substances, minerals, metals and water. The incineration produces flue-gases whose energy is in the form of heat. The organic fuel substances in the waste burns once the necessary ignition temperature is reached and there is enough oxygen. In this condition the combustion process takes place.

Referring to 2011, among the 27 European Member States (MS), the amount of Municipal Solid Waste (MSW) suitable for thermal waste treatment is approximately 253 million tons. The scale of use of incineration as a waste management technique (i.e. percent of solid waste treated via incineration) varies significantly from place to place ranging from zero to 65%. The average value in the same year was approximately 20 %. The target of thermal treatment is to provide an overall environmental impact reduction that might arise from the waste. WtE usually includes a complex set of interacting technical components which, when considered together, effect an overall treatment of the waste. Each of these components has a slightly different main purpose, the main ones as below:

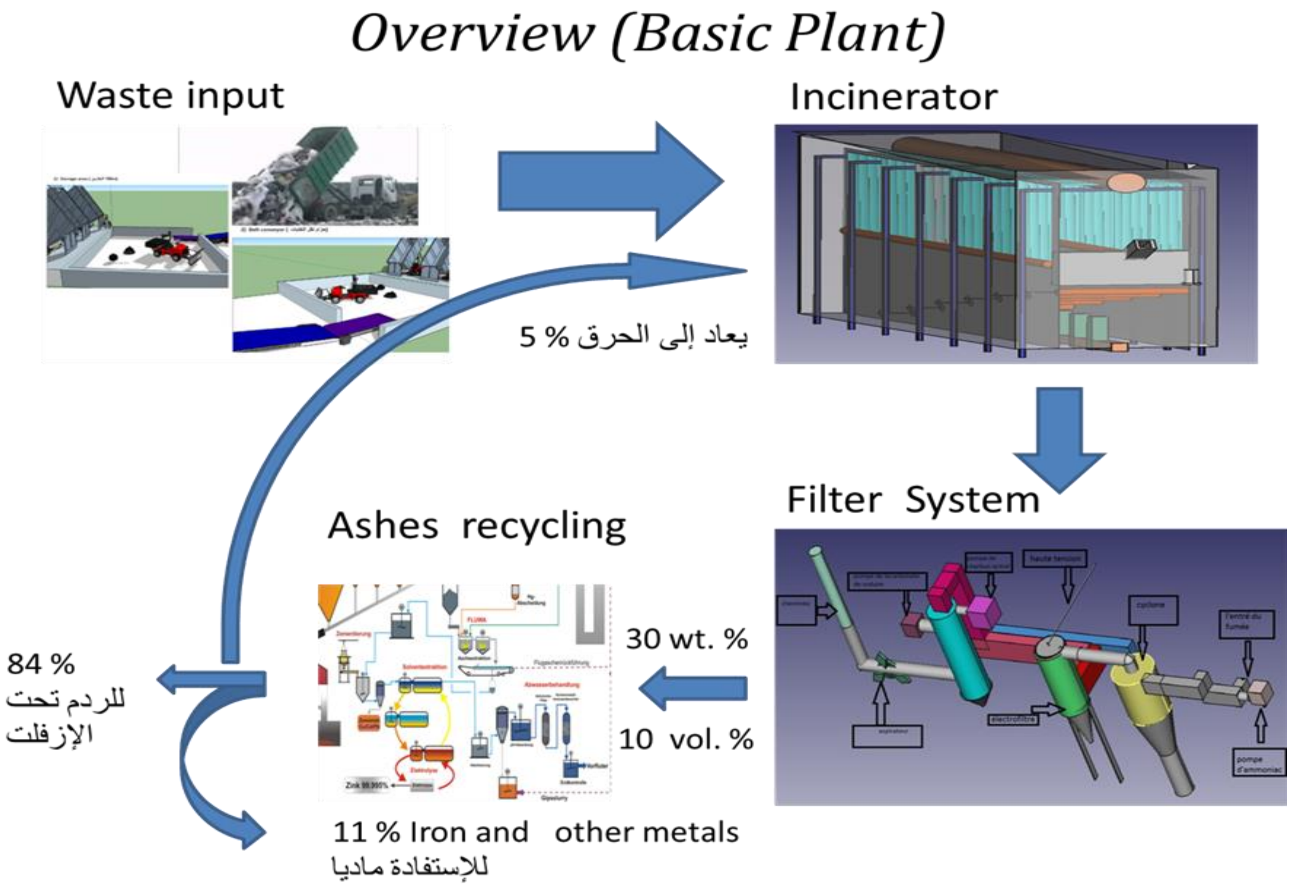
- volume reduction of residues and destruction of organic substances
- evaporation of water to recover energy
- evaporation of volatile heavy metals and inorganic salts
- production of potentially exploitable slag
- removal and concentration of volatile heavy metals and inorganic matter into solid residues

According to the New York Times, modern incineration plants are so clean that "many times more dioxin is now released from home fireplaces and backyard barbecues than from incineration. "[13] According to the German Environmental Ministry, "because of stringent regulations, waste incineration plants are no longer significant in terms of emissions of dioxins, dust, and heavy metals".

57 Purpose

The purpose of this dpocument is to provide high level description of the Compact Mobile Waste to Energy power plant proposed for **Meshaa** Municipality

As per Munciplaity feedback, it is estimated to have 8-10 tons daily



The project can be classified into 5 different phases/stages as follows:

- Site Preparation
- Waste Management
- Incineration +Boiler+Filter system
- Output (Ashes) Management/supplementary services
- Process control system PCS

58.1 Site preparation

The project needs a land surface show in the figure below:

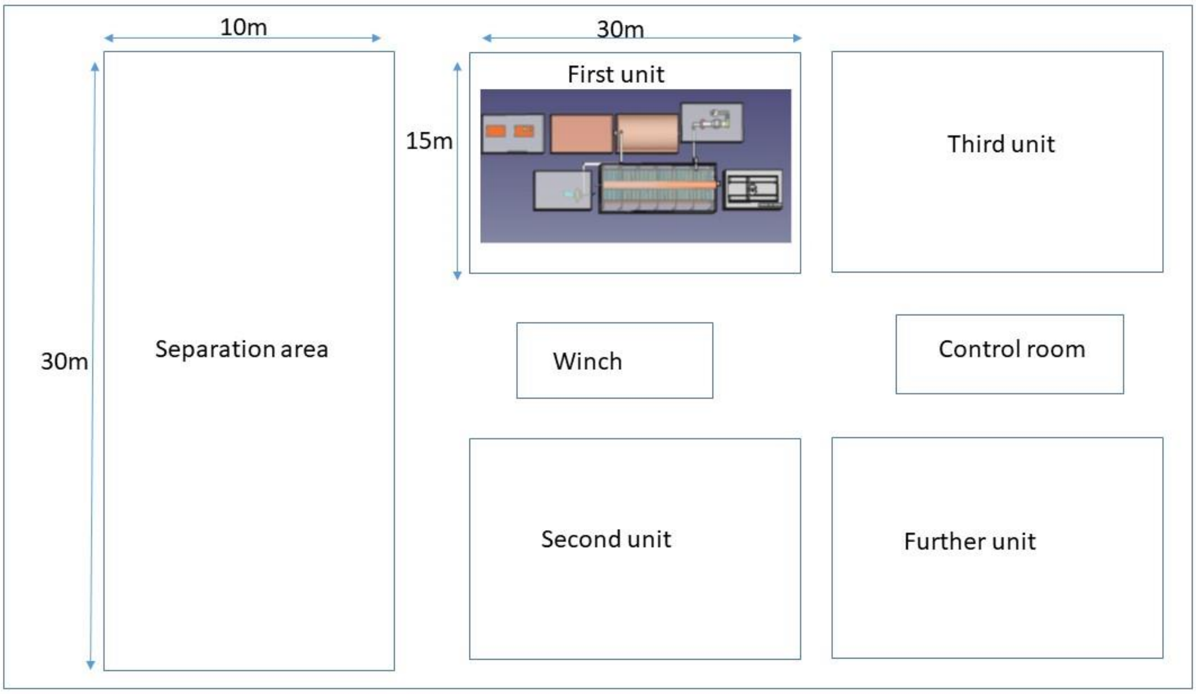


Figure 43:land surface diagram

The municipality needs to provide the above land to install the power plant. Border concrete wall is build surrounding the plant where proper security is required

58.2 Waste Management

A sorting room to eliminate glass,metals and batteries from other waste that will be incinerate.it is important to sorte the waste to be sure the efficiency is suitable to generate thermal power.

Fraction	Net Calorific Value (MJ/kg)
Paper	16
Organic material	4
Plastics	35
Glass	0
Metals	0
Textiles	19
Other materials	11

Source: ISWA (2013)

Figure 44: net calorific value of waste

As per the above waste categtroy classification, we need to isolate Glass as well as Metals from waste collection area

The separation area consists of the following componenets:

1.storage area and belt conveyor

2.shredder

3.air filter to remove stench

4.magnetic sorting

5.carry ferrous material to recycling

6.belt conveyor .

Firstly we need to separate the waste before the incineration if the waste isn't separated, the best case is the separation from the source, and we have two type of this case:

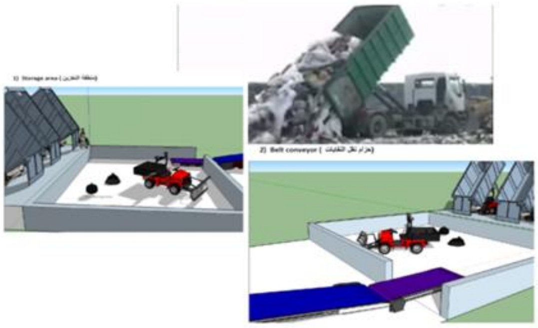
i. Individual separation: the waste must be separated in two containers one for the waste like (plastics, glass, papers, metals), and the other for the organic waste. This type is simple and possible to achieve it for everyone. **It is estimated that we need 3-4 persons per 10 Ton to separate**
ii. Multi separation: in this case each type of waste must be separated into a container, so we need a container for the paper, and other one for the plastics, etc… this type is difficult to achieve it need consciousness and great response from the citizens and need several containers…

The waste must be bringing into a storage region, have autonomy of 2 days, 200 m^3 of waste, and the deep of the storage is 1.5 m, so the land surface needed is approximately 12*10 meters = 120 m^2

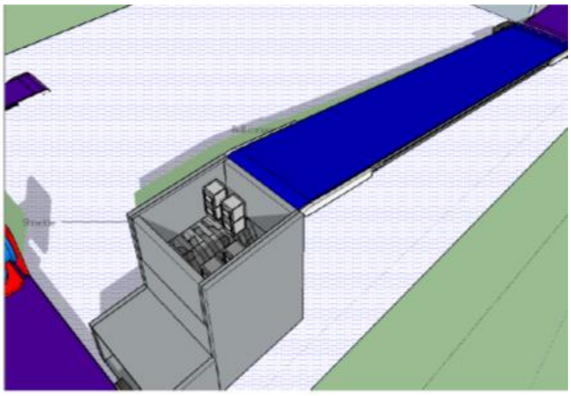
Critical substances should not be burned so as not to produce toxic smoke requiring costly treatment, like PVC and batteries.

The figures below describe the process of sorting

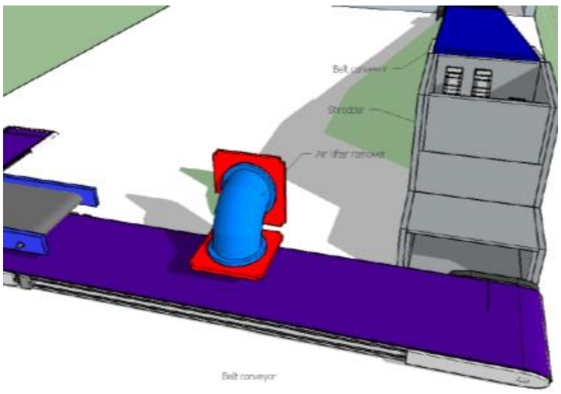
1.Storage and belt Conveyor



2.Shredder (machine how cut the waste)



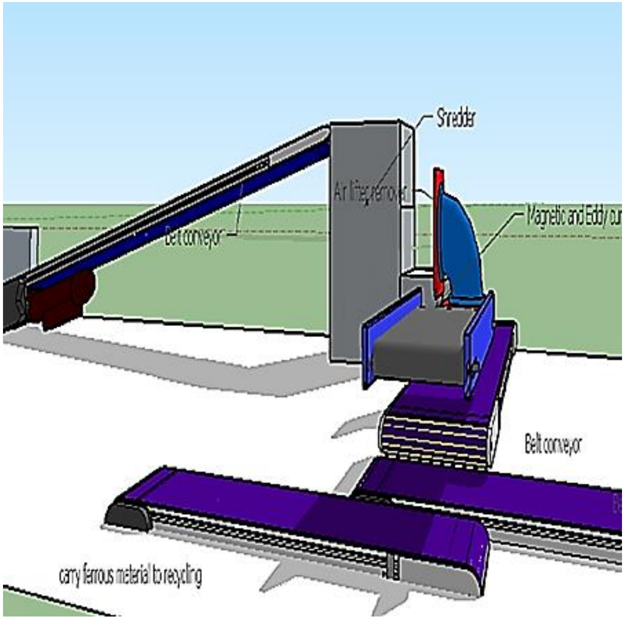
3.Air filter remover



4.Iron separation system using the magnetic power(magnetic sorting)

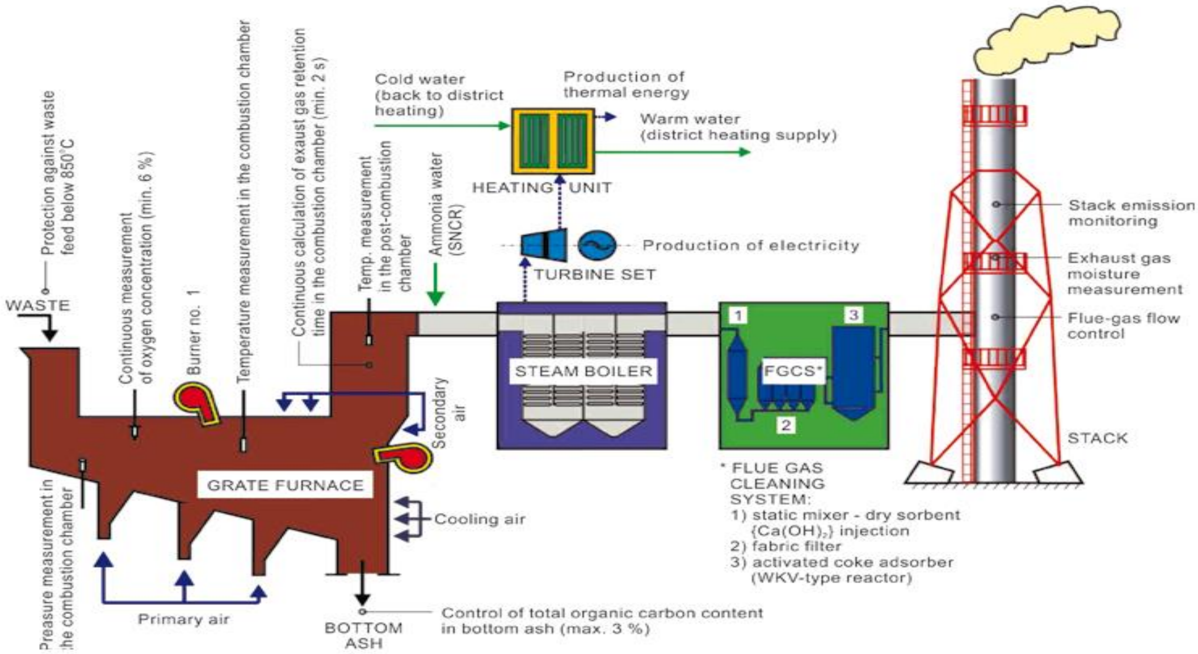
5.carry ferrous material to recycling

6.belt conveyor

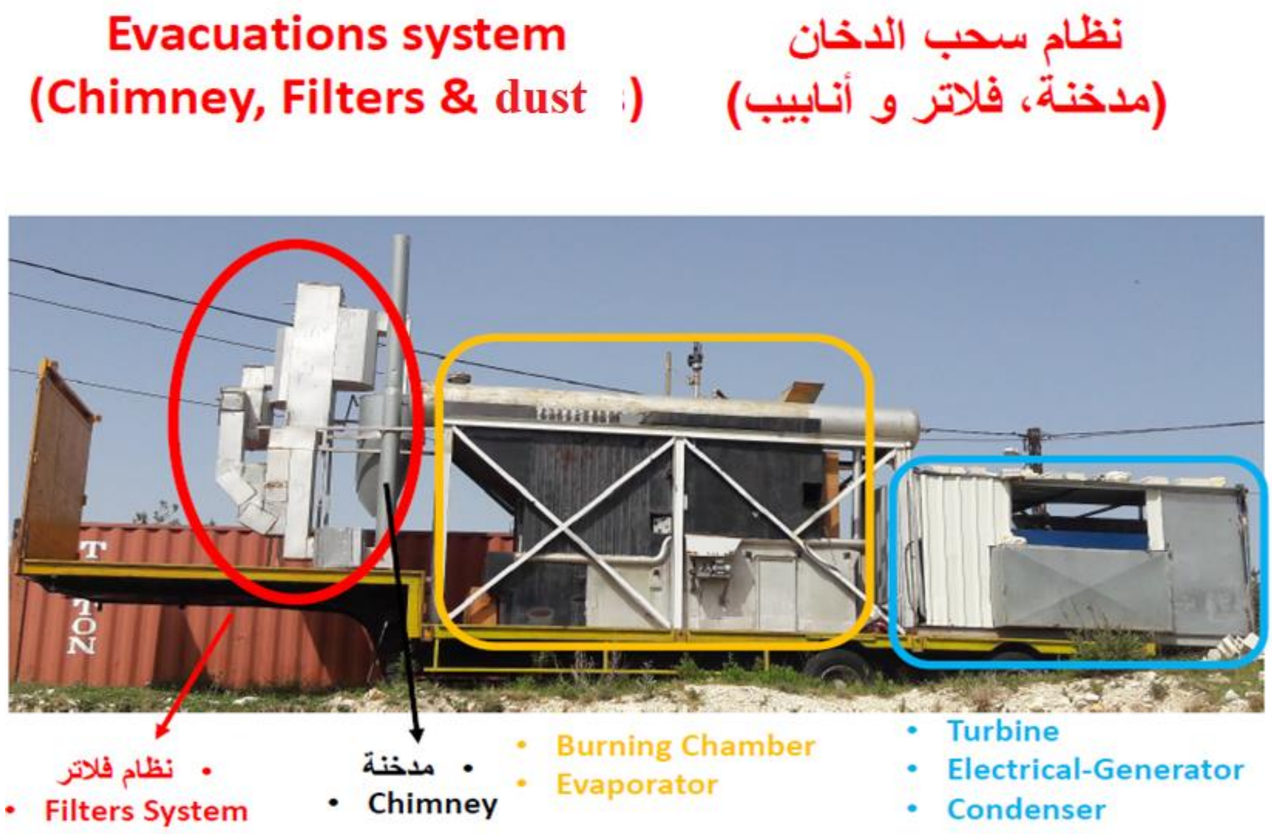


Then,the waste is ready to enter to the furnace room.

