Product Knowledge Document

CASTING

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AGENDA : CASTING

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2. PURPOSE OF CASTING
3. APPLICATION OF CASTING
4. BASIC STEPS IN CASTING
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CHAPTER 2

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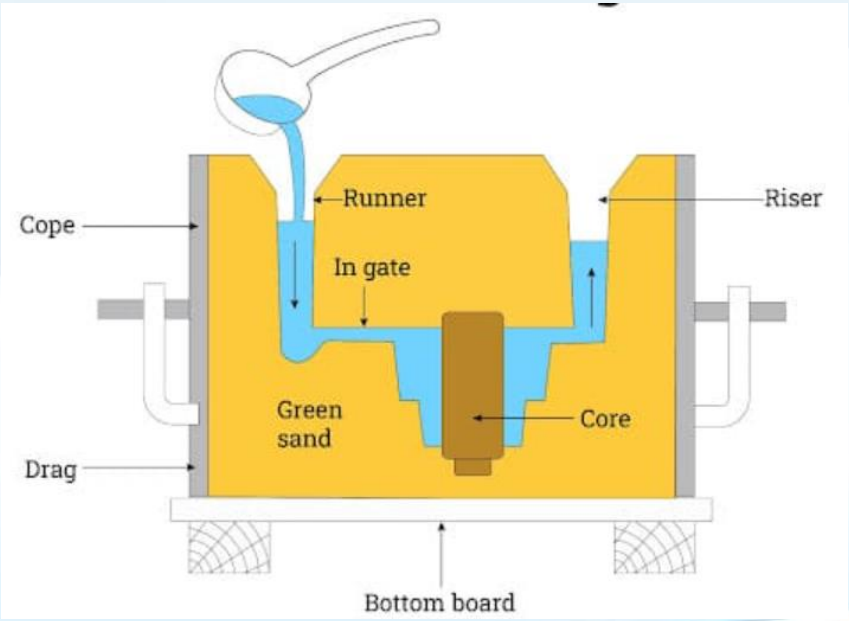
CHAPTER 1 : INTRODUCTION TO CASTING

1 - INTRODUCTION TO CASTING

It’s a manufacturing process which liquid metal is poured into a mould which contains a hollow cavity of desired shape and then allowed to solidify.

Upon solidification metal is taken out from mold and machined per dimensional requirement.

Casting process is versatile and can manufacture intricate shapes with wide range of materials(steel, cast iron, zinc, Aluminum.



1 – BASIC STEPS IN CASTING

1. Prepare a pattern.
2. Prepare a mold with pattern.
3. Remove pattern to form cavity.
4. Fill the cavity with liquid metal and allow it to solidify.
5. Remove the solidified castings from mold.
6. Further process(grinding, machining) casting per requirements.

1 - ADVANTAGES OF CASTING

- Castings can be produced with any ferrous or non ferrous material.
- Low tooling cost.
- Versatile in manufacturing intricate shape.
- Mass production is feasible.
- Less time consuming.

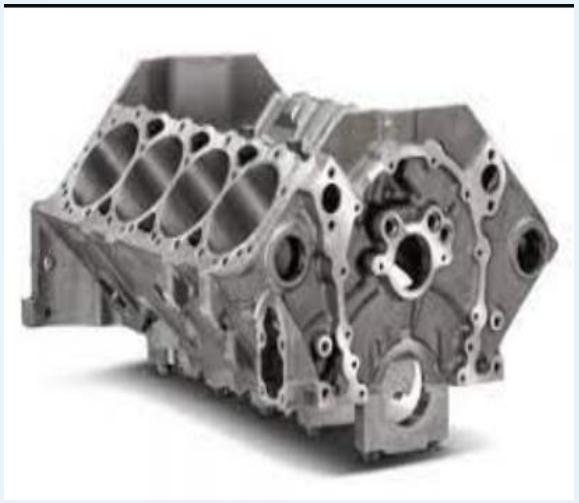
1 - LIMITATIONS OF CASTING

- Lower dimensional accuracy.
- Pattern creation and maintenance.
- Surface finish.
- Labour intensive.
- Allowance to be considered.

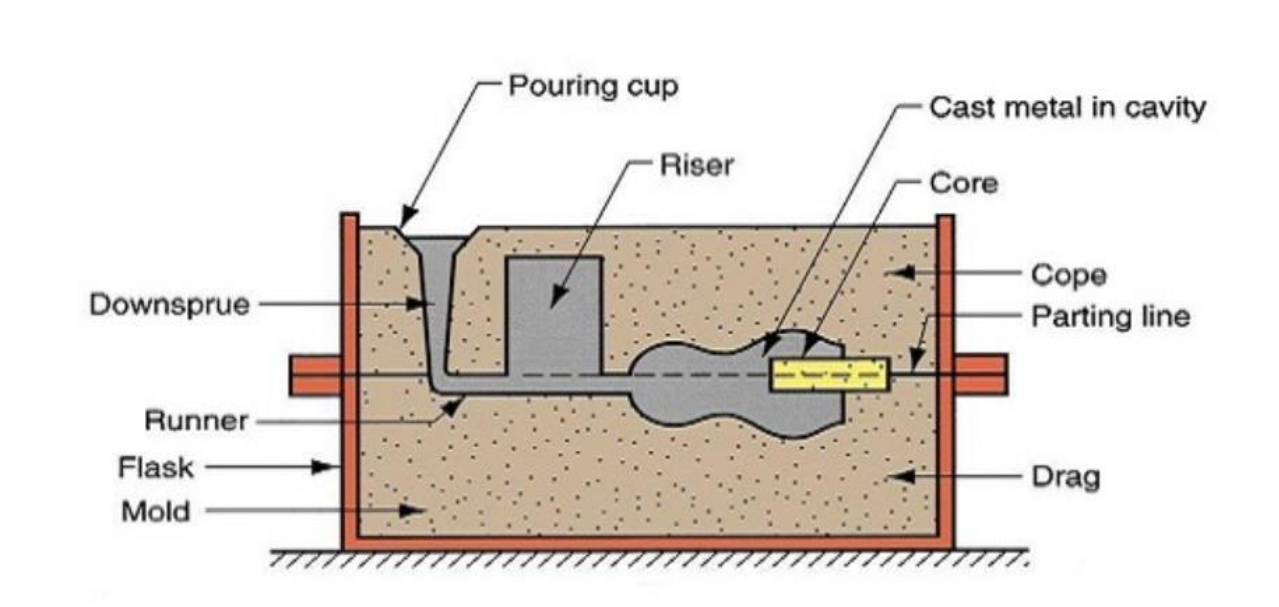
1 – APPLICATION OF CASTING IN AUTOMOBILE INDUSTRY

Components manufactured by castings.

1. Piston
2. Engine Blocks
3. Valve Cover
4. Wheels
5. Transmission housing
6. Carburetors
7. Fan clutches.
8. Shifter Forks.



DEFINATIONS



(1) FLASK:- It is the box that contains the molding aggregate.

(2) Pattern:-It is the replica of the final object to be made with some modification.

(3) Parting Line:-This is dividing line b/w two parts of flask that makes the sand molds.

(4) Bottom board:- This is normally made of wood which is used to support the one end of the flask.

DEFINATIONS

5) Facing sand:- The Small amount of carbonaceous sand material sprinkle on the internal mold surface of cavity to give better surface finish to the casting.

(6) Molding Sand:- It is Freshly Prepare refractory use for making the mold cavity.

(7) Backing Sand:- It is the bulk of the sand used to back up the facing sand & to fill up the volume of the flask.

(8) Pouring basin:- A Small Funnel Shaped Cavity at the top of mold in to inch the molten metal is poured.

(9) Core:- A core is used in Casting and molding Process to produce internal hollow cavities in final product.

(10) Sprue:- It is Vertical Cavity in the mold to flow the molten metal from the pouring basin.

(11) Runner:- The pass way in the parting line through which molten metal regulated before they reach to mold cavity.

(12) Chills:- Chills are metallic object which are placed in mold to increase the cooling rate of the casting.

(13) Chaplet:- It is used to support core inside the mold cavity to take core of it's own weight.

(14) Riser :- It is reservoir of molten metal provided in casting show that metal can flow back into the more cavity there is a reduction in volume of metal due to solidify.

DEFINATIONS

15) Green Sand:- Green sand castings are formed using sand molds formed from wet sand that contains water and organic bonding compounds, also known as clay. The term Green Sand refers to the sand mold not being “set” or “green” or “uncured” when the metal is poured into the mold. This sand can be reused.

