Foundry techniques

I.1- Foundry

The foundry is a process (FIG. (1) making it possible to melt metals or alloys and to pour them into a mould to reproduce, after cooling, a given part (inner and outer shape), limiting as far as possible subsequent finishing work.

The techniques used depend on the melted alloy, the dimensions, the characteristics and the quantities of parts to be produced.

FIG. 1 Foundry process

Foundry technology is most often used, as it is not only economical, but:
- It makes it possible to produce parts of complex shapes which are difficult to produce by machining or other processes.
- The series of parts is identical.
- Obtaining solid parts

I.2- Casting

When the metal is ready, i.e. when:

- the casting temperature is reached and controlled (this temperature depends on the alloy and the shapes of the part to be produced).
- The composition, in particular the magnesium content, is in accordance.
- Degassing was carried out and controlled.

The parts can be cast.

I.3 - Molding

Molding is the action of taking an imprint which will then serve as a mold in which a material will be placed, which will allow the drawing or production in several copies of a model. The molding therefore consists in placing a material (liquid, paste, powder, etc.) in a mold of which it will take the form.

There are several types of moulds:

I.3.1 Types of moulds

I.3.1.1 Permanent mold

The permanent mould can be used several times to produce several parts, it is generally made of metal or more rarely of refractory ceramic.

In this type, the shapes are limited, since it is necessary to be able to open the mold in order to extract the part. On the other hand, permanent mold processes are more economical in large series.

Thanks to the use of metal moulds, the molding has the following characteristics:
- Rigidity of the imprint;
- High dimensional accuracy;
- Excellent surface condition of the moulding elements;
- High thermal conductivity of the impressions that give the moulded parts:
- Improved surface condition;
- Higher mechanical characteristics of the cast alloy,

I.3.1.2 Non-permanent moulds

In this type, a mold is used which must be destroyed at the end to extract the part.
The material constituting the mold may be sand, plaster and similar materials with the addition of a binder.
With this type of mould, it is possible to have more complex geometries, because it is possible to break the mould to extract the part

I.4 Desired properties for a mould

• **Rigidity**: to preserve the shape of the imprint and to resist erosion.
• **Thermal stability**: to prevent crack formation in contact with hot metal.
• **Permeability**: to allow hot air and gases to filter through the sand.
• **Reusability of the mould**

I.5 Types of moulding techniques

The foundry industry is developing very rapidly. In general, the choice of molding methods depends on the metal to be cast, the melting temperature of the cast metal must be lower than the melting temperature of the material constituting the mold.

There are also different types of molding processes.

I.5.1 Sand casting

Sand molding is one of the most popular types of molding techniques that produce molded parts in sand molds (FIG. 2).

