University of Jordan

Department of Industrial Engineering

Manufacturing Engineering Lab

Luna Makram Tadros	0183639
Leen Sakijha	0185566
Asma'a Ibrahim	0188427

Date: /12/2021

Manufacturing laboratory IE0906412

Metal Casting and Foundry; EXPERIMENT 2

DR. Mohamad Al-Tahat

Abstract

The purpose of the experiment is to produce a copy of a desired module of aluminum through casting, and to review the basic principles for the design of casting patterns, feeding and gating systems.

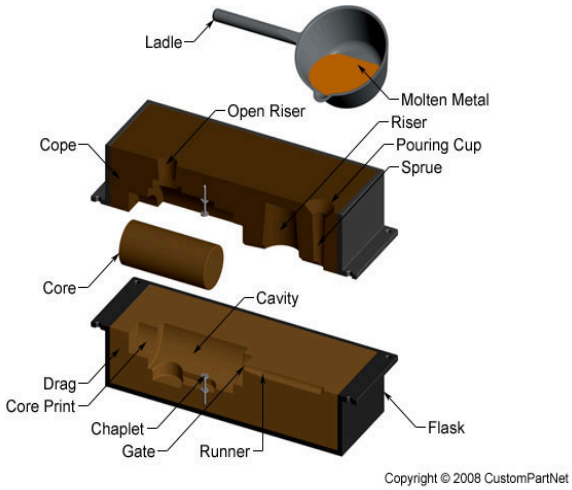
Casting offers the best design flexibility when compared to other production methods such as forging. It offers a significant advantage in the form of enabling the formation of attractive designs, as there is no restriction to the assembly of pieces or shapes.

For producing a successful casting operation, we should prepare the moulds of patterns, melt and pour the liquefied metal, solidify the metal, check the defects and inspections.

Objectives of this report:

- Understand the layout of foundry
- Identify the major machines and equipments used in foundry
- Identify raw materials used in the foundry
- Understand the concept of major industrial activities in the foundry
- Identify the various casting defects

1 Introduction



Foundry shop, is the place where work is done by melting and pouring the molten metal into the moulds.

It involves molding, melting, and casting of parts; that is, producing castings by filling the prepared molds with molten metal **(mostly aluminum)**.

In metalworking, casting involves pouring liquid metal into a mold, which contains a hollow cavity of the desired shape and then allowing it to cool and solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process.

Metals are casted into shapes by melting them into a liquid, pouring the metal into a mold, and removing the mold material after the metal has solidified as it cools. The most common metals processed are aluminum and cast iron. However, other metals, such as bronze, brass, steel, magnesium, and zinc, are also used to produce castings in foundries. In this process, parts of desired shapes and sizes can be formed.

Materials for Casting Processes.

The most frequently cast are iron, steel, aluminum, brass, bronze, magnesium, certain, zinc alloys, and nickel based super alloys. Out of these, cast iron is the dominant casting material, primarily because of its low cost, good fluidity, low shrinkage, ease of control and wide range of properties including useful strength and rigidity**.**

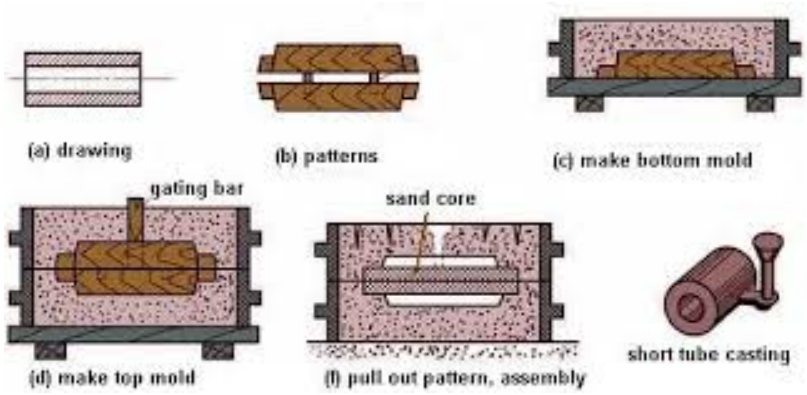
Metal casting is the process of melting the metals of different specification and alloys and pouring them in cavities (Molds) to give the desired shapes of the final component. These components are ready to use either as it is or after machining.