58.3 Power plant of waste incineration



58.3.1 The already built kernel power plant (mobile plant NLAP-IPP)



58.4 System of Filtration

The comparaison of emissions(depending on their size and the degree of severity) can be described as this form :

-Non-harmful to the environment: Nitrogen (N_2), Oxygen (O_2), and water vapor (H_2O)

-harmful to the environment: Acid gases: nitrogen dioxide (NO_2), nitrogen oxide (NO), Sulfur dioxide (SO_2), carbon dioxide (CO_2),HCl, Dust.

-Toxic gases: Furans, dioxins, heavy metals (Hg from batteries, cadmium, plumb, zinc).

Then we should treat the fumes before chimney as this following process

-Injection of NH_3: treatment of nitrogen oxide. The reactions realized at temperature between 850 and 1000 ° C, with higher reaction rates and lower in this range. This special reaction takes place:

- 1: directly by injection in boiler (exit of fumes) at a temperature between 850 and 1000°C. It's correspondent to Selective Non Catalytic Reduction (SNCR)

- 2: with assistance of a catalyst in a temperature range of 170 - 450°C Selective Catalytic Reduction (SCR)

3- Cyclone: The fumes are accelerated in a cylinder, the particles will impact on the walls and lose their speed, they are then recuperated in the filter bottom.it reduce a large percentage of particles.
4- Electrostatic: The dust through a sufficiently large electric field .it's so efficace in order 90 % to eliminate small particles less 5 micron .

5- heat exchanger between gas flue and air that will enter to the boiler and contribue to a combustion .heat exchanger is necessary to minimize the gas temperature to 230°C. at this temperature the charcoal is effective even as bicaronate of soduim.

6-injection of activated charcoal :to reduce the ratio of dioxin and furan in fumes . By activated carbon(can be also called "lignite Coke for odorous compounds.)

7- injection of soduim bicarbonate(powder) : to reduce the ratio of acid gas (SO_2 , HCl, HF), at 150-230°C. The filters in flat bags are successfully used for the chemical absorption of acid gases such as HF, HCl and SO_2 in addition to the adsorption of other pollutant compounds. Generally it is used, among others, calcium hydroxide and sodium bicarbonate ($Ca(OH)_2$) of typical commercial quality, which is injected in the gas stream before entering the filter. To achieve proper compliance with the emission limits required, the additive should be added in amounts over-stoichiometric (from 1.5 to 3 times).

8-filter media: after bicarbonate,charbon was reacted to flue gas ,fumes came to filter media where a cacke was formed in the face ahead flue .

Figure 45: implenentation of the system of treatment

Type	Quantity	Type	Quantity
Waste	**8 ton /day**	**Electricity**	**45 kW**
Cooling water	**10 m³/day**	**Ashes that will be treated in the recovery columns**	**300 kg /ton of waste**

Figure 46:the input and output of the plant

Injection	Quantity/ ton of waste	Price of 1 kg	Quantity injection / 8 tons /day	Cos/day	Quantity /month	Quantity/year	Cost /year
Sodium bicarbonate	15 kg	0.23 $	120 kg	27.6 $	3.600 kg	43.200 kg	9.936 $
Activated carbon	1 kg	0.6 $	8 kg	4.8 $	240 kg	2.880 kg	1.728$

Figure 47: Quantities of chemicals materiels

58.4.1 Continuous Emission Monitoring (CEM)

A series of sensors will be implemented to assure a continuous emission monitoring of different gas formed in the flue gas without the Dioxins and furans that measured by GC(gas chromatographic);Sensors of:CO,CO_2,NO,NO_2, SO_2,SO,HCl,heavy metals.This system is important to monitor the emissons according with the lebanese environmental mnistry :

	<1 ton/h	1-3 ton/h	>3 ton/h
Elements (pollutants)	Maximum value(mg/m^3)	Maximum value(mg/m^3)	Maximum value(mg/m^3)
Dust	200	100	30
Pb+Cr+Cu+Mn	-	5	5
Ni+As	-	1	1
Cd+Hg	-	0.2	0.2
Cl (HCl)	250	100	50
F (HF)	-	4	2
SO_2	-	300	300

Emission limit values in mg /m^3 to respected (Lebanese environmental ministry

58.5 Heavy metals recovery and treatment of ashes

Solvent extraction, or liquid-liquid extraction is a separation technique isothermal in a heterogeneous liquid medium.

The method is based on the existence of a difference in the solubility of a substance in two immiscible liquids. The process has three steps, as shown in next figure:

In order to transport the material as quickly as possible, the area of the transfer surface is increased by various artifices. These objectives can be obtained in a column such as RDC column .

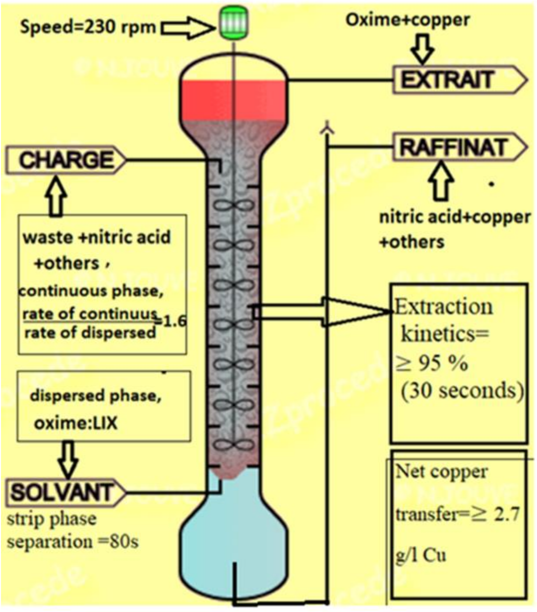


Figure 48:RDC diagram

The amount of feed solution that considered as aqueous solution at 90°c (3h) is about 300L.A column of 40 cm radius is suitable in this case.

58.5.1 Extractants types

Basic on the following list, we determine the type of heavy metals that we should begin to recovery.

Element bottom ash	Bottom ash	Fly ash	Dry / quasi-dry	wet
Al	22.000-73.000	49.000 - 90.000	12.000-83.000	21.000-39.000
Cd	0.3-70	50-450	140-300	150-1.400
Cu	190-8.200	600-3.200	16-1.700	440-2.400
Fe	4.100-1500	12.000 - 44.000	2.600-71.000	20.000-97.000
Hg	0,02-8	0,7-30	0,1-51	2,2-2.300
Mo	2-280	15-150	9-29	2-44
Pb	100-13.700	5.300-26.000	2.500-10.000	3.300-22.000
Zn	61-7.800	7.000-70.000	7.000-20.000	8.100-53.000

Copper (Cu) is present in the ashes in high level. The direct solvent extraction of copper using the oxime .Each 1 L require 1.6 of oxime .

59 Process control system

59.1 Basic Plant Control System

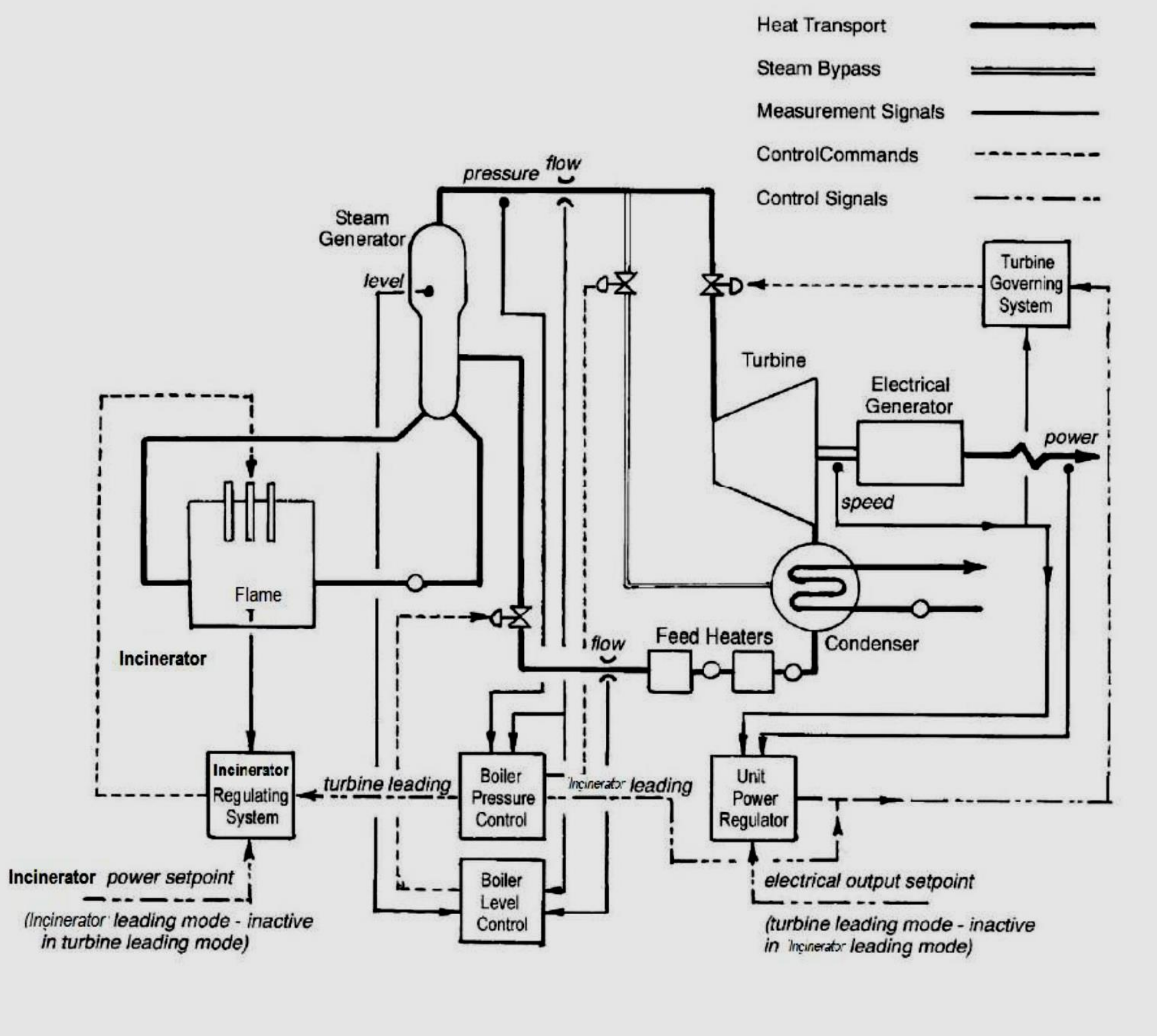
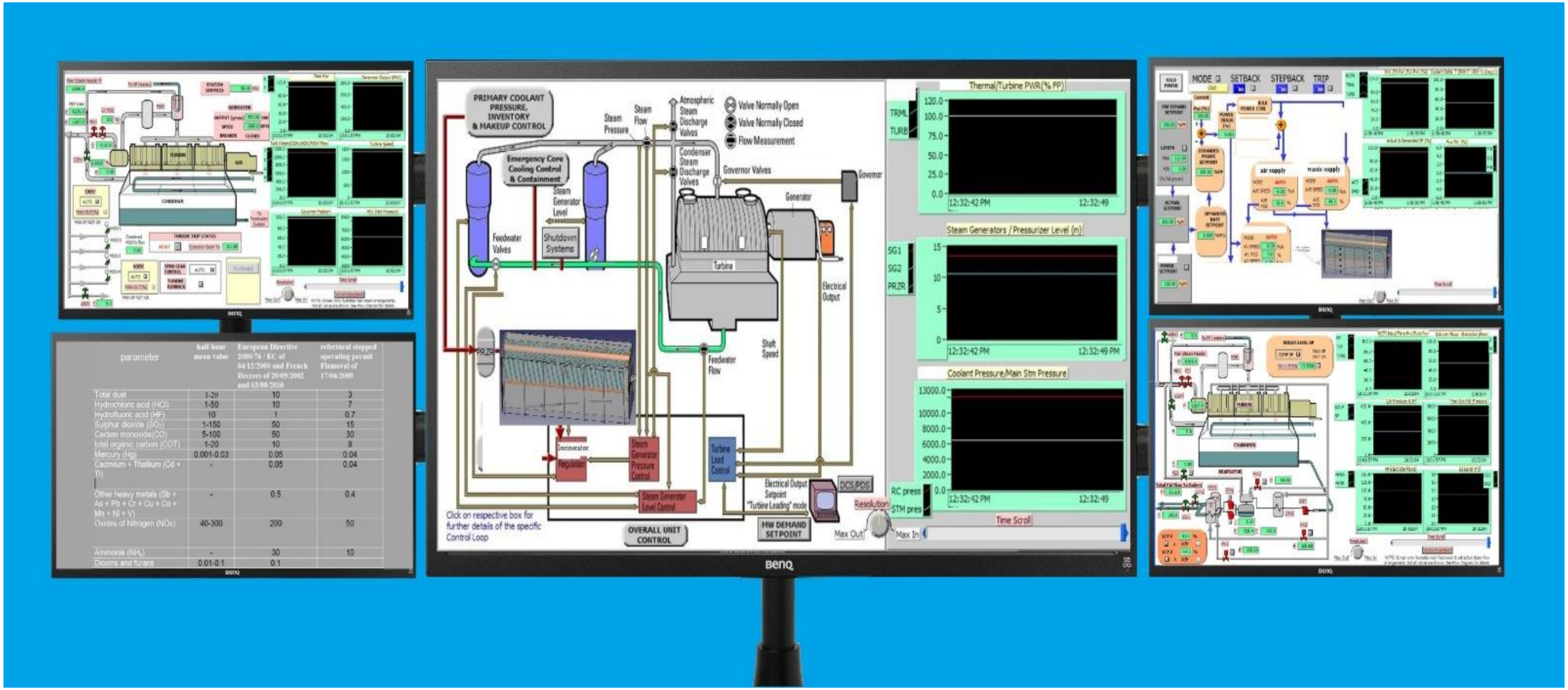


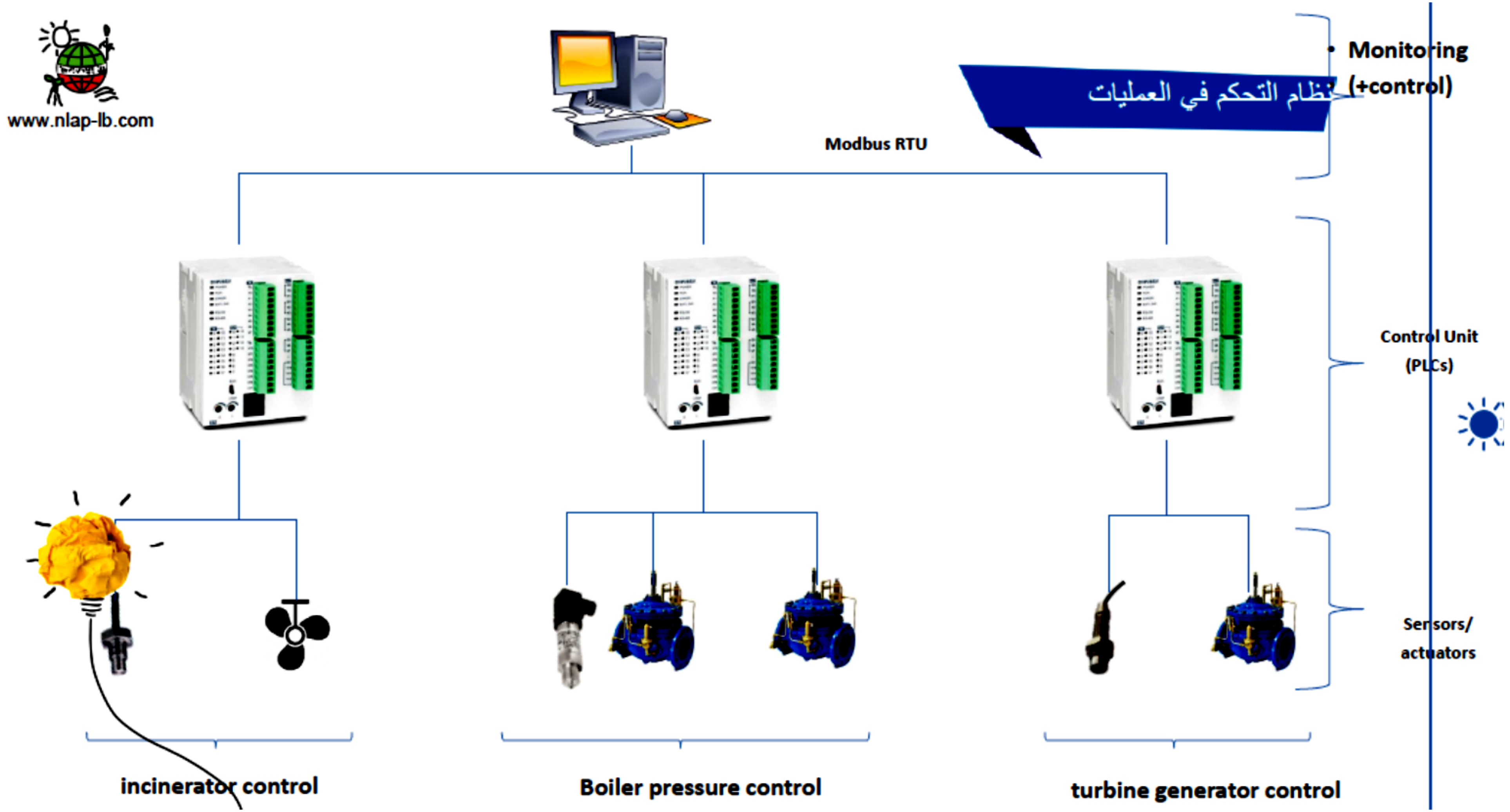
Figure 2 Basic plant control system

59.2 User Interface



59.3 System Architecture

Process control systems in power plants are also affected by new trends in the automation market. Changing requirements of customers and government rules are influencing the requirements of the power generation industry. These requirements can be met by either using new technologies or combining them with existing ones.



