CASTING

Molten material is poured into a mould or cavity to get the desired shape.

CASTING PROPERTIES OF MATERIAL:

Casting material should be selected according to its physical, mechanical properties & chemical properties like melting point, corrosion resistance & tensile strength.

Metal used for casting is characterized by its casting properties:

1. Fluidity: Ability of a metal to flow and fill all areas of the mold before solidifying. Influenced by the casting temperature, the type of metal, and its quality.
2. Shrinkage: Reduction in size or volume of cast metal or alloy as it cools and solidifies. As the metal cools, its atoms arrange themselves into a more ordered, condensed structure, leading to a decrease in volume and resulting in shrinkage
3. Machinability: Ease with which a metal casting can be machined to remove the unwanted material occurs due to the overflow of metal or to achieve the surface finish and precision.
4. Surface Finish: Different metals produce different surface finish qualities, ranging from rough to glossy smooth.
5. Pouring temperature: Temperature at which metal is pour into the mold. The pouring temperature should be more than 50 to 100% of the melting temperature.
6. Draft: Small angle applied on all the vertical walls of the pattern that help the component to easily come out from the mold without damaging its walls.

Components used in casting:

1. Pattern: Replica of the object to be cast, used to prepare the cavity into which molten metal will be poured, made of wood, plastic, or metal.
2. Mold or Die: They are the vessels into which the materials are poured and formed. They can be open or closed mold.
3. Cores: Insert(made of sand, metal, or other material) used to create cavity or hollowness in the final component. Core is placed inside the mold before the molten metal is poured. Molten metal then fills the space around the core, taking its shape and forming the desired internal features.

Removed after the modification of metal or in some cases, the core is made of soluble material

1. Casting Material: Depends upon the product, but metals such as iron, steel, aluminum, bronze, brass and alloys are commonly used.
2. Melting Furnace: Used to melt the metal to be cast. Can be electric, gas, or induction-based.
3. Ladle: Once the metal is metal ladle is used for transporting and pouring out molten metals.
4. Chills: Heat sinks(made of metal, ceramics or other material) that help solidify the molten metal more quickly in a certain region and are used when even cooling and solidification is required.
5. Parting Compound: Used to prevent the casting from sticking to the mold, facilitating its removal.
6. Flask: Box, without top and bottom, in which the mold is made, having its upper and lower halves, cope and drag, respectively.
7. Finishing tools: After casting, the product might need finishing touches like polishing or machining to remove the excess material or to get an aesthetic look.

STEPS INVOLVED IN THE CASTING PROCESS:

1. Pattern Making: The first step in the casting process is making the pattern.
2. Mold Making: Once the pattern is ready, it's time to prepare the mold. pattern is placed inside a container called a mold box, which is then filled with molding material like sand, clay, or plaster & then removing the pattern, leaving a cavity of the desired shape in the mold.
3. Mold Assembly: If the mold is made in multiple parts, assemble them to create the complete mold. Make sure there are channels (called sprues and gates) for pouring the molten metal and allowing air to escape.
4. Melting the Metal: Heat the metal to above its melting point in a furnace and pour it into mold with the help of a ladle.
5. Cooling: After the molten material is poured into the mold, it then needs to cool until it solidifies.
6. Shakeout & cleaning: Once the material is solidified, it can be removed from the mold by vibrating or shakeout to remove. In some cases, the mold needs to be broken to get the final product.
7. Cleaning and Inspection: After the removal of sand, excess material like gates or runners which were integral for the casting process. These are cut or broken off, and the casting is cleaned and inspected for quality.
8. Finishing: Sometimes must be need of finishing operations such as grinding, machining, painting, or coating, are to finalize the product according to specifications.
9. These are the basic steps involved in casting but it may varies from different types of casting methods such as die casting, investment casting, sand casting, etc., and may follow slightly different steps or procedures.

DEFECT OF CASTING: during solidification, poring of metal in mould or the present of any other irregularities in casting material defect may arise. Defects may affect the strength durability and quality of the final product. Casting defect arises due to many reasons:

1. Due to the evolution of gases :
2. Blow holes: When gases are entrapped on the surface of the casting due to solidifying metal, a rounded or oval cavity is formed called as blowhole. These defects are always present in the cope part of the mould.

Causes :

(i) Excessive moisture in the sand.

(ii) Low Permeability of the sand.

(iii) Sand grains are too fine.

(iv) Too hard rammed sand.

(v) Insufficient venting is provided.

Remedies:

Moisture content must be controlled in sand.

Sand of appropriate grain size should be used.

Sufficient ramming should be done.

Proper venting facility.

1. Pin hole: Small holes of about 2 mm in size which appear on the surface of the casting.

Cause: Dissolution of the hydrogen gases in the molten metal.

Remedies: Dissolved gases may be removed from the molten metal by using one of the metal practicing like : the vaccum melting process and avoiding high poring temperature

1. Vain defect: Vains or cracks on the surface of final product.

Causes:

Expansion of the sand mold due to high temperature when the molten metal is poured into it.

High pouring temp.

Poor quality of sand.

Remedies:

Better sand quality.

Applying suitable coatings and release agents on the mold surface can help in preventing the adhesion of molten metal to the mold, reducing the formation of veins

1. Blister
2. Due to the poring of metal:
3. Misrun: Molten metal may solidify before completely filling the mold, and leaving space in mould.

Causes:

1. Low temperature of the molten metal which decreases its fluidity.
2. Thin and improper gating system

Remedies

(i) Increasing the pouring temperature of the molten metal increases the fluidity.

(ii)Proper gating system

(iii) Too thin section is avoided.

