

Gas Canister Smashing Machine

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Dedication

I dedicate this work to my father for his support, affection and confidence in me, to my mother for her love, encouragement and sacrifices, and to the soul of my grandfather who left us recently, to the IPB university for giving me this chance to improve my academic formation and contact competent and professional professors, to my supervisor that he was always available to help me.

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Resumo

Uma prensa hidráulica é uma máquina com um circuito hidráulico caracterizado pela elevada força de compressão. É passível de transmitir esforços múltiplos, servindo para esmagar, deformar ou elevar componentes pesados. O princípio de funcionamento da prensa hidráulica é baseado no princípio de Pascal que foi empregue pela indústria para produzir máquinas capazes de utilizarem a pressão de um fluido para tarefas de compressão, utilizando fluido como meio de transmissão de energia num sistema fechado para esmagar, endireitar, etc. A pressão é imposta pela máquina graças a um cilindro hidráulico que exerce esta força no sistema e provoca os movimentos do cilindro.

Projetar uma máquina de pressão hidráulica de cilindro de gás (13kg), objetivo deste trabalho, foi bastante interessante, para garantir uma boa abordagem, importantes aspectos foram considerados. Primeiro, fez-se uma revisão bibliográfica das diferentes prensas existentes, evidenciando seu modo de funcionamento, além de estudar a estrutura dos cilindros de gás e suas diferentes características. No projeto do sistema hidráulico e seus componentes foi utilizado o software de automação industrial da Festo. Também foi utilizado o software SolidWorks para fazer o estudo de resistência dos materiais empregues e assim projetar a máquina de pressão, além disso, foi verificada a viabilidade econômica da máquina projetada; realizando um estudo financeiro para confirmar que a máquina é benéfica para as indústrias de botijões de gás. Finalmente apresentaram-se conclusões deste estudo, apresentando propostas a desenvolver no futuro.

Abstract

A hydraulic press is a machine with a hydraulic circuit, characterized by their very powerful compression force. It makes it possible to transmit a multiplied effort, serving to crush, deform an object or lift a heavy part, The hydraulic press is based on the principle of Pascal, then is mainly adopted in the industrial sector in order to ensure the execution of large pressure tasks and compression, their function is to use the pressure exerted on the fluids contained in its closed system to crush, straighten, etc. The pressure is made at the level of the plate (plateau) of the machine thanks to a hydraulic trigger which exerts this force on the system and causes the cylinder movements.

The subject of designing a gas cylinder hydraulic pressure machine (13kg) is interesting and to ensure a good approach, important points must be followed. At first, making a bibliographical study of the different presses by giving their operating mode and their specifications, as well as to talking about the structure of the gas cylinders and their different characteristics, also going to the core of project is to design the hydraulic system components, then using the software of industrial automation FESTO to develop it, for this subject also it is necessary to make a study of materials resistance, then a very known software in the mechanical field it is the SOLIDWORKS to design the pressure machine, in addition it is essential to check whether this project is profitable by carrying out a financial study to find out the cost of this project and to confirm that it is beneficial to the gas canister industries, finally it must conclude this study by putting proposals to develop this machine in future.

Keywords : Hydraulic press, gas canister, sizing, design ,dimensions, steel.

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Chapter 1

Introduction

1.1 General presentation

In the national oil distribution companies, the park of the recycled gas canisters in the LPG (Liquefied Petroleum Gas) centers complains about the large number of irreparable canisters that take up a large space in the centers. The companies managers are looking for a solution to exploit this wasted space. For juridical reasons, they should not sell the reformed canisters in their factory form. For economic reasons, the companies wants to study, design and manufacture a pressing machine for 13 kg gas canisters. This idea will be developed in this project to achieve this goal to free these areas from waste so that production can run more smoothly, and on the other hand, the company will sell these irreparable canisters so that she can win a sum of money, with this last capable of helping the company, even a little, financially.

1.2 Problematic

The storage of recycled canisters in the LPG centers has a large number of irreparable canisters, and the storage of the canisters occupies a large space, which causes a difficulty in managing the production, and the managers of the companies find it very difficult to find a solution for the disposal of this wasted space. They also do not have to sell the reformed canisters in the form of a factory because of juridical reasons. And in an over time the number of canisters increases gradually and it causes a congestion that may be very dangerous to the workers and the center generally because some irreparable canister still have the gas, and in a closed space, there is always a risk of explosion.

1.3 Aim of the work

In order to minimize the volume of irreparable canisters in LPG centers and especially to find a safe and an effective solution for pressing the irreparable canisters to facilitate their transportation, all the conditions have deemed it necessary to design a pressing system for 13 KG LPG canisters. In this case, the first step is to change their original shape and makes them legally available for sale, as well as to free up space and makes it more beneficial. Finally, and most importantly, the turnover improves, when the production and the performance of the company improves.

1.4 Work structure

Our report is divided into five chapters:

- Chapter 1 gives a general presentation of the subject of study, the aims of this work, as well as the document structure.
- Chapter 2 presents the state of the art in which different pressing systems available, also a literature review and definitions are presented.

- Chapter 3 gives an overview of the chosen materials and a study of the materials resistance in order to create a canister press machine.
- Chapter 4 gives a financial study to confirm that the project is profitable by comparing it with the machines that exist in the market and that they perform the same function.
- Chapter 5 brings a general conclusion which summarizes the main results obtained in this project and mention proposals for the future works.

Chapter 2

State Of The Art

2.1 Introduction

The press is a technique that can be used for all types of solid waste. It is mainly used for household waste, in landfills, and in many industries to reduce the volume of both ordinary industrial waste and special industrial waste. The purpose of pressing is to increase the density of the waste, and to reduce the volume occupied by a certain amount of waste, thus increasing the storage capacity. In this chapter, we start with an overview of the basic definitions and then give an idea of the canisters in the second part of the press systems in industry.

2.2 Press machine types

There are multiple varieties of pressing machines in the globe, each with a particular material and energetic composition to ensure the crushing of various types of products (gas bottles, plastic, cardboard, etc.). Among different press machines there is:

- Pneumatic press machines.
- Hydraulic press machines.
- Mechanical press machines.

2.3 Pneumatic press machines

In both the manufacturing and domestic industries, press machines are rapidly evolving. The construction of a pneumatic press machine is generally basic, with a higher level of security for operator safety. Aside from that, the transferred energy system has a flexible air structure [1].



Figure 2.1: Pneumatic press machine [1].

2.4 Hydraulic press machines

This type of machines is commonly used to press a variety of raw materials, including waste plastic, old cans, cardboard boxes, papers, drums and other items. In general, this type of press machine is used to compact so that they don't require a lot of storage space before being recycled, hydraulic presses are generally powerful and durable. The form and the size of the press machine produced can also be influenced by the press's construction and operation adapted to users requirements [2].

2.4.1 Plastic Bottles Pressure Machine

The waste is put back in its place. After the automatic opening of the upper door, the wastes will be pressed by a compacting cylinder placed vertically. During pressing, the effect of the weight of its piston adds to the force it exerts on the waste. Due to the high pressing force, the pressed mass can reach 300 kg. After the opening of the release door (lower door), the pressed waste is released inwards in the form of a bundle by a horizontally placed cylinder.

The resulting shape is a rectangular prismatic ingot of high density with a mass of up to 300 kg, this shape can be safely managed on several heights, thus reducing the storage surface (more space saving than a cylindrical shape). This press has many advantages such as high density of the waste, ease of transport from one place to another, one operator can perform all the work tasks. Figure 2.2 shows a vertical hydraulic press used to compact packaging waste [3].



Figure 2.2: Machine Presses Baling Plastic Bottles [4].

2.4.2 Cardboard Pressure Machine

Its sturdy and compact construction allows significant savings in cardboard volume. It's simple to set up and takes up minimal space on the floor. Huge trash can be pressed thanks to the large loading aperture. The bales are lightweight and easy to store and carry for recycling. Enables compaction of a wide range of materials (carton, plastic, etc.). High dependability and cheap maintenance, which there is no danger to the users, it conserves time and also.[5].



Figure 2.3: Cardboard Pressure Machine [6].

2.4.3 Drum Pressure Machine

The drum press is great for compacting non-explosive gasoline drums and other drums. It has a big pressing chamber that can accommodate drums up to 200 liters in volume. The machine can decrease waste volume by up to 90% while also being easy to store and stack. The pressure plate's spikes penetrate the drum's non-explosive substance and expel the air [7].



Figure 2.4: Drum Pressure Machine [8].

2.5 Mechanical Pressure Machine

Mechanical press machines come in a variety of shapes and sizes. In the industrial sector, one of the following categories often utilized is the screw press that is a press machine with a worm gear drive mechanism that rotates the worm gear as part of the engine slide. Another form is the rack press, which is a mechanical press machine with a gear (pinion) that moves part of the slide integrated with the rack as the drive mechanism. This machine is ineffective for large-scale production, also another category of mechanical presses is the horizontal press, this machine performs left and right reciprocating actions in the horizontal direction [9].

2.5.1 Screw Presses

The stationary screw press consists of a fixed press and an exchangeable container. The press is fixed to the ground, while the container remains mobile and can be exchanged by simply unhooking it and transporting it to the landfill site by truck. On the other hand, the press and the container form a homogeneous unit on the mobile screw press. The whole unit can be moved to be emptied [10].



Figure 2.5: Screw Presses [11].

2.5.2 Horizontal Presses

There are many different types and models of horizontal presses, including the flatten press. The latter is a device for crushing and bundling light metal debris before transporting and processing. The flatterer's radio control allows it to be used by the grid operator. The material to be pressed is flattened by the two articulated flaps, and the ultimate compression is ensured by the longitudinal cylinder. The package is loaded on top of the loading grid as soon as the flaps are opened. The longitudinal cylinder is retracted inside the box during transit. It is a modern piece of equipment that is compact, quick, safe, and clean because the effluents are recovered. It is also easily transported from one location to another using a truck with a hydraulic loading arm [12].