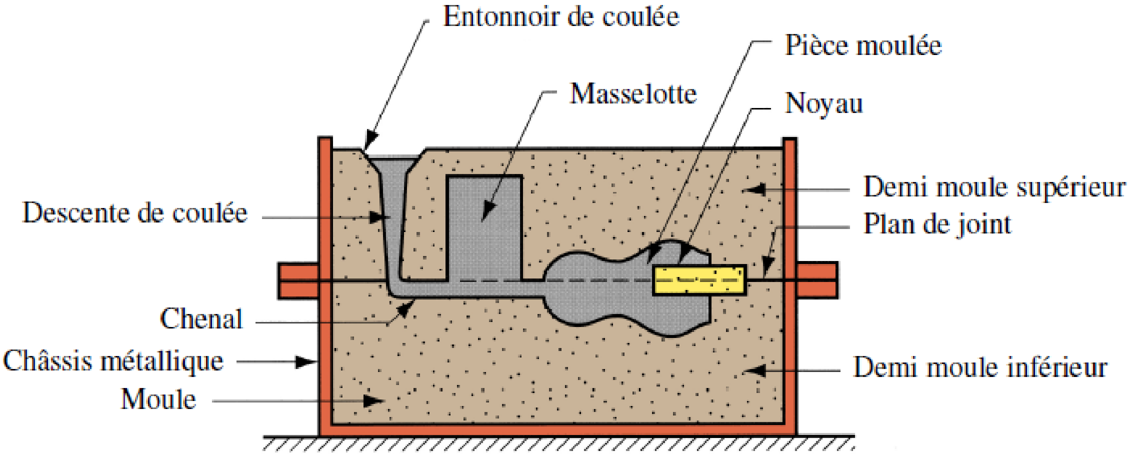

FIG. 2 Sand casting process

It adapts well to small production series and especially for large parts.

Foundry sands are generally composed of:

- 70 to 80% silica ➔ support
- 5 to 15% clay ➔ agglutinating
- 7 to 10% water
- 3 to 5% impurities (iron oxide, organic matter,