16) Water Glass or Sodium Silicate:- Sodium silicate can be used to create sand mold castings. This process is beneficial in sand casting, where a cavity is required. Sodium Silicate can quickly go from a liquid to a solid by passing carbon dioxide through it. This causes the sodium silicate to dehydrate. Sodium silicate must be mixed with other materials so the core can be removed during product break down. If the mixture isn’t correct, the core will become stuck within the casting.

17) Resin Sand:- The molding material for resin sand casting is a blend of quartz sand and resin sand. When resin sand is mixed and heated, it hardens into a solid, smooth mold. A solid mold produces fewer faulty castings, but it comes at a greater cost and a slower production rate. Resin sand molds take longer to make because each one must be mixed and burned individually.

DEFINATIONS

18) Gray Cast Iron:- The most common type, gray cast iron features a graphite microstructure consisting of many small fractures. It's called "gray cast iron" because the presence of these small fractures creates the appearance of a gray color. When gray cast iron is produced, the fractures open up to reveal the gray-colored graphite underneath the surface. Gray cast iron isn't as strong as steel, nor is it able to absorb the same shock as steel. With that said, gray cast iron offers similar compressive strength as steel. As a result, it's become a popular choice of metal for applications involving compressive strength.

19)White Cast Iron:- While not as common as gray cast iron, white cast iron is another type worth mentioning. It receives its namesake from its off-white color, which is the result of iron compounds known as cementite. Like gray cast iron, white cast iron features many small fractures. The difference is that white cast iron features cementite below its surface, whereas gray cast iron features graphite below its surface. The graphite creates the appearance of a gray color, while the cementite creates the appearance of a white color. White cast iron is hard and offers excellent resistance against abrasions.

DEFINATIONS

20) Ductile Cast Iron:- Also known as nodular cast iron, ductile cast iron is a type of soft, ductile iron alloy with a high carbon content. It's typically made with trace amounts of other compounds, including magnesium and cerium. When added, these trace compounds inhibit the speed at which graphite grows, thereby keeping the metal soft and ductile. Ductile cast iron was invented in the early to mid-1940s.

21) Malleable Cast Iron:- Malleable cast iron is typically created using heat treatment processes on white cast iron. The white cast iron is heated treated for up to two days, after which it's cooled. When finished, malleable cast iron can be bent and manipulated to achieve unique shapes and sizes.

22) Compacted Graphite Iron:- It known as CGI or Vermicular Graphite Iron, is a form of cast iron in which the shape of the graphite particles is between that of conventional grey iron flakes and ductile iron where the graphite is in spheres. The worm-like compacted-graphite shape provides physical properties that mirror the most beneficial properties of grey and ductile irons.

CHAPTER 2 : VARIOUS CASTING PROCESSES

2 – VARIOUS CASTING PROCESSES

- SAND CASTINGS(IRON/STEEL)
- CENTRIFUGAL CASTINGS
- CENTRIFUGAL LINERS
- INVESTMENT CASTINGS(IRON/STEEL)
- ALUMINUM SEMI PERMANENT MOLD CYLINER HEADS
- ALUMINUM SAND CASTINGS
- ALUMINUM METAL MOLD
- ALUMINUM HIGH PRESSURE DIE CAST
- MAGNESIUM HIGH PRESSURE DIE CAST
- ZINC HIGH PRESSURE DIE CAST

2 – SAND CASTINGS

Sand castings are those castings whose mold are prepared by sands and liquid metal is poured into sand mold.

Use of sand as the molding media is the most distinguished feature of sand casting process due to making intricate shapes and cost effectiveness.

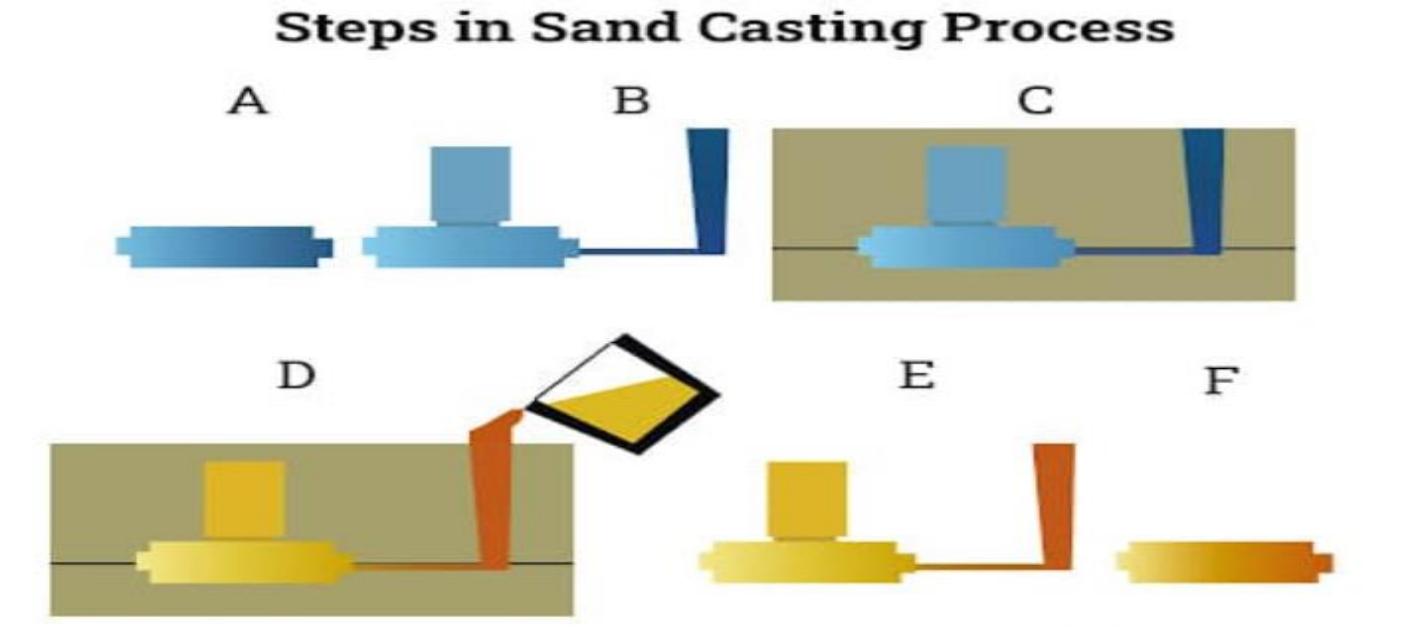
Components of sand mold are,
Base sand-is the sand which is used for making mold in the purest form Eg. silica sand, zircon sand.
Binders- are those agents which glue sands particles together Eg. clay and water, oil, resin, silica sand.
Additives- are those agents which improves mold surface finish, dry strength(strength of mold after curing), refractoriness, cushioning.
Parting compounds- are those agents which eases release of casted part from mold.

2 – METHOD OF MAKING SAND CASTINGS

- **Producing the pattern**

- A reusable pattern with same details as the desired completed product is used in the process.

- A pattern is always made larger than the final part to give allowance for thermal contraction or shrinkage, machining allowance.



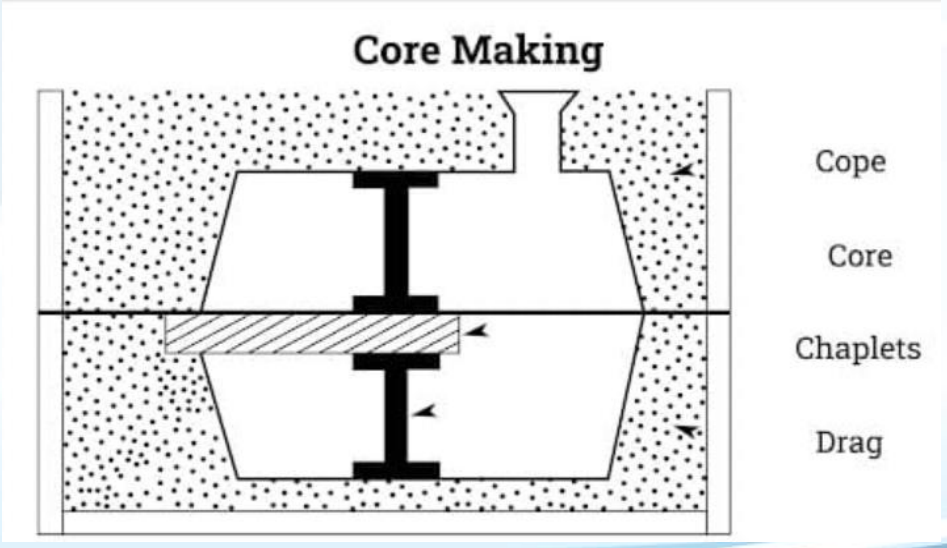
2 – METHOD OF MAKING SAND CASTINGS

- **Pattern Creation Gates and riser(Metal delivery system)**

- Metal channels that will feed the required cast product design with proper gating and risers are also included in the pattern.

