

Production Engineering

Casting Processes



-1-



First class-2020

Dr. Khalil Ibrahim ABASS

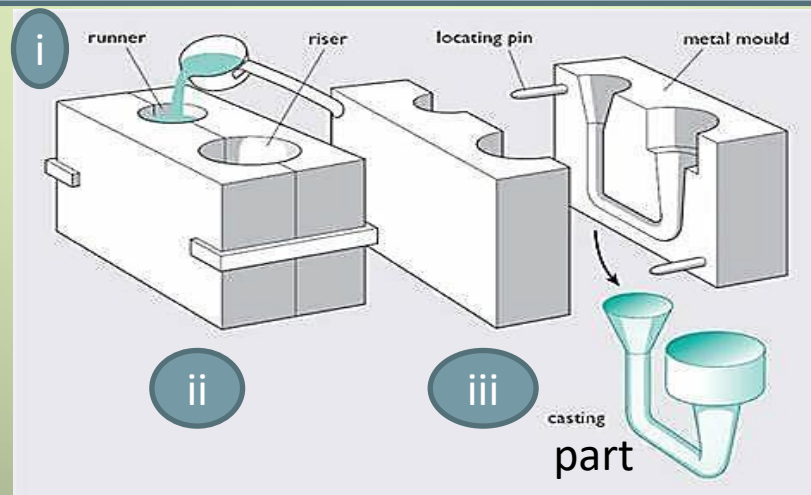
FUNDAMENTALS OF METAL CASTING

Casting is a process in which molten metal flows by gravity or other force into a mold where it solidifies in the shape of the mold cavity.

The term casting is also applied to the part that is made by this process.

The principle of casting:

i. melt the metal, ii. pour it into a mold, and iii. let it cool and solidify;

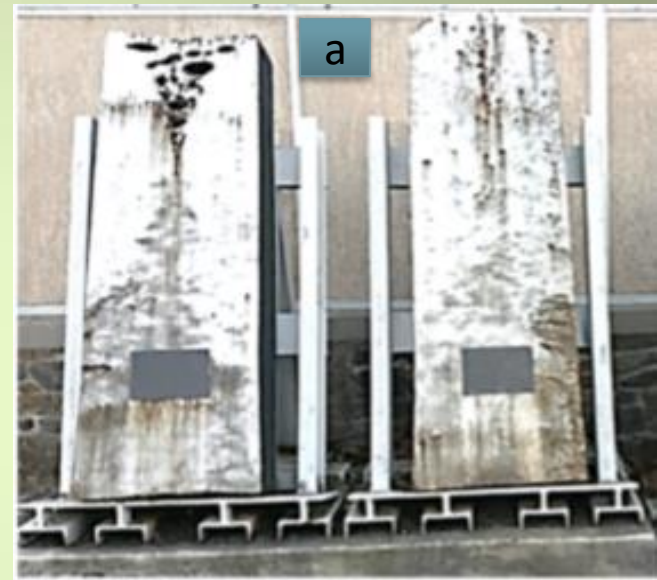


Casting includes both:

a. the casting of ingots, and b. the casting of shapes.

a. casting of ingots:

is usually associated with the primary metals industries; it describes a large casting that is simple in shape and intended for subsequent reshaping by Processes such as rolling or forging.



b. casting of shapes:

involves the production of more complex geometries that are much closer to the final desired shape of the part or product.



Advantages are the following

- ✓ Casting can be used to create complex part geometries (external and internal shapes).
- ✓ Some casting processes are capable of producing parts to net shape (no further manufacturing operations). Other casting processes are near net shape (some additional shape processing is required).
- ✓ Casting can be used to produce very large parts. Castings weighing more than 100 tons have been made.
- ✓ Casting process can be performed on any metal that can be heated to the liquid state.
- ✓ Some casting methods are quite suited to mass production.

Disadvantages are the following

- ✓ limitations on mechanical properties,
- ✓ porosity,
- ✓ poor dimensional accuracy and surface finish for some casting processes,
- ✓ safety hazards to humans when processing hot molten metals,
- ✓ environmental problems.