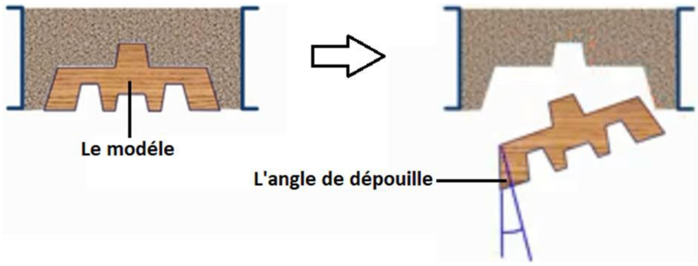

Fig.3 Obtaining the mould

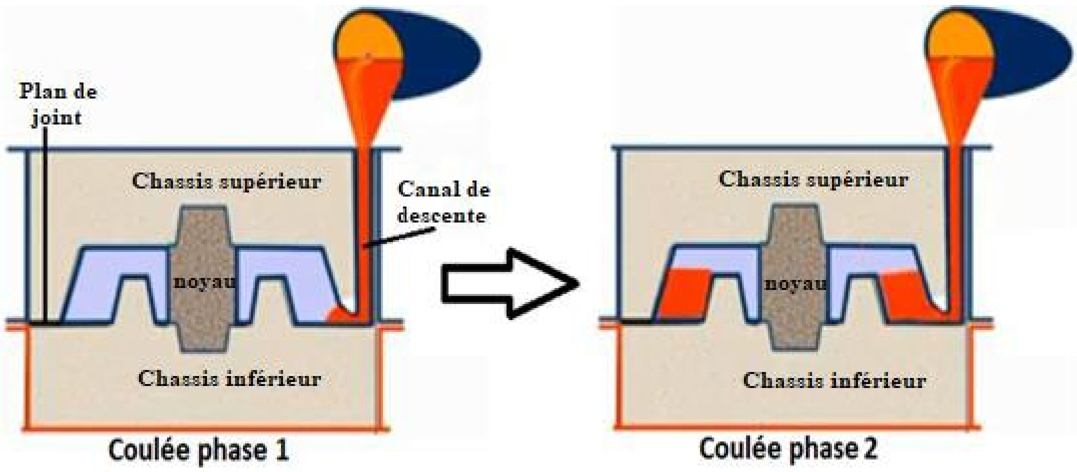

Fig.4 Metal casting

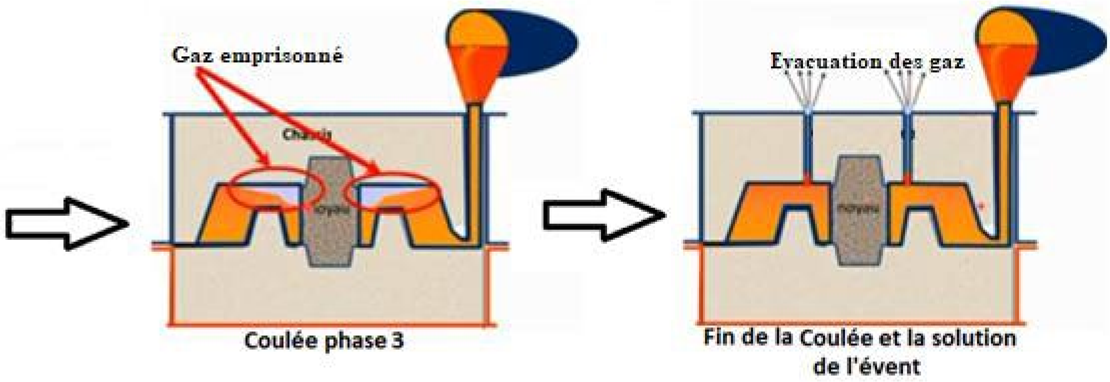

Fig.5 Metal casting and gas exhaust

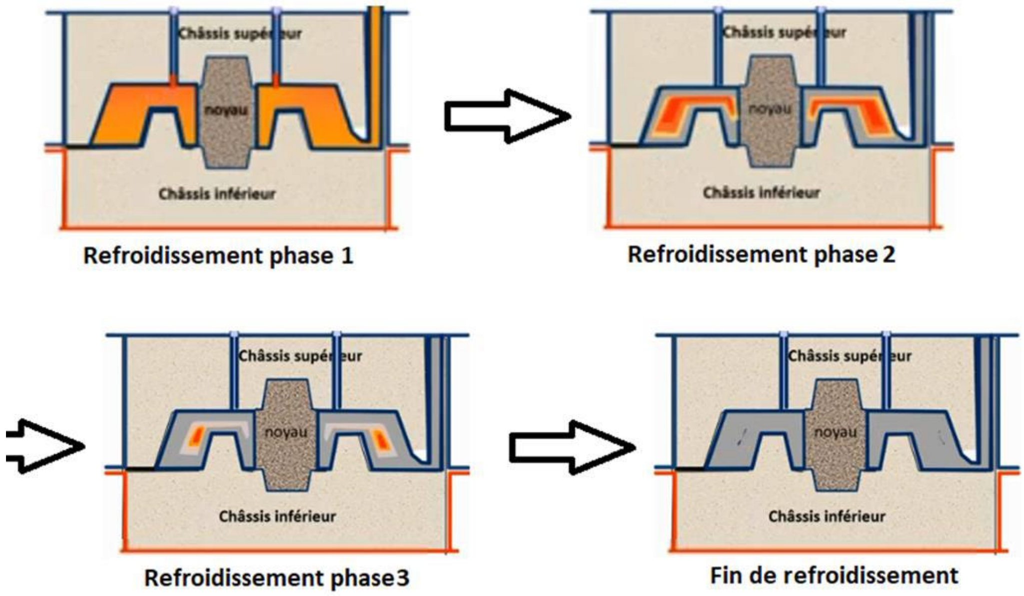

Fig.6 Room cooling

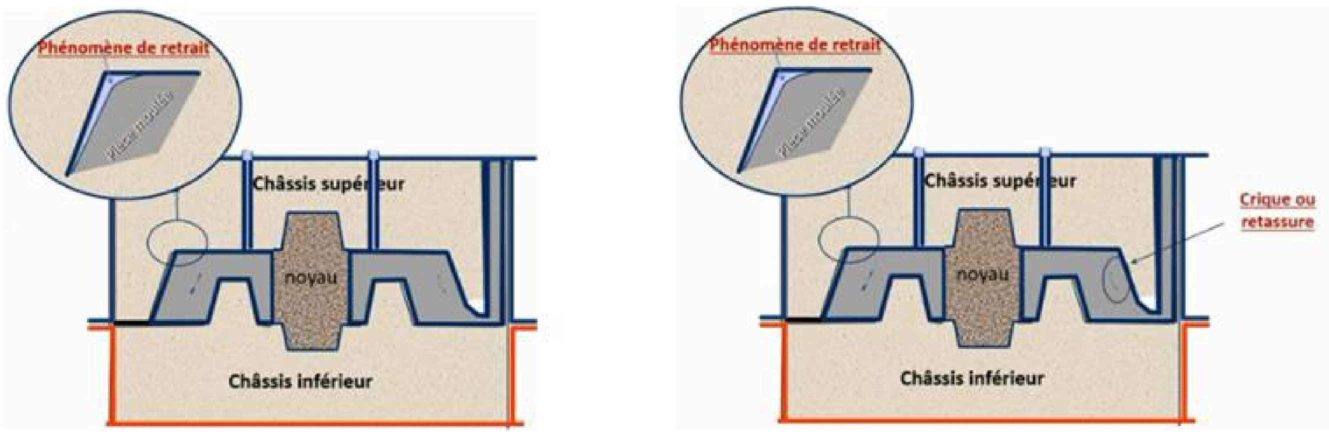

Fig.7 Possible defects

I.5.1.1 Steps in the sand casting process

1. Mix the sand with a sand mixer and add the appropriate clay for mixing.
2. Manufacture of moulds for casting.
3. Place the mould in the sand mixture, then seal the box containing the sand mixture.
4. Divide according to the metal to be cast and choose a suitable melting oven to melt the metal. Know that the metal turns into liquid metal.

5. Pour the liquid metal prepared in the previous step into the desired mould. (This process is dangerous, attention to safety)
6. Once the liquid metal has cooled and solidified in the mold, use a tool to clean the chips around the molded part.

I.5.1.2 Advantages of sand casting

Sand casting is one of the most common casting techniques.

1. It is suitable for the manufacture of blanks of complex shapes, in particular with complex inner cavities;
2. High adaptability and low cost;
3. For non-plastic materials, such as cast iron. Sand casting is the only forming process for the manufacture of cast iron parts or blanks.

I.5.2 Lost wax casting

Lost wax casting (FIG. 8) is a precision moulding process which consists in replacing a wax model with molten metal after heating the ceramic mold. This technique has been used for years. Unlike the types of molding under pressure, the process of molding with lost wax is relatively simple.

