Properties of Moulding materials

1) Refractoriness - It is the ability of the moulding material to withstand the high temperatures of the molten
metal so that it does not cause fusion.

2) Green Strength **-** The moulding sand that contains moisture is termed as green sand. The green sand should have enough strength so that the constructed mould retains its shape.

3) Dry Strength - When the moisture in the moulding sand is completely expelled, it is called dry sand. When molten metal is poured into a mould, the sand around the mould cavity is quickly converted into dry sand as the moisture in the sand immediately evaporates due to the heat in the molten metal. At this stage, it should retain the mould cavity and at the same time withstand the metallostatic forces.

4) Permeability **-** During the solidification of a casting, large amounts of gases are to be expelled from the mould. The gases are those which have been absorbed by the metal in the furnace, air absorbed from the atmosphere, steam and other gases that are generated by the moulding and core sands. If these gases are not allowed to escape from the mould, they would be trapped inside the casting causing defects. The moulding sand should be sufficiently porous so that the gases are allowed to escape from the mould. **This gas**

Properties of Moulding materials

5) Cohesiveness - Cohesiveness is known as the strength of the moulding sand. Cohesiveness is that property of the moulding sand which enables the sand particles to stick together. Following factors may affect the strength or cohesiveness of the moulding sand.

- Shape and size of the grain
- Bonding material and its distribution
- Moisture

For the production of sand casting, the moulding sand must have adequate strength to retain shape when molten material is poured into the mould

6) Adhesiveness - Adhesiveness can be defined as the property of moulding sand, which enables the sand particles to stick with other objects such as moulding box. This property plays an important role in keeping the sand mass together in the moulding box and does not allow it to fall when turned upside down. It should also be ensured that the sand should not stick to the casting and strip off easily, leaving a clean surface.

Properties of Moulding materials

7) Flowability - Flowability is the property of moulding sand to properly pack the moulding box all around the pattern. Good flowability ensures the moulding sand to flow all over the pattern when the mould is rammed.

***8) Collapsibility* -** The molten material in the mould needs sufficient time to get solidified. Once it is solidified, the mould must be collapsible enough so that free contraction of casting can occur. Collapsibility is that property of the moulding sand, which will permit easy break down of the sand mass and its subsequent use after the casting has been taken out of the mould. Collapsibility can be improved by cereals, or by other organic bonding agents, which “burn out” when it comes in contact with high temperature of the molten material in the mould.

Melting and Pouring

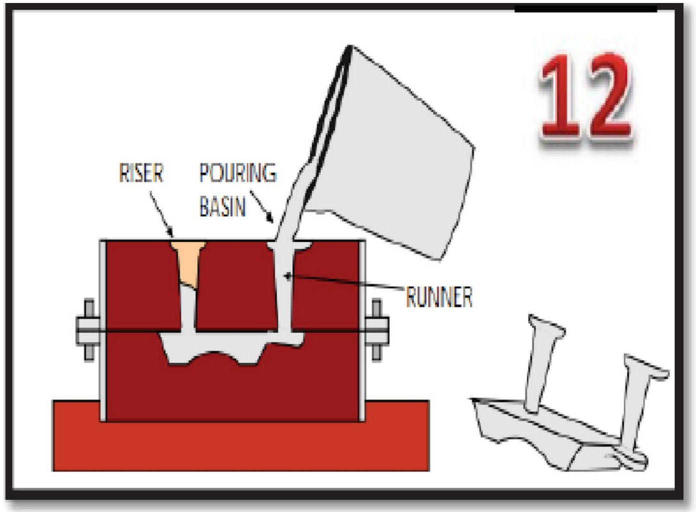
- Molten metal is transferred from the furnace to a ladle and cleaned and held until it reaches the desired pouring temperature. The molten metal is poured into the mould and allowed to solidify.

Cooling and Shakeout

- Once the metal has been poured, the mould is cooled. Castings may be removed manually or using vibratory tables that shake the refractory material away from the casting.

Fettling, Cleaning and Finishing

- Gating system is removed, often using band saws, abrasive cut-off wheels or electrical cut-off devices. A 'parting line flash' is removed by grinding or with chipping hammers.