Parts made by casting processes range in size from small components weighing only a few ounces up to very large products weighing tons.

The list of parts includes dental crowns, jewellery, statues, engine blocks and heads for automotive vehicles, machine frames, railway wheels, frying pans, pipes, and pump housings.

All varieties of metals can be cast, **ferrous and nonferrous**.

Casting can also be used on polymer, sand, ceramics.

1. Overview of Casting Technology

As a production process, casting is usually carried out in a foundry.

A **foundry** is a factory equipped for making molds, melting and handling metal in molten form, performing the casting process, and cleaning the finished casting.

The workers who perform the casting operations in these factories are called foundry men.



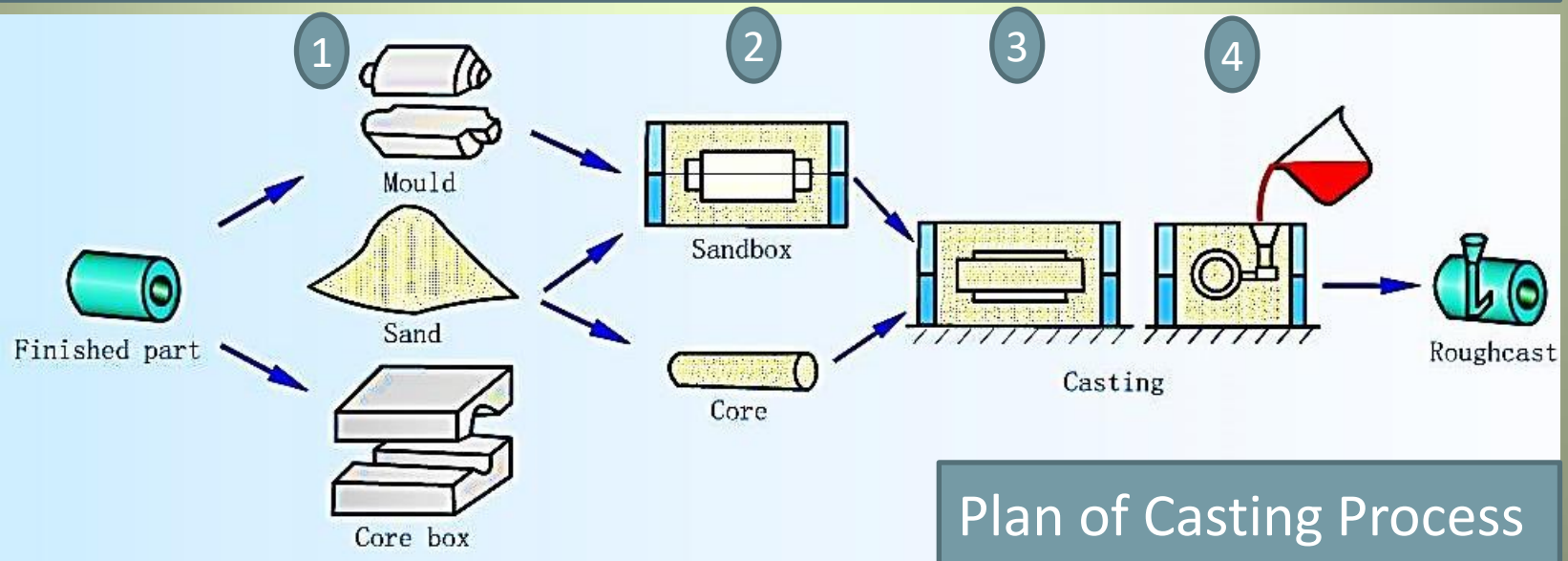
<http://www.metals-china.com/china-casting-foundry.html>

Casting Processes

The mold contains a cavity (geometry determines the shape of the cast part).