1. Cold shut: Molten metal enters into the mold from two gates and when these two streams of molten metal meet at a junction with low temperatures than they do not fuse with each other and solidifies creating a cold shut (appear as line on the casting). It looks like a crack with round edge.

Causes:

(i) Poor gating system

(ii) Low melting temperature

(iii) Lack of fluidity

Remedies:

(i) Improved gating system.

(ii) Proper pouring temperature.

5. Flash: Unwanted or excess layer of metal that accidentally comes out of the mold

Remedies:

proper alignment of mould.

Clean up the die cavity and parting surface.

Cause :

minor gap left between cope and drag

Insufficient clamping force.

Inadequate cleaning of the parting surface.

Too high injection speed and filling temperature.

6. Runout: Occur when molten metal leaks from the mold during pouring molten metal.

Remedies:

Design casting molds with precision.

Inspect molds before casting and replace defective ones.

Use high-quality raw materials that can withstand high temperatures for designing molds.

Cause

TYPES OF CASTING PROCESS:

Sand casting: Sand mould are used to create the components, a cost-effective method for producing a wide range of metal components, making it a popular choice in foundries worldwide.

STEPS INVOLVED IN THE SAND CASTING PROCESS:

1. Pattern Making: The first step in the casting process is making the pattern.
2. Mold Making: Once the pattern is ready, it's time to prepare the mould. pattern is placed inside a container called a mould box, which is then filled with moulding material like sand, clay, or plaster & then removing the pattern, leaving a cavity of the desired shape in the mould.
3. Mold Assembly: If the mould is made in multiple parts, assemble them to create the complete mold. Make sure there are channels (called sprues and gates) for pouring the molten metal and allowing air to escape.
4. Melting the Metal: Heat the metal to above its melting point in a furnace and pour it into mold with the help of a ladle.
5. Cooling: After the molten material is poured into the mold, it then needs to cool until it solidifies.
6. Shakeout & cleaning: Once the material is solidified, it can be removed from the mold by vibrating or shakeout to remove. In some cases, the mold needs to be broken to get the final product.
7. Cleaning and Inspection: After the removal of sand, excess material like gates or runners which were integral for the casting process. These are cut or broken off, and the casting is cleaned and inspected for quality.
8. Finishing: Sometimes must be need of finishing operations such as grinding, machining, painting, or coating, are to finalize the product according to specifications.

2. PERMANENT MOULD CASTING: Molten materials are poured into a reused, permanent mold typically made of metal to get the desired shape.

DIE CASTING PROCESS: Permanent mold casting in which high pressure is used to pressurize the molten metal into the die cavity.

Mould used in die casting is also called die and is much more expensive than sand mould because it is made up of metal block and very high tolerances machines are used to create the cavity in the die.

Die contains two halves. One half is fixed (stationary cover) and the other is (ejector) movable.

If the molten metal is forced into a metallic die under a gravity head as done in sand cavity, the process is known as Gravity Die Casting or Permanent Mould Casting.

Commonly used die materials are medium carbon, low alloys, hot steels.

Molten metal is pressurized with the help of pneumatically (with the help of compressed air) or hydraulically.

steps involved in the die-casting process:

Mold Preparation: Begins with the preparation of the mold, which is typically made of steel. mould consists of two halves, the "cover die" and the "ejector die." These halves are precisely machined to form the desired shape of the part.

Die Lubrication: Die surfaces must be lubricated. This keeps the molten metal from adhering to the mould. Graphite and water-based solutions are common lubricants.

Melting of Metal: Heat the metal to above its melting point in a furnace.

Injection: Once the molten metal reaches the desired temperature, it is injected into the die under high pressure. Pressure plays a crucial role as it helps fill the mold quickly and ensures the molten metal reaches all corners and cavities of the mold.

Cooling and Solidification: Molten metal fills the mold cavity, and it is allowed to solidify. Cooling can be accelerated by the circulation of water channels within the mold. Cooling time depends on factors like the design of the part and the metal being used.

Mold Opening and Ejection: Once the metal has solidified, the cover die and ejector die are separated, and the part is ejected. Ejector pins or slides are used to push the part out of the mold cavity. The ejector pins leave small marks or "ejector pin marks" on the part, which can be removed through subsequent processes.

Trimming and Finishing: After the part is removed from the mold, excess material or flash may be present. Trimming or deburring processes are performed to remove any unwanted material or rough edges, resulting in a smooth finish.

Post-Casting Operations: Depending on the specific requirements of the part, additional operations such as heat treatment, surface finishing (such as painting, polishing, or plating), and inspection may be carried out to meet the desired specifications.

3. CENTRIFUGAL CASTING: Mould is rotated at high speed so that the molten metal is

distributed by the centrifugal force to the outer regions of the die cavity

METHOD OF CENTRIFUGAL CASTING :

TRUE CENTRIFUGAL: Molten metal is poured into the rotating mould to produce tabular part e.g. pipes, gun, barrels and lamp posts, hollow bushes, etc.

Mould orientation can be horizontal or vertical.

1. Die casting: Molten material is forcibly injected into a metal mold (die) under high pressure.
2. Investment Casting (or Lost Wax Process): The wax pattern is coated with refractory material to create a mold and molten metal is poured and melted into the wax pattern to get the desired shape.
3. Permanent Mold Casting
4. Centrifugal Casting: Used for cylindrical shapes, Molten material is poured into a continuously rotating permanent mold centrifugal force pushes the material towards the mold walls and helps to get the desired shape.
5. Plaster Mold Casting: Similar to sand casting, but instead of sand uses a mold made from a plaster mixture.