Requirements of the moulding sand:

- It should be cheap and easily available
- It should be reusable to effect economy.
- It should not react chemically with the molten metal.
- It should not stick to the surface of the casting.

The basic steps in making sand castings are:

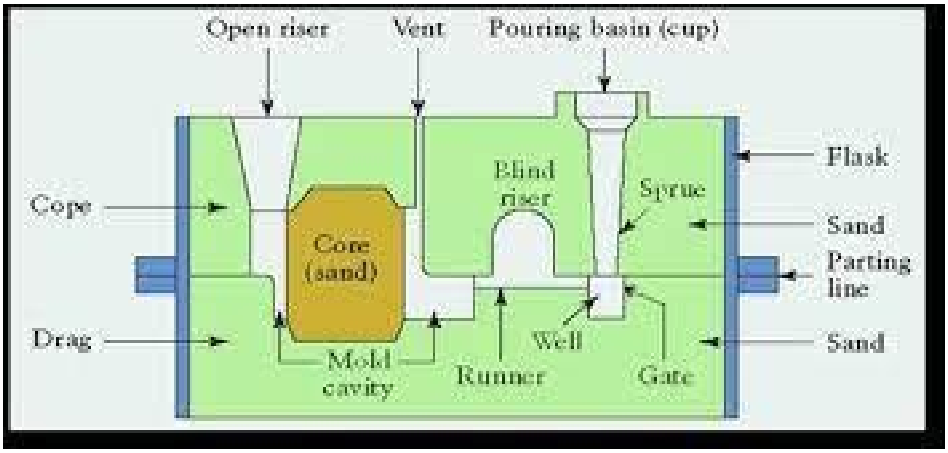
1. Pattern making
2. Core making
3. Moulding
4. Melting and pouring
5. Cleaning



SAND-CASTING

Sand casting, also known as (sand molded casting), is a metal casting process characterized by using sand as the mold material. It is relatively cheap and sufficiently refractory even for steel foundry use. A suitable bonding agent (usually clay) is mixed or occurs with the sand. The mixture is moistened with water to develop strength and plasticity of the clay and to make the aggregate suitable for molding. The term "sand casting" can also refer to a casting produced via the sand-casting process. Sand castings are produced in specialized factories called foundries. Over 70% of all metal castings are produced via a sand-casting process.

The various terms related to sand mold are:



Cope: The upper part of the molding flask.

Cheek: The middle part of the molding flask.

Drag: The lower part of the molding flask.

Runner: It is the passage through which the molten metal is poured.

Gate: It is the small passage connecting the runner to the mold cavity.

Parting Line: It is the line along which the sand surface of the drag and cope meet each other.

Riser: It is the passage through which the molten metal rises up after filling the cavity. On seeing the metal through it, it is ensured that the mold has completely filled.

Pouring Basin: It is the enlarged portion in the form of a countersunk, at the top of the runner.

Vent: Vents are placed in the mold to carry off gases produced when the molten metal comes into contact with the sand in the mold and core. They also exhaust air from the mold cavity as the molten metal flows in to the mold.

Casting workshop tools:

- **Sand:** An amount of sand used to make a sand mold must have a moisture content to help the binder process.

-Sand molds: The box like frame without top and bottom base into which sand is rammed is called "flask". It holds the sand mold intact. It is made up of wood for temporary applications and more generally of metal for long term use. It is generally made of two or more parts. We put the sand in it to made a sand mold.

-Parting Powder: is used to release cope from drag and over pattern preventing the molding sand from sticking and ruin the mold finishing. Talc powder can be used too and will be as effective.

-Sprue and Riser: To create the Sprue and Riser can be done simply by cutting timber to fit the work flask.

-Sand Sifter: A sifting tool is used for spreading very fine textured sand directly into contact with the pattern to get the best finishing results.

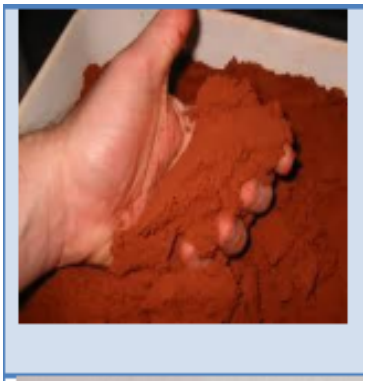
-Slick: This could be replaced with a simple small kitchen spoon to create the pouring basin or runner or to clear off unwanted sand particles.