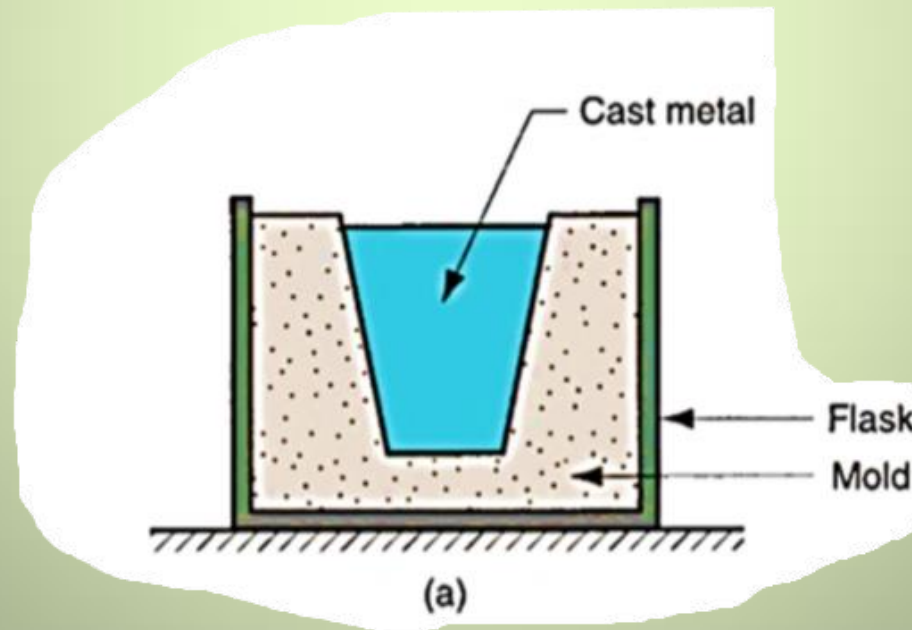
The actual size and shape of the cavity must be slightly oversized to allow for shrinkage that occurs in the metal during solidification and cooling (Different metals undergo different amounts of shrinkage).

Molds are made of a variety of materials: sand, plaster, ceramic, and metal.



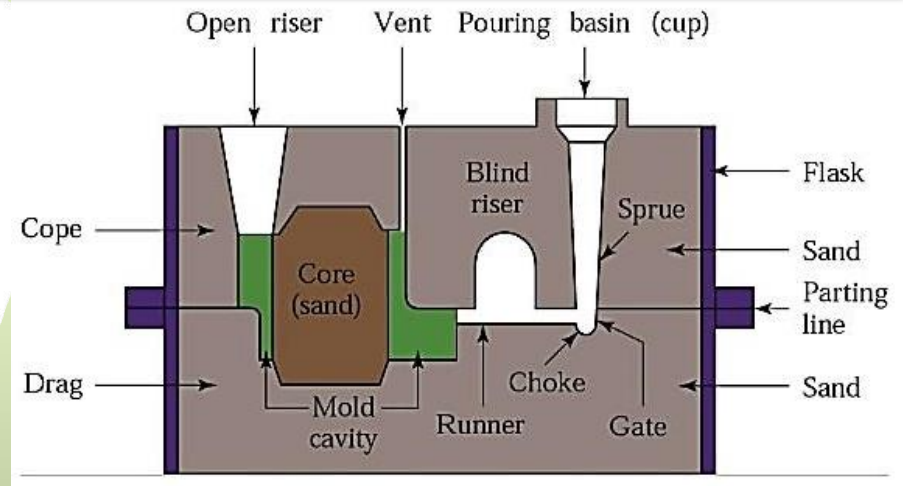
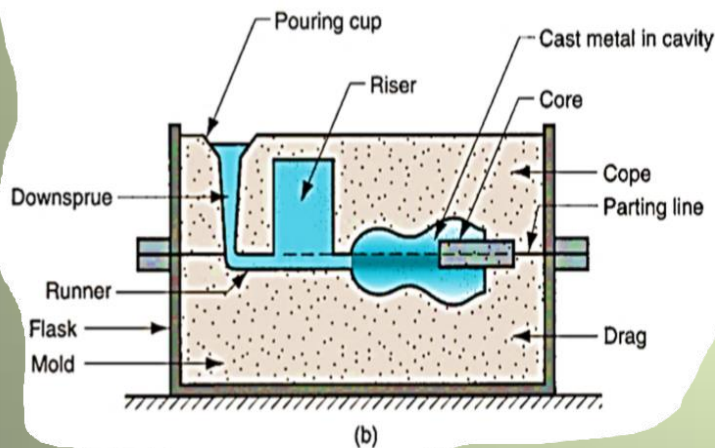
To accomplish a casting operation, the metal is first heated to a temperature high enough to completely transform it into a liquid state. then poured, or otherwise directed, into the cavity of the mold.