60 Environmental impact assessement

60.1 What is the purpose of the EIA?

- To evaluate and identify the predictable environmental consequences
- Selection of the best combination of economic and environmental costs and benefits of the proposed project.

- لتقييم و تحديد العواقب البيئية المتوقعة.
- اختيار أفضل مزيج من التكاليف الاقتصادية والبيئية و فوائد المشروع المقترح.

60.2 How is EIA done?

- Identification of the consequences of the proposal.
- Prediction of the extent of consequences.
- Evaluation of the predicted consequences. (Significant or not)
- Mitigation of the adverse consequences.
- Documentation to inform decision makers what needs to be done.

- تحديد عواقب الاقتراح.
- التنبؤ بمدى العواقب.
- تقييم العواقب المتوقعة. (مهم أم لا)
- التخفيف من الآثار الضارة.
- وثائق لإعلام صناع القرار بما يجب القيام به .

60.3 Steps of the EIA

60.3.1 Screening (as appropriate)

- The competent authority makes a decision about whether EIA is required.
- At the end of this stage, a screening decision must be issued and made public.

- السلطة المختصة تتخذ قرارا بشأن ما إذا كان مطلوبا تقييم الأثر البيئي.
- في نهاية هذه المرحلة ، يجب إصدار قرار الفحص ونشر

60.3.2 Scoping (as appropriate)

- The Directive provides that Developers may request a scoping opinion from the competent authority which:
  - Identifies the content and the extent of the assessment
  - Specifies the information to be included in the EIA Report.

- ينص التوجيه على أنه يجوز للمطورين طلب رأي تحديد من السلطة المختصة:
  - يحدد المحتوى ومدى التقييم
  - يحدد المعلومات التي سيتم تضمينها في تقرير تقييم الأثر البيئي

60.3.3 EIA Report

It includes the following points:

- Information regarding the project,
- The Baseline scenario,
- The likely significant effect of the project,
- The proposed alternatives,
- The features and measures to mitigate adverse significant effects as well as a non-technical summary.

- معلومات عن المشروع ،
- سيناريو خط الأساس ،
- التأثير المحتمل المحتمل للمشروع ،
- البدائل المقترحة،
- الميزات والتدابير للتخفيف من الآثار السلبية الضائرة وكذلك ملخص غير فني.

60.3.4 Decision Making and Development Consent

This step includes the:

- Examintion of the EIA report by the competent authority
- Consultation with the environmental responsibilities ,local and regional authorities .
- Conclusion on whether the project entails significant effects.

- فحص تقرير تقييم الأثر البيئي من قبل السلطة المختصة
- تشاور مع المسؤولين البيئيين والسلطات المحلية والإقليمية
- استنتاج حول ما إذا كان المشروع ينطوي على آثار كبيرة.

60.3.5 Information on Development Consent And Monitoring

After consultation and decision making, it is important to:

- Informing the public .
- During construction and operation ,the developer must monitor the significant adverse
- effects to mitigate them

- إعلام الجمهور.
- أثناء البناء والتشغيل يجب على المطور مراقبة الآثار الضارة الهامة للتخفيف منها.

60.4 Financials

A specialized office will be contracted for his purpose. It may take 2-3 months @ an estimate cost of 10k$

APPENDIX D
ENVIRONMENTAL INFORMATION REQUIREMENTS SET OUT IN ANNEX IV OF DIRECTIVE 97/11/EC

Article 5(1) of Directive 97/11/EC requires the Developer to provide to the Competent Authority the information set out below in so much as the information is relevant to the given stage of the consent procedure and to the specific characteristics of the project and of the environmental features likely to be affected, and the developer may reasonably be required to compile the information having regard *inter alia* to current knowledge and methods of assessment.

Environmental Information Requirements for EIA

1. Description of the project, including in particular:
   - a description of the physical characteristics of the whole project and the land-use requirements during the construction and operational phases,
   - a description of the main characteristics of the production processes, for instance, nature and quantity of the materials used,
   - an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting from the operation of the proposed project.

2. An outline of the main alternatives studied by the developer and an indication of the main reasons for this choice, taking into account the environmental effects.

3. A description of the aspects of the environment likely to be significantly affected by the proposed project, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and the inter-relationship between the above factors.

4. A description of the likely significant effects of the proposed project on the environment resulting from:
   - the existence of the project,
   - the use of natural resources,
   - the emission of pollutants, the creation of nuisances and the elimination of waste,

   and the description by the developer of the forecasting methods used to assess the effects on the environment.

5. A description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment.

6. A non-technical summary of the information provided under the above headings.

7. An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information.

61 Financials

61.1 Power Plant cost 2MW (CAPEX)

Item Description	Total
0. Civil Work Total	$0
1. Waste Management Total	$490,000
2. NLAP 2MW PP Total	$3,045,476
3. Software Total	$70,000
4. Testing and verification Total	$210,000
Grand Total	**$3,815,476**

61.2 Maintenace and feed (OPEX)

Ref#	Description	Unit Price	Type	Qty	Total
3	Operational Cost per year				$332,083
3.1	Annual Maintenance Contract	$218,083	Yearly	1	$218,083
3.2	Diesel	$2,500	Monthly	12	$30,000
3.3	Chemical				$84,000
3.3.1	Sodium bicarbonate	$6,000	Monthly	12	$72,000
3.3.2	Activated carbon	$1,000	Monthly	12	$12,000
	Total per year				**$332,083**

61.3 Operation Team (PS)

Job description	Qty	Salary per month	Total per year
Project Manager	1	$2,000	$24,000
Operator/control	2	$1,000	$24,000
Forman (Municipality)	1	$0	$0
Bulldozer/winch driver (Municipality)	1	$0	$0
Waste separation (Municipality)	3	$0	$0
Total	**8**		**$48,000**

61.4 Environment Impact Assessment (3rd Party Contractor)

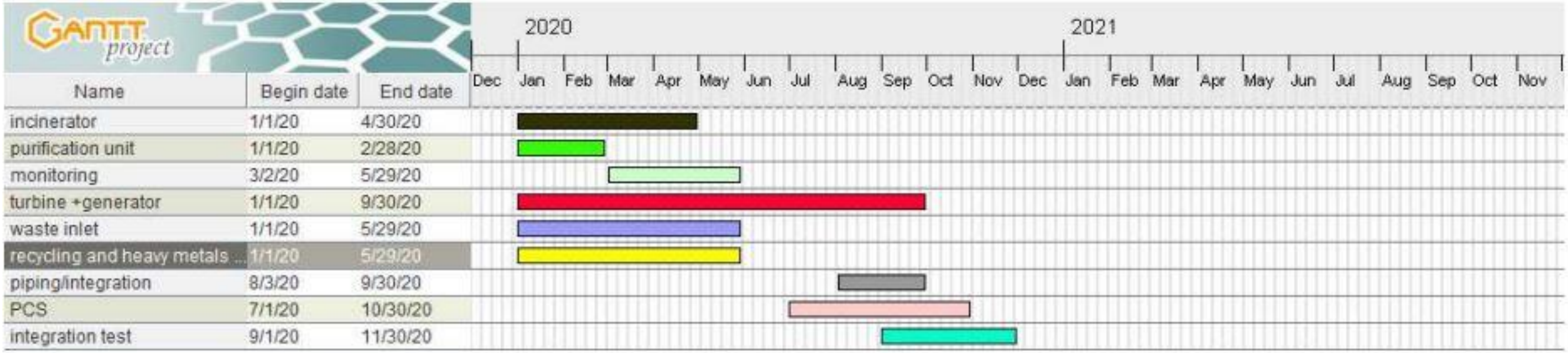
Ref	Description	Unit Price	Type	Qty	Total
5	EIA	$ 15,000	LS	1	$ 15,000
	Total				**$ 15,000**

61.5 Revenues

Item description	Price	Unit	Qty	Total per day
Waste treatment	$ 25	per ton	50	$ 1,250
Electricity	$ 0.13	kWh	2000	$ 3,120
Metal recycling	$ -	per ton	0.6	$ -
Bottom ash usage	$ -	per ton	10	$ -
Total per year	**Efficiency**	**90%**	**365**	**$ 1,435,545**

62 Time Schedule

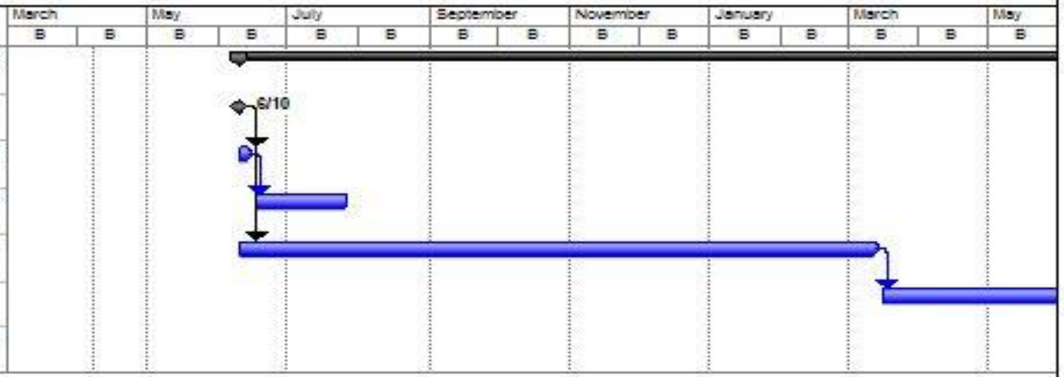
62.1 NLAP 2 MW Manufacturing Life Cycle



62.2 Project Life Cycle

MASHAA WTE PP

ID		Task Name	Duration	Start	Finish
1		**Mashaa Waste to energy Power Plant**	**265 days**	**Mon 6/10/19**	**Fri 6/12/20**
2		Sign agreement	0 days	Mon 6/10/19	Mon 6/10/19
3		Site survey	5 days	Mon 6/10/19	Fri 6/14/19
4		Site preparation	30 days	Mon 6/17/19	Fri 7/26/19
5		NLAP PP Manufacturing & testing	10 mons	Mon 6/10/19	Fri 3/13/20
6		EIA	60 days	Mon 3/16/20	Fri 6/5/20
7		Ready for Operation	5 days	Mon 6/8/20	Fri 6/12/20



Project: 11042019_Mashaa WT
Date: Mon 4/8/19

North Lebanon Alternative Power

Task		Milestone		External Tasks	
Split		Summary		External Milestone	
Progress		Project Summary		Deadline	

Page 1

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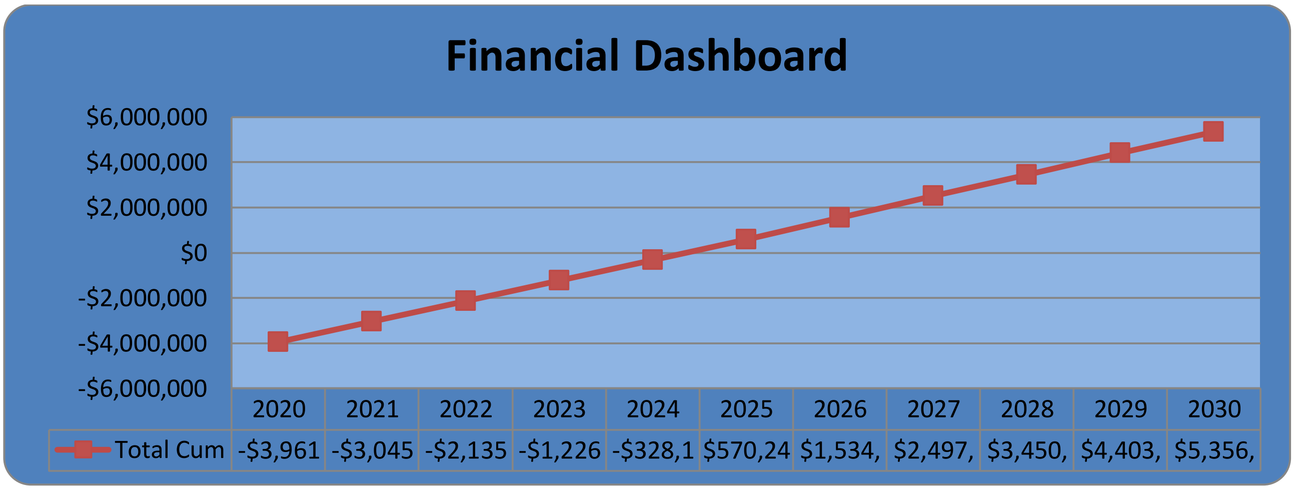
63 Final:Our Proposal

We are proposing a BOT model of 10 years. The following table provides the different financial functions involved through the project life cycle:

Description	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Revenues	$0	$1,435,545	$1,435,545	$1,435,545	$1,435,545	$1,435,545	$1,435,545	$1,435,545	$1,435,545	$1,435,545	$1,435,545
CAPEX	$3,815,476	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
OPEX	$0	$332,083	$332,083	$332,083	$332,083	$332,083	$332,083	$332,083	$332,083	$332,083	$332,083
Financial Inv	$0	$76,310	$76,310	$76,310	$76,310	$76,310	$0	$0	$0	$0	$0
PS	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000
Maintenance		$0	$21,808	$21,808	$32,712	$32,712	$43,617	$43,617	$54,521	$54,521	$54,521
Site Prep	$50,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Municipality	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000	$48,000
EIA	$0	$15,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	-$3,961,476	$916,152	$909,344	$909,344	$898,440	$898,440	$963,845	$963,845	$952,941	$952,941	$952,941

The following chart provides financial dashboard through BOT



- Our proposal is for a period of 11 years (BOT) – (1 year Manufacturing / 10 years operation)
- Optional: Operation and maintenance to continue after period by NLAP
- The municipality will be provide the needed land to install the power plant as per layout Figure 2
- The municpality will be responsible on the waste team as indicated in section 7.3
- This proposal is valid for 30 days

Hope you find the above proposal meets favorably with you and remain

Looking forward to have a fruitfule cooperation and work together for the best of our community.

Best Regards,

Eng. Ziad MALAK

COO

Tripoli, 10.4.2019

Dr. Eng. Samir Mourad

CEO

Tripoli, 10.4.2019

Other marketing activities

64 Mashha مشحا عكار - North Lebanon April 2019

- presentation (pdf) (للتحميل)

- presentation (pptx) (للتحميل)

- project proposal (pdf) (للتحميل)

- project proposal (docx) (للتحميل)

تقرير عن اللقاء

http://nna-leb.gov.lb/ar/show-news/403587/

https://www.facebook.com/152904024791806/posts/2108129579269231/

بلدية مشحا

April 13 at 5:05 PM ·

. ندوة حوارية عن مشروع توليد الطاقةالكهربائية من النفايات في بلدة مشحا

نظمت بلدية مشحا، بالتعاون مع شركة " طاقة الشمال " ندوة حول مقترح مشروع توليد الطاقة الكهربائية من النفايات في البلدة، في مبنى المدرسة الحميدية الأثرية، بحضور رئيس بلدية مشحا خالد عبدالقادر الزعبي ، ونائب الرئيس محمد سليمان الضناوي ، والاعضاء وعن شركة "طاقة الشمال" حضر رئيس الشركة سمير مراد، مسؤول التسويق زياد ملك، عبدالله مراد مدير قسم التصنيع الميكانيكي، وشارك المجلس المدني لانماء عكار ممثلا برئيسه حامد زكريا ، رئيس اتحاد نهر اسطوان عمر الحايك ممثلا بمصطفى الدركوشي ، مدير ثانوية مشحا الرسمية رياض الزعبي ، والمختار احمد الزعبي ، بالاضافة الى مختصين ومهتمين.