- **Core Making**

- Cores are separate portion of the mold that will prevent the liquified material from filling in any gaps. They are utilized to make interior cavities that the mold cant produce.

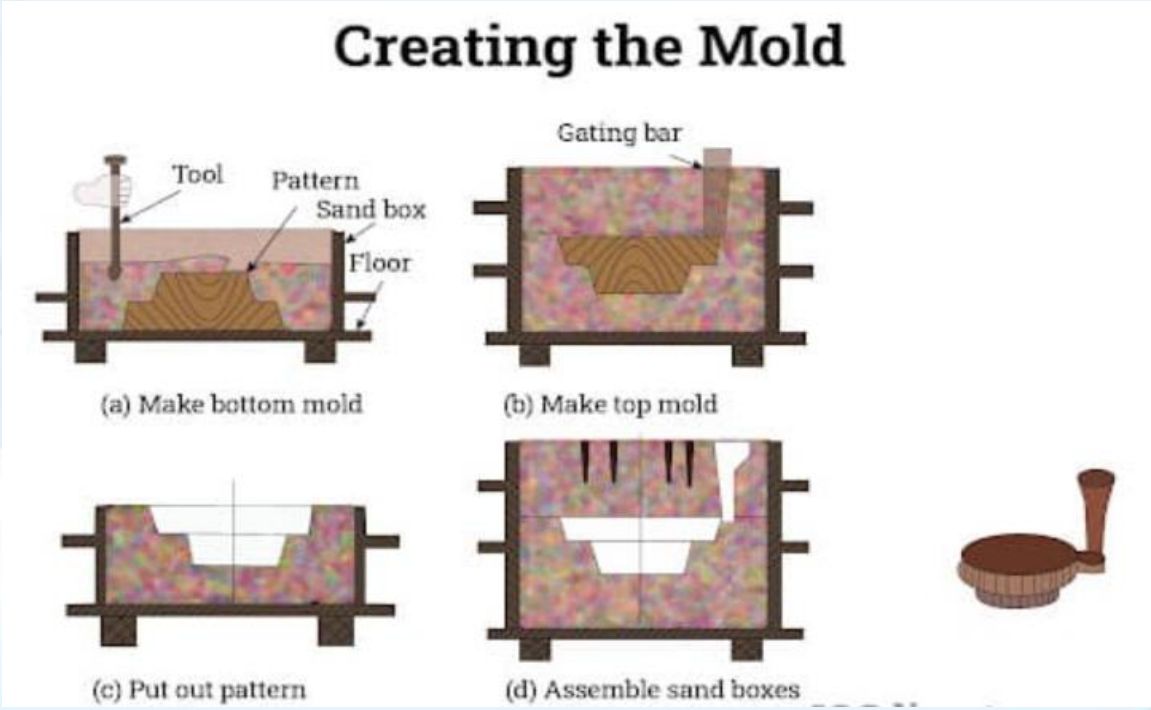


2 – METHOD OF MAKING SAND CASTINGS

- **Mold making**

- Around the design, a refractory substance that is stale at high temperature is created.

- Top half of mold is called Cope and bottom half is called drag.



2 – METHOD OF MAKING SAND CASTINGS

- **Pouring molten metal.**

- Molten metal is injected into mold directly. A continues supply of molten metal comes from riser to the casting.

2 – METHOD OF MAKING SAND CASTINGS

- **Shake out operation.**

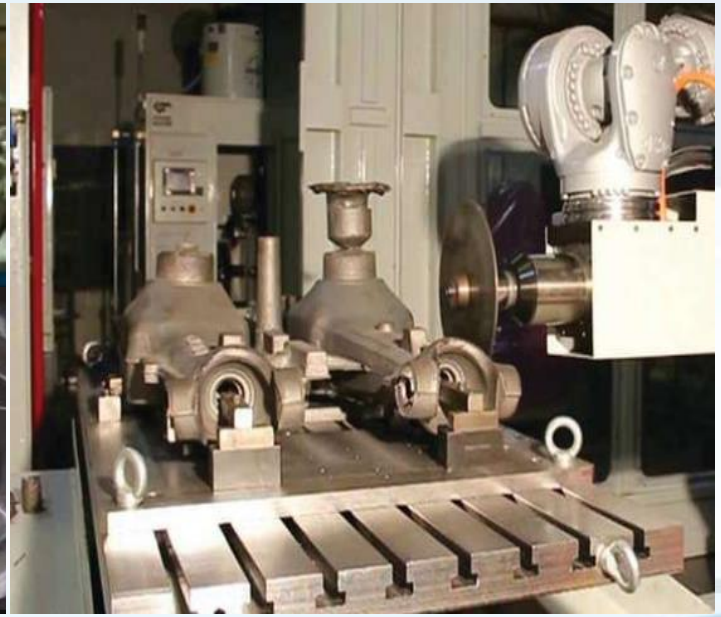
- Casting hardens and cools, containing both the desired item and the additional metal required to manufacture it. In a shake out operation, sand is split up. The sand use to make up the mold is recovered, reconditioned and reused.



2 – METHOD OF MAKING SAND CASTINGS

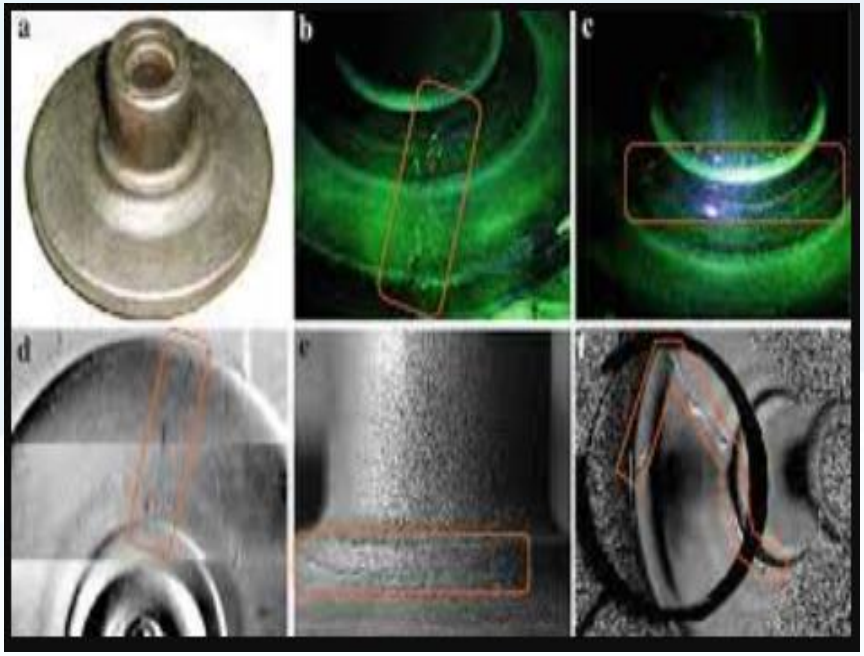
- **Final operations**

- Gate, runners and risers are cut from casting and final post processing such as sand blasting, grinding and other methods are used if necessary to finish the casting dimensionally. To achieve the final tolerance, castings may require extra machining.