In an open mold, Figure 2(a), the liquid metal is simply, poured until it fills the open cavity.



In a closed mold, Figure 2 (b), a passageway called the gating system is provided to permit the molten metal to flow from outside the mold into the cavity. The closed mold is by far the more important category in production casting operations. As soon as the molten metal is in the mold, it begins to cool. When the temperature drops sufficiently (e.g., to the freezing point for a pure metal), solidification begins.

Sand casting parts: Cope, Drag, Flask, Parting line, Pattern, Core, Gating system, Sprue, Runner, Riser, Mold Cavity



Sand casting parts: Cope, Drag, Flask, Parting line, Pattern, Core, Gating system, Sprue, Runner, Riser, Mold Cavity

The mold consists of two halves: cope and drag. The cope is the upper half of the mold, and the drag is the bottom half. These two mold parts are contained in a box, called a flask, which is also divided into two halves, one for the cope and the other for the drag.

The two halves of the mold separate at the parting line. In sand casting, the mold cavity is formed by means of a pattern, which is made of wood, metal, plastic, or other material and has the shape of the part to be cast. The cavity is formed by packing sand around the pattern, about half each in the cope and drag, so that when the pattern is removed, the remaining void has the desired shape of the cast part.

The pattern is made oversized to allow for shrinkage, it solidifies and cools of the metal. The sand for the mold is moist and contains a binder to maintain its shape.

Sand casting parts: Cope, Drag, Flask, Parting line, Pattern, Core, Gating system, Sprue, Runner, Riser, Mold Cavity

The cavity in the mold provides the external surfaces of the cast part. In addition, a casting may have internal surfaces. These surfaces are determined by means of a core, a form placed inside the mold cavity to define the interior geometry of the part, (cores are generally made of sand, metals, plaster, and ceramics).

The gating system in a casting mold is the channel, or network of channels, by which molten metal flows into the cavity from outside the mold.

The gating system typically consists of a down sprue (also called simply the sprue), through which the metal enters a runner that leads in to the main cavity. At the top of the down sprue, a pouring cup is often used to minimize splash and turbulence.

Sand casting parts: Cope, Drag, Flask, Parting line, Pattern, Core, Gating system, Sprue, Runner, Riser, Mold Cavity

Some pouring cups are designed in the shape of a dowel, with an open channel leading to the down sprue, or as a simple cone-shaped funnel .

The riser is a reservoir in the mold that serves as a source of liquid metal for the casting to compensate for shrinkage during solidification. The riser must be designed to freeze after the main casting in order to satisfy its function. As the metal flows into the mold, the air that previously occupied the cavity, as well as hot gases formed by reactions of the molten metal, must be evacuated so that the metal will completely fill the empty space. In sand casting, for example, the natural porosity of the sand mold permits the air and gases to escape through the walls of the cavity.

Once the casting has cooled sufficiently, it is removed from the mold. Depending on the casting method and metal used, further processing may be required. This may include:

- i. trimming the excess metal from the actual cast part,
- ii. cleaning the surface,
- iii. inspecting the product, and
- iv. heat treatment to enhance properties.
- v. in addition, machining may be required to achieve closer tolerances on certain part features and to remove the cast surface.