Figure 2.6: Horizontal Presses [12].

2.5.3 Crankshaft Punch Press

A punch press includes two cooperating parts: the punch, which is coupled to the machine's reciprocating ram, and the die, which is secured onto a flat bed or anvil that is parallel to the ram's path. When in use, the workpiece is pushed against by the punch as it is being held in the die, and in the other hand the crank press a punch press in which a crank is used to apply force to the slide.



Figure 2.7: Crankshaft Punch Press .

2.5.4 Mullion Press

A servo press with great rigidity and precision that uses a million-dollar unique roller follower technology.



Figure 2.8: Million Press .

2.6 Gas Canister

Gas canister of this type (LPG 13 kg) is the most utilized in the world due to its many uses, so it is important to know its properties.

2.6.1 Gas Canister's Components

All over the world, gases (butane and propane) are made available to users in cylinders. Generally the cylinders are equipped with the following components:

- **Handwheel Valve:** its role is to ensure the opening and closing of the canister.
- **Collar:** to protect the valve and to facilitate handling.
- **Foot of the canister:** used to keep the canister horizontally balanced during their transport.
- **Lower and upper stamped:** to facilitate the construction of the bottle.

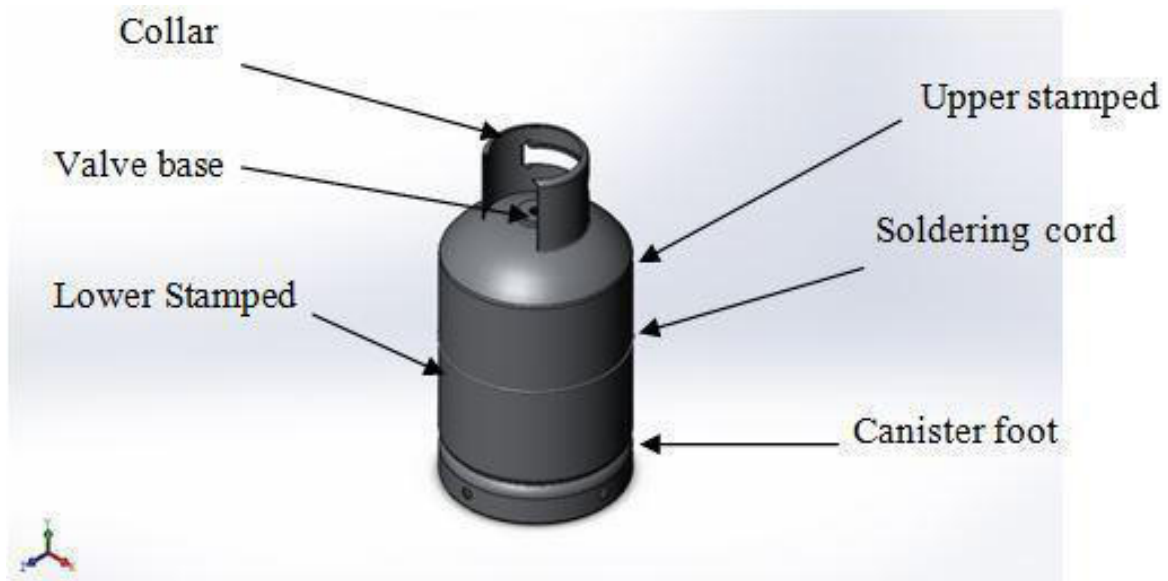


Figure 2.9: Representation of Gas Canister.

2.6.2 Physical characteristics of the gas canister

Table 2.1 illustrate the physical characteristics for a gas canister to know for example its resistance and its nature of steel manufacturer and its dimensions [13].

Canister Characteristics	
Nature Of The Transported Gas	L.P.G
Working Pressure (WP)	20 Bar
External Diameter (D)	300±11 mm
Min. Bottle Wall Thickness (E)	2.4 mm
Height Of Welded Elliptical Bottoms Without Foot Or Flange (h)	452±4 mm
Canister Height (Total) Without Valve (H)	580±5 mm
Min. Expansion Of Cylinder Volume Before Rupture	20%
Total Approximate Weigh	28 kg

Table 2.1: Canister Characteristics.

Figure 2.10 shows the 13 kg gas canister dimensions that are used for the mechanical design when it was constructed, therefor, in this case, the three parameters (Height with collar, Height without collar, External Diameter) are needed for this project.

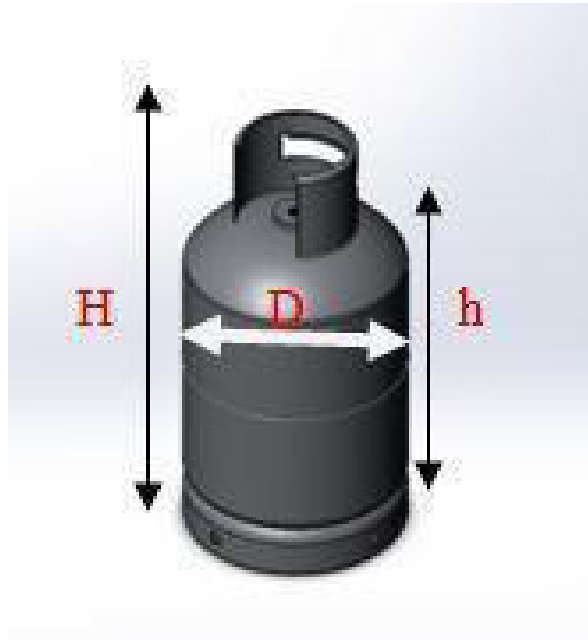


Figure 2.10: Gas Canister Dimensions.

2.6.3 Mechanical characteristics

There are many different types of gas canisters all around the world, in this case, the parameters for the 13 kg gas canister are listed below [14].

- **Steel plate P265NB:** Standard NF EN10120-2008. (This specification, BS EN 15202, is for LPG accessories and equipment. These ICS categories are used to categorize the key operating parameters for LPG cylinder valve outlets and related equipment connections.)
- **Resistance to traction:** 410-500 N/mm².
- **Elastic limit:** 265 N/mm².
- **Foot in rolled sheet S235JR:** Standard NF EN 10025.
- **Forged steel flange, grade C22:** EN 10083 standard.

2.6.4 Chemical analysis

The steel canister manufacturer contains the following chemical components [15]

- **C (carbon):** with 0.19 % as maximum.
- **Si (silicon):** with 0.25 % as maximum.
- **Mn (manganese):** with 0.4 % as minimum.
- **P (phosphorus):** with 0.025 % as maximum.
- **S (sulfur):** with 0.015 % as maximum.

2.6.5 Workshop maintenance for 13 kg LPG canister

The cylinder maintenance workshop is provided by the following operations:

- **Outgassing:** Drainage Banks provide this service, which necessitates the use of a pneumatic draining pump by the drainage unit.
- **Machine to wash the inside of the canister:** Need to residue vacuum cleaner and cleaning machine for waste.
- **Unscrewing and screwing of valves:** Screwing and unscrewing machine.
- **Machine for changing faucets or valves on full canister:** Hydraulic machine for screwing and unscrewing valves on a conveyor or at a fixed station.
- **Treatment of foot and protectors:** Using machine for straightening deformed feet or protectors.
- **Grinding station:** grinder.
- **Soldering bench:** soldering station, an electric arc welding machine.
- **Dent removal:** suction cup.

- **Normalization:** Normalization furnace.
- **Shot blasting:** Canister blasting machine.
- **Metallization:** Metallization cabin.
- **Painting:** Paint cabins for filling centers, maintenance, repair and canisters manufacturing workshops.
- **Test:** Test ramp, Test unit.
- **Washing:** Washing set, High pressure wash tunnel.

2.6.6 Different type of gas canister

The size and weight of a gas bottle are heavily influenced by the use for which it is created. For leisure activities such as Barbecue or in a caravan, smallest canisters are the appropriate to use, as its have a capacity of less than 10 kg. Other activities, such as heating or cooking, require consideration of the normal use. It's also important to know whether the gas canister will be used inside or outside. A canister of butane will not work at low temperatures, however a canister of propane would.

Type number 1: 4kg gas canister

4kg LPG canisters are used for camping, BBQs, picnics, and more.

Type number 2: 9kg gas canister

A 9kg gas bottle is considered the standard size BBQ gas bottle and is roughly equivalent to a 20 lb propane tank. 9kg represents the nominal weight of the gas contents. A 9kg gas bottle weighs approximately 17.5 kg when full, so it is very portable. 9kg gas bottle dimensions vary according to the manufacturer.

Type number 4: 45kg gas canister

A typical installation has two 45kg gas canisters, and it is used for home gas canister refill exchange service. LPG storage vessel is also used with automatic tanker LPG refill delivery service.

45kg Gas Bottle Dimensions:

- Diameter: 375mm
- Height: 1250mm
- Capacity: 88 Litres

Type number 5: 90kg gas canister

90 kg gas canister sizes (LPG gas cylinder sizes) are the second most common size for home use. This size is commonly used with automatic tanker delivery service. A typical installation has one 90 kg gas canister .

90 kg gas canister dimensions:

- Diameter: 510mm
- Height: 13800mm
- Capacity: 176 Litres

Type number 6: 210kg gas canister

210 kg LPG gas cylinder sizes (propane bottle sizes) are provided for high volume use. Larger storage vessels are also available, when needed.

- Diameter: 765mm
- Height: 1460mm
- Capacity: 411Litres



Figure 2.11: Different Types Of Gas Canister [16].