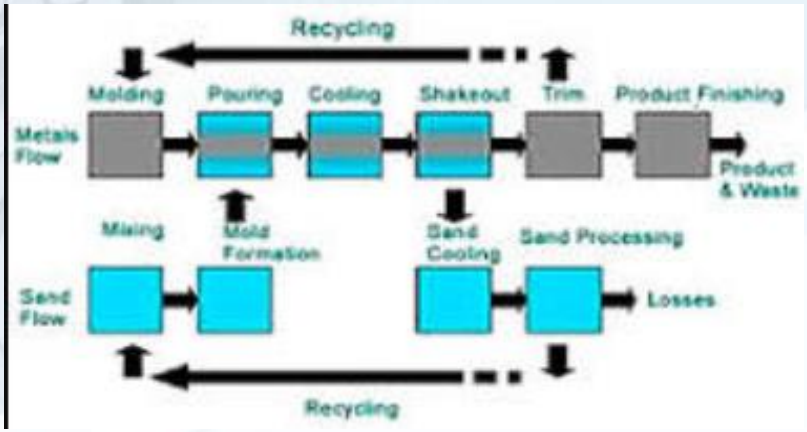
2 – METHOD OF MAKING SAND CASTINGS

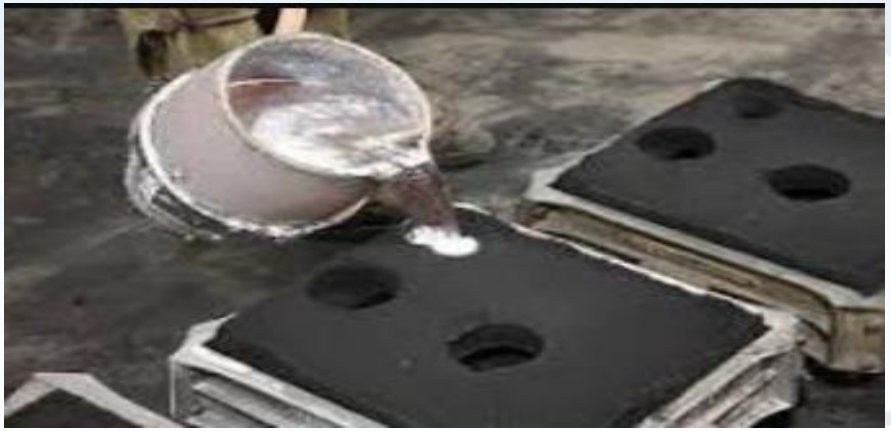
- Heat treatments are performed for extra mechanical properties and NDT methods are used for final inspection.



2 – ALUMINUM SAND CASTINGS

- When molten metal used is Aluminum and molds used is prepared by sand.



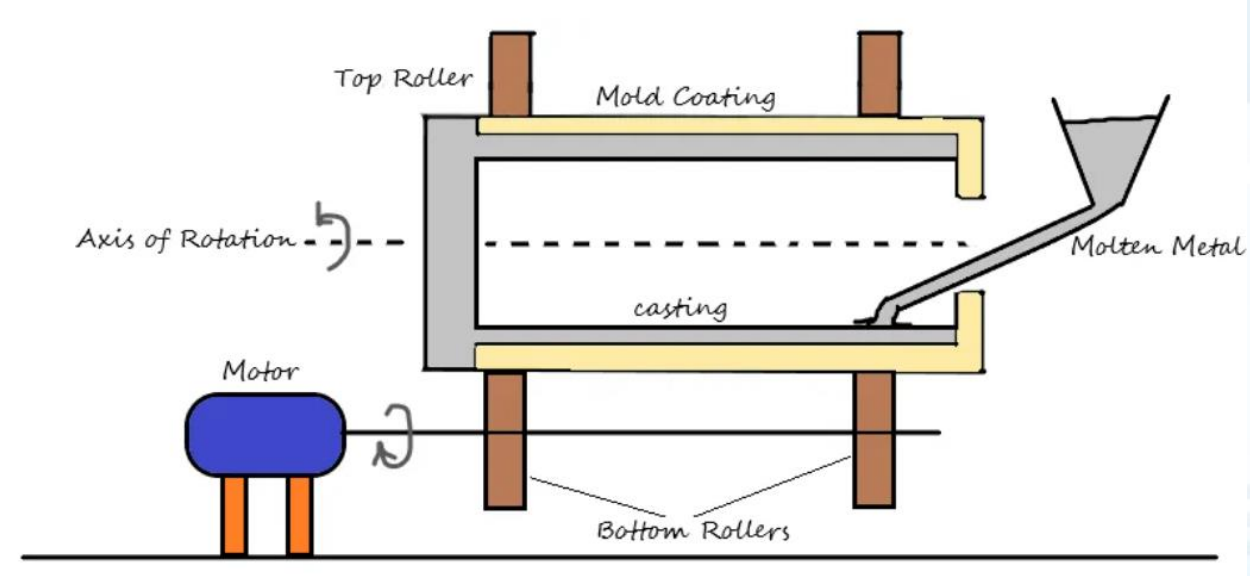


2 CENTRIFUGAL CASTING

In centrifugal castings, molten metal is introduced in mold which is continuously rotated during whole process.

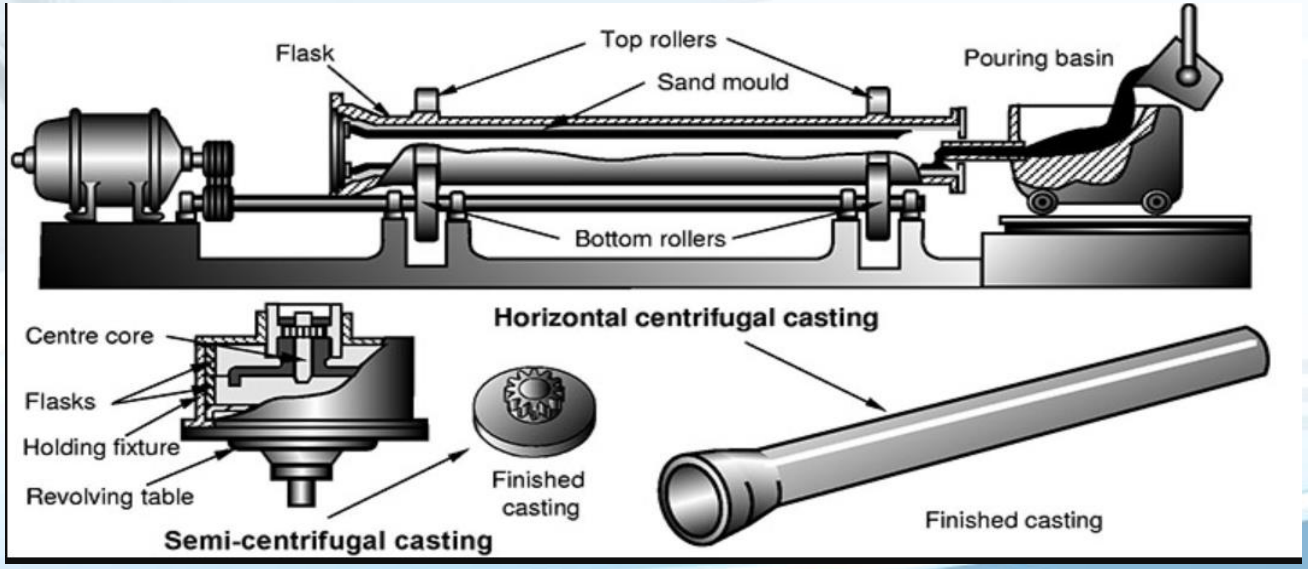
Mold can itself be rotated horizontally or vertically depending upon the design requirements.

Modern centrifugal casting provides high quality end products with strength, high density, good performance and even granular structure at a much lower cost.



2 CENTRIFUGAL CASTINGS

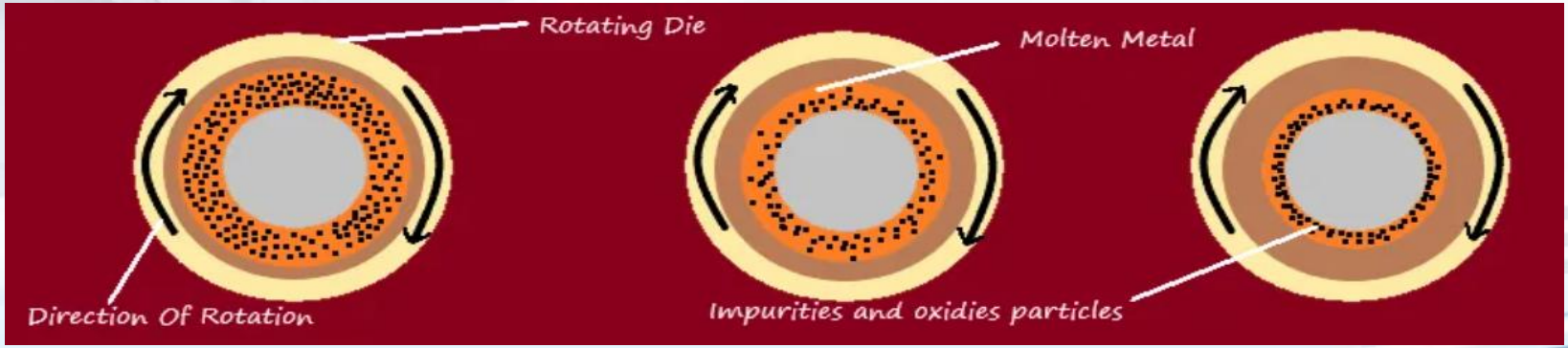
- Molten metal is poured into a spinning mold preheated to a certain temperature.
- Due to rotational motion of mold, a centrifugal force is acted upon the molten metal just poured into the spinning mold. This force displaces the molten metals towards the periphery forcing them to deposit on the walls. Molten metal is spread uniformly on the walls of die.
- The relatively denser element tends to deposit on towards the wall while lighter elements and slug deposit at the center.
- The whole process itself leads to a reduction in defects due to slags, irregular grain structure and trapped air. The final product have closed grain structure with improved elongation, tensile strength and yield strength.