2. SAND-CASTING MOLDS

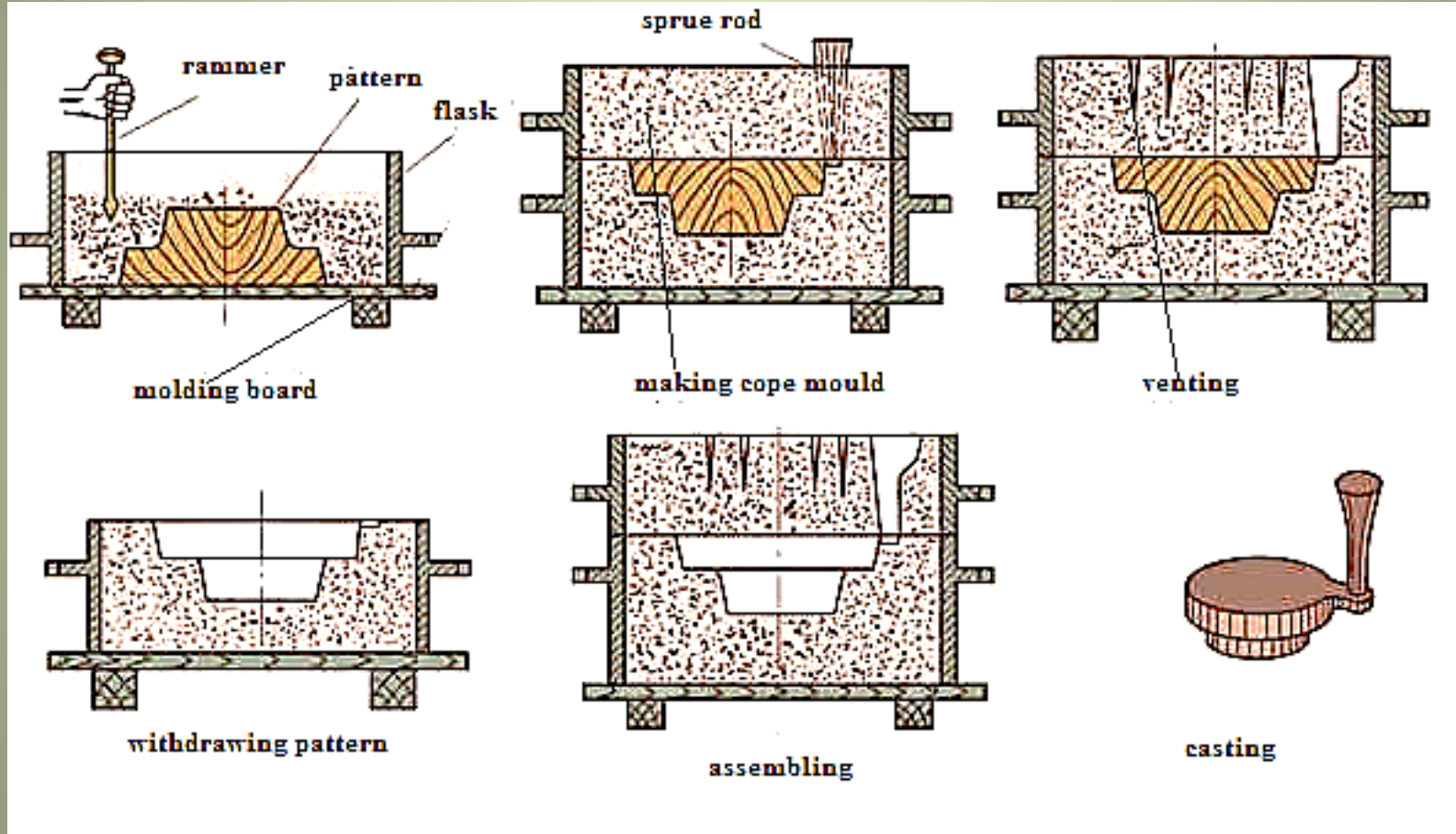
A sand-casting mold will be used to describe the basic features of a mold.