Chapter 3

Designing of the system components

3.1 Introduction

Any real object that is subject to difficulty of selecting materials in accordance with specific restrictions and the action of one or more forces will necessarily deform. The objective of this chapter is to choose and to size the components of this system in order to create a gas canister press machine.

3.2 Hydraulic power

Hydraulic power, also known as Fluid power, is the energy supplied by a pressured fluid, usually a mineral oil. Hydraulic power systems are more flexible than mechanical and electrical power systems, it can provide more power to deform metals, this type of energy also respond to controls quickly and accurately. As a result, hydraulic power systems are found in a wide range of modern airplanes, vehicles, heavy industrial machines, and machine tools [17]. In this system the power needed to make it work will be hydraulic, the system will use the energy of the fluid to produce the proper force.

3.3 Materials selection

Choosing the right materials for a given application is important, the different materials properties that need to be combined with the best possible way, so the properties must find a balance between two main elements, the first (strength, modulus, tenacity, etc.) and the second (weight, cost, environmental impacts, etc.).

3.3.1 Carbon steels

These are non-alloyed steels with a carbon content of approximately 1%. They are characterized by their low cost price, both for purchase and for use. They are generally water hardenable their high carbon content gives a high hardness and their hardenability is limited (from 2 to 4 mm), however, it should be noted that beyond a diameter of 60 mm, it's no longer possible to harden the surface. Therefore, these steels are used for small tools such as medals, coins, etc [18].

3.3.2 Low-alloyed Steel

Carbon steels have a high hardness and sufficient wear resistance in some cases but their low hardenability makes them unsuitable for some large tooling. By adding of alloying elements such as vanadium, manganese etc, and by maintaining the carbon content, a steel is obtained those properties are close to those of a carbon steel, but it can harden up to 30 mm in diameter [19].

3.3.3 High alloyed steel

These steels are highly alloyed with carbon and chromium and have a high resistance to wear. The chromium gives the steel good hardenability, the addition of alloying elements such as molybdenum and vanadium increases this further. These steels are widely used in cold work such as stamping. However, the high proportion of carbide and chromium they contain makes them relatively brittle. For this reason, their implementation requires some

precautions and in particular that the heat treatments are conducted with care because these properties have an important influence on the properties of service life [20].

3.3.4 The characteristics of the materials used

In the following, and taking into account all the properties and parameters, the steel selected is :

- **Steel AISI 1020** : for the construction of all elements of the press frame.

Unalloyed structural steel for quenching and tempering, mild case hardening steel for pieces not subject to impact, but requiring good surface resistance. Also, used for processing in the mass.

Chemical composition

The following table shows the chemical composition of AISI 1020 carbon steel.

C (carbon) %	S (sulfur) %	Mn (manganese) %	P (phosphorus) %	Fe (iron) %
0,18 – 0,23	0,05	0,30-0,60	0,04	balance

Table 3.1: chemical compositions in % [21].

Mechanical properties

The following table lists the physical parameters of AISI 1020 carbon steel.

Parameter	AISI 1020
Tensile Strength (MPa)	420
Yield Strength (MPa)	350
Poisson Ratio	0.290
Elongation (%)	15
Modulus of Elasticity (GPa)	205

Table 3.2: Mechanical Properties of AISI 1020 [22].

Physical properties

In the following table it exhibits the density of this metal, this characteristic is very important for calculating their resistance and the overall mass of the machine.

Physical Properties	Metric
Density	7.87 g/cm ³

Table 3.3: Physical Properties of the steel AISI 1020 [23].

3.3.5 Dimensions Of The Pressing Pistons

To estimate the necessary force of the piston to press the gas canister, this force must be greater than the maximum stress, which must be calculated by using the formula as below .

Stress study on cylinder body

Technically to determine the maximum stress of the canister body it is necessary to apply a charge on the body and then choose a fixed geometry that is opposite to the applied charges.



Figure 3.1: gas canister.

As illustrated in the Figures, the pressure will be horizontally with reparted load.

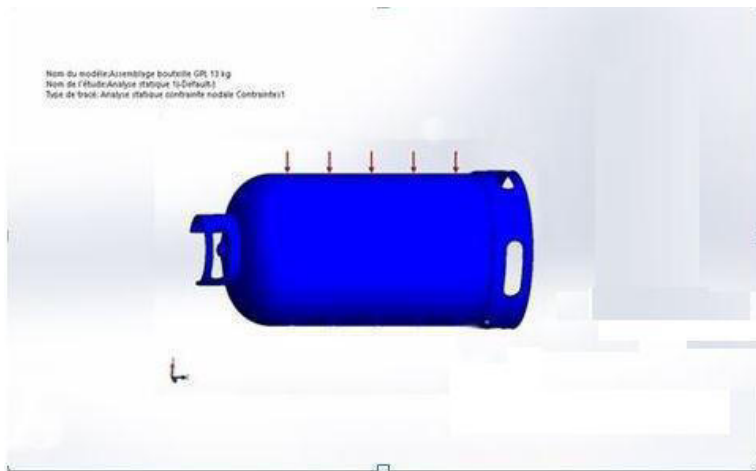


Figure 3.2: Gas Canister under press.

Calculation of the maximum stress of the canister

The formula for critical stress of a plate can be written in the following form (Bleich, 1952) [24]:

$$\sigma_{Max} = K \frac{\pi^2 E}{12(1 - \nu^2)(b/t)^2}$$

Where:

- **K**: buckling stress coefficient (Using the table "position and mode of attachment" provided in Appendix A, the attachment of cylinder type F has coefficient of the mode of attachment K equal to 2).
- **E**: elastic modulus of elasticity (looking to the table of gas canister's physical characteristics in chapter 1 = 265 Mpa [13]).
- **v**: poisson's ratio (in international system v=0.3 for every metals).
- **b**: width of plate (looking to the table of gas canister's physical characteristics in chapter 1=0.3m [13]).
- **t**: thickness of plate (looking to the table of gas canister's physical characteristics in chapter1 =0.0024m [13]).

$$\sigma_{Max} = 2 \frac{\pi^2 \cdot 265 \times 10^6}{12 (1 - 0.3^2) (0.3/0.0024)^2} = 30626.15 \text{ Pa}$$

Knowing

$$F = \sigma_{Max} \times A$$

The press is horizontal. So, the formula for the lateral surface area of a canister is [25]:

$$A = D \times H \times \pi$$

$$F = 30626.15 \times 0.3 \times 0.58 \times \pi = 16538.12 \text{ N}$$

- The pressing cylinder must be able to produce a force F=17000 N.
- The maximum stroke of the cylinder rod is set to 650 mm: the diameter of the bottle is 300 mm and the pressure will be on the canister while it is in a horizontal position that's why the cylinder stroke is 650 mm.

- The maximum pressure of the hydraulic system will be 20 MPa.

$$F = P \times A$$

$$A = \frac{F}{p} = \frac{17000}{20.10^6} = 0.00085 \text{ m}^2$$

This is the circular area of the cylinder receiving oil from the pump

$$A = \frac{\pi D^2}{4}$$

The diameter of the cylinder is

$$D = \sqrt{\frac{4 \times A}{\pi}} = \sqrt{\frac{4 \times 0.00085}{\pi}} = 0.033 \text{ m} = 33 \text{ mm}$$

For a stroke of 650 mm, the free length of the pressing cylinder rod is obtained by the following formula [26] :

$$L = \text{stroke} \times K$$

Using the table (position and mode of attachment) provided in Appendix A, the attachment of cylinder type F has coefficient of the mode of attachment K equal to 2 [27].

$$L = 650 \times 2 = 1300 \text{ mm}$$

For this purpose, according to Appendix A dimension :

$$L_{F\max} = 1300 \text{ mm or } L_F \leq L_{F\max}$$

- Piston Rod diameter : 25 mm.
- Piston diameter : 40 mm.

Cylinder rod output speed:

$$V_s = \frac{C}{t}$$

with:

- **C** : is the stroke of the cylinder rod ($c = 650$ mm).
- **t** : the work time is 20 seconds.

$$V_s = 0,032 \text{ m/s}$$

Oil flow out of the pressing cylinder rod:

$$Q_{sv} = V_s \times A$$

With:

$$A = 0.00085 \text{ m}^2$$

$$Q = 0,032 \times 0.00085 \times 10^3 \cdot 60 = 0.000027 \times 10^3 \cdot 60 = 1.631/\text{min}$$

Cylinder rod retraction speed:

$$V_r = \frac{Q_{sv}}{S_a}$$

With: Annular section : in this case this operation is happened in the cylinder's rod, so to calculate the annular section (cylinder rod's area) it must be taken into consideration the cylinder rod's diameter.

$$S_a = \frac{\pi D^2}{4}$$
$$S_a = \frac{\pi \cdot 25^2}{4} = 490,625 = 500 \text{ mm}^2$$

$$S_a(\text{Annularsection}) = 500\text{mm}^2$$

$$V_r = \frac{0.000027}{500 \cdot 10^{-6}} = 0.054 \text{ m/s}$$

Return oil flow of the pressing cylinder rod:

$$Q_{rv} = V_r \times S_a$$

With:

$$S_a = 500 \text{ mm}^2$$

$$Q = 0.054 \times 500 \cdot 10^{-6} \times 10^3 \cdot 60 = 1.63 \text{ l/min}$$

3.3.6 Calculation of the pipe diameters of the pressing cylinder

A pipe is a connecting element between the hydraulic system components. It allows the passage of fluids at high pressures, so it is necessary to calculate their diameter:

$$Q = v \times s [28]$$

$$Q = 0.000027 \text{ m}^3/\text{s}$$

$$S = \frac{\pi \cdot d_{\text{interior}}^2}{4}$$

hence:

$$d_i = \sqrt{\frac{4 \cdot Q}{v \cdot \pi}}$$

In a pipe, the nominal speed of a liquid is between 1 to 3 m/s [28].