Casting Defects

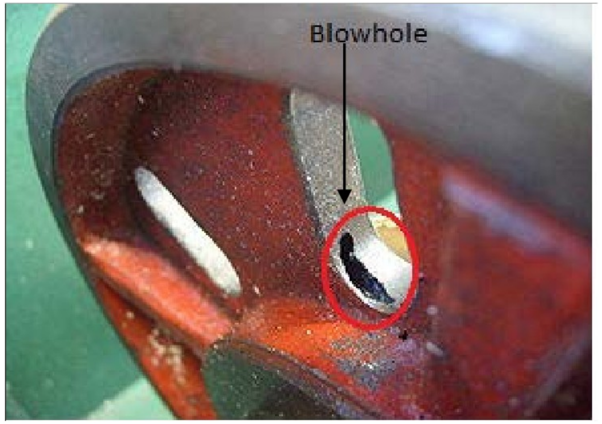
- Any irregularity in the moulding process causes defects in castings which may sometimes be tolerated, sometimes eliminated with proper moulding practice or repaired using methods such as welding and metallisation.

- The following are the major defects which are likely to occur in sand castings:
  (i) Gas defects
  (ii) Shrinkage cavities
  (iii) Moulding material defects
  (iv) Pouring metal defects
  (v) Metallurgical defects

Casting Defects

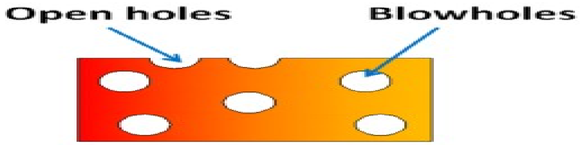
Gas defects

- ***Blow holes and open blows*** - These are the spherical, flattened or elongated cavities present inside the casting or on the surface.



- On the surface they are called ***open blows*** and inside, they are called ***blow holes***. These are caused by the moisture left in the mould and the core.

- Because of the heat in the molten metal, the moisture is converted into steam, part of which when entrapped in the casting ends up as blow hole or ends up as open blow when it reaches the surface.

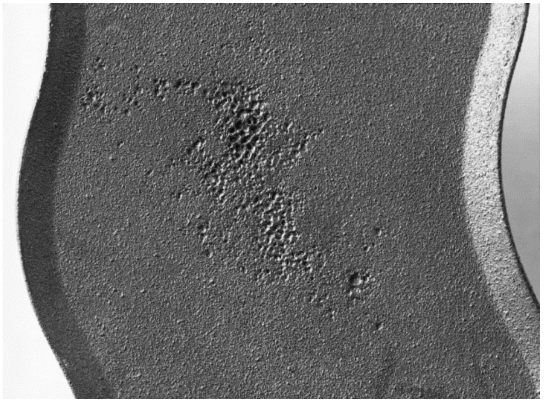


- The main reason for this is the **low permeability** of the sand mould. Low permeability is caused by the use of too fine sand grains, higher amount of binder or over ramming of the mould. This can also be caused by insufficient venting practice.

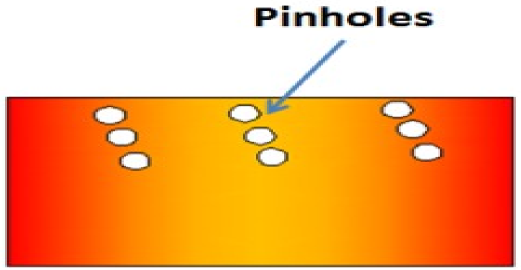
Casting Defects

Gas defects

- ***Pin hole porosity*** **-** This is caused by hydrogen in the molten metal. This could have been picked up in the furnace or by the dissociation of water inside the mould cavity.



- As the molten metal gets solidified, it loses the temperature which decreases the solubility of gases and there by expelling the dissolved gases. The hydrogen while leaving the solidifying metal would cause **very small diameter** and long pin holes showing the path of escape.