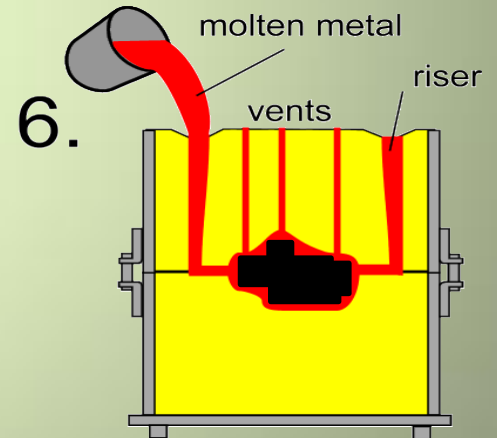
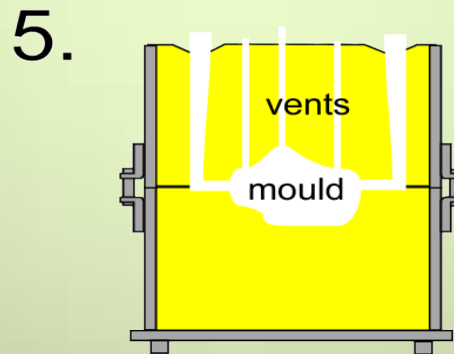
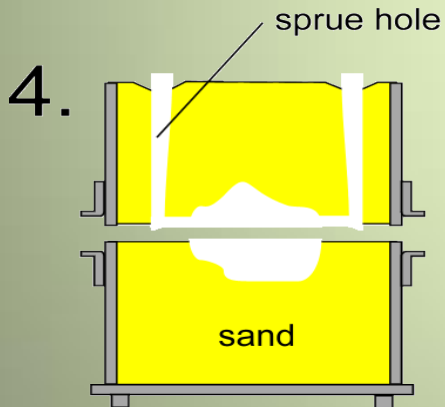
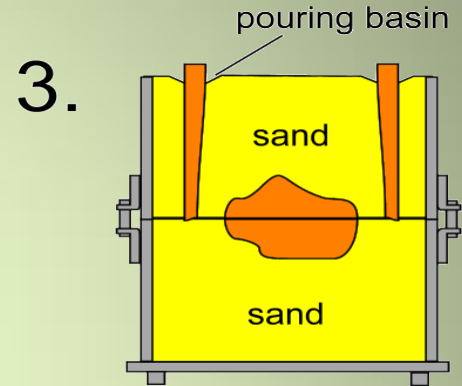
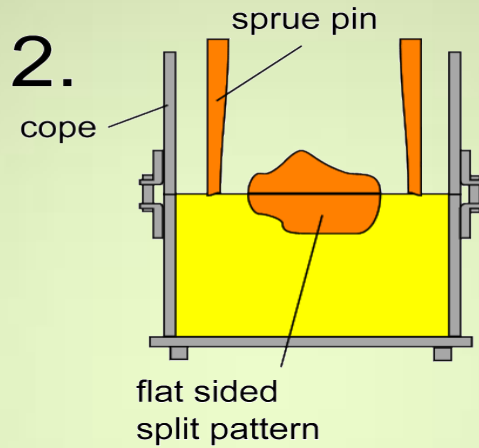
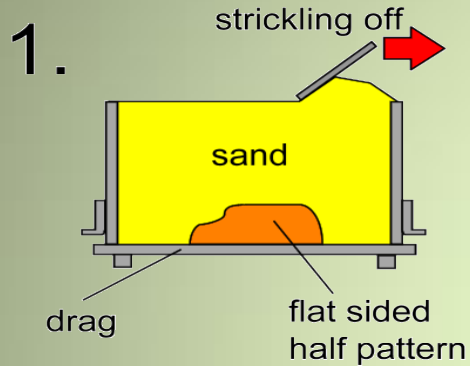
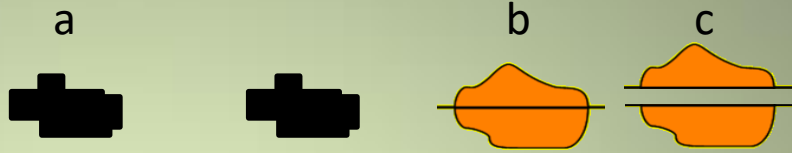
<https://www.youtube.com/watch?v=1oZnxZj6-lg&t=22s>

a b

Ex: Sand Casting



Ex: Sand Casting



References

- B.H. Amstead, Phillip F. Ostwald, Myron L. Begeman, Manufacturing Processes, Seventh Edition, SI Version (1979, 1987).
- Mikell P. Groover, Fundamentals of Modern Manufacturing, Materials, Processes and Systems, 4th Edition (2010).

Thanks you

Dr. Khalil Ibrahim ABASS