hence:

the speed taken is: $v = 1$ m/s.

$$d_i = \sqrt{\frac{4 \times 0.000027}{1 \times \pi}} = 5.8 \cdot 10^{-3} \text{ m}$$

Figure 3.3 shows the dimensions of standard pipe:

Nuance St 35, état de livraison selon DIN 2391, 2 ^{ème} partie, juillet 1981, certifié par ex selon DIN 50049-2.2							
Tubes 4 à 16 mm				Tubes de 18 à 42 mm			
d_a	s	d	PN	d_a	s	d	PN
4	1.0	2	400	18	1.5	15	160
6	1.0	4	320	20	3.0	14	320
6	1.5	3	400	22	2.0	18	160
8	1.5	5	320	25	3.0	19	250
10	1.5	7	320	25	4.0	17	320
10	2.0	6	400	28	3.0	22	160
12	1.5	9	160	30	4.0	22	250
12	2.0	8	320	35	3.0	29	160
12	3.0	6	400	38	4.0	30	160
15	1.5	12	160	38	5.0	28	250
16	2.5	11	320	42	3.0	36	160

Désignation d'un tube précision en acier de nuance St 35 ayant un diamètre extérieur de 30 mm et une épaisseur de paroi de 4 mm, étant de livraison selon DIN 2391, 2^{ème} partie, juillet 1981, normalisé supérieur (NBK). Tube DIN 2391-C-30X4-St35 NBK.

Figure 3.3: Standard Pipe.

According to the table 3.3, the standard pipe chosen with the following dimensions:

- Interior diameter $d_i = 6$ mm.
- Exterior diameter $d_a = 3$ mm.
- Thickness $S = 1.5$ mm.

Tube designation is DIN 2391- C - 3×1,5 – St35NBK.

3.3.7 Selection of the hydraulic installation components

Choice of pump

$$C_y = \frac{Q_p}{N \times r_p}$$

Q_p : Pump flow.

η_p : Global performance: 0,95%.

N : number of turns /min : 1450tr/min.

Pump flow calculation:

$$Q_p = \frac{Q_v}{r_v}$$

η_v : pump volumetric performance : 0,95%.

Q_v : tilting cylinder flow (max flow) (Oil flow out of the pressing cylinder rod).

$$Q_p = \frac{1.63}{0,9} = 1.81 \text{ l/min}$$

To ensure the good choosing of the pipe , and to increase them life. The flow at the pipe must be increased by 3 l/min.

hence:

$$Q_p = 5 \text{ l/min}$$

$$C_y = \frac{5 \times 10^3}{1450 \times 0,95} = 3.62 \text{ cm}^3/\text{tr}$$

According to Appendix B of the 1450 rpm gear pump type PFG-216:

- Cylindrical (cm^3/tr) : 4.1.
 - Pressure (bars) : 210.
 - Flow (l/min) : 5.7
 - Power (KW) : 2.4.
- FLSB160L 2.4Kw1450tr/min.

Choice of the electric motor

The power of the electric motor is determined as follows [29]:

$$P_m \geq \frac{Q_p \times P}{600} = \frac{5 \times 200}{600} = 1.6 \text{Kw}$$

According to the table below, the electric motor must take it:

Standard Specifications									
Three-phase 400V series									
Type	VXSM-3 Series	40	75	150	220	400	550	750	
Nominal applied motor	kW	0.4	0.75	1.5	2.2	4.0	5.5	7.5	
Output ratings	Rated capacity *1)	kVA	1.1	1.9	2.8	4.1	6.8	9.9	13
	Rated voltage *2)	V	3-phase 380, 400, 415V/50Hz, 380, 400, 440, 460V/60Hz						
	Rated current *3)	A	1.5 (1.4)	2.5 (2.1)	3.7 (3.7)	5.5 (5.3)	9.0 (8.7)	13 (12)	18 (16)
	Overload capability		150% of rated current for 1min.		200% of rated current for 0.5s				
	Rated frequency	Hz	50, 60Hz						
Input ratings	Phases, Voltage, Frequency		3-phase 380 to 480V 50/60Hz						
	Voltage / frequency variations		Voltage: +10 to -15% (Voltage unbalance *4): 2% or less			Frequency: +5 to -5%			
	Momentary voltage dip capability *5)		When the input voltage is 300V or more, the inverter can be operated continuously. When the input voltage drops below 300V from rated voltage, the inverter can be operated for 15ms. The smooth recovery mode is selectable (by Auto-restart function).						
	Rated current *6)	(with DCR)	0.82	1.5	2.9	4.2	7.1	10.0	13.5
		(without DCR)	1.8	3.5	6.2	9.2	14.9	21.5	27.9
	Required power supply capacity *7)	kVA	0.6	1.1	2.1	3.0	5.0	7.0	9.4
Control	Starting torque		200% (with Dynamic torque-vector control selected)						
Braking	Braking torque (Standard) *8)		70		40		20		
	Braking torque (Using options)		150						
	DC injection braking		Starting frequency: 0.0 to 60.0Hz Braking time: 0 to 30.0s Braking level: 0 to 100% of rated current						
Enclosure (IEC 60529)		IP 20							
Cooling method		Natural cooling		Fan cooling					
Standards		-UL/cUL -Low Voltage Directive -EMC Directive -TUV adjustable frequency a.c. power drive systems -IEC 61800-2 (Ratings, specifications for low voltage -IEC 61800-3 (EMC product standards including specific test methods)							
Mass	kg	1.1	1.2	1.3	1.4	1.9	4.5	4.5	

Figure 3.4: Electric motor's specifications [30].

- P = 2.2 KW.
- F = 50/60 Hz.
- $I_n = 5.5$ A.
- Mass = 1.4 Kg.

Choice of Tank

The capacity of the tank should be 2 to 3 times the flow at the hydraulic pump to allow air and impurities to separate from the fluid being processed and to avoid the risk of 'camouflage'.

$$Q_p = 5l/\text{min}$$

$$C_V = 3 \times Q_p$$

$$C_V = 3 \times 5 = 15 \text{ l}$$

Taking into account the air contained in the tank and it must be 15% of the oil volume, the final volume is: $15 + (15 \times 0.15) = 17.25 \text{ l}$.

3.4 Hydraulic system

The power plant (engine), transmissions, pumps, fluid tanks, manifolds, valves, pneumatic, and electrical systems make up the Hydraulic Power Pack. For a variety of services and coiled tubing injector diameters, the Hydraulic Power Pack will vary. The power pack houses an electric supply system that can start the engine as well as meet other operating needs. The containerized system features a succession of pans to capture all fluids from the unit and prevent undesirable site spills, ensuring acceptable environmental protection.

To realize a hydraulic circuit that meets our need, we resorted to the hydraulic simulation software "FESTO". Figure 3.5 shows the hydraulic system diagram.

11. **Double acting cylinder :** To ensure the pressure.
12. **Accumulator:** Store hydraulic energy and consume it when needed.
13. **Level sensor:** To keep the fluid level in the tank.
14. **The temperature sensor:** It informs the driver of the engine temperature on the dashboard. It is also this sensor that lights up the overheating indicator.
15. **Cooler:** A cooler plays an important role in keeping the hydraulic system running smoothly by dissipating heat while it is working.

3.4.2 Type of fluid used

Hydraulic fluid (or hydraulic oil) is a "liquid used as a means of transmitting power in a hydraulic system". It is an incompressible mineral oil capable of rapidly transmitting power from the pump to the receivers, so in this system the fluid chosen is OIL HYDREX

OIL HYDREX's definition

this fluid is designed for hydraulic piston, gear, and vane pumps used in industrial machinery (forestry, construction, mining, utilities, and marine machinery) as well as mobile equipment.

The main benefit of this semi-synthetic hydraulic fluid is the wide operating temperature range it offers. At 34 °C, the cold start is doable. It's designed to be used in temperatures ranging from -13 to 80 °C. Hydraulic systems operates more quickly and smoothly in cold weather because they can warm up faster. Hydrex XV offers a 3x longer service life in all seasons, a 5% fuel savings, and a significant increase in fuel economy. This oil also provides 2 times greater anti-wear protection, as well as anti-rust protection, by safeguarding the equipment throughout the most severe and lengthy periods of usage. It also offers protection when used in extreme situations. As a result, maintenance and mechanical problems are decreased [31].

3.4.3 Result and Descussion

The hydrolic system is the core of this project and the diagram above shows the smooth functioning of the system without any obstacle. But when there are major, big and sudden problems, how will they be dealt with?

important notes

Filtre: the filter is placed in the return of the circuit and it is never placed at the suction of the pump in order not to obtain the problem of pressure drop.

The first hypothesis: when the pump start working without activating, the distributor (This happens when the worker forgets to start the engine, whether it is manual or there is a technical failure, if it is automatic), the fluid must return to the tank, so there is a risk of over-pressure phenomenon, so it is necessary to put the pressure relief valve in the activation state and the fluid will return to the tank, in the case of the absence of a pressure relief valve, the tank must have an open center(like the one that exists in the project) so that the fluid return to the tank through a filter.

The second hypothesis: functioning of the left hydraulic valve spool the system works easily and without problems, but in case the other hydraulic valve spool (right hydraulic valve spool) starts, the pump will push the oil back to the other chamber (left hydraulic valve spool).

The third hypothesis: if there is a problem on the pump and we need to activate the cylinder, it is necessary to open the vane then the cylinder will be activated by the accumulator.