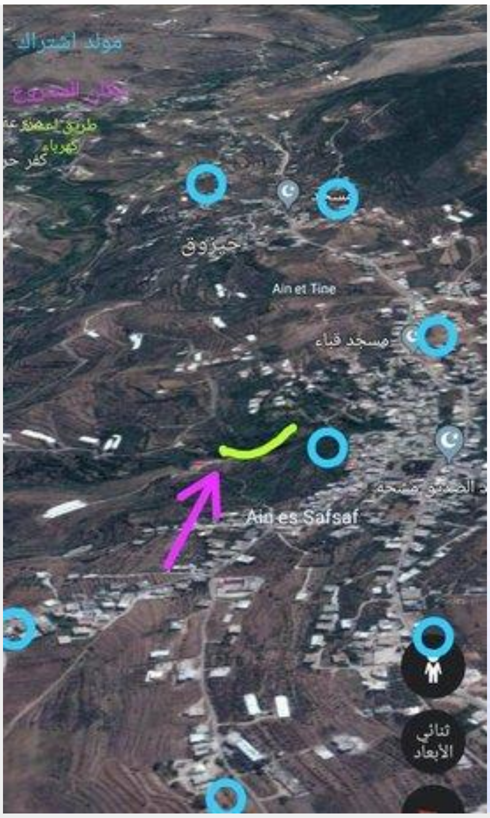
بدأت الندوة بكلمة لرئيس بلدية مشحا خالد عبدالقادر الزعبي الذي رحب بالحضور، وتكلم عن ازمة النفايات.

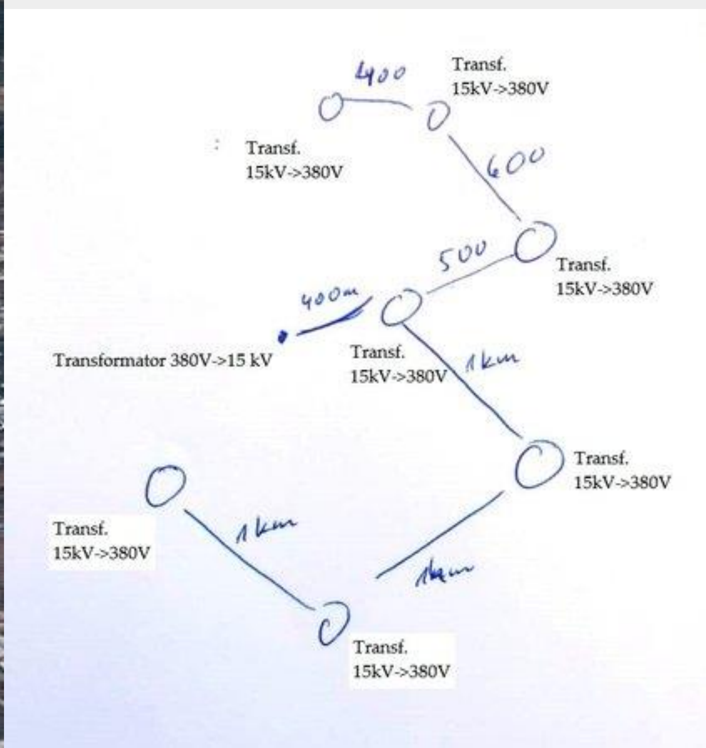
وتحدث الزعبي عن تجربة بلدية مشحا الرائدة في مجال الفرز من المصدر وانشاء مركزي الفرز والتسبيخ وانتاج السماد العضوي. وقال: "نحن اليوم بصدد مناقشة مشروع معالجة النفايات عن طريق التفكك الحراري وانتاج الطاقة الكهربائية التي ستغذي بلدة مشحا ب 2 ميغاواط من الكهرباء لمدة 30 سنة قادمة، وهو مشروع استثماري تستفيد منه البلدية والشركة في ان معا."

ملك

وعرض ملك المشروع بتفاصيله، وتحدث عن الجدوى الاقتصادية من خلال: تأمين فرص عمل، صناعة محلية لكامل المصنع تكون اوفر، معالجة لمشكلة النفايات المزمنة في الحال، تقليل العجز في الكهرباء، الاستفادة من بقايا الحرق لصيانة وتعبيد الشوارع، واعادة تدوير المعادن.

وفي الختام، كانت مناقشة عامة مع الحضور حول المشروع واستفسارات رد عليها مراد.



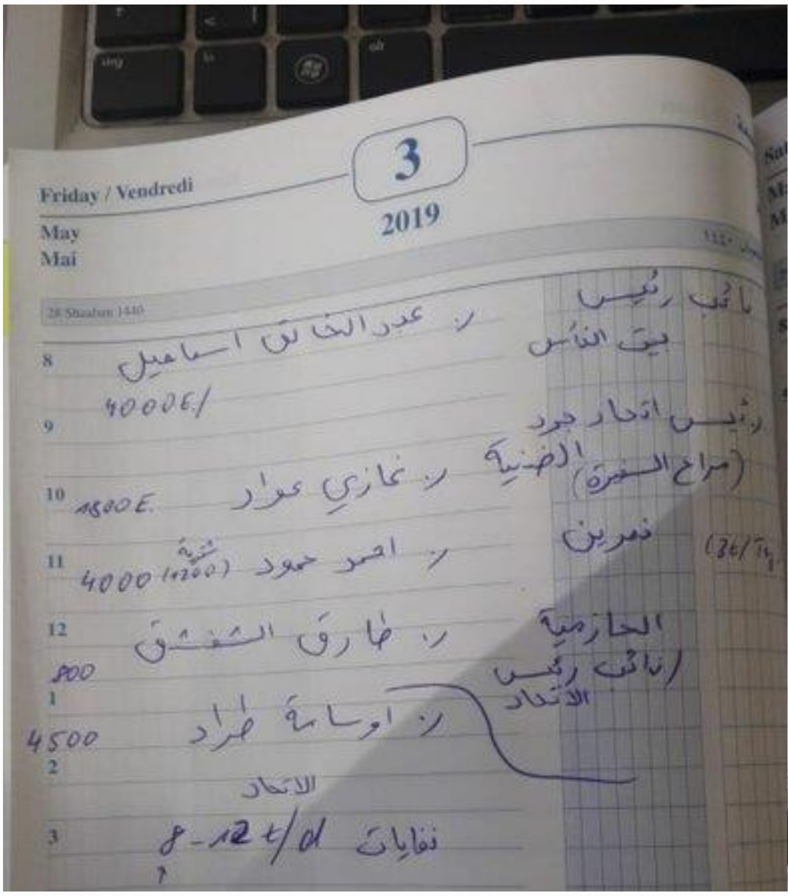


Electrical Distribution Plan (pdf)

65 Taran/Diniyye - North Lebanon 2019

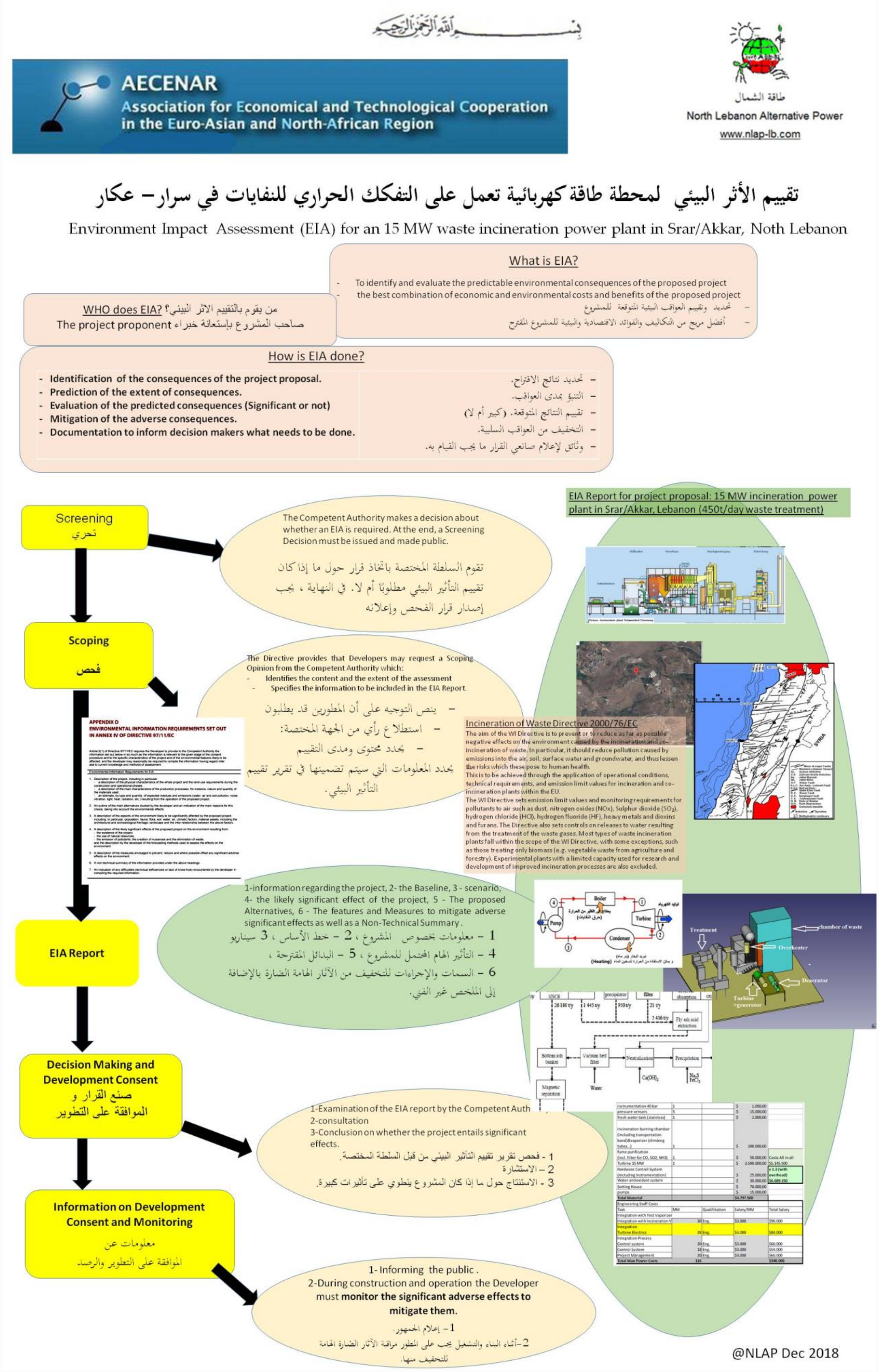
-Project Proposal (pdf) (please click)

لقاء مع رئساء بلديات اتحاد جرد الضنية في مركز طاقة الشمال في راسمسقا في تاريخ 3 ايار 2019



66 Srar - North Lebanon 2018

- Environment Impact Assessment - report (doc) (تقييم الاثر البيئي) (please click)



67 بلدية عيات(Ayyat / Akkar - North Lebanon)

30 tons/day Waste incinerator + hydrogen production (Project Proposal Feb 2018)

- project proposal (pdf) (please click)

68 Al-Denniye 120 tons/day Waste incinerator (Project Proposal Dec 2017)

- presentation (power point), presentation (pdf) (please click)
- film (please click)