Allows the creation of very complex and detailed pieces for fields such as sculpture or the aeronautical and medical industry. The process includes the creation of a wax model, its coating.

FIG 8 Lost wax moulding

I.5.2.1 Steps in the lost wax moulding process

1. Choose an easy-to-melt material to make the mould. The surface of the mold may be covered with several layers of refractory material to form the shell of the molded part.
2. Remake the cast iron mould. In this way, a complete cast iron model can be obtained.
3. After roasting at high temperature, it must be filled with sand and cast. This is the process of cast iron with lost wax. It is also often referred to as "lost wax cast iron."

I.5.2.2 Advantages of the lost wax moulding process

Lost wax casting is one of the most common types of metal casting processes.

1. Lost wax casting has high dimensional and geometric accuracy. It is suitable for precision industrial castings.
2. High surface roughness.

3. It can cast complex parts, and the cast alloy is not limited.

I.5.3 Pressure moulding

Pressure molding (FIG. 9) is a manufacturing process which consists in injecting a molten metal into a high-pressure mold to produce precise and high-quality metal parts. This reduces the need for additional machining. There are two types of pressure moulding processes: the hot chamber and the cold chamber. These two types of pressure moulding are often used.

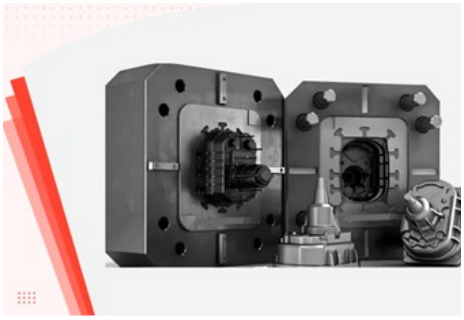

Fig.9 Pressure moulding

I.5.3.1 Steps in the pressure moulding process

1. Use of high pressure to press the molten metal into a high-speed precision metal mould.
2. The molten metal is cooled and solidified under pressure to form a casting.