2 CENTRIFUGAL CASTINGS

Advantages

- Whole process of centrifugal castings does not rely on gates or riser.
- Unlike conventional casting where the mold solidifies from both inside and outside; molten metal at the center ensures unidirectional solidification.
- Impurities collected at the center are relatively easier to remove.
- Mass production of symmetrical product was made possible at a much lower cost.
- After the casting process is heavily reduced.



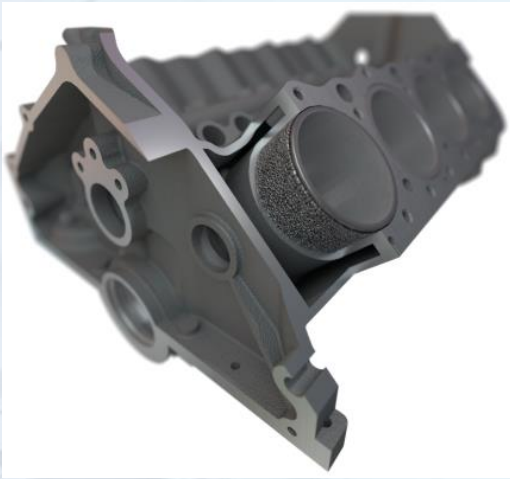
2 CENTRIFUGAL CASTINGS

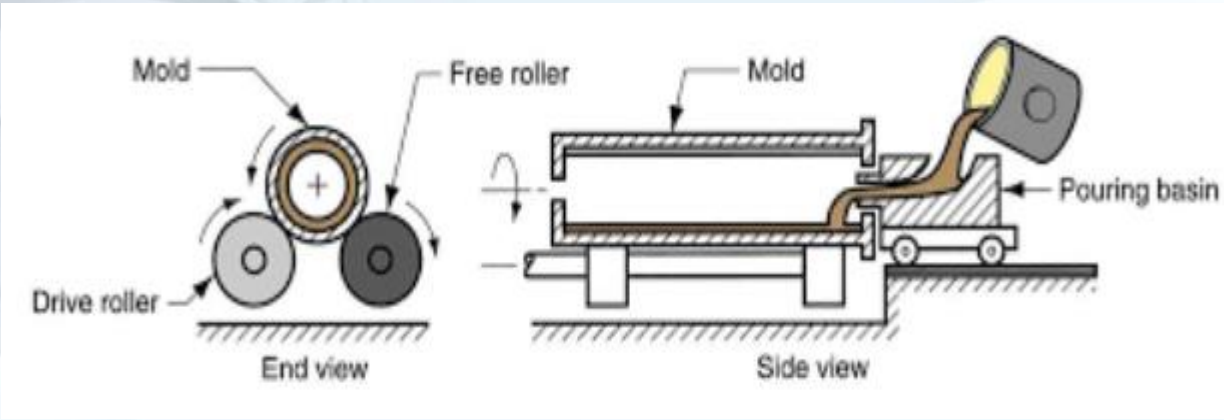
Limitations and disadvantages

- More skilled laborers are required for the implementation of the process.
- Only a few defined shapes can be produced using this process.
- Not all metal and alloys are compatible with this process.
- A high initial investment is required in machinery and tools
- The diameter of the inner surface is incorrect in this casting.

2 CENTRIFUGAL LINERS

Cast iron sleeve in Aluminum block of engine is made of centrifugal castings.





2 INVESTMENT CASTINGS

- What exactly is the investment in “investment” casting?
- The term “invested” historically carries the meaning of “clothed” or “surrounded.”
- Investment casting employs a shell made of ceramic, plaster, or plastic that is formed around a wax pattern.
- The wax pattern is melted and removed in a furnace and metal is poured into the shell to create the casting.
- Investment casting, also known as precision casting or lost-wax casting, is a manufacturing process in which a wax pattern is used to shape a disposable ceramic mold.

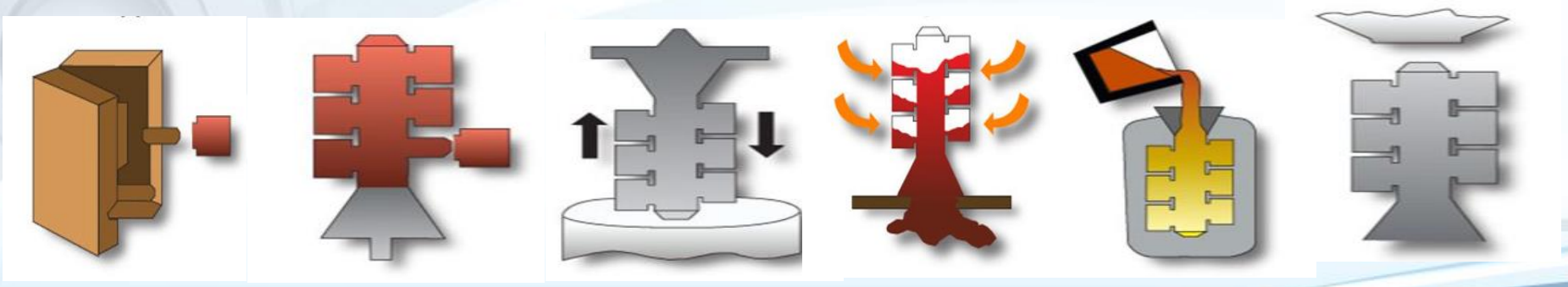
2 INVESTMENT CASTINGS

- A wax pattern is made in the exact shape of the item to be cast. This pattern is coated with a refractory ceramic material
- Once the ceramic material is hardened, it is turned upside-down and heated until the wax melts and drains out.
- The hardened ceramic shell becomes an expendable investment mold. Molten metal is poured into the mold and is left to cool.

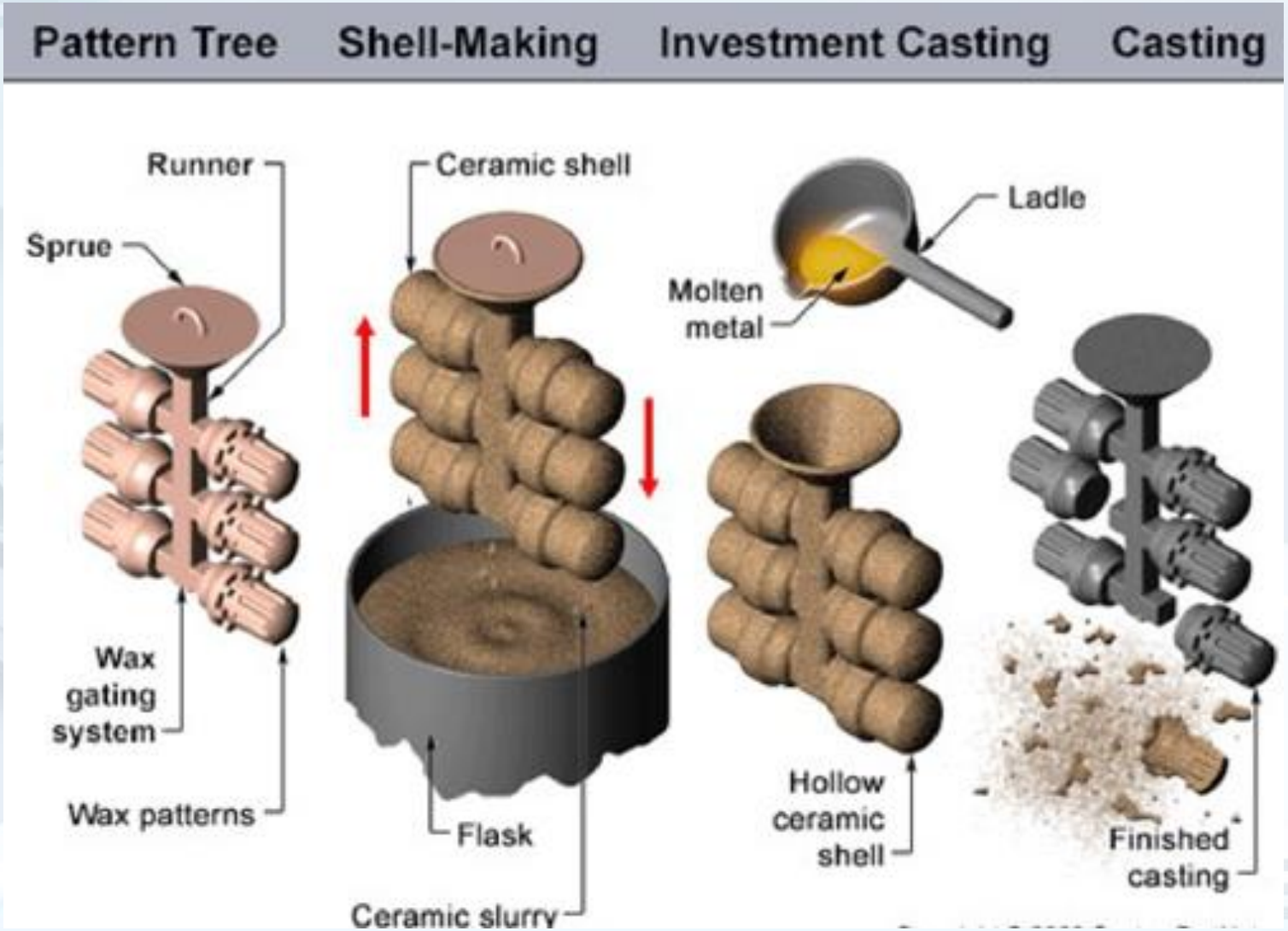
- The metal casting is then broken from of the spent mold.