The fourth hypothesis: when the level sensor in the tank fails, it is impossible to know if there is fluid or not, then the pump will suck air instead of oil, in this situation

the system will be under the phenomenon of camouflage and this is a very dangerous phenomenon because it is able to sabotage the system, In this case, in order to fix this problem, it is necessary to follow a traditional operation, which is to remove the plumbing nipple (is an element that ensures the connection between the pipes) and activate the motor and quickly the air that is sucked by the pump comes out.

3.5 ROM study

The objective of studying the Resistance Of Materials (ROM) is to figure out how internal forces and deformations of objects subjected to external forces are distributed (through calculation or experiment).

For the calculation of the ROM, we have three Hypotheses which are :

- Hypotheses about the materials of the beam: continuity, homogeneity and isot-ropy.
- Hypothesis on external forces.
- Hypothesis on the deformations.

In this situation The role of the plate support in the pressing system is to hold the pressing plate as well as the cylinder that will ensure the passage operation. The support is composed of standard elements and must be both strong and light. The calculation in this part is as follows. The pressing support structure, Figure 3.6 explains the ROM analysis.

- L : structure length = 800 mm.
- H : structure height = 1000 mm.
- W : structure width = 800 mm.
- F : pressing force = 25000 N (the force of the machine must be higher than the force calculated (17000) to delete the risk).

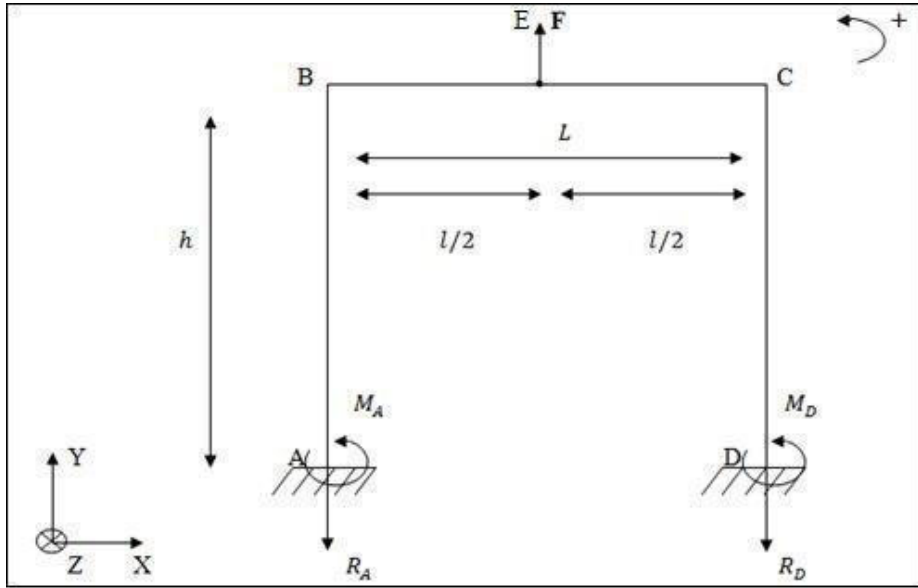


Figure 3.6: ROM analysis.

Knowing:

- System : $\{AB, BC, CD\}$.
- AB et CD : Gantry height.
- BC : Gantry length.

Plan of mechanical actions:

$$\begin{aligned}
 \text{In A : } & \left\{ \begin{array}{l} \vec{R}_A = -R_A \vec{y} \\ \vec{M}_A = M_A \vec{z} \end{array} \right\} \text{Unknown} \\
 \text{In D : } & \left\{ \begin{array}{l} \vec{R}_D = -R_D \vec{y} \\ \vec{M}_D = M_D \vec{z} \end{array} \right\} \text{Unknown} \\
 \text{In E : } & \{ \vec{F} = F \vec{y} \} \text{Known (3.40)}
 \end{aligned}$$

By applying the PFS:

$$\sum \vec{F}_{\text{ext}} = \vec{0}$$

$$\vec{F} + \vec{R}_A + \vec{R}_D = \vec{0} \quad \longrightarrow \quad R_A + R_D = F$$

By symmetry:

$$R_A = R_D \quad \longrightarrow \quad R_A = R_D = \frac{F}{2}$$

transform all the torsors on the point A:

$$\vec{M}_A + \vec{M}_D + \vec{AD} \wedge \vec{R}_D + \vec{AE} \wedge \vec{F} = \vec{0}$$

$$\vec{AB} = AD \cdot \vec{x} = \begin{pmatrix} AD \\ 0 \\ 0 \end{pmatrix}; \vec{AE} = \begin{pmatrix} \frac{AD}{2} \\ AB \\ 0 \end{pmatrix}$$

hence:

$$\vec{M}_A + \vec{M}_D + \vec{AD} \wedge \vec{R}_D + \vec{AE} \wedge \vec{F} = \vec{0}$$

$$\begin{pmatrix} 0 \\ 0 \\ M_A \end{pmatrix} + \begin{pmatrix} 0 \\ 0 \\ M_D \end{pmatrix} + \begin{pmatrix} AD \\ 0 \\ 0 \end{pmatrix} \wedge \begin{pmatrix} 0 \\ -R_D \\ 0 \end{pmatrix} + \begin{pmatrix} \frac{AD}{2} \\ AB \\ 0 \end{pmatrix} \wedge \begin{pmatrix} 0 \\ F \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

$$M_A + M_D - AD \cdot R_D + AB \cdot \frac{AD}{2} \cdot F = 0$$

For the system to become hyperstatic it is necessary that:

$$M_A + M_D = 0$$

Another equation is needed (isolate AB):

$$M_{fz} = M_A$$

3.5.1 Calculation of the embedding moments

According to the moments theorem:

$$M_A = -\frac{\frac{Fl^2}{16El}}{\left(\frac{h}{El} + \frac{l}{2El}\right)} = -\frac{Fl^2}{\left(\frac{16il}{El} + \frac{16iEl}{2El}\right)} = -\frac{Fl^2}{16h + 8l} = -\frac{Fl^2}{8(2h + l)}$$

$$M_A = -\frac{25000 \times 0.64}{8(2(1) + 0.8)} = -714,28 \text{ N.m}$$

$$M_A = -M_D = -714,28 \text{ N} \cdot \text{m}$$

$$M_D = 714,28 \text{ N.m}$$

3.5.2 Calculation of fleeing moment

$$0 \leq x \leq h$$

$$M_{fz}(x) = M_A = -714,28 \text{ N} \cdot m$$

$$0 \leq x \leq \frac{L}{2}$$

$$M_{fz}(0) = M_A = -714,28 \text{ N} \cdot m$$

$$M_{fz}\left(x = \frac{l}{2}\right) = -R_A \times \frac{l}{2} - M_A = -\frac{Fl}{4} - M_A$$

$$M_{fz}\left(x = \frac{l}{2}\right) = -4258,72 \text{ N} \cdot m$$

$$\frac{L}{2} \leq x \leq L$$

$$lM_{fz}\left(x = \frac{l}{2}\right) = -R_D \frac{l}{2} + M_D = M_D - \frac{Fl}{4}$$

$$l = 714,28 - 5000 = -4285.72 \text{ N} \cdot m$$

$$M_{fz}(l) = M_D = 714,23 \text{ N} \cdot m$$

3.5.3 Calculation of shear forces

$$0 \leq x \leq h$$

$$\|\vec{T}_y\| = -R_A \vec{y} = -12500 \text{ N}$$

$$0 \leq x \leq \frac{L}{2}$$

$$\|\vec{T}_y\| = -R_A \vec{y} = -12500 \text{ N}$$

$$\frac{L}{2} \leq x \leq L$$

$$\|\vec{T}_y\| = -R_D \vec{y} = -12500 \text{ N}$$

3.6 Deformation study on the pressing plate

The load applied by the pressing cylinder on the plate is: $F = 25000\text{N}$.

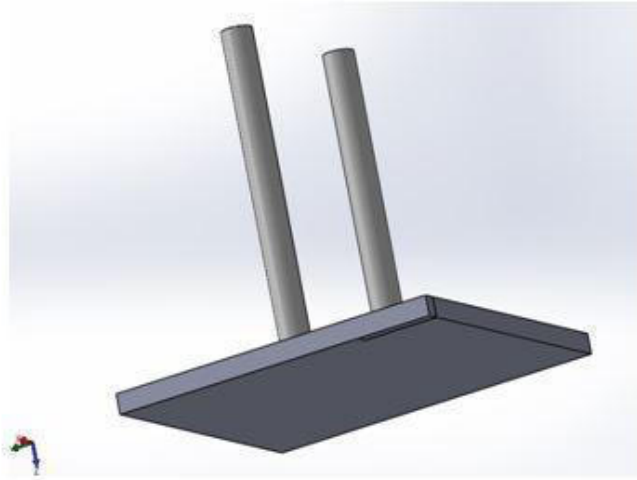


Figure 3.7: pressing plateau with applied load.

After Solidworks simulation:



Figure 3.8: The constraints imposed on the plateau.

3.7 Study of the effort on the door articulation

The load applied by the door on the articulation and their weight:

$$F_a = M \times g$$

With:

- M : the mass of the door:

- $\text{Mass}(M) = \text{volume}(V) \times \text{density}(D)$.

- Density = 7.87g/ cm³ look at the table of Physical Properties of the steel selected [23]

- Volume (V) = length \times width \times height.

- The majority of hydraulic press machine's door's width between 5 to 10 cm

In this case the width of the door is 8 cm so:

$$V = 80 \times 8 \times 100 = 64000 \text{ cm}^3$$

$$M = 64000 \times 7.87 = 503680 \text{ g} = 504 \text{ kg}$$

And:

g = symbole for gravitational acceleration expressed as $\text{m/s}^2 = 9.81$

$$F = 504 \times 9.81 = 4944.24 = 5000N$$

Figure 3.9 shows the machine's door articulation.