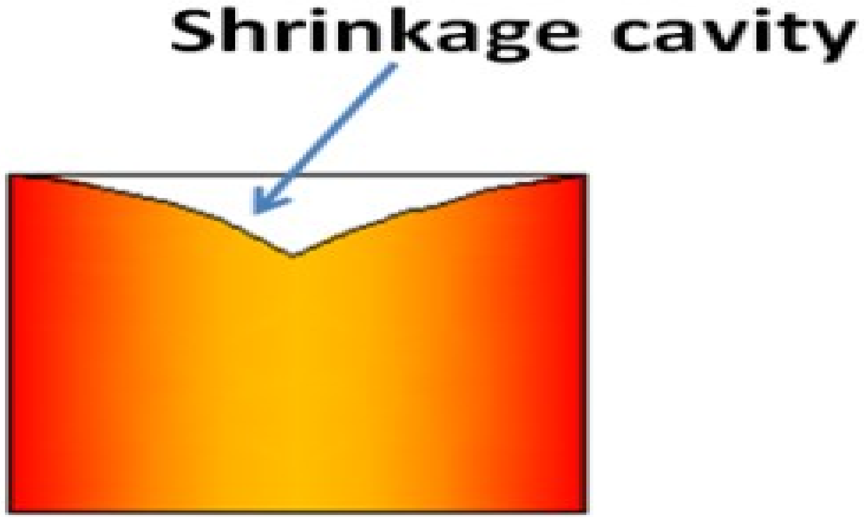


- The main reason for this is the high pouring temperature which increases the gas pick up. This is particularly severe in aluminium alloys or steels and irons having aluminium.

Casting Defects

Shrinkage cavities

- These are caused by the liquid shrinkage occurring during the solidification of the casting. To compensate this, proper feeding of liquid metal is required as also proper casting design.



Casting Defects

Moulding material defects

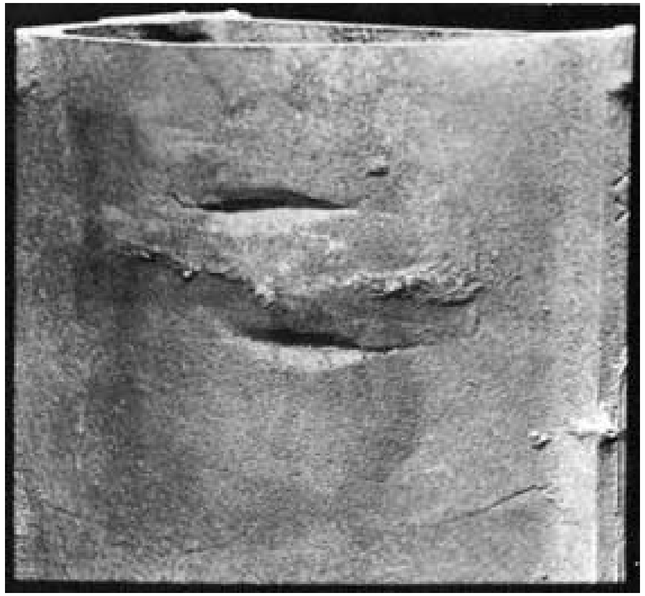
- ***Metal penetration*** **-** When the molten metal enters the gaps between the sand grains, the result would be a rough casting surface. The main reason for this is that, either the grain size of the sand is too coarse or no mould wash has been applied to the mould cavity.

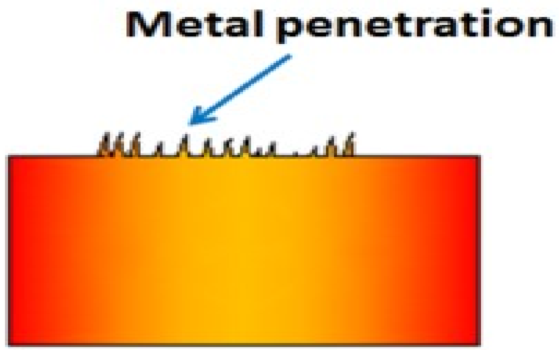
- ***Swell*** - Under the influence of the metallostatic forces, the mould wall may move back causing a swell in the dimensions of the casting. The main cause of this is the faulty mould making procedure adopted.

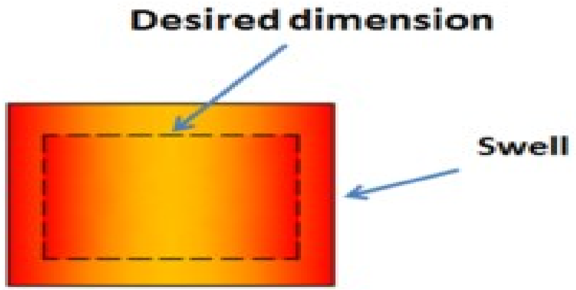
- ***Drop*** **-** The dropping of loose moulding sand or lumps normally from the cope surface into the mould cavity is responsible for this defect. This is essentially due to improper ramming of the cope flask.