بسم الله الرحمن الرحيم

طاقة الشمال

North Lebanon Alternative Power

www.nlap-lb.com

Subject: Project Proposal

Project title: Al-Denniye 120 tons/day Waste incinerator

First Member: Municipality of Al-Denniyeh

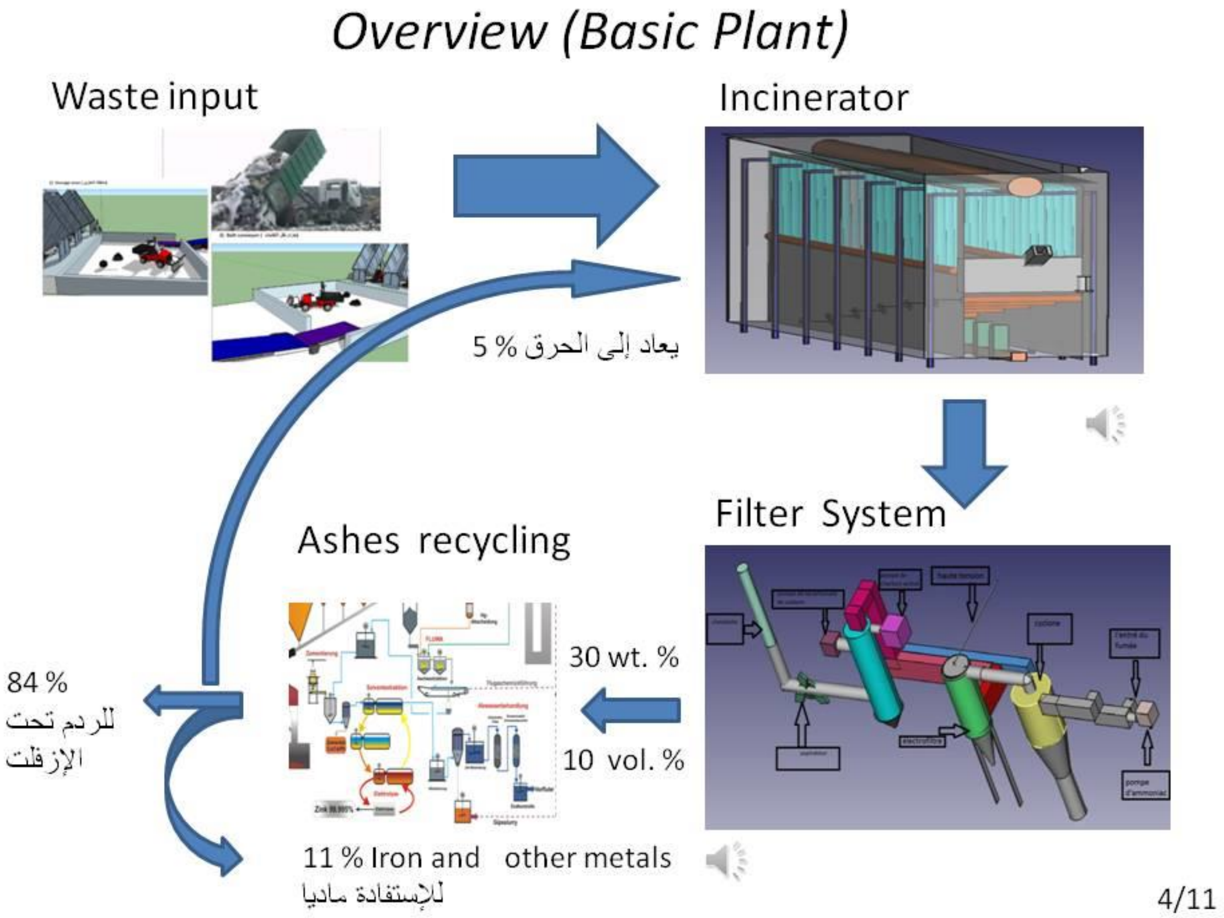
Second Member: NLAP Company

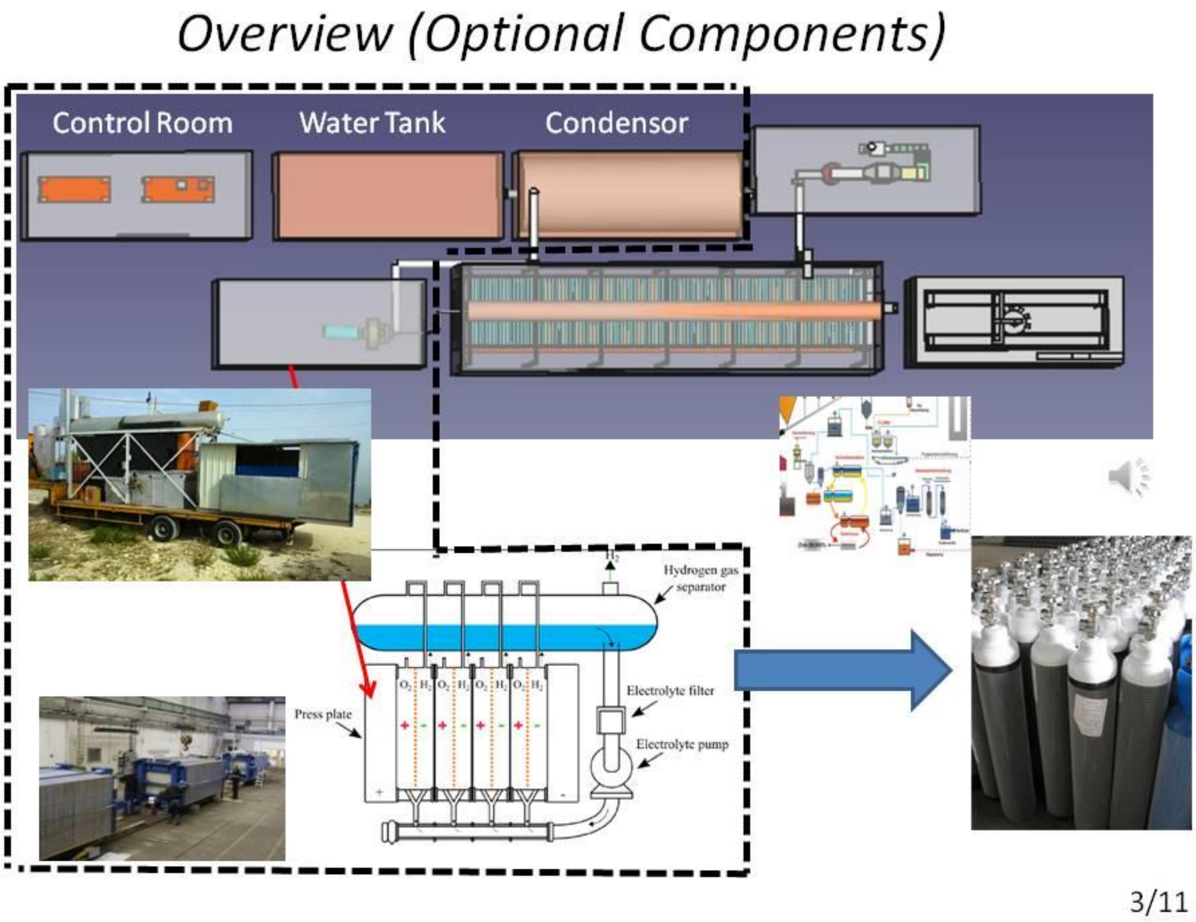
1/11

Project overview

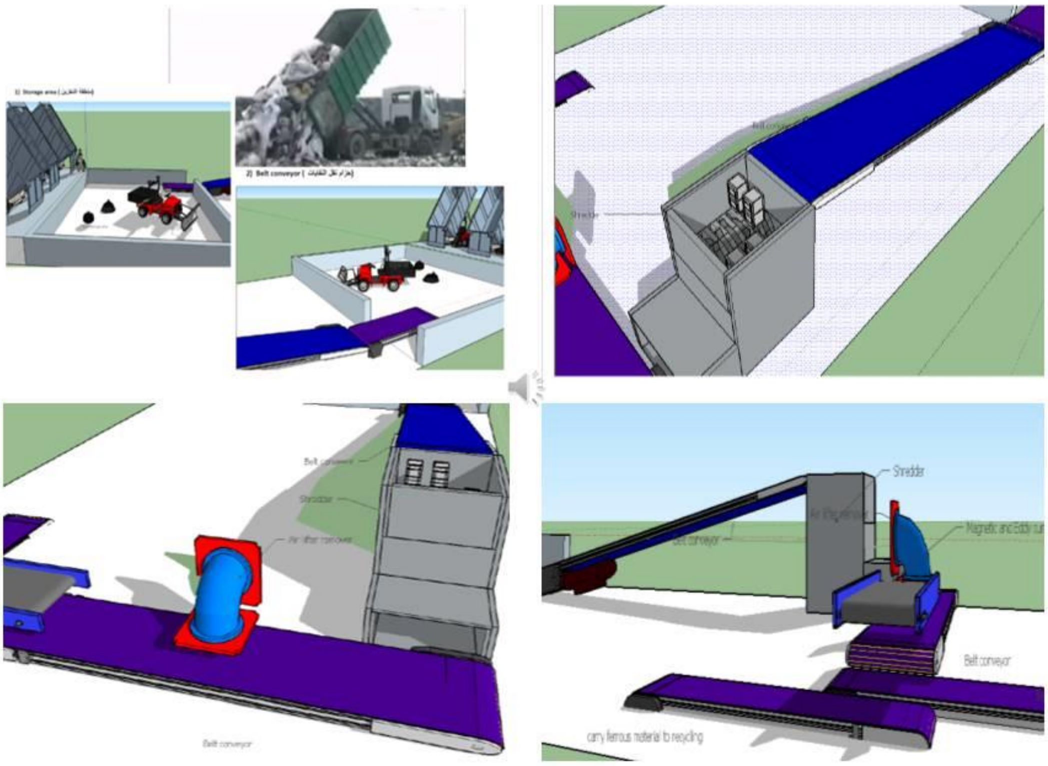
- The plant eliminates 120 tons / day of treated household waste.
- The plant includes a **filtration system** to fulfill the Lebanese and International requirements and norms concerning smoke emissions.
- Incineration remnants (**Smoke and Ashes**) are **recycled**.
- Optional: Expandability to **electrical power** generating plant and / or **hydrogen production** plant.

2/11


Overview (Basic Plant)
Waste input
Incinerator
5 % يعاد إلى الحرق
Filter System
Ashes recycling
30 wt. %
10 vol. %
84 %
للردم تحت
الإزفلت
11 % Iron and other metals
للإستفادة ماديا
4/11

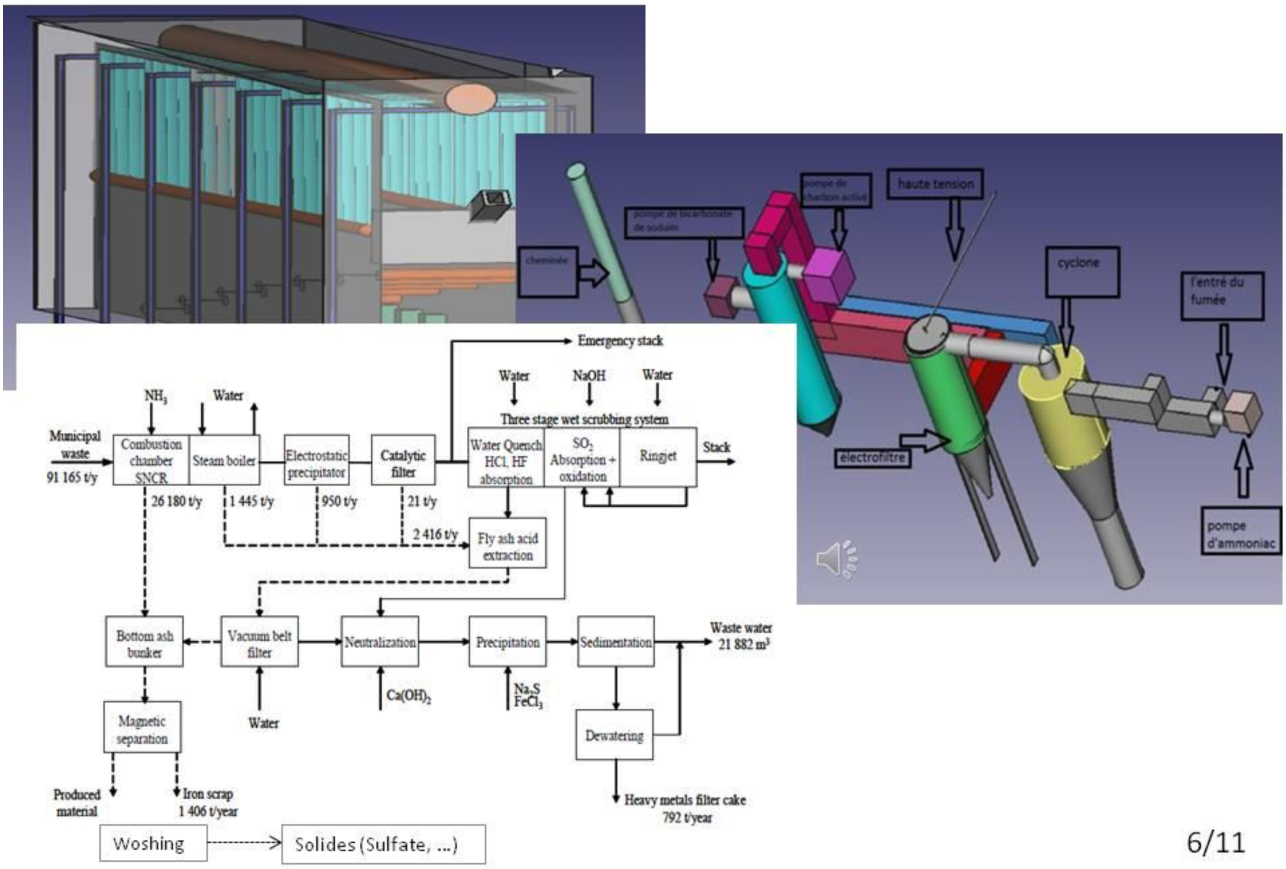

Overview (Optional Components)
Control Room
Water Tank
Condensor
Hydrogen gas separator
Press plate
Electrolyte filter
Electrolyte pump
3/11

Basic Plant Components – Waste input



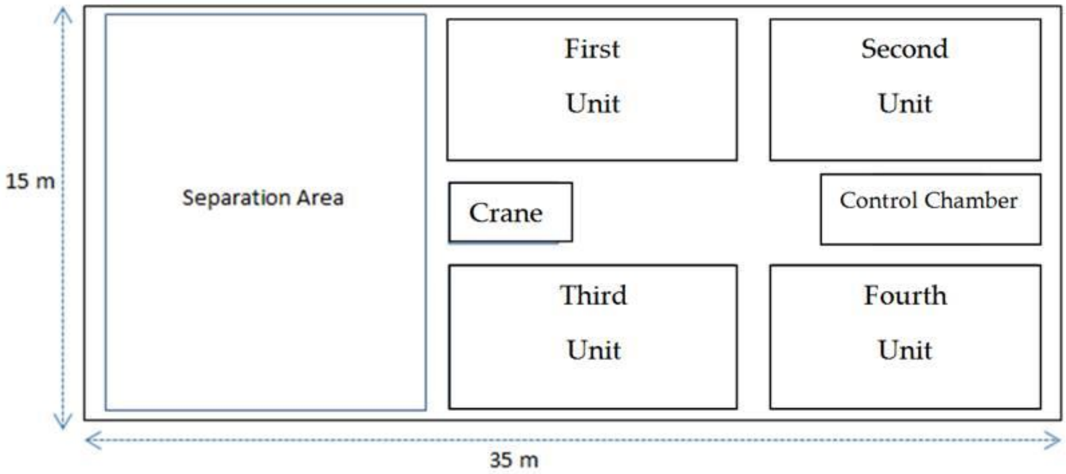
5/11

Basic Plant Components – Incinerator+Filters



6/11

مساحة الأرض المطلوبة



7/11

Business Plan Project Cost

Incinerator for 150 tons of waste per day, total installation costs				
Material Costs (including workers for manufatoring)				
Part	Number of pieces	Description	Total	Supplier
Separtion waste system	2		$ 70,000.00	
Winch for separated waste	1		$ 100,000.00	
Pipining tubes (Stainless)			$ 45,000.00	
diesel burner including fuel feed	4		$ 8,000.00	
safety valve 15 bar	1		$ 1,000.00	
pressure sensor	5		$ 15,000.00	
fresh water tank (stainless)	4		$ 8,000.00	
incineration burning chamber (including transportation band)&vaporizer (climbing tubes...)	4		$ 800,000.00	
Smoke Filtration including the (Electrlic filter, Bicarbonates system, Active Coal sytem, Bag filter, Chimney)	4		$ 600,000.00	Costs All in all
Hardware Control System (Including Instrumentation)	4		$ 100,000.00	x 1.3 (with overhead)
Mobile blatform	1		$ 30,000.00	$2,518,100
Remains smoke treatment (FLUWA/FLUREC)	1		$ 110,000.00	
Bottom ash treatment			$ 50,000.00	
Total Material			**$1,937,000**	
Empolyers Staff Costs				
Task	Number	Qualifikation	Salary/month	Total Salary/yea
Forman	1	Forman expert	1000 $	12,000 $
Winch employee	1	Winch expert	1000 $	12,000 $
Control system employee	2	Eng expert	1000 $	24,000 $
Bulldozer driver	1	Bulldozer expert	1000 $	12,000 $
Waste Separation empolyee	8	Empolyer	600 $	57,600 $
master students, Practicants	2	Professional mast	1000 $	24,000 $
Total man power salary / year				141,600 $

Price for AL-Denniyeh Municipality
2,700,000 $ * 1.1
= 2,970,000 $

Win For NLAP sharikah 10%

Total Project Cost
2,700,000 $

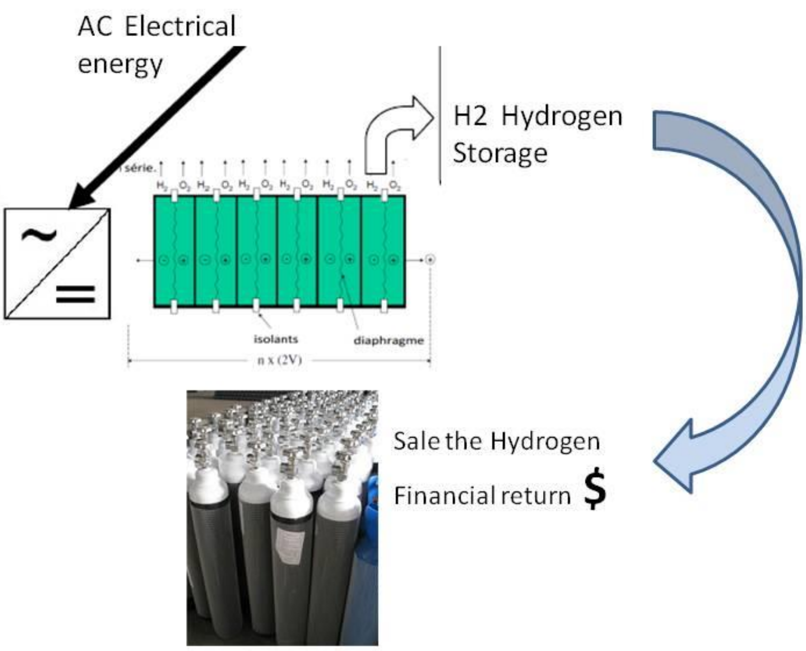
8/11

Funding utilization and milestones

		Milestone		Funding need
2018	كانون الثاني	Steam Control Valve Testrig finished, Waste inlet control finished	Basic Development	300k$
	شباط	Ground for production facility ready	Infrastructure	400k$
	آذار	NLAP production plant at Ras Nhache site installed (Hangar)	Infrastructure	200k$
	نيسان	Ground for 1.5 MW is aquisited and prepared DetailedSpecification &Design according to customers wish finished	Incinerator plant project	300K$
	أيار	Start of manufacturing &installation	Incinerator plant project	300K$
	حزيران	Manufacturing of Incinerator & Vaporizer finished	Incinerator plant project	300K$
	تموز	Smoke filtration System	Incinerator plant project	300K$
	آب	Process control system installed and tested & wohle plant integration tested	Incinerator plant project	300K$
2018	أيلول	Delivery of plant	Incinerator plant project	300K$

9/11

Hydrogen Production by electrolysis of water



10/11

Addition Cost table on the Pre-cost

Part	Quantity	Price	Total by $
Water antioxidant system	4	25,000 $	100,000 $
Turbine System	1	1,000,000 $	1,000,000 $
Generator	4	32,500 $	130,000 $
Condenser	4	35,000 $	140,000 $
Condenser cooling	4	1,500 $	6,000 $
Convertor	4	40000 $	160,000 $
Electrolysis system	800 €/kW, for 8 MW	800,000 €	1,000,000 $
Total additional cost			2,400,000 $
Total Cost with the first project			5,000,000 $

Financial return

	H2 Production
Daily quantity	160 Kg
Annual quantity	58,400 Kg
Market price per kg	10 $/kg
Total price per year	584,000$

Total Payback per year 584,000 $

Total Cost 5,000,000 $

Amotization Time 10 years

10/11

69 Prices on nlap-lb.com

المنتوجات:محارق للنفايات مع رعاية المواصفات البيئية للاتحاد الاروبي ومحطات طاقة كهربائية عن طريق حرق النفايات بأحجام مختلفة

Products: Waste incinerators and Incineration power plants

A. Municipal Waste Incinerators (محارق مع معالجة بيئية لصفوة الحرق)

الاستعاب اليومية للنفايات للحرق (طون في اليوم) Daily Waste Capacity [tons/day]	العدد التقريبي من المواطنين Number of citizens	Needed Installation Place	Model
15-30 (8 - 16 working hours per day)	15,000 -30,000	10m x 15 m = 150qm	NLAP-NWI 30
50 -100 (8 - 16 working hours per day)	50,000 - 100,000	300 qm	NLAP-NWI 100

النفايات يجب ان تكون خالة من الزجاج والحديد (فرز من المصدر)

In inlet waste must not include big pieces of glass or metals

Ashes (after incineration): 10% of volume / 30% of weight

B. Waste Incineration Power Plants (محطات طاقة كهربائية عن طريق حرق النفايات)

المواصفات الفنية
2MW NLAP-IPP Technical Specification

Steam Generator

2 MW Turbine

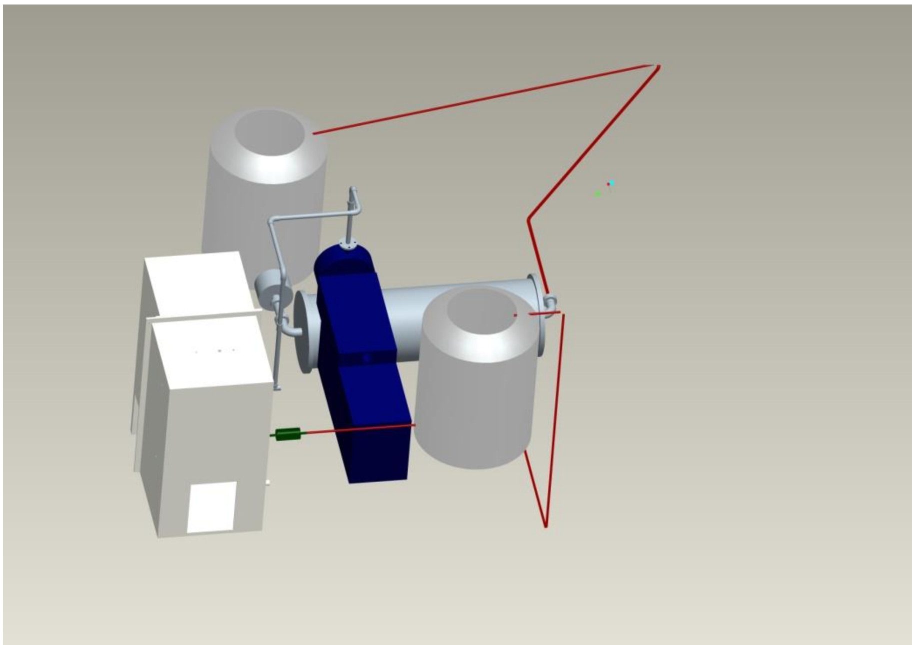
NLAP-IPP 2 MW el. power , 50 tons waste daily
Price: 3 - 3.8 Mio $
Filter costs monthly: 6000 $
8-10 operators