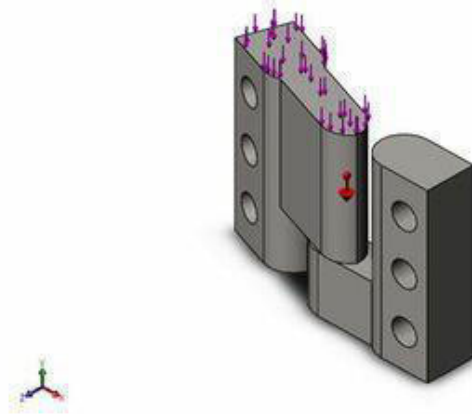


Figure 3.9: the articulation of the door with the applied load.

After Solidworks simulation:

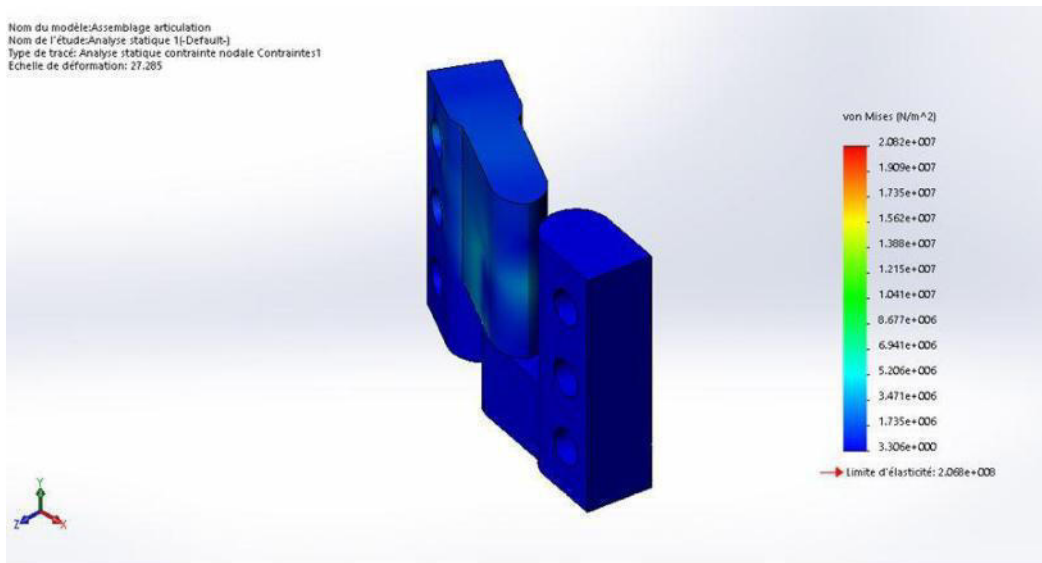


Figure 3.10: Stresses imposed on the articulation of the door.

This is the press machine that is capable of compacting gas canister LPG 13 kg after numerous studies and researches of metal types and hydraulic system dimensions.

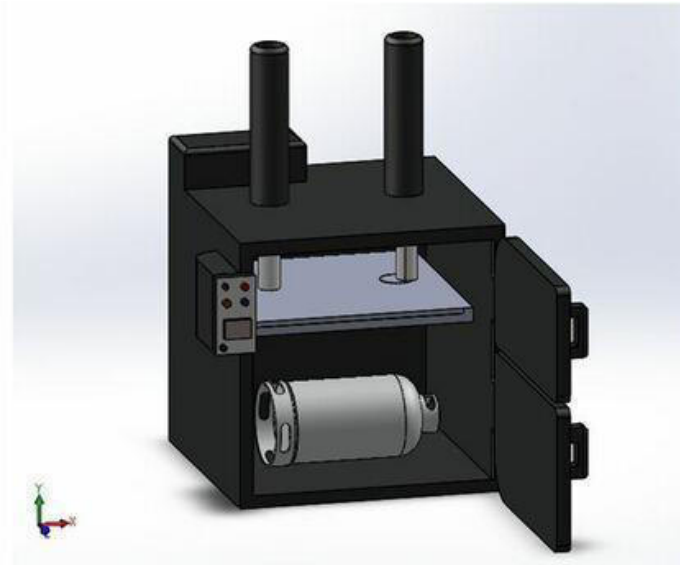


Figure 3.11: 3D view of the press machine.

To understand well it is the machine with another angle (front view).

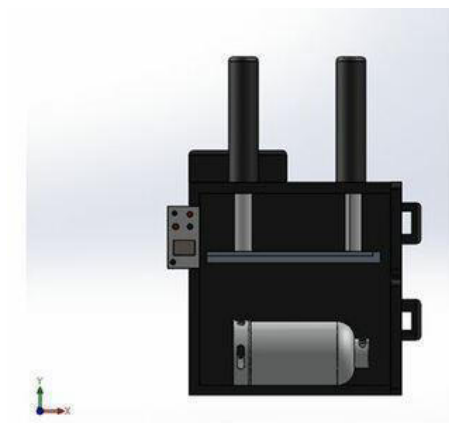


Figure 3.12: Press machine (front view).

Chapter 4

Financial Study of Project

The financial study, is very useful for decision making in order to understand if there is a profit or a loss for an investment . The objective of this chapter is to understand if the project is profitable and feasible. Among the various stages of project management, the evaluation of the project cost is important and delicate. Indeed, this phase requires a lot of rigor and must be as exhaustive as possible in order to provide an accurate, reliable and relevant costing. The objective is to establish the potential cost of the project, from its launch to its closing. Project costing takes place well before the project is launched and is closely linked to the time estimate.

4.1 The Different Costs

To establish the projected cost of the project, a direct and indirect costs must be listed.

Direct costs

The salaries of the human resources mobilized internally, according to the hours you have planned for them to work on the project (including yourself). The cost of external human resources, such as a consultant or subcontractor. The cost of purchasing and/or renting equipment, supplies and materials specific to the realization of the project (rooms, computers, software, construction materials, tools, etc). Any travel expenses.

Indirect costs

Overheads (or operating costs): these are all the costs of the project other than the costs of direct labor and materials, i.e. housing, heating, communication, outside services, etc. ; Management costs such as salaries for the company's cross-functional departments (administrative, marketing, finance, accounting, etc.).

4.1.1 Project Components Costs

There are numerous variables to get the price of the components because there are many firms that offer these components, and there is a huge competition among them, so it takes a time to find a product that is both good quality and economical.

Machine Mass

It is very necessary to know the mass of the machine to provide the suitable quantity of metal.

$$\text{Mass}(M) = \text{volume}(V) \times \text{density}(D)$$

Density = 7.87g/ cm³ look at the table of Physical Properties of the steel selected

$$\text{Volume}(V) = \text{length} \times \text{width} \times \text{height}$$

This machine is like a parallelogram so in this case it must to calculate the volume of parallelogram's faces (six faces = 4 rectangles in sides and 2 squares the ceiling and the bottom), then the following calculations will show the partial and the total volume of this machine

Volumes of the 4 rectangles in sides

$$V = 80 \times 8 \times 100 = 64000 \text{ cm}^3$$

$$V = 64000 \times 4 = 256000 \text{ cm}^3$$

Volumes of the 2 squares the ceiling and the bottom

$$V = 80 \times 8 \times 80 = 512000 \text{ cm}^3$$

$$V = 512000 \times 2 = 102400 \text{ cm}^3$$

The total volume of the machine

$$V = 102400 + 256000 = 358400 \text{ cm}^3$$

Mass(M)= volume(V) \times density(D)

$$\text{Mass(M)} = 358400 \times 7.87 = 2820608 \text{ g} = 2821 \text{ kg}$$

The Pressing Tool Mass

This tool is built by metal (AISI 1020) with a square shape was embedded by the two cylinders and this plateau is the effector in this project, so it ought to know them mass to demand it.

The plateau's dimensions

- Length: 70 cm
- Width: 8 cm
- Height: 70 cm

Mass(M)= volume(V) \times density(D)

$$\text{Volume} = 70 \times 8 \times 70 = 39200 \text{ cm}^3$$

$$\text{Mass(M)} = 39200 \times 7.87 = 308504 \text{ g} = 308.6 \text{ kg}$$

Total Mass

Total mass is = machine's mass + pressing tool's mass= 2821+308.6=3129.6 kg
= 3.129 Ton

Then according to the previous calculations the mass of the machine and of the plateau(pressing tool) become known, this implies that 3.13 tons of metal (AISI 1020) must be demanded

Table 4.3 represents the cost of each hydraulic system component and the machine body metal obtained from the lower cost available in the market

Components/ Supplier	Quantity	The price per piece (€)	Sum (€)
Tank/ Au-comptoir-hydraulique	1	232.01	232.01
Electric motor/ Horecatiger	1	896.32	896.32
Pump/ Hydrodis	1	453.22	453.33
Flow meter/ Bc-elec	1	39.31	39.31
Pressure relief/ Ebay valve	1	29.33	29.33
Pressure gauge/ Rakuten	1	38.76	38.76
4/3 Distributor/ Mabeo	1	178.56	178.56
Vane/ Thersane	1	68.52	68.52
Flow regulator/ Ebay	3	68.08	204.24
Check valve/ Rakuten	3	29.08	87.24
Double acting cylinder/ Ebay	2	127.07	254.14
Accumulator/ Hydromot	1	79.32	79.32
Level sensor/ Ebay	1	47	47
The temperature sensor/ /Underwoodsmotorsport	1	70	70
Cooler/ Nissens	1	50.73	50
Filtre hydraulique/ Manomano	1	24.36	24.36
The metal used (AISI 1020)/ Made-in-china	3.13 Tons	593.555/Ton	1857.81
Oil (HYDREX)/oelluxx24	20L	107/20L	107

Table 4.1: Components costs

Total cost: 4717.25€

Due to the limited availability of gas canister(LPG 13 kg) pressure machine, this project is unique and interesting to analyze in terms of cost effectiveness, dimensions, weight, and space consumption. The machines that are often available in the market and that have almost some operational mode are huge and very heavy, weighing at least 60 tons and standing at least 5 meters high.It's true that they can also press a variety of materials, not just gas canisters, but in this case, the gas canister industries will benefit from this machine due to the many advantages provided by this project, comparing to the market's machines prices, this study shows that the cost of the machine constructed is cheaper , as well as, it is easier to be transported and take less space (knowing that the fundamental problem is that the irreparable gas canisters take a very large space)

Table 4.2 shows some presser machines most used in the Market which come to conclude that this project's study is profitable.