I.5.3.2 Advantages of pressure moulding

Pressure molding is also one of the most common types of molding techniques.

1. The metal liquid is subjected to a high pressure and to a rapid flow during the molding under pressure.
2. Good product quality, stable size and good interchangeability;
3. Production efficiency is high and the pressurized casting mould is used many times;
4. It is suitable for mass production and has good economic benefits.

I.5.4 Low pressure casting process

Low pressure casting (FIG. 10) is a foundry process where a low gas pressure is used to push the molten metal from the bottom through an elevator tube to fill a mold. This method makes it possible to obtain parts of high metallurgical quality with low porosity.

Low pressure casting (LPDC) is a common process used today in foundries where the molten metal gradually fills the matrix, thus reducing the swirl.

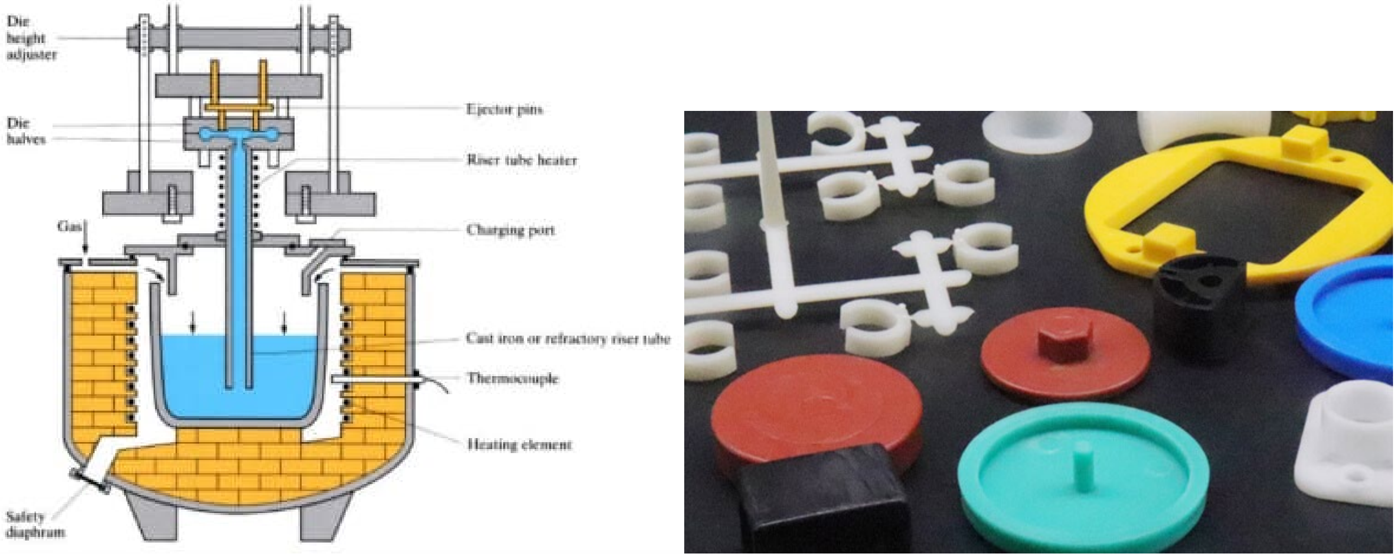

FIG. 10 Low pressure casting

I.5.4.1 Steps in the low pressure casting process

1. Melt a metal into liquid at high temperature.
2. The pressure is used to fill the mold with liquid metal. The liquid metal then solidifies under low pressure to form cast parts.