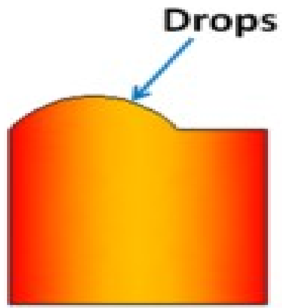
Casting Defects

Moulding material defects









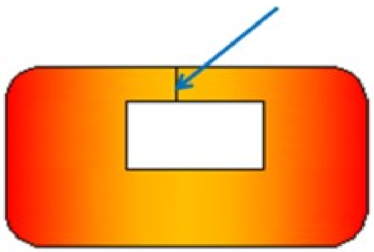
Casting Defects

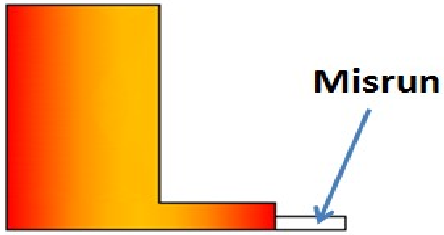
Pouring metal defects

- ***Mis runs and cold shuts*** - Mis run is caused when the metal is unable to fill the mould cavity completely and thus leaving unfilled cavities.
- A cold shut is caused when two metal streams, while meeting in the mould cavity, do not fuse together properly thus causing a discontinuity or weak spot in the casting
- These defects are caused essentially by the lower fluidity of the molten metal or that the section thickness of the casting is too small. The latter can be rectified by proper casting design.
- The remedy available is to increase the fluidity of the metal by changing the composition or raising the pouring temperature.

Casting Defects

Pouring metal defects

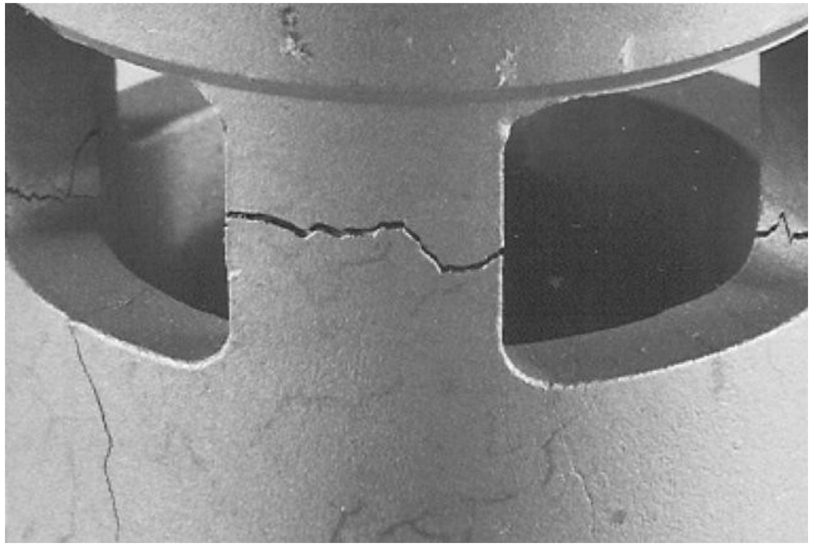


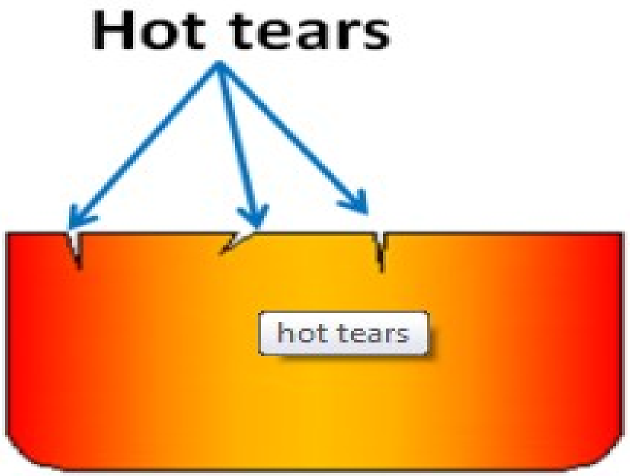


Casting Defects

Metallurgical defects

- ***Hot tears*** **-** Since metal has low strength at higher temperatures, any unwanted cooling stress may cause the rupture of the casting. The main cause for this is the poor casting design.