Supplier	Mark name	Price (€)	Reference
Alibaba	WORLD	10000	Alibaba[32]
Alibaba	DONRUN	25250	Alibaba[33]
Made In China	ZHONG YOU	19152	Made In China[34]
Manomano	MW-Tools	11958	Manomano[35]

Table 4.2: Different presser machines used in the market.

4.1.2 Preventive Prices

Preferably additional components to obtain to avoid the risk of unanticipated difficulties caused by worker carelessness, breakdowns during manufacturing, or other external factors due to their small size or their sensitive composition. And on this very topic it is important to request more metal than the specified quantity to reduce the possibility of loss during transportation; nonetheless, the surplus quantity will be beneficial for example in repair or maintenance. As a result, then It is essential to have an additional quantity of fluid in case of oil change

This table show the additional component's costs

Components/ Supplier	Quantity	The price per piece (€)	Sum (€)
Flow meter/ Bc-elec	1	39.31	39.31
Pressure relief/ Ebay valve	1	29.33	29.33
Pressure gauge/ Rakuten	1	38.76	38.76
Vane/ Thersane	1	68.52	68.52
Flow regulator/ Ebay	1	68.08	68.08
Check valve/ Rakuten	1	9.08	9.08
1 Level sensor/ Ebay	1	47	47
The temperature sensor/ /Underwoodsmotorsport	1	70	70
Cooler/ Nissens	1	50.73	50
Filtre hydraulique/ Manomano	1	24.36	24.36
The used metal (AISI 1020)/ Made-in-china	0.5Tnnes	593.555/tonne	269.775
Oil (HYDREX)/oelluxx24	20L	107/20L	107

Table 4.3: Components costs

Total cost= 821.215€

Chapter 5

Conclusion

This project included a completed pressure machine is the conception of a hydraulic development to be used to press 13 kg gas canisters. A hydraulic pressure machine system, and also mechanical system was designed . As tools for sizing and verifying the strength of the different hydraulic components constituting our pressing unit, and to represent the different elements and hydraulic components used, we used the software FESTO in addition also a detailed ROM calculation is also accomplished to verify some components of our pressing system, With the help of this sizing step, we were able to improve our skills in numerical calculation, once the sizing part was done and the different pieces received, we started the realization of the press, then The overall drawings of the pressing systems is represented by using SolidWorks software This step (which was the longest) allowed us to discover the importance of this software (solidworks), we found this part very interesting and formative. Then we made a very detailed financial study to confirm that the system is profitable by comparing our cost study with other machines that do the same function In short, for this machine to be properly realized, two essential points must be emphasized: fast pressure with conservation of life of the materials and economic profitability.

The main conclusion can be taken from this work is that we have developed a very useful machine that is not available yet in the market, and can be produced at a decent price.

5.1 Future Works

Technology is developing very rapidly in this era, particularly in the field of fluid mechanics, so this project is accessible to develop by doing deeper analysis and adding new proposals to try new methods, so here are some perspectives for this machine as future work:

- Be able to do other function such as drilling and cutting: The basis is the same (use of hydraulic energy) but changing the effector (the last component of the operating chain)
- Enlarge Pressure Space: Accommodate more than one bottle for faster space release
- Add an ejection system (contains a pneumatic cylinder): to quickly eject the pressed canister
- Provide a cleaning system: to clean rapidly the working scene of scrap metal after each pressing operation to ensure the smooth running of the pressing process
- Integrate wheels under the machine: to facilitate the displacement of this machine by putting it close to the storage area and to avoid the transport of irreparable canisters to the machine and this causes an economic and temporal gain

Bibliography

- [1] A. Sonera, *Design of pneumatic press for bending and punching operation ?*, https://www.academia.edu/33108580/Design_of_Pneumatic_Press_for_Bending_and_Punching_Operation.
- [2] A. Vaishnav, *Design optimization of hydraulic press plate using finite element analysis*, https://www.researchgate.net/publication/305411837_Design_Optimization_of_Hydraulic_Press_Plate_using_Finite_Element_Analysis.
- [3] C. Nadia, D. Sinugroho, F. Triawan, *et al.*, “Component design concept of hydraulic gear pressing machine for plastic bottle waste recycle”, in *IOP Conference Series: Materials Science and Engineering*, IOP Publishing, vol. 1098, 2021, p. 062 104.
- [4] <https://rikobaler.com/wp-content/uploads/2019/07/pet-bottle-baler-01.jpg>,
- [5] M.-T. BWL, *Comment fonctionne une presse à balles pour carton ?*, <https://www.miltek.be/guides/comment-fonctionne-une-presse-a-balles-pour-carton>.
- [6] https://img.directindustry.com/images_di/photo-g/32488-3336283.webp,
- [7] S. M. P. H. A. Kamble and D. P. M. Patil, “Hydraulic drum handling system”,
- [8] <https://www.nanninirenato.com/images/pf200-principale.png>,
- [9] Y. Bai, *Design of mechanical presses driven by multi-servomotor*, https://www.researchgate.net/publication/225620488_Design_of_mechanical_presses_driven_by_multi-servomotor.

- [10] S. Deli, F. M. Masturah, T. Y. Aris, and W. W. Nadiah, “The effects of physical parameters of the screw press oil expeller on oil yield from nigella sativa l seeds”, *International Food Research Journal*, vol. 18, no. 4, p. 1367, 2011.
- [11] <https://i.machineryhost.com/9fbf8a3bb77a1bfd85d410f038856238/424c4c789f.jpg>,
- [12] https://img.directindustry.com/images_di/photo-m2/120151-10152604.jpg,
- [13] *Bouteille gpl 13 kg*, https://www.cgm.com.tn/produit/bouteille-gpl-13-kg/#:~:text=_C3_89paisseur_20min_20paroi_20des_20bouteilles_20_3A_202.4_20mm.
- [14] H. BEBON, *En 10120 p265nb gas cylinder steel coils/sheets/plates*, <http://www.bebonchina.com/v3/Gas-Cylinder-Steel-Plates/EN-10120/en-10120-p265nb-gas-cylinder-steel-coilssheetsplates-3222.html>.
- [15] —, *En 10120 p265nb gas cylinder steel coils/sheets/plates*, <http://www.bebonchina.com/v3/Gas-Cylinder-Steel-Plates/EN-10120/en-10120-p265nb-gas-cylinder-steel-coilssheetsplates-3222.html>.
- [16] https://www.antargaz.be/sites/default/files/styles/3_2/public/2021-06/flessencollectieBE.png?h=1cab81ef&itok=Lxd4nmCH.
- [17] T. E. of Encyclopaedia Britannica, *Hydraulic power*, <https://www.britannica.com/science/hydraulic-power>.
- [18] corrosionpedia, *Carbon steel*, <https://www.corrosionpedia.com/definition/4922/carbon-steel>.
- [19] —, *Low-alloy steel*, <https://www.corrosionpedia.com/definition/7059/low-alloy-steel#:~:text=A%20low-alloy%20steel%20is,are%20intended%20to%20prevent%20corrosion.1>.
- [20] Aesteiron, *High alloyed steel*, <https://www.aesteiron.com/blog/high-alloy-steel-vs-low-alloy-steel.html>.

- [21] A. MATERIALS, *Aisi 1020 carbon steel (uns g10200)*, <https://www.azom.com/article.aspx?ArticleID=9145>.
- [22] J. Shiva Krishna, A. Shetye, and P. Mallapur, “Design and analysis of chassis for sae baja vehicle”,
- [23] MatWeb, *Physical properties*, <https://www.matweb.com/search/DataSheet.aspx?MatGUID=10b74ebc27344380ab16b1b69f1cffbb&ckck=1>.
- [24] A. H. Al-Wathaf and Y. M. Hunaiti, “Behavior of steel plates under axial compression and their effect on column strength”,
- [25] Hotmath, *Surface area*, https://www.varsitytutors.com/hotmath/hotmath_help/topics/surface-area-of-a-cylinder.
- [26] unilim, *Dimensionnement des tiges*, https://www.unilim.fr/pages_perso/thierry.cortier/Hydraulique_cours/co/Hydraulique_-_De_la_mecanique_des_fluides_a_la_transmission_de_Puissance_204.html.
- [27] Orange, *Coefficient k*, https://prod-maint-indus.pagesperso-orange.fr/dr/automatisme/actionneur/dr_actionneur20pneumatique.pdf.
- [28] processindustriell, *Relation entre le débit d’un fluide, sa vitesse et la dimension de la tuyauterie*, <https://processindustriel.wordpress.com/2017/02/12/relation-entre-le-debit-dun-fluide-sa-vitesse-et-la-dimension-de-la-tuyauterie/>.
- [29] L. MARTIN, *Pompes et moteurs*, <http://fredericlalanne.free.fr/bep/beptechnologie/themesetudebep/moteurs/RES/Pompes%20Et%20Moteurs.pdf>.
- [30] farnell, *General purpose ac drives*, <https://www.farnell.com/datasheets/102756.pdf>.
- [31] dupuis, *Fluide*, <https://pcdupuis.ca/2018/08/comment-les-huiles-de-qualite-superieure-petro-canada-peuvent-vous-aider-a-augmenter-vos-revenus-daffaires/>.