NLAP FreeCAD Database

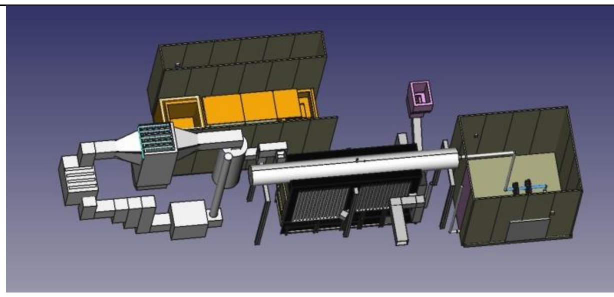
70 North Lebanon Alternative Power_FREECAD_DATABASE

Last update: 24.11.2016

70.1 40 kW Testplant in Qubaisi Center

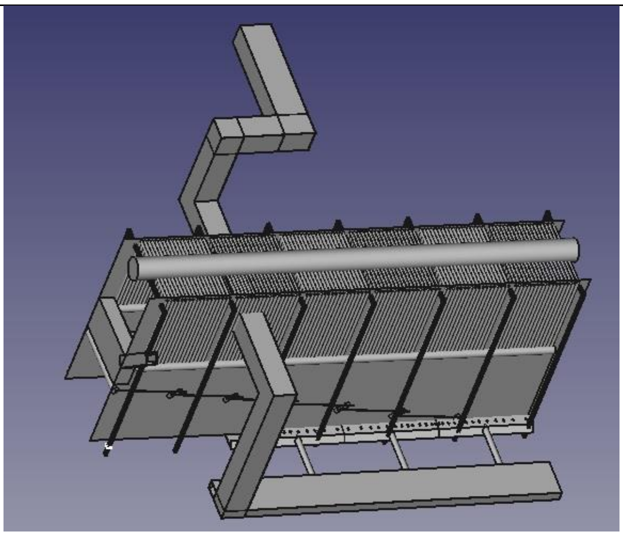
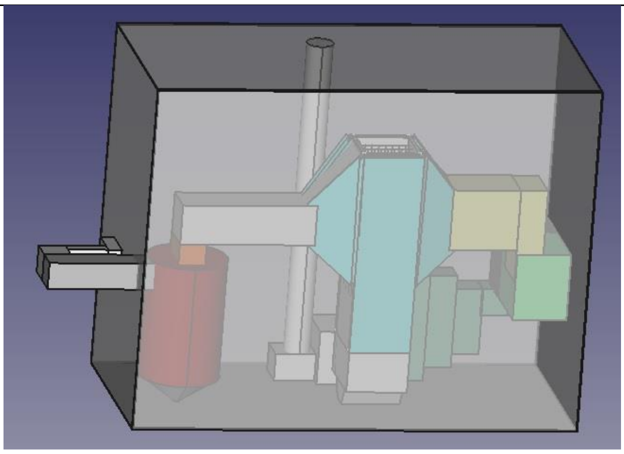
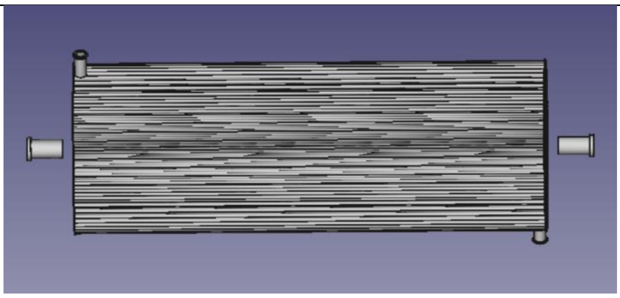
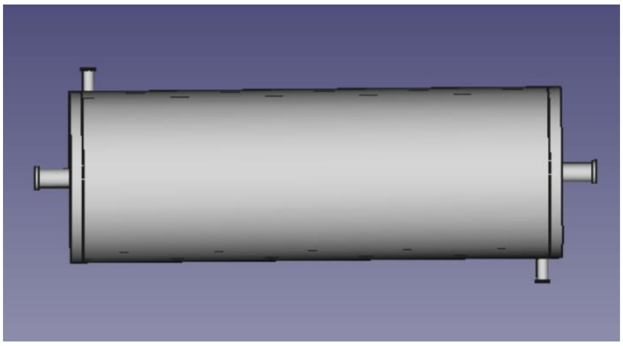


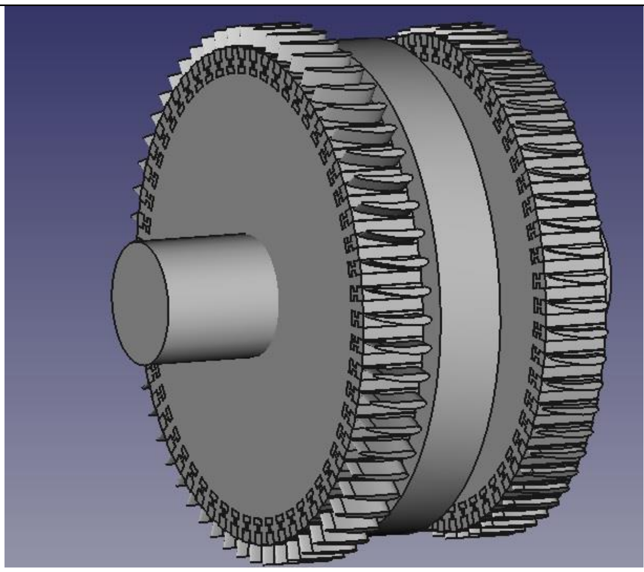
70.2 40 kW NLAP-IPP Demoplant

Vaporizer		
Turbine		
FlueGasPurification		
Complete System	Version July 2016 250716TEMO-IPP_completeSystem2016.F	

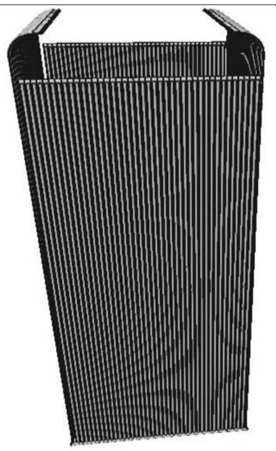
70.3 1.5 MW NLAP-IPP

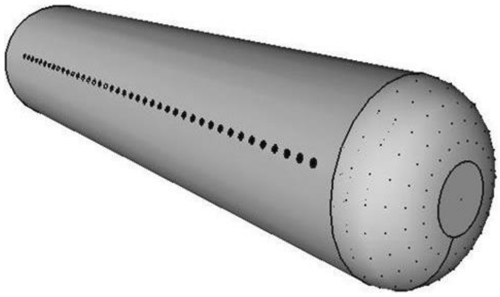
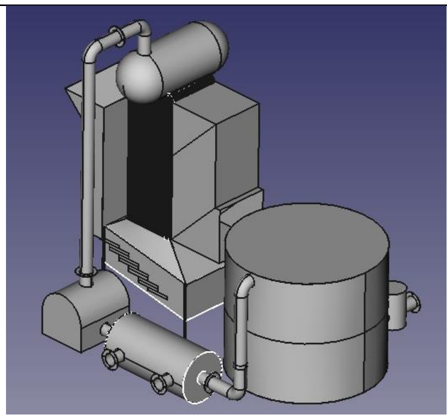
Device No.	Part+details		

1	Waste Inlet Container (مع كماشة)		
2	Incineration chamber +Vaporizer	Version14. November 2016 Version 23.11.2016	
3	Flue Gas Purification (Cyclotrone, Electrofilter, Carbonfilter, ...)	Version 21.11.2016 Version 22.11.2016	
4	Condensor	Version 21 Nov 2016	 

5	Turbine	1.5 MW non-static piece (ready for manufactoring with 3D CNC)	
	TurbineBlock (including Generator)		
6	Control Room		
7	Complete System		

70.4 40 MW NLAP incineration power plant

Part details	Version	Design
Combustion Chamber • volume is 7500 cu ft. (212 meter cube) (width: 4m, length: 4m, height:12m)	Version 20.09.2015 (FORMAT FCStsd)	

Drum • Length: 32 ft. (10 m) • Diameter: 7 ft. (2.1 m) • Weight: 9200 pound (4173 kg) • Capacity: 6600 gallon (24 983 l) • Thickness: 5 mm • Material: Stainless steel 316L	Version 2015 40MW_vaporizer_drum.FCStd	
Complete Plant cycle	Version 14.08.2015	

Posters

بسم الله الرحمن الرحيم

AECENAR
Association for Economical and Technological Cooperation in the Euro-Asian and North-African Region

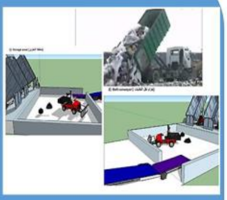
MEAE - Middle East Alternative Energy Institute
مركز الشرق الاوسط للطاقة البديلة
http://aecenar.com/institutes/meae

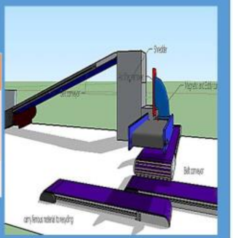
طاقة الشمال
North Lebanon Alternative Power
www.nlap-lb.com

Waste to energy 2 MW platform

I-Waste input

Steps of this part are:
1-storage area
2-belt conveyor
3-shredder
4-air filter to remove stench
5-magnetic sorting + eddy
6-carry ferrous material to recycling
7-belt conveyor

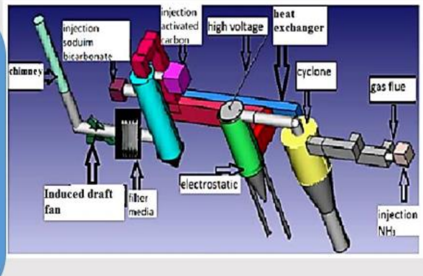




	COST $
Construction: Separation waste system	350.000 $
Winch	100.000 $

System of filtration

Heat exchanger between flue gas and air that will enter to the boiler and participate in combustion .Heat exchanger minimize the gas temperature to 200°C. at this temperature the charcoal is effective even as sodium bicarbonate .
-Injection of activated charcoal :to reduce the ratio of dioxin and furans in fumes .
- **Injection sodium bicarbonate (powder) : to reduce the ratio of acid gas (SO_2 , HCl, HF), at 150-230°C.**
- **Filter media: fumes came to filter media where a cake was formed in the face ahead flue .It eliminate the toxic gas and bad smell**



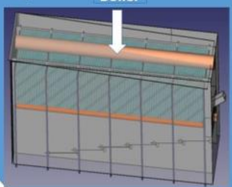
Injection	Quantity/ ton of waste	Price of 1 kg	Quantity of injection to 50 tons	Cost / day($)	cost/ Month	Operation (Each day 1 silo of 30 kg should be filled out)	Construction of basic structure
Sodium bicarbonate	15 kg	0.23 $	750 kg	172.5 $	5.175 $	Silo of 30 kg	
Activated carbon	1 kg	0.6 $	50 kg	30 $	900$	silo of 1 ton	
Total					6.075	1 staff :300 $	150.000 $

Ref:- https://www.alibaba.com/product-detail/Bulk-sodium-bicarbonate-industrial-grade_60760896553.html?spm=a2700.7735675.normalList.6.3ciZzM&s=p
-https://www.alibaba.com/product-detail/activated-carbon-fine-powder_579170072.html?spm=a2700.7724857.2017127.18.54d71acbltCx8n&s=p

II-Incinerator +Boiler

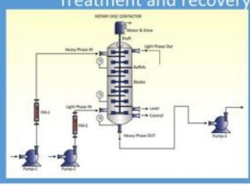
A- Receiving sorted waste to be incinerated.
Combustion
- takes place between 850 and 1000 ° C,
- **reduces the waste volume by 90%.**
- **-Reduces mass to 80 %**
- **In doing so it produces pollutants residues potentially dangerous.**
- **They are of two types: solid residues, called clinker, are recovered in the furnace vessel and flying residues**

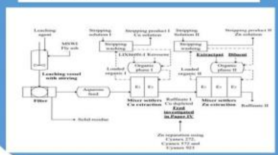
Boiler



	Cost($)
Construction	200.000 $
Maintenance of all platform	150.000 $
Diesel burner	2.000 $
Total	352.000 $

Treatment and recovery of heavy metals(Cu , Pb ,Mg ,Zn)

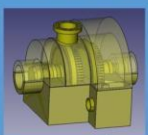




	Cost
Construction :4 columns	50.000 $
Operation :2 staff	800 *2=1600 $/month

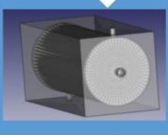
III-Turbine + generator

water transforms to steam in the incinerator then it passes to the turbine to .this mechanical power transforms to electrical power by a generator. The ,the steam passes in condenser to repasses to the boiler .



Turbine

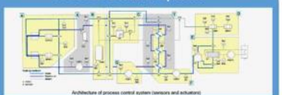
Generator



Condenser

	Cost($)
Turbine	1. 000.000 $
generator	32.500 $
condenser	35.000 $
Condenser cooling	1.500 $
convertor	40.000 $
Total	1.109.000$

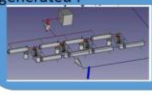
Process Control system



	Cost
Construction	65.000 $

Electrolysis

-Production of H_2 and O_2 from water by using the electricity generated .



Cost: 912 $ /KW

This Power plant use:
50 tons per day to generate 2 MW

Operation cost

Task	Number	Qualification	Salary/ month
Forman	1	Forman expert	1.000 $
Winch employee	1	Winch expert	1.000 $
Control system	2	Eng. expert	1.000 $
Bulldozer driver	1	Bulldozer expert	1.000 $
Waste separation	8	Employer	600 $
Total			9.800 $

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MEAE - Middle East Alternative Energy Institute
مركز الشرق الاوسط للطاقة البديلة
http://aecenar.com/institutes/meae

طاقة الشمال
North Lebanon Alternative Power
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تنقية دخان مصانع التفكك الحراري
Flue Gas Purification
(Thermal treatment: incineration)

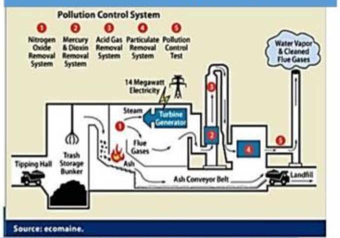
Residues of incineration of 1 ton of waste
700 kg of gas,
300 kg of solid residues including 30 kg of fly ash.

Division of emissions(depending on their size and the degree of severity:)

Challenges

Non-harmful to the environment لا تضر بالبيئة	harmful to the environment تضر بالبيئة	Toxic gases: الغازات السامة
Nitrogen (N_2), Oxygen (O_2), and water vapor (H_2O)	Acid gases: nitrogen dioxide (NO_2), nitrogen oxide (NO), Sulfur dioxide (SO_2), carbon dioxide (CO_2),HCl, Dust	Furans, dioxins, heavy metals (Hg from batteries, cadmium, plumb, zinc)

Waste to energy diagram



كما سبق وذكرنا ,ان بقايا الحرق كثيرة لذلك كان من الضروري معالجتها .نبدأ بالنيتروجين الذي سيعالج عن طريق رش الأمونيا على دفعتين .ثانيا,الديوكسين و الزئبق الذي سيملر في خرطوشات الكربون المنشط.ثالثا,الغازات الحمضية ستم ازالتها برش ال بيكربونات الصوديوم.واخيرا ,الغبار سيتم ازالته ميكانيكيا وكهربائيا (ESP).اعتمادا على ذلك ,فان الانبعثات ستكون مطابقة لما ورد في الجدول التالي.

والبقايا الصلبة سيتم معالجتها في نظام خاص منفرد ,ولمراقبة الانبعاثات بشكل متواصل ,سوف يركب أجهزة مراقبة على المحطة للتأكد من صحة الفلاتر المستعملة.

Emission limit values in mg / m^3 to 11% O_2 dry gas According to EC 20/09/2010 to an incinerator >6 ton/h

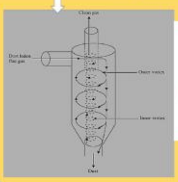
parameter	half-hour mean value	European Directive 2000/76 / EC of 04/12/2000 and French Decrees of 20/09/2002 and 03/08/2010	refectural stopped operating permit Flamoval of 17/06/2009
Total dust	1-20	10	3
Hydrochloric acid (HCl)	1-50	10	7
Hydrofluoric acid (HF)	10	1	0.7
Sulphur dioxide (SO_2)	1-150	50	15
Carbon monoxide(CO)	5-100	50	30
total organic carbon (COT)	1-20	10	8
Mercury (Hg)	0.001-0.03	0.05	0.04
Cadmium + Thallium (Cd + Tl)	-	0.05	0.04
Other heavy metals (Sb + As + Pb + Cr + Cu + Co + Mn + Ni + V)	-	0.5	0.4
Oxides of Nitrogen (NOx)	40-300	200	50
Ammonia (NH_3)	-	30	10
Dioxins and furans	0.01-0.1	0.1	-

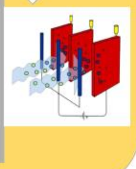
	<1 ton/h	1-3 ton/h	>3 ton/h
Elements (polluants)	Maximum value(mg/m^3)	Maximum value(mg/m^3)	Maximum value(mg/m^3)
Dust	200	100	30
Pb+Cr+Cu+Mn	-	5	5
Ni+As	-	1	1
Cd+Hg	-	0.2	0.2
Cl (HCl)	250	100	50
F (HF)	-	4	2
SO_2	-	300	300

Emission limit values in mg /m^3 to respected (Lebanese environmental ministry

4.Treatment of dust (علاج الغبار)

Particles between 5 & 50 micron and volatized heavy metals	Less than 5 micron
Mechanical treatment : العلاج الميكانيكي Cyclone(efficiency:91%)	Electrical treatment : العلاج الكهربائي The electrostatic precipitator (ESP)(efficiency:95%)





1.Techniques for the reduction of nitrogen oxide(تقنيات للحد من أكسيد النيتروجين)

-Thermal NOx: When burning a portion of the nitrogen in the air is oxidized to nitrogen oxides. This reaction occurs only significantly at temperatures above 1300 ° C. The reaction rate depends exponentially on the temperature and is directly proportional to the oxygen content
-Fuel NOx: when burning a portion of the nitrogen contained in the fuel is oxidized to nitrogen oxides.