Basic steps in Investment casting.

- Creating the pattern
- Mounting the wax patterns and creating the tree
- Creating the mold shell
- Wax removal
- Melt and cast
- Final operations



2 INVESTMENT CASTING



2 CENTRIFUGAL CASTINGS

Advantages

- Size range is large, investment castings can be made weighing up to 400 Kg.
- Versatile in making intricate shapes.
- Capable of producing dimensionally accurate and smooth surface.

2 INVESTMENT CASTINGS

Limitations and disadvantages

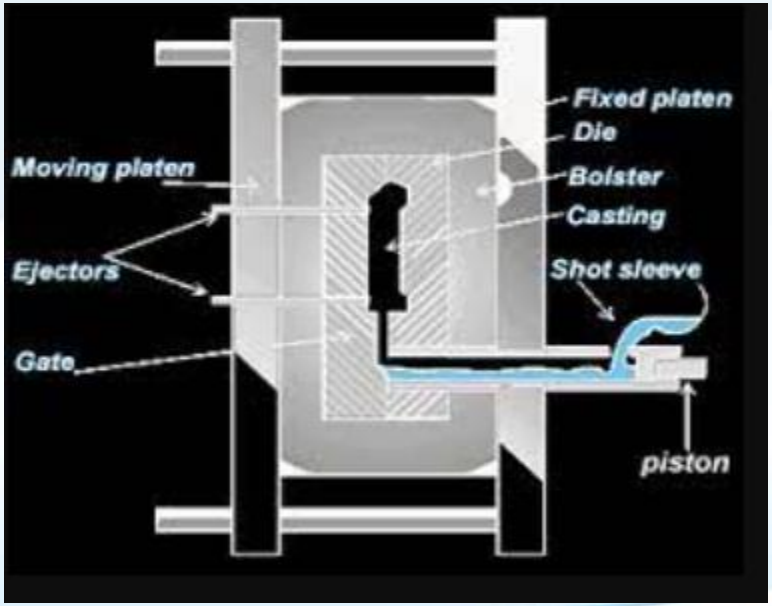
- More tooling cost.
- Multiple steps is time consuming.
- Labor intensive.
- Difficult to cast cores.
- Expensive

2 ALUMINUM HIGH PRESSURE DIE CAST

- The die has a stationary and moving halves both of which are mounted on die casting machines.

- Die casting machine has an injection end that uses hydraulics and pressurized gas to move a piston forward injecting the molten metal into closed steel die.

- Die Casting machine also has a clamping end that utilizes hydraulics and mechanical toggles to absorb the injection pressure and hold the die shut while the part solidifies.

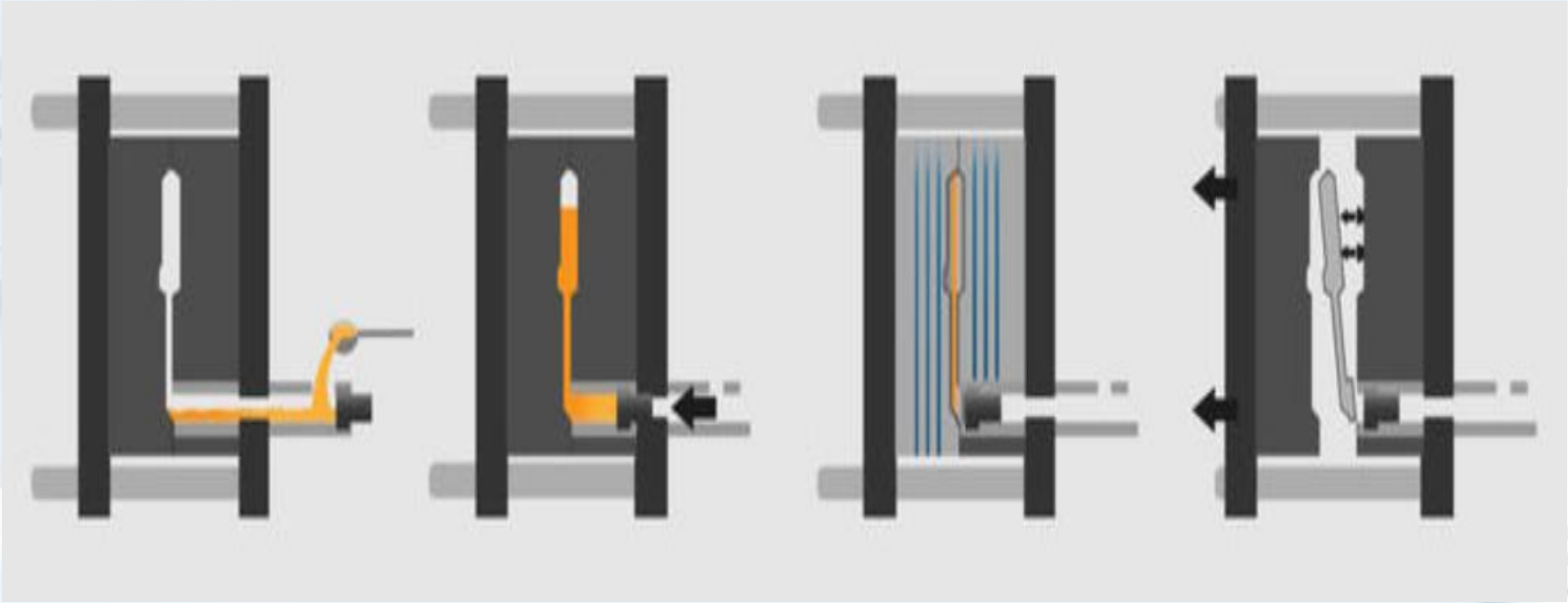


2 ALUMINUM HIGH PRESSURE DIE CAST

HDPC forces molten metal at high speed and high pressure into a closed steel die cavity.

It is extremely efficient method for producing various product forms.

Process is capable of turning molten metal into near net shape part in seconds.