Advantages of Sand Casting

- Molten material flows into any small section in the mould cavity and as such any intricate shapes, internal or external, can be made with the casting process.

- It is possible to cast practically any material, be it ferrous or non–ferrous.

- The necessary tools required for casting moulds are very simple and inexpensive. As a result, for trial production or production of a small lot, it is an ideal method.

- It is possible in casting process to place the amount of material where exactly required. As a result, weight reduction in design can be achieved.

- Castings are generally cooled uniformly from all sides and therefore they are expected to have no directional properties.

- Casting of any size and weight, even up to 200 tons, can be made.

Limitations of Sand Casting

- The dimensional accuracy and surface finish achieved by normal sand casting process would not be adequate for final application in many cases.

- The sand casting process is labour intensive to some extent and therefore many improvements are aimed at it like machine moulding and foundry mechanisation.

- With some materials it is often difficult to remove defects arising out of the moisture present in sand castings.

Applications of Sand Casting

Cylinder blocks

Liners

Machine tool beds

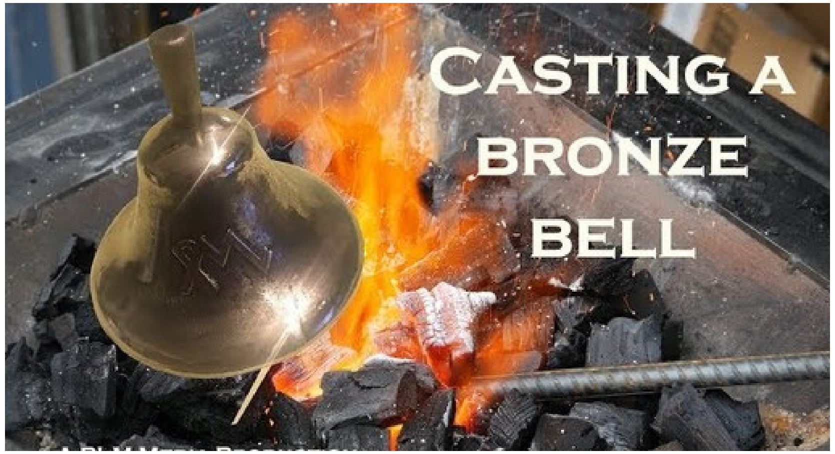
Pistons and piston rings

Mill rolls

Wheels

Housings

Bells.



Special Casting Processes

- Sand casting processes described so far are not suitable and economical in many applications. In such situations special casting processes would be more appropriate.

- The following two special casting processes are discussed in the following sections –

1) Precision Investment Casting

2) Centrifugal Casting

Special Casting Processes

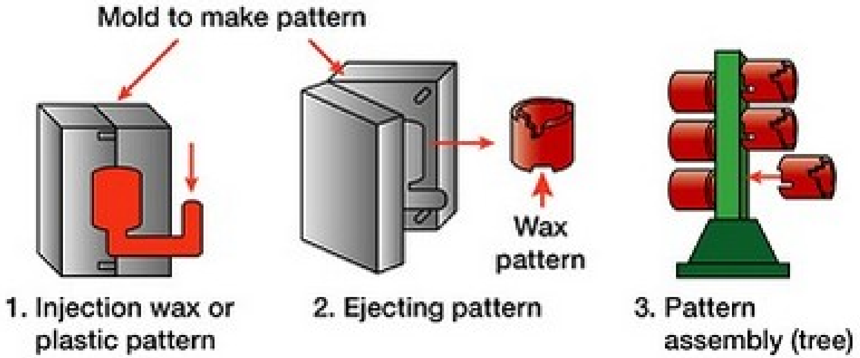
Precision Investment Casting

- This is the process where the mould is prepared around an expendable pattern.

- The first step in this process is the preparation of the pattern for every casting to be made. To do this, molten wax which is used as the pattern material is injected under pressure of about 2.5 MPa into a metallic die and has the cavity of the casting to be made as shown in Step 1.

- The wax when allowed to solidify would produce the pattern. The pattern is ejected from the die as shown in step 2.

- Then the cluster of wax patterns is attached to the gating system by applying heat as shown in step 3.