PROCESS OF REDUCING NON-SELECTIVE CATALYTIC (SNCR):
the reducing agent (typically ammonia or urea) is injected into the furnace and reacts with nitrogen oxides. The reactions occur at temperatures between 850 and 1000 ° C, with higher reaction rates and lower in this range.

Selective Catalytic Reduction (SCR) is a catalytic process during which ammonia mixed with air (the reduction agent) is added to the exhaust gas and passes through a catalyst, usually a sieve (e.g. Platinum, rhodium, TiO_2, zeolites). When passing through the catalyst, ammonia reacts with NOx to give nitrogen and water vapor.

2.Treatment of dioxin and furans and mercury Hg(heavy metals) & CO_2(علاج الديوكسين والفيوران)

By activated carbon(can be also called "lignite Coke for odorous compounds.)
Activated carbon is in the form of a fine black talc. Its elementary particles are made porous by a suitable heat treatment so as to create therein pores having dimensions of affinity with the molecules to be filtered. So there are formulations of active carbon adapted to different molecules that one wishes to retain.

The Environmental Protection Agency (EPA) showed that dioxins broke down easily when exposed to temperatures in excess of 1,200 °C.

To obtain a minimum feeding rate (F(min)) of activated carbon (AC), It was found that dioxin removal efficiency(eta) increased with an increase in AC feeding concentration. This had an almost linear function to F/Q when F/Q was less than 65 g/Nm(3), where F was the AC feeding rate (mg/min), and Q was the volumetric flow rate of flue gas (Nm(³)/min). However, it did not seem to be affected by F/Q, when F/Q was larger than 150 mg/Nm(³). On the basis of the experimental data obtained in this study, the removal efficiency of dioxins by the application of AC could be correlated as eta (%)=100/[1.0+(40.2/(F/Q)(3))].

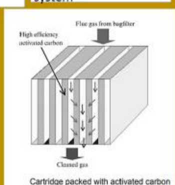
Measurement :The Intelligent Gravimetric Analyzer (IGA)
The system is an ultra-high vacuum (UHV) system and allows measurement of isotherms and accurate determination of the adsorption and desorption kinetic profiles for each pressure step. The system consists of a fully computer controlled microbalance, pressure admit system and temperature regulation system

Dioxins concentrations at activated carbon adsorber

	Dioxins concentrations (ng-TEQ/m^3-norm.)		Removal-efficiency (%)
	Inlet	Outlet	
Electric furnace for steel	5.5	0.009 3	99.83
Ash melting furnace	1.8	0.000 80	99.96
Waste furnace	1.1	0.000 16	99.99

Hg concentrations at activated carbon adsorber

	Inlet (mg/m^3-norm.)	Outlet (mg/m^3-norm.)
Waste furnace	0.065	<0.005 (Under determination limit)
Ash melting furnace	0.57	<0.005 (Under determination limit)



Cartridge packed with activated carbon

Ref:Minimum feeding rate of activated carbon to control dioxin emissions from a large-scale municipal solid waste incinerator. Article in Journal of Hazardous

3.Acid gas treatment technologies(HF, HCl and SO_2)تقنيات معالجة الغاز الحمضي

Depending on the concentrations, temperature, size of the flow to be treated and of further parameters, can be used different technologies for the treatment of acid gas emissions. Being a quick summary we can mention:

Bag filters with reagent injection(calcium hydroxide ($Ca(OH)_2$) or sodium bicarbonate))

The filters in flat bags are successfully used for the chemical absorption of acid gases such as HF, HCl and SO_2 in addition to the adsorption of other pollutant compounds. Generally it is used, among others, calcium hydroxide and sodium bicarbonate ($Ca(OH)_2$) of typical commercial quality, which is injected in the gas stream before entering the filter. To achieve proper compliance with the emission limits required, the additive should be added in amounts over-stoichiometric (from 1.5 to 3 times).
at least 130-200 ° C

• Treatment by $Ca(OH)_2$:

$Ca(OH)_2 + 2HCl \leftrightharpoons CaCl_2 + 2H_2O$

$Ca(OH)_2 + 2HF \leftrightharpoons CaF_2 + 2H_2O$

$Ca(OH)_2 + SO_2 \leftrightharpoons CaSO_3 + H_2O$

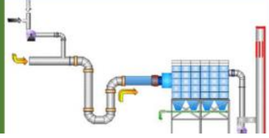
$CaSO_3 + 1/2\ O_2 \rightarrow CaSO_4$

• Treatment by $NaHCO_3$:

$NaHCO_3 + HCl \leftrightharpoons NaCl + CO_2 + H_2O$

$NaHCO_3 + HF \leftrightharpoons NaF + CO_2 + H_2O$

$2NaHCO_3 + SO_2 + 1/2O_2 \rightarrow Na_2SO_4 + 2CO_2 + H_2O$



5.Continuous Emission Monitoring (CEM)

A series of sensors will be implemented to assure a continuous emission monitoring of different gas formed in the flue gas without the Dioxins and furans that measured by GC(gas chromatographic); Sensors of:CO,CO_2,NO,NO_2, SO_2,SO,HCl,heavy metals.

@NLAP/AECENAR March 2019
Maysaa Kamareddine

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Heavy Metals Recycling Unit for NLAP-IPP Demonstration Plant

Lists of metals (mg/kg)

Element bottom ash	Bottom ash	Fly ash	Dry / quasi-dry	wet
Al	22.000-73.000	49.000 - 90.000	12.000-83.000	21.000-39.000
Cd	0.3-70	50-450	140-300	150-1.400
Cu	190-8.200	600-3.200	16-1.700	440-2.400
Fe	4.100-1500	12.000 - 44.000	2.600-71.000	20.000-97.000
Hg	0,02-8	0,7-30	0,1-51	2,2-2.300
Mo	2-280	15-150	9-29	2-44
Pb	100-13.700	5.300-26.000	2.500-10.000	3.300-22.000
Zn	61-7.800	7.000-70.000	7.000-20.000	8.100-53.000

Design & manufacture

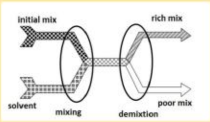
Process

Solvent extraction, or liquid-liquid extraction is a separation technique isothermal in a heterogeneous liquid medium.

The method is based on the existence of a difference in the solubility of a substance in two immiscible liquids. The process has three steps, as shown in next figure :

- Mixture of the two immiscible liquids, one of them containing the solute,
- Obtaining physico -chemical equilibrium, leading to demixing ,

Separation of the two new liquid phases obtained based on the difference of



EXTRACTANTS

Oxime based extractants for copper are largely based on salicyaldoximes which have been modified with one of three modifier types. Examples of the three main extractant types currently in use are:

1. LIX® 984N

A mixture of 2-hydroxy-5-nonylacetophenone oxime and 5-nonylsalicylaldoxime in a high flash diluent. The acetophenone oxime modifies the aldoxime and also performs as an extractant in its own right. Molecular Weight:262.393 g/mol.

2. Acorga® M5640

5-Nonylsalicylaldoxime modified with an ester, 2,2,4-Trimethyl-1,3-pentanediol Diisobutyrate (TXIB) in a high flash diluent.

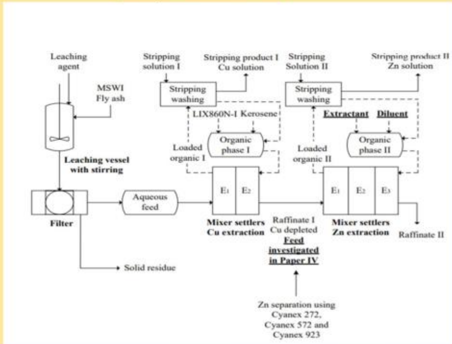
3. LIX® 622N

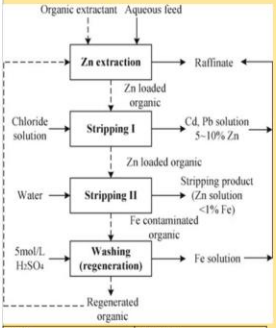
5-Nonylsalicylaldoxime modified with tridecyl alcohol in a high flash diluent.

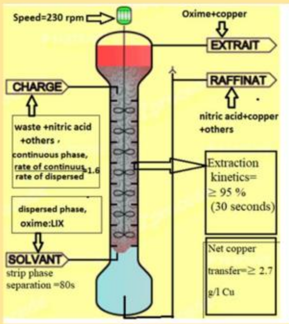
Each of the extractants marketed by the major chemical suppliers has been designed for a specific type of PLS with regard to pH and copper tenor. Used under the conditions for which they were designed they all deliver very similar copper net transfer values. The physical properties of the various types of extractant do show some differences with the aldoxime/ketoxime mixtures such as LIX984N showing lower entrainments and greater tolerance to crud than the other reagents when treating some types of PLS. The vol% concentration of the commercially available extractants is limited by organic viscosity constraints to about 30-33% and this means that the maximum net transfer of copper will be about 10g/l. For leach solutions containing significantly higher copper tenors than this the throughput O/A ratio will have to be increased above 1.0.

1. Direct solvent extraction of **copper, cobalt and nickel from acid leach solutions using oximes, phosphinic acids and versatic acids to extract copper, cobalt and nickel in sequence.**

Steps of extraction

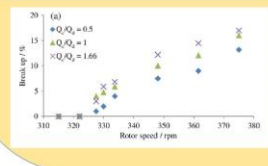


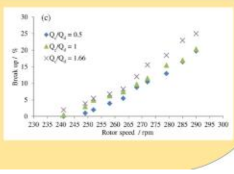




materials	Density (kg/m³)
Copper	999
Nitric acid	1510
Oxime LIX	806

The breakage probabilities versus rotor speed for mentioned chemical systems using glassy nozzles with different inner diameters (1.2 and 2.5 mm) to form various drop sizes by adjusting the Qc/Qd ratios and continuous phase heights are presented in next figure regarding to these graphs, the drop breakage increases by increasing the volumetric phase ratio that leads to decrease of the first critical rotor speed. It could be justified with increasing this ratio, the drag forces between the continuous phase and dispersed drops increase results to enhance the probability of drop break up due to collision with the rotors.





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Water Boilers and Auxiliary Standards (Norms)

متطلبات إنشاء غلايات المياه

Pressure equipment shall be designed, manufactured, tested and, if necessary, equipped and installed in such a way as to ensure its safety .

Water tube boiler EN 12952-1 to 17
Shell boiler EN 12953-1 to 14

General

Pressure equipment shall be designed, manufactured, tested and, if necessary, equipped and installed in such a way as to ensure its safety when put into service in accordance with the manufacturer's instructions or under reasonably foreseeable conditions.
[Guideline E-03 | Guideline H-07 | Guideline H-15]

تصمم معدات الضغط وتصنع وتختبر ، وإذا لزم الأمر ، مجهزة ومركبة بطريقة تضمن سلامتها عند وضعها في الخدمة وفقاً لتعليمات الشركة الصانعة أو في ظروف معقولة بشكل معقول.

Design to the required load capacity: EN 12952-3

Load

In general, a method of calculation according to 2.2.3, supplemented if necessary by an experimental design method .

Pressure equipment shall be designed for loads appropriate to its intended use and other reasonably foreseeable operating conditions. In particular, the following factors should be considered:

Internal and external pressure; الضغط الداخلي والخارجي: EN 12952-3
ambient and operating temperatures;

درجات الحرارة المحيطة والتشغيلية

Static pressure and filling weights under operating and test conditions;

ضغط ثابت وملء الأوزان تحت ظروف التشغيل والاختبار

Reaction forces and moments related to supporting elements, fixings, piping, etc .;
قوات رد الفعل واللحظات المتعلقة بدعم العناصر ، المثبتات ، الأنابيب ، وما إلى ذلك
corrosion and erosion, material fatigue, etc .;

Decomposition of unstable fluids.
تحلل السوائل غير المستقرة

Special Quantitative Requirements for Specific Pressure Equipment {Guideline H-06 المتطلبات الكمية الخاصة لمعدات الضغط المحددة

Symbols

Re, t (elastic limit) refers to the following values at the calculation temperature, depending on the case:
- Upper yield strength for materials having a lower and upper yield strength;
- 1.0% proof strength for austenitic and unalloyed aluminum;
- 0.2% proof strength in the remaining cases.
-Rm, 20 denotes the minimum value of tensile strength at 20 ° C.
-Rm, t denotes the tensile strength at the calculation temperature.

The permissible general membrane stress shall

Not exceed the lower of the following values for predominantly static loads and at temperatures outside the range in which creep phenomena are significant, depending on the material used:
Ferritic steel, including normally annealed (normalized rolled) steel, with the exception of fine grain steel and special heat treated steel: 2/3 of Re, t and 5/12 of Rm, 20;
Austenitic steel:
-If the elongation at break is greater than 30%: 2/3 of Re, t;
Or alternatively, if the elongation at break is above 35%: 5/6 of Re, t and 1/3 of Rm, t;
-Unalloyed and low alloy cast steel: 10/19 of Re, t and 1/3 of Rm, 20;
-Aluminum: 2/3 of Re, t;
-Non-hardenable aluminum alloys: 2/3 of Re, t and 5/12 of Rm, 20.
[Guideline G-14]

Connection

Coefficients For welded connections , the connection coefficients must not exceed the following values

For pressure equipment that undergoes destructive and nondestructive tests to verify that the joints are free from significant defects: 1,0 ;

For pressure equipment undergoing non-destructive random sampling: 0,85 ;
For pressure equipment which does not undergo non-destructive testing except for visual inspection: 0,7 .

If necessary, the type of stress and the mechanical and technological properties of the connection must also be taken into account

Pressure

Limiting devices , in particular for pressure vessels The temporary pressure exceeding specified in section 2.11.2 shall be limited to 10% of the maximum permissible pressure

Material

Properties Unless other criteria to be considered require other values, a steel shall be considered to be sufficiently ductile within the meaning of 4.1 (a) if its elongation at break is at least 14% in the standard tensile test and the notch impact work on an ISO-V sample at a temperature of not exceeding 20 ° C, but not exceeding 27 J at the intended lowest operating temperature.
[Guideline G-13 | Guideline G-17 | Guideline G-18 | Guideline G-22 | Guideline G-28]

Hydrostatic test pressure

For pressure vessels, the hydrostatic test pressure specified in section 3.2.2 shall be the higher of the following:
- 1.25 times the maximum load of the pressure equipment in service, taking into account the maximum permissible pressure and the maximum permissible temperature, or
-The 1.43-fold value of the maximum allowable pressure
[Guideline C-06 | Guideline H-02 | Guideline H-16]

Fired or otherwise heated overheating-prone pressure equipment in
-a) Appropriate safeguards are provided to limit operating parameters such as heat input, heat output and, where applicable, fluid level to avoid the risk of local or general overheating
(b) where necessary, provide sampling points so that the properties of the fluids can be assessed to avoid risks associated with deposits and / or corrosion;
-(c) Reasonable precautions are taken to eliminate the risks of deposit damage;
d) Possibilities for the safe removal of residual heat after a shutdown are created;
-e) measures are taken to prevent the dangerous accumulation of flammable mixtures of flammable substances and air and flashback

They must be sufficiently chemically resistant to the fluids carried in the pressure equipment; the chemical and physical properties required for operational safety must not be significantly impaired during the intended service life;
c) they must not be significantly impaired by aging;

Production materials

The materials used in the manufacture of pressure equipment, unless they are to be replaced, must be suitable for the entire intended service life.
Welding consumables and other joining materials need only comply with the relevant requirements of sections 4.1, 4.2 (a) and 4.3 first paragraph, both individually and in combination.
EN 12952-2 : 3.1; 3.3

Appropriate design calculations shall be carried out to demonstrate the load capacity of the pressure equipment concerned.

In particular, the following applies:
The calculation pressures must not be lower than the maximum allowable pressures, and the static and dynamic fluid pressures as well as the decay pressures of unstable fluids must be taken into account.
The calculation temperatures must have reasonable safety margins.
The maximum stress and stress concentrations must be within safe limits.
–Yield strength, 0.2% or 1% proof strength at the calculation temperature
The operating instructions referred to in section 3.4 must indicate design features that are relevant to the life of the device, for example:
For creep : design life in hours at specified temperatures;
For fatigue : design cycle number at specified voltage values;
-For corrosion : corrosion surcharge during design.

The test program must include:

a) A compressive strength test designed to verify that, in the event of pressure with a margin of safety above the maximum allowable pressure, the instrument will not show significant leakage or deformation beyond a specified limit.