I.5.4.2 Advantages of the low pressure casting process

1. It is possible to adjust the pressure and the rate of casting of the liquid metal. It should therefore apply to various casting moulds (such as metal moulds, sand moulds, etc.), the casting of several alloys and the casting of parts of different sizes;
2. The process of filling the molten metal is regular, without splashing, and can avoid the presence of gas. Improve the qualification rate of moulded parts;
3. The casting crystallizes under pressure, the casting structure is dense, the contour is clear and the surface is smooth.
4. The rate of use of the metal in the casting process is increased to 90-98%;
5. Low labour intensity and simple equipment, easy to mechanize and automate.

I.5.5 centrifugal casting process

Centrifugal casting, also known as roto-casting, is a process for the industrial manufacture of cylindrical parts with centrifugal forces. This type of metal casting uses a preheated spinning matrix in which the molten metal is cast. Centrifugal forces help to distribute the molten metal in the high pressure die.

Centrifugal casting (FIG. 11) is used to manufacture parts with axial symmetry, such as cylinders or discs, which are generally hollow. There are generally three types of centrifuge molding processes: real centrifuge molding, semi-centrifuge molding and vertical centrifuge molding. Semi-centrifugal casting is used for larger parts that are symmetrical on the vertical axis. Centrifugal casting products include flywheels, gear blanks, etc.

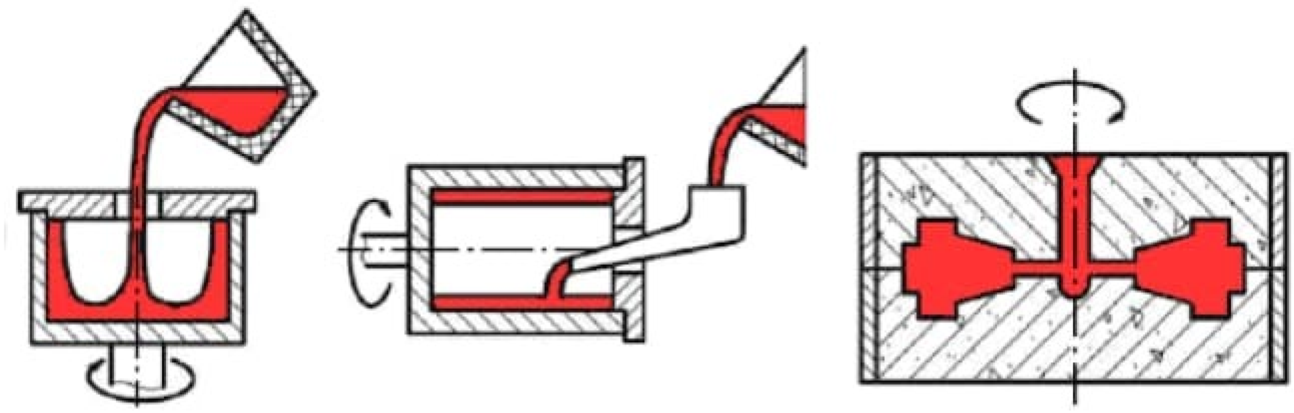

FIG. 11 Centrifugal casting

I.5.5.1 Steps in the centrifugal casting process

1. Pour the molten metal into a rotary mould.
2. Fill the mould with centrifugal force to solidify and form.

I.5.5.1 Advantages of the centrifugal casting process

1. There is virtually no consumption of metal in the metal casting process, which improves the efficiency of the process and reduces waste;
2. We do not need models for the production of hollow moulded parts. Consequently, it is appropriate to improve the filling capacity of the metal in the case of long tubular castings. The casting has a high density and has practically no defects, such as pores and slag inclusions. Like pores and slag inclusions, their mechanical properties are increased.
3. It is convenient to manufacture moulded composite metal parts for guns and sleeves.

I.6 Conclusion

We have presented in this modest work the different types of molding as well as the steps of making a mold with their advantages.