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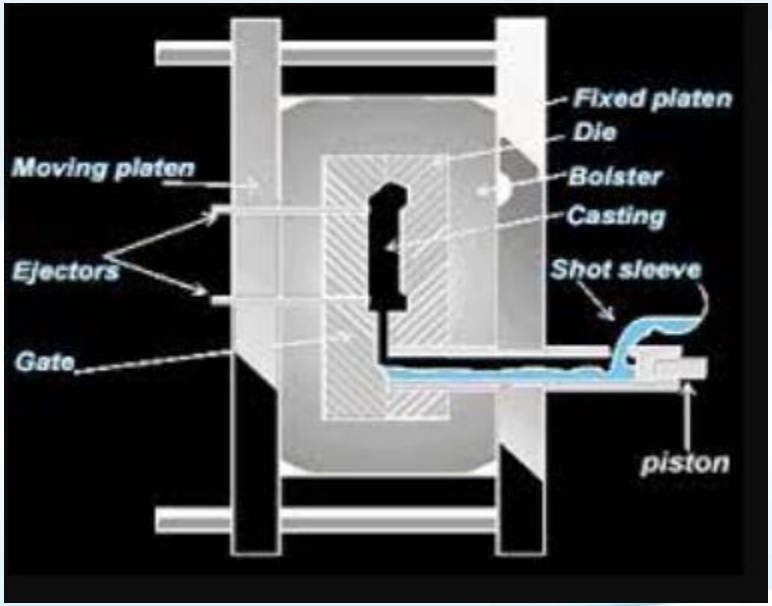


2 ALUMINUM HIGH PRESSURE DIE CAST

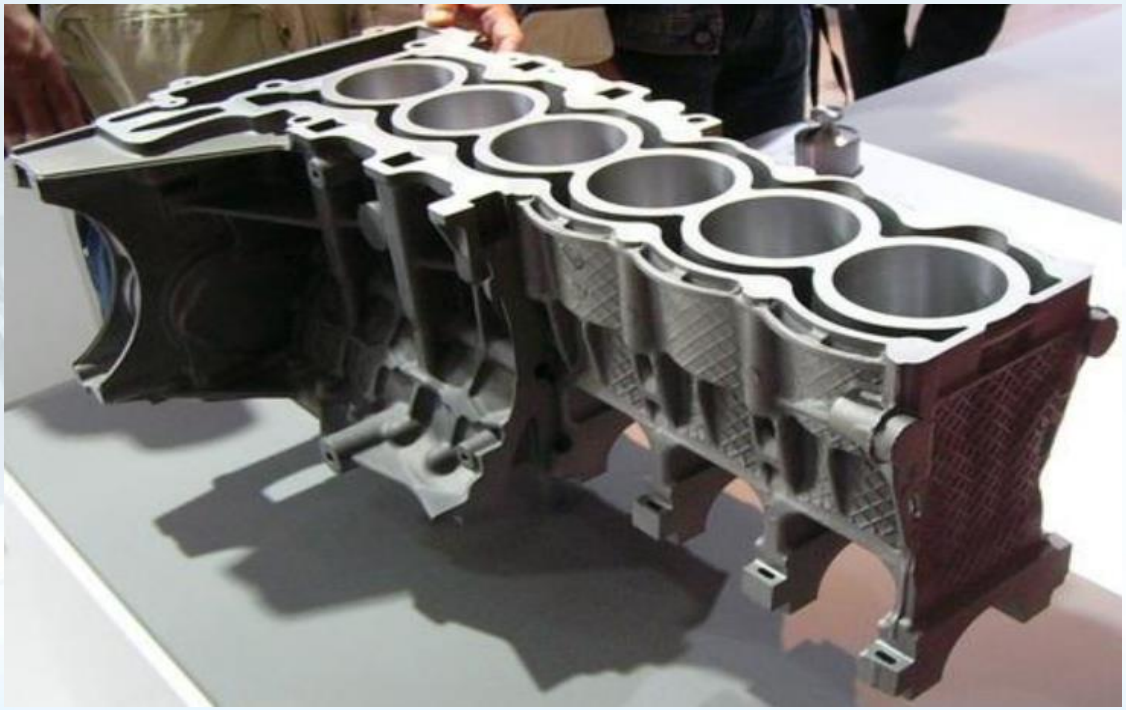
Advantages

- Large light alloy parts can be manufactured in high volume with great speed efficiency.
- Parts are manufactured with superior surface finish, excellent dimensional accuracy and smooth surfaces.
- Create complex and intricate shape in single piece and eliminates need of welding, assembly and joints.

2 ALUMINUM HIGH PRESSURE DIE CAST

Limitations and disadvantages

- High capital cost.
- Process is limited to high fluidity cost.
- Main disadvantage is porosity due to which heat treatment is not possible which could then expands the micropores and converts them into micro cracks.



2 MAGNESIUM HIGH PRESSURE DIE CAST

Magnesium is the light weight champion in die casting assembly.

Magnesium has excellent fluidity and less susceptible to hydrogen porosity.

It has better castability then aluminum.

2 MAGNESIUM HIGH PRESSURE DIE CAST

Advantages

- Excellent strength to weight ratio.
- Longer tool life.
- Easiest alloy to machine.
- Good thermal and electrical conductivity.
- Excellent for thin walled and complex part.
- Excellent noise and vibration dampening property.

2 MAGNESIUM HIGH PRESSURE DIE CAST

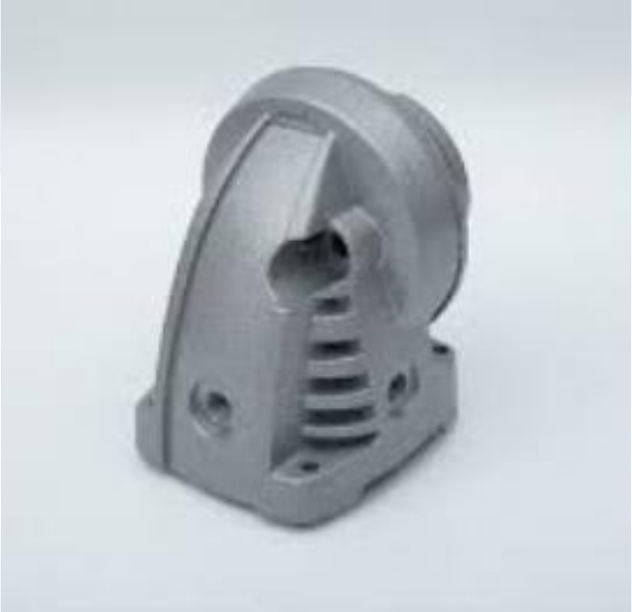
Limitations and disadvantages

- High capital cost.
- Process is limited to high fluidity material.
- More prone to defects like porosity, misrun and blister.
- Usually not heat treatable.
- Difficult to produce large metal parts.

2 ZINC HIGH PRESSURE DIE CAST

Advantages

- Higher strength than Aluminum casted counterparts.
- Higher production rates than Aluminum and Magnesium Castings.
- Can be casted to closer tolerances (net shaped or zero machining) than Aluminum and Magnesium.
- Higher impact properties than Aluminum and Magnesium.
- Lower pressure and temperatures are required as compared to Aluminum and Magnesium.



CHAPTER 3 : DEFECTS

3-DEFECTS

Cracks

Possible causes-

- Shrinkage of casting within die.
- Under cut or damage within die cavity.
- Thermal imbalance in die.
- Uneven or excessive ejection forces.
- Excessive porosity in critical region.

Possible remedies-

- Reduce pouring temperature.
- Avoid superheating of metal.
- Use Chills.
- Avoid early knockout, give sufficient cooling time.

3-DEFECTS

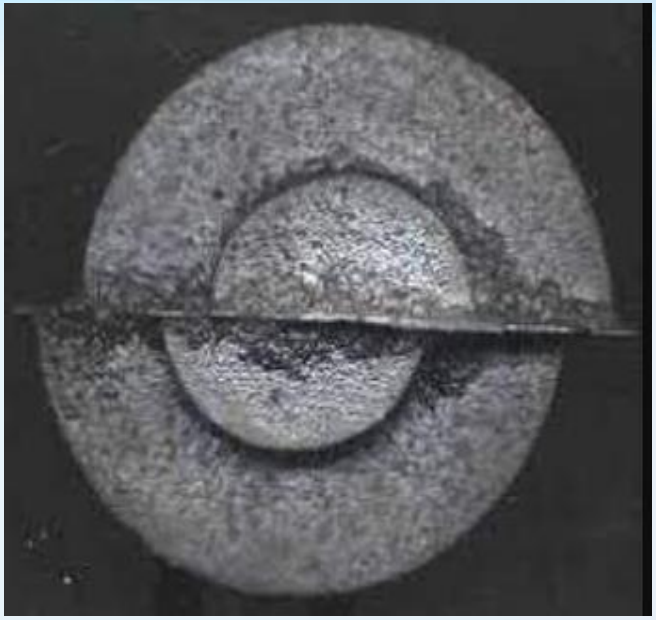
Mismatch- The defect caused due to misalignment of upper and lower part of the casting and misplacement of the core at parting line.