For the determination of the test pressure, the differences between the values measured under test conditions for the geometrical characteristics and the material properties on the one hand and the values permitted for the construction on the other hand shall be taken into account; the difference between test and design temperatures must also be considered.
EN 12952-3 : 12.1.2;12.1.3;

Precautions for Safety in Handling and Operation

The pressure equipment controls shall be such that their operation does not give rise to a reasonably foreseeable hazard. If applicable, the following points should be noted:
-Closing and opening devices;
-Dangerous blow-off from pressure relief valves;
- Devices to prevent physical access in case of overpressure or vacuum in the device;
- Surface temperatures taking into account the intended use;
- Decomposition of unstable fluids.
- EN 12952-12 : 5;for tube B
- EN 12953-7 : for shell B
- EN 12953-10 : 4; 5;

Precautions for inspection

a) Pressure equipment shall be designed so that all required safety inspections can be carried out.
b)) Other means to ensure a safe condition of the pressure equipment can be used
c) EN 12952-3 : 5.6.2,for tube B
d) EN 12953-3 : 14; for shell B

Draining and venting facilities

If necessary, suitable devices for draining and venting the pressure equipment must be provided:
EN 12952-3 : Tube Boiler
EN 764-7 : 8.1.4;8.1.5; 8.2.3; 8.5.6; shell Boiler
To avoid harmful effects such as water hammer, vacuum collapse, corrosion and uncontrolled chemical reactions; all operating and test conditions, in particular pressure tests, must be taken into accountEN 12952-3 : 5.6.3;

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تقييم الأثر البيئي لمحطة طاقة كهربائية تعمل على التفكك الحراري للنفايات في سرار – عكار

Environment Impact Assessment (EIA) for an 15 MW waste incineration power plant in Srar/Akkar, Noth Lebanon

What is EIA?

- To identify and evaluate the predictable environmental consequences of the proposed project
- the best combination of economic and environmental costs and benefits of the proposed project
- تحديد وتقييم العواقب البيئية المتوقعة للمشروع
- أفضل مزيج من التكاليف والفوائد الاقتصادية والبيئية للمشروع المقترح

WHO does EIA? من يقوم بالتقييم الاثر البيئي؟

The project proponent صاحب المشروع بإستعانة خبراء

How is EIA done?

- **Identification of the consequences of the project proposal.**
- **Prediction of the extent of consequences.**
- **Evaluation of the predicted consequences (Significant or not)**
- **Mitigation of the adverse consequences.**
- **Documentation to inform decision makers what needs to be done.**

- تحديد نتائج الاقتراح.
- التنبؤ بمدى العواقب.
- تقييم النتائج المتوقعة. (كبير أم لا)
- التخفيف من العواقب السلبية.
- وثائق لإعلام صانعي القرار ما يجب القيام به.

EIA Report for project proposal: 15 MW incineration power plant in Srar/Akkar, Lebanon (450t/day waste treatment)

Screening
تحري

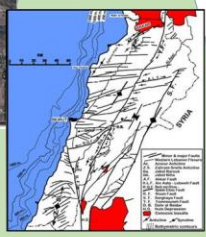
The Competent Authority makes a decision about whether an EIA is required. At the end, a Screening Decision must be issued and made public.

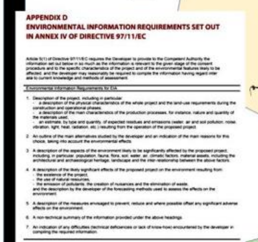
تقوم السلطة المختصة باتخاذ قرار حول ما إذا كان تقييم التأثير البيئي مطلوبًا أم لا. في النهاية ، يجب إصدار قرار الفحص وإعلانه

Scoping
فحص

The Directive provides that Developers may request a Scoping Opinion from the Competent Authority which:
- Identifies the content and the extent of the assessment
- Specifies the information to be included in the EIA Report.

- ينص التوجيه على أن المطورين قد يطلبون
- استطلاع رأي من الجهة المختصة:
- يحدد محتوى ومدى التقييم
- يحدد المعلومات التي سيتم تضمينها في تقرير تقييم التأثير البيئي.




APPENDIX D
ENVIRONMENTAL INFORMATION REQUIREMENTS SET OUT IN ANNEX IV OF DIRECTIVE 97/11/EC

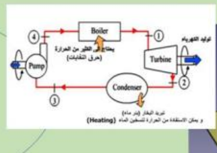
Incineration of Waste Directive 2000/76/EC

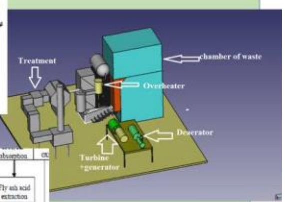
The aim of the WI Directive is to prevent or to reduce as far as possible negative effects on the environment caused by the incineration and co-incineration of waste. In particular, it should reduce pollution caused by emissions into the air, soil, surface water and groundwater, and thus lessen the risks which these pose to human health.
This is to be achieved through the application of operational conditions, technical requirements, and emission limit values for incineration and co-incineration plants within the EU.
The WI Directive sets emission limit values and monitoring requirements for pollutants to air such as dust, nitrogen oxides (NOx), Sulphur dioxide (SO_2), hydrogen chloride (HCl), hydrogen fluoride (HF), heavy metals and dioxins and furans. The Directive also sets controls on releases to water resulting from the treatment of the waste gases. Most types of waste incineration plants fall within the scope of the WI Directive, with some exceptions, such as those treating only biomass (e.g. vegetable waste from agriculture and forestry). Experimental plants with a limited capacity used for research and development of improved incineration processes are also excluded.

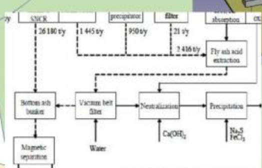
EIA Report

1-information regarding the project, 2- the Baseline, 3 - scenario, 4- the likely significant effect of the project, 5 - The proposed Alternatives, 6 - The features and Measures to mitigate adverse significant effects as well as a Non-Technical Summary.

1 – معلومات بخصوص المشروع ، 2 – خط الأساس ، 3 سيناريو
4 – التأثير الهام المحتمل للمشروع ، 5 – البدائل المقترحة ،
6 – السمات والإجراءات للتخفيف من الآثار الهامة الضارة بالإضافة إلى الملخص غير الفني.







instrumentation 40 bar	1		$ 1.000,00	
pressure sensors	5		$ 15.000,00	
fresh water tank (stainless)	1		$ 2.000,00	
incineration burning chamber (including transportation band)&vaporizer (climbing tubes...)	1		$ 200.000,00	
fume purification (incl. filter for CO, SO2, NH3)	1		$ 50.000,00	Costs All in all
Turbine 15 MW	1		$ 3.500.000,00	$5.145.500
Hardware Control System (including Instrumentation)			$ 25.000,00	x 1.3 (with overhead)
Water antioxidant system			$ 30.000,00	$6.689.150
Sorting House			$ 70.000,00	
pumps			$ 15.000,00	
Total Material			$4.797.500	
Engineering Staff Costs				
Task	MM	Qualifikation	Salary/MM	Total Salary
Integration with Test Vaporizer				
Integration with Incineration V	30	Eng.	$3.000	$90.000
Integration Turbine Electrics	28	Eng.	$3.000	$84.000
Integration Process Control system	20	Eng.	$3.000	$60.000
Control System	18	Eng.	$3.000	$54.000
Project Management	20	Eng.	$3.000	$60.000
Total Man Power Costs	116			$348.000

Decision Making and Development Consent
صنع القرار و الموافقة على التطوير

1-Examination of the EIA report by the Competent Auth
2-consultation
3-Conclusion on whether the project entails significant effects.

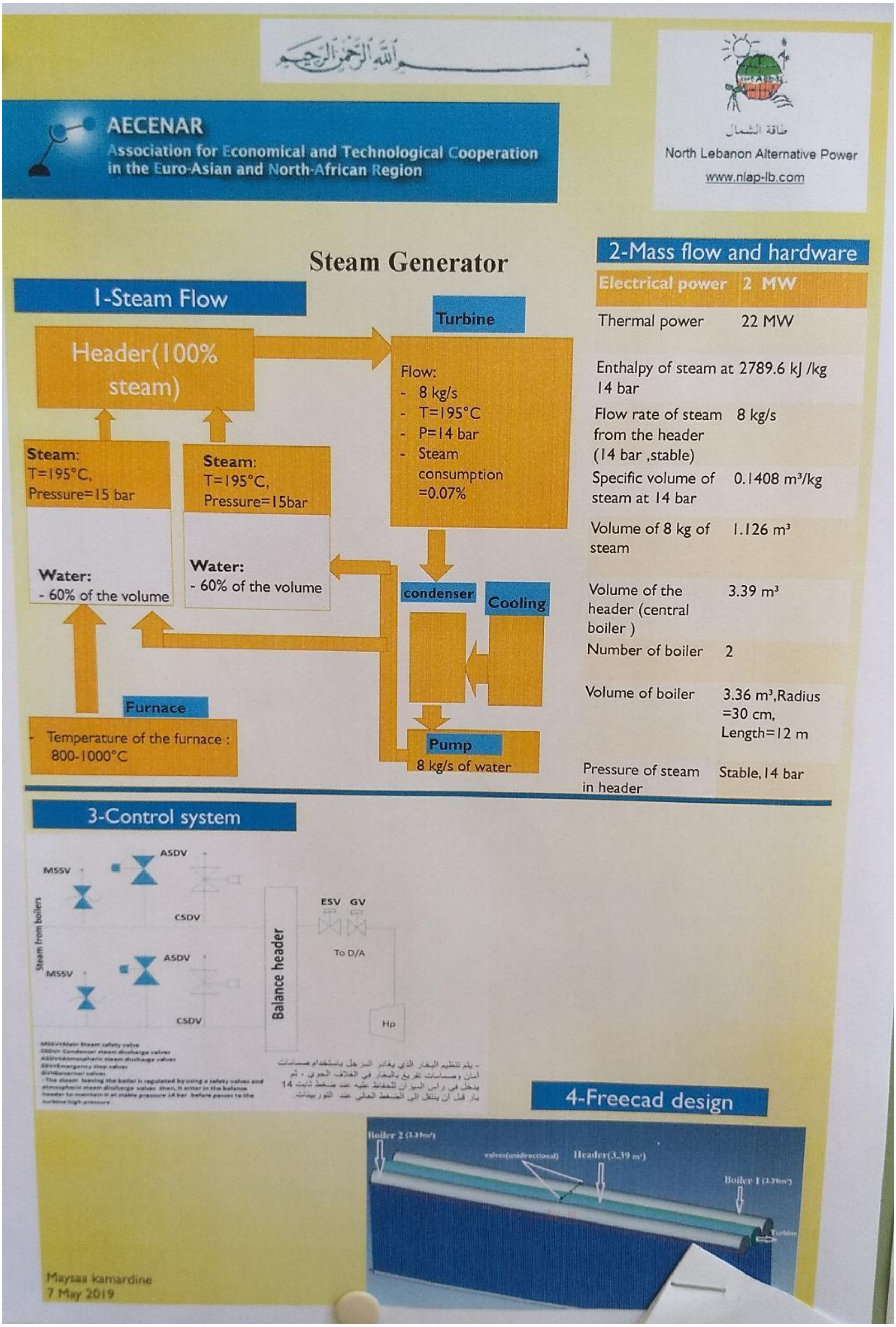
1 - فحص تقرير تقييم التأثير البيئي من قبل السلطة المختصة.
2 – الاستشارة
3 - الاستنتاج حول ما إذا كان المشروع ينطوي على تأثيرات كبيرة.

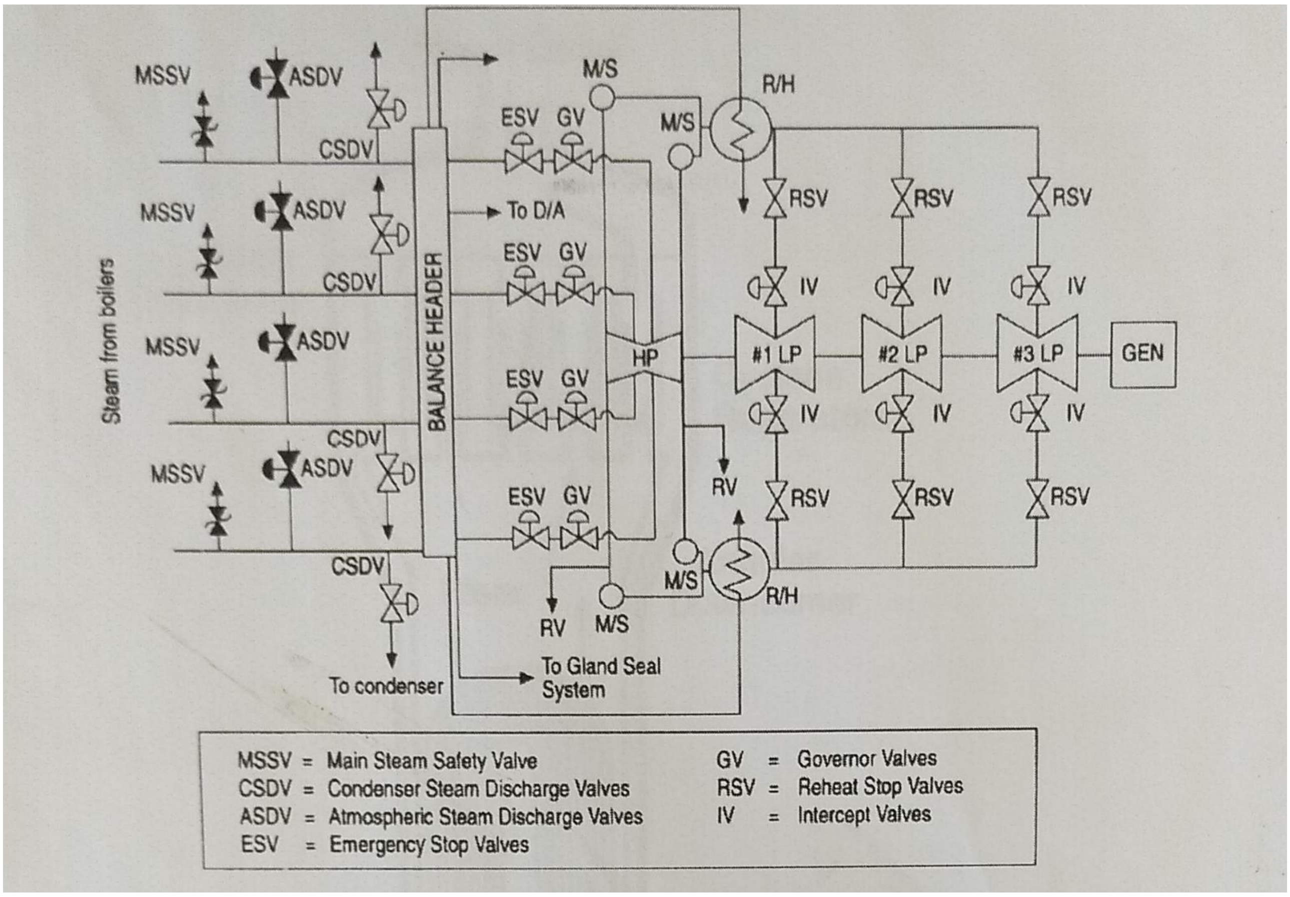
Information on Development Consent and Monitoring
معلومات عن الموافقة على التطوير والرصد

1- Informing the public .
2-During construction and operation the Developer must **monitor the significant adverse effects to mitigate them.**

1– إعلام الجمهور.
2–أثناء البناء والتشغيل يجب على المطور مراقبة الآثار الضارة الهامة للتخفيف منها.

@NLAP Dec 2018


AECENAR
Association for Economical and Technological Cooperation in the Euro-Asian and North-African Region
طاقة الشمال
North Lebanon Alternative Power
www.nlap-lb.com
Steam Generator
1-Steam Flow
Header(100% steam)
Turbine
Flow:
- 8 kg/s
- T=195°C
- P=14 bar
- Steam consumption =0.07%
Steam: T=195°C, Pressure=15 bar
Steam: T=195°C, Pressure=15bar
Water: - 60% of the volume
Water: - 60% of the volume
condenser
Cooling
Furnace
- Temperature of the furnace : 800-1000°C
Pump
8 kg/s of water
2-Mass flow and hardware
Electrical power 2 MW
Thermal power 22 MW
Enthalpy of steam at 14 bar 2789.6 kJ /kg
Flow rate of steam from the header (14 bar ,stable) 8 kg/s
Specific volume of steam at 14 bar 0.1408 m³/kg
Volume of 8 kg of steam 1.126 m³
Volume of the header (central boiler) 3.39 m³
Number of boiler 2
Volume of boiler 3.36 m³,Radius =30 cm, Length=12 m
Pressure of steam in header Stable,14 bar
3-Control system
ASDV
MSSV
CSDV
ASDV
MSSV
CSDV
Steam from boilers
Balance header
ESV GV
To D/A
Hp
4-Freecad design
Header(3.39 m³)
Maysaa kamardine
7 May 2019


MSSV
ASDV
CSDV
MSSV
ASDV
CSDV
MSSV
ASDV
CSDV
MSSV
ASDV
CSDV
Steam from boilers
To condenser
BALANCE HEADER
To D/A
To Gland Seal System
ESV GV
ESV GV
ESV GV
ESV GV
M/S
M/S
M/S
M/S
HP
RV
RV
R/H
R/H
RSV
RSV
RSV
RSV
RSV
RSV
IV
IV
IV
IV
IV
IV
#1 LP
#2 LP
#3 LP
GEN
MSSV = Main Steam Safety Valve
CSDV = Condenser Steam Discharge Valves
ASDV = Atmospheric Steam Discharge Valves
ESV = Emergency Stop Valves
GV = Governor Valves
RSV = Reheat Stop Valves
IV = Intercept Valves

Literature

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