-Molder Trowel: Could be replaced with a pointy block layer finishing trowel.

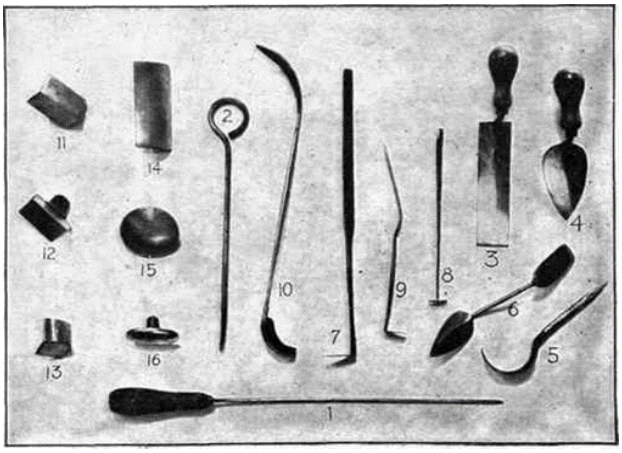
-Strike off bar is used to strike all the extra sand from the flask top or bottom.

-Sand Rammer: this is used to pack all the sand into the flask eliminating air pockets and lose sand that might ruin the final mold after pouring the molten metal. The rammer comes in different sizes. Most rammers are made of wood or aluminum.

-Metal wire: Can be used to create the gas vent holes.




The Mold
Cope
Drag


11
14
2
10
7
9
8
3
4
12
15
6
13
16
5
1

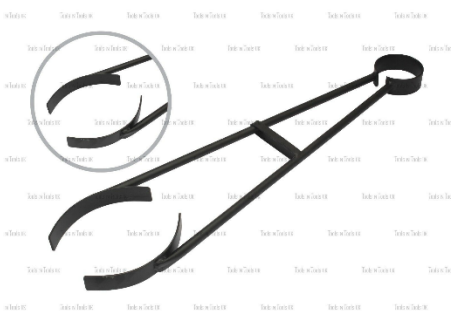


Fig. 4.1. (*e*) Strike off ba

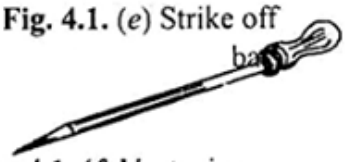


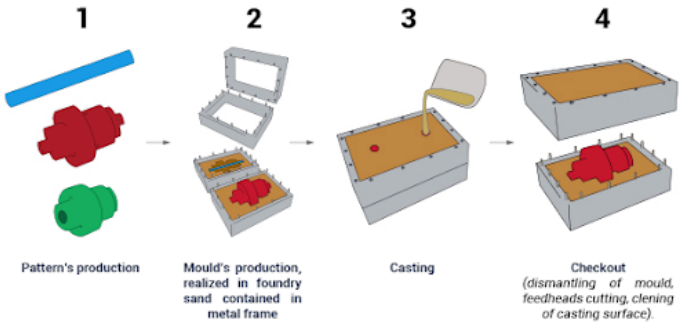
Fig. 4.1. (*f*) Vent wire.

Fig. 4.1. (*n*) Mallet.

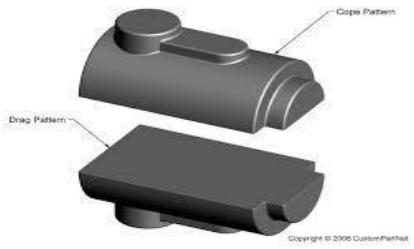
2 Methodology:

1. Place the drag on wooden board and put the model sample (pattern) inside it in the middle.

2. Prepare the sand used in casting with suitable humidity rate (about 8%), the humidity was tested by hand and observing the stickiness of the sand.
3. Pour sand and use a rammer to make the sand consistent and solid.
4. With a scraper, we scrap extra sand that is over the mold height. Then we place the mold up down and with a spoon we wipe and reveal the edges of the model clearly.