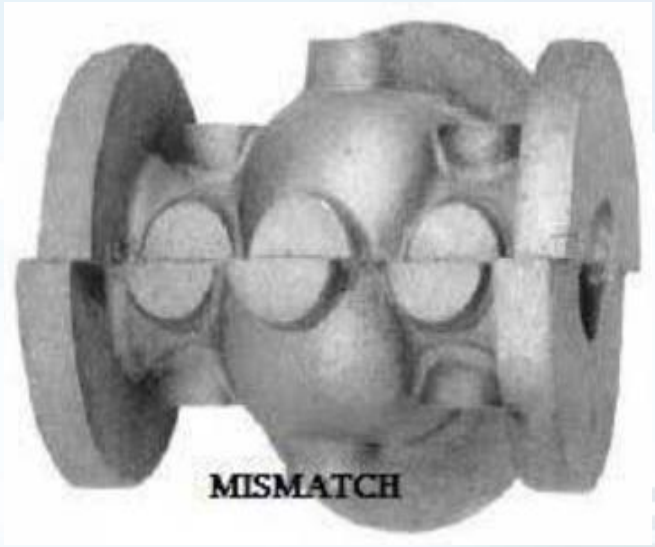
Possible causes-

- Improper alignment of upper and lower part during mold preparation.
- Misalignment of flask

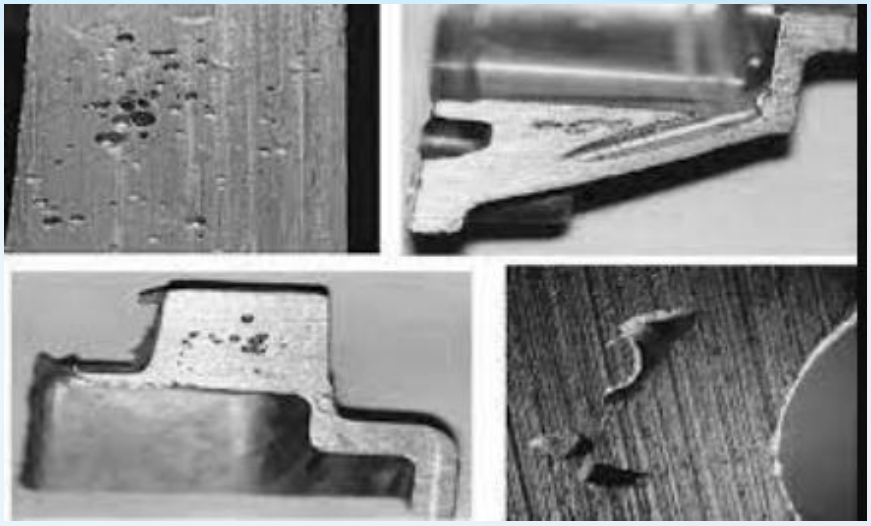
Possible remedies-

- Use of proper molding box and closing pins.





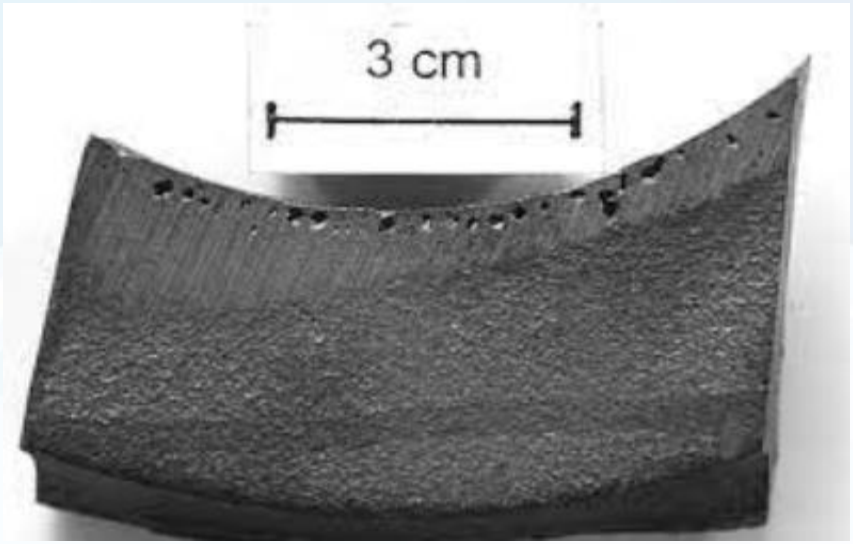
3-DEFECTS



Gas Porosity- Porosity describes the presence of voids inside casting of different size, shapes, surface constituents

Possible causes-

- Speed of metal pouring is too slow .
- Presence of gas in metal.
- Presence of moisture in flux.
- Metal section is too thin.



Possible remedies-

- Improve metal composition to improve fluidity.
- Pour metal as rapidly as possible**.**
- Melt the metal in vacuum.
- Keep the temperature of mold low.
- Use adequate venting of molds.
- Improve the gating system. Improve runner design.
- Increase the metal pouring temperature.

3-DEFECTS

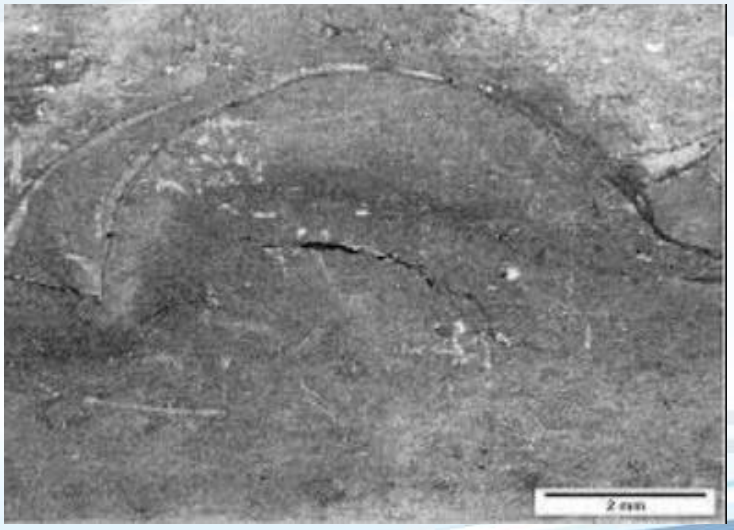
Cold Shut- Two metal streams do not fuse together due to lack of fluidity in molten metal.

Possible causes-

- Faulty design.
- Faulty Gating.

Possible remedies-

- Adjust proper pouring temperature.
- Modify design.
- Modify gating system.

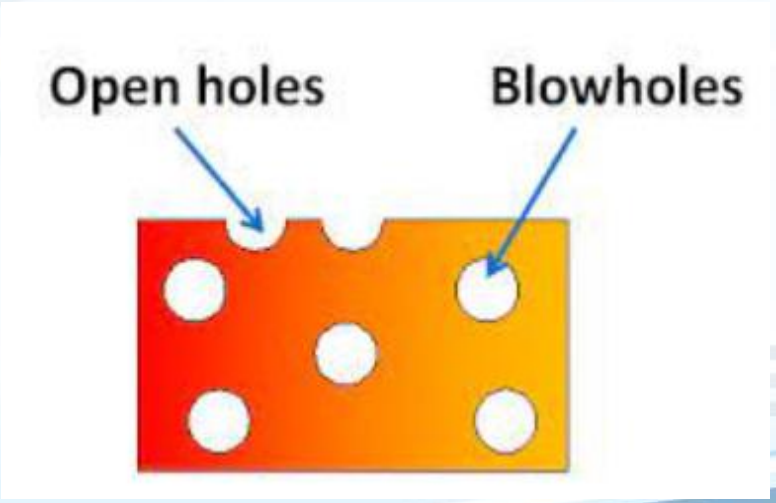


3-DEFECTS

Blow holes-When gases entrapped on the surface of the casting due to solidifying metal, a rounded or oval cavity is formed called as blowholes. These defects are typically present in the cope part of the mold.

Possible causes-

- Excessive moisture in the sand.
- Low Permeability of the sand.
- Sand grains are too fine.
- Too hard rammed sand.
- Insufficient venting is provided.



Possible remedies-

- Reduce quantity of binder.
- Improve core venting.
- Reduce moisture content.
- Sufficient ramming

3-DEFECTS

Shrinkage- The formation of cavity in the casting due to volumetric contraction is called as shrinkage cavity

Possible causes-

- Unavailability of feed metals as the metals solidify.

Possible remedies-

- Liquid metal under pressure should continuously flow.

CHAPTER 4 : TESTINGS

3 – Testing involved in Castings.

- Tensile strength per ASTM E 8 or ASTM A 48.
- Hardness Per ASTM E 10.
- Microstructural studies of graphite per ASTM A 247 .
- Chill testing for cast iron per ASTM A 367.
- Radiographic examinations for metallic castings per ASTM E 1030.

THANK YOU

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Are there any Questions?