- [32] Alibaba, *Machine de presse hydraulique*, [://french.alibaba.com/p-detail/Price-60692080276.html?spm=p](https://french.alibaba.com/p-detail/Price-60692080276.html?spm=p).
- [33] ———, *Machine de presse hydraulique*, [://french.alibaba.com/p-detail/4-62249308997.html?spm=a2700](https://french.alibaba.com/p-detail/4-62249308997.html?spm=a2700).
- [34] M. in china, *Machine de presse hydraulique*, [://china-hydraulicpress.en.made-in-china.com/product/ZsGxLNhcnDVp/China-Four-Column-Wheelbarrow-Kitchen-Sink-Door-Stainless-Steel-Plates-Making-Machine.html](https://china-hydraulicpress.en.made-in-china.com/product/ZsGxLNhcnDVp/China-Four-Column-Wheelbarrow-Kitchen-Sink-Door-Stainless-Steel-Plates-Making-Machine.html).
- [35] Manomano, *Machine de presse hydraulique*, [://www.manomano.fr/catalogue/p/presse-hydraulique-d-atelier-motorisee-100-t-mw-tools-agmcpm100-1687800?model_id=1687800awc=184481655238095_a4c136e1a4a1e4a6208a2b83edc60d3referer_id=687956utm_source=awinutm_medium=affiliationutm_campaign=Awin_Affiliation_FR_hellopro553877](https://www.manomano.fr/catalogue/p/presse-hydraulique-d-atelier-motorisee-100-t-mw-tools-agmcpm100-1687800?model_id=1687800awc=184481655238095_a4c136e1a4a1e4a6208a2b83edc60d3referer_id=687956utm_source=awinutm_medium=affiliationutm_campaign=Awin_Affiliation_FR_hellopro553877).

Appendix A

Cylinder's dimensions and their
fixing mode (coefficient k)

Dimensions CDH1: MP3 (dimensions in mm)

ØAL	ØMM	KK ⁵⁾	A ⁵⁾	KK ⁶⁾	A ⁶⁾	NV	ØD	ØDA	ØD4 ²⁾	EE ^{4, 16)}	EE ^{4, 17)}	Y
40	22/28	M16x1.5	16	M18x2	30	16/22	88	52	34	G1/2	M22x1.5	79
50	28/36	M22x1.5	22	M24x2	35	22/30	102	62	34	G1/2	M22x1.5	87
63	36/45	M28x1.5	28	M30x2	45	30/36	120	78	42	G3/4	M27x2	100
80	45/56	M35x1.5	35	M39x3	55	36/46	140	95	42	G3/4	M27x2	104
100	56/70	M45x1.5	45	M50x3	75	46/60	170	125	47	G1	M33x2	124
125	70/90	M58x1.5	58	M64x3	95	60/75	206	150	58	G1 1/4	M42x2	135
140	90/100	M65x1.5	65	M80x3	110	75/85	226	170	58	G1 1/4	M42x2	156
160	100/110	M80x2	80	M90x3	120	85/95	265	190	65	G1 1/2	M48x2	185
180	110/125	M100x2	100	M100x3	140	95/110	292	210	65	G1 1/2	M48x2	199
200	125/140	M110x2	110	M110x4	150	110/120	310	235	65	G1 1/2	M48x2	205

ØAL	ØMM	X1	WA	XC	L	MR	M1	ØCD ^{H11}	EW ^{-0.4}	ØRA ⁷⁾	VE ⁷⁾	ØRA ⁸⁾
40	22/28	41	14	252	32.5	31	28	25	23	52	40	52
50	28/36	48.5	18	265	37.5	36	32.5	30	28	65	40	65
63	36/45	56.5	22	302	45	42	40	35	30	75	45	75
80	45/56	67	20	330	50	52	50	40	35	95	45	95
100	56/70	82	30	385	60	65	62.5	50	40	115	55	115
125	70/90	99	32	447	70	70	70	60	50	135	60	135
140	90/100	109.5	35	490	75	82	82	70	55	155	70	155
160	100/110	129	40	550	85	95	95	80	60	200	80	200
180	110/125	142.5	40	610	90	113	113	90	65	220	90	220
200	125/140	152	40	645	115	125	125	100	70	235	95	235

ØAL = Piston Ø

ØMM = Piston rod Ø

X* = Stroke length

1) Bleeding: With view to the piston rod, the position is offset by 90° in relation to the line connection (clockwise)

2) Ø D4 max. 0.5 mm deep

3) Throttle valve only with end position cushioning "E" (180° for bleeding)

4) Flange connections see separate table pages 36 and 37

5) Thread design "G"

6) Thread design "A"

7) Dimensions for cylinders with seal design M, T, G, and V

8) Dimensions for cylinders with seal design A and B

11) Standard version "W" Lubricating nipple, cone head form A according to DIN 71412

16) Line connection "B" and "C"

17) Line connection "M"

Coefficient K de correction pour le flambage de la tige

Fixation de la tige					
Cou D	B	B	B	A	A
Fixation du cylindre					
Fet I	F	Fet I	J'	I	J
				G	J''
				Fet I	F
					I

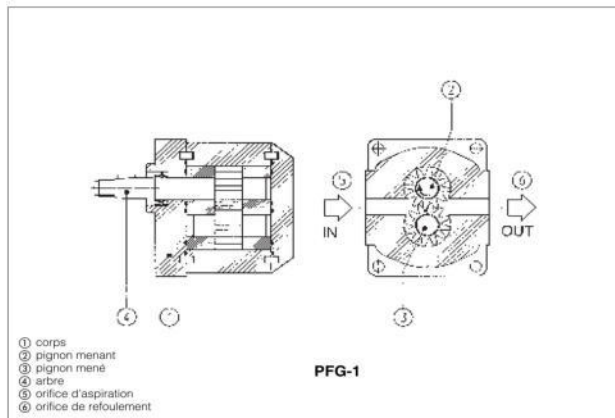
Figure A.1: Cylinder's dimensions and their fixing mode (coefficient k) [27].

Appendix B

Pump's types

Pompes à engrenages type PFG

engrenages extérieurs - cylindrée fixe



Les pompes PFG sont des pompes à engrenages externes, à cylindrée fixe, avec équilibre hydraulique axial, construction simple, solide, et bas niveau sonore.

Ces pompes sont appropriées pour des huiles hydrauliques ou pour des fluides synthétiques ayant des propriétés lubrifiantes analogues.

Grande plage de cylindrées: de 1,4 à 78 cm³/tour.

Pression maxi. 230 bar

1 CODE DE DESIGNATION

PFG * - 2 14 / - ** /*

Pompe à engrenage à cylindrée fixe

Suffixe éventuel caractérisant les pompes PFG-3 à accoupler aux pompes à pistons de type PFR (voir fiche A045), voir fiche A190.
Option sur demande

Tailles, voir paragraphe 2: 1, 2, 3

Cylindrée [cm³/tour] voir paragraphe 2 pour PFG 1: 14, 20, 28, 35, 42, 49, 60, 74, 87, 99 pour PFG 2: 07, 10, 11, 14, 16, 18, 21, 27 pour PFG 3: 27, 40, 54

Option sur demande

Numéro de série

Sens de rotation (vue face à l'arbre)
 - = horaire (fourniture standard sans autre spécification)
 S = anti-horaire
 Note: les pompes PFG ne sont pas réversibles. Le sens de rotation est indiqué par une flèche sur le corps de la pompe; cette flèche indique également la direction du flux d'huile (de l'orifice d'aspiration à l'orifice de refoulement)

2 CARACTERISTIQUES DE FONCTIONNEMENT à 1450 tours/min (avec huile minérale ISO VG 46 à 50°C)

Type	Cylindrée cm ³ /tour	Pression maxi. (1)	Plage de vitesse tours/min (2)	Débit l/min (3)	Puissance kW
PFG-114	1,4	220 bar	800 - 6000	2	0,8
PFG-120	2,1			2,8	1,2
PFG-128	2,8			3,7	1,6
PFG-135	3,5	210 bar	800 - 5000	4,7	2,1
PFG-142	4,1			5,7	2,4
PFG-149	5,2			7,2	3
PFG-160	6,2	200 bar	800 - 3800	8,5	3,4
PFG-174	7,6	170 bar	600 - 3200	10,5	3,5
PFG-187	9,3	160 bar	600 - 2600	13	4,1
PFG-199	11	140 bar	600 - 2200	15,2	4,2
PFG-207	7,0	230 bar	800 - 4000	9,7	4,4
PFG-210	9,6			13,2	5,7
PFG-211	11,5			15,8	6,8
PFG-214	14,1	210 bar	600 - 4000	19,5	8
PFG-216	16			22	9
PFG-218	17,9			24,6	9,6
PFG-221	21	180 bar	500 - 3200	29	10,2
PFG-227	28,2	150 bar	500 - 2500	38,7	11,4
PFG-327	26	230 bar	500 - 3000	35,8	16,2
PFG-340	39			54	23,3
PFG-354	52			71,5	28

(1) En fonctionnement intermittent, on admet des pointes de pression dépassant de 20% les valeurs de pression maxi. indiquées (correspondant au fonctionnement en continu).

(2) Le débit et la puissance absorbée sont rerefée à la pression maxi de fonctionnement (1) et sont proportionnels à la vitesse de rotation.

Figure B.1: The pump's types