5. We put separation layer of finer sand or powder after placing the cope half of pattern on the drag half.

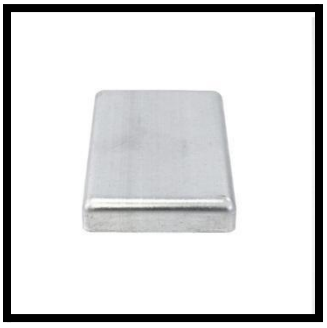


6. Place the feeder on the top of the model at the most susceptible area to compensate shrinkage of the metal and to create a passage that allows gases to escape.

7. Insert a runner then close the mold with sand layer, compact it and use a scraper to remove extra layers.
8. Using needle to make holes to remove extra gases (helps the feeder).
9. Remove the runner and the feeder and separate the drag from the cope. And remove the module from the mold.
10. Use the spoon to make a small cavity in the sand under the runner's pattern which will entrap the dense impurities and prevent them from entering the model' pattern.
11. A furnace was used to melt the raw aluminium inside a graphite container and was heated until it melted.
12. We can remove metal impurities by which it has a lower density so it flows above.
13. Use tongs to hold the container.

14. Pour the molten aluminium through the runner, there will be gases flowing out and the shrinkage of the molten metal happen inside.

15. Let it cool for approximately 2 hours (depends on the type of the metal).
16. Open the mold and we get the required peace of aluminium.
17. Use a smooth file to smoothen the surface of the required product.



3 Results and discussion

Casting process entails the following advantages.

1. Cheapest method of fabrication
2. The objects having complex and complicated shapes, which cannot be produced by any other method of production, can usually be cast.
3. Casting with wide range of properties can be produced by adding various allowing elements.
4. accuracy in casting can be achieved.
5. The number of castings can vary from very few to several thousands.

Disadvantages of casting process:

1. The time required for the process of making casting is quite long.
2. Metal casting involves melting of metal which is a high energy consuming process.
3. The working conditions in the foundry are quite bad due to heat, dust, fumes, and slag etc., compared to other processes.
4. Metal casting is still highly labor –intensive compared to other processes.

Applications Of sand casting:

The applications include cylinder liners, machine tool beds, pistons rings, mill rolls, wheels, large pump housings, valves, hydroelectric plant parts, turbine blades, wafer supply pipes, and bell, agricultural parts, aircraft engine blades etc.

Discussion:

Sand casting is a solidification process classified from metal casting process which contains melting the metal then pouring it into the mold.

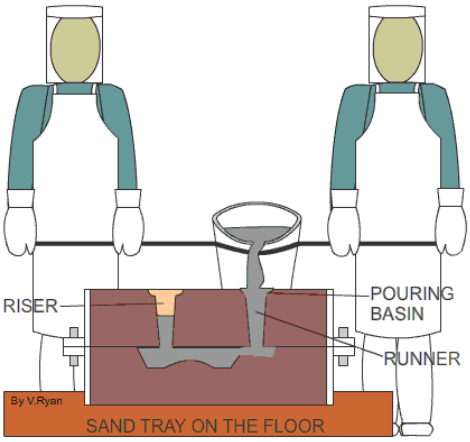
Molds are classified into: sand and metallic molds. Sand molds cand be permanent (from iron) that has high costs and non-permanent (from sand) has low cost.

We have to take into consideration the shrinkage of the metal after cooling up inside the mold (aluminium has a shrinkage constant : 2.3 mm for every 100 mm) and the feeder helps this purpose.

In the pattern (we use wooden or foam peace) there supposed to be inclination on the edges to help dealing with the model (getting it out from the mold).

Safety Precautions

- **Hazards:**
  - High temperature workplace.
  - Inhalation of toxic gases.
  - Noise hazards.
  - Lack of lighting.
  - Lack of ventilation.
  - Working for long durations.
- **Required Protective Devices.**
  - Helmet.
  - Safety Goggles.
  - Face Mask.
  - Earplugs.
  - Gloves.
  - Safety Shoes.
  - Fireproof Clothing.



4 Conclusions

In this experiment, we demonstrated how to use aluminium ore to create a cast from heating it and creating a mold, to solidifying it in the desired state using the tools needed for this procedure while wearing the required protective gear and following the safety precautions.

5 Acknowledgements:

The majority of information was directly presented by Dr.Mohammad Al-Tahat -Thanks to him-and done experimentally by our mentor Eng Amer Alzenat-Thanks to him too-

6 References:

- Report on Casting Process of Materials - Assignment Point
- casting molds - Bing images
- casting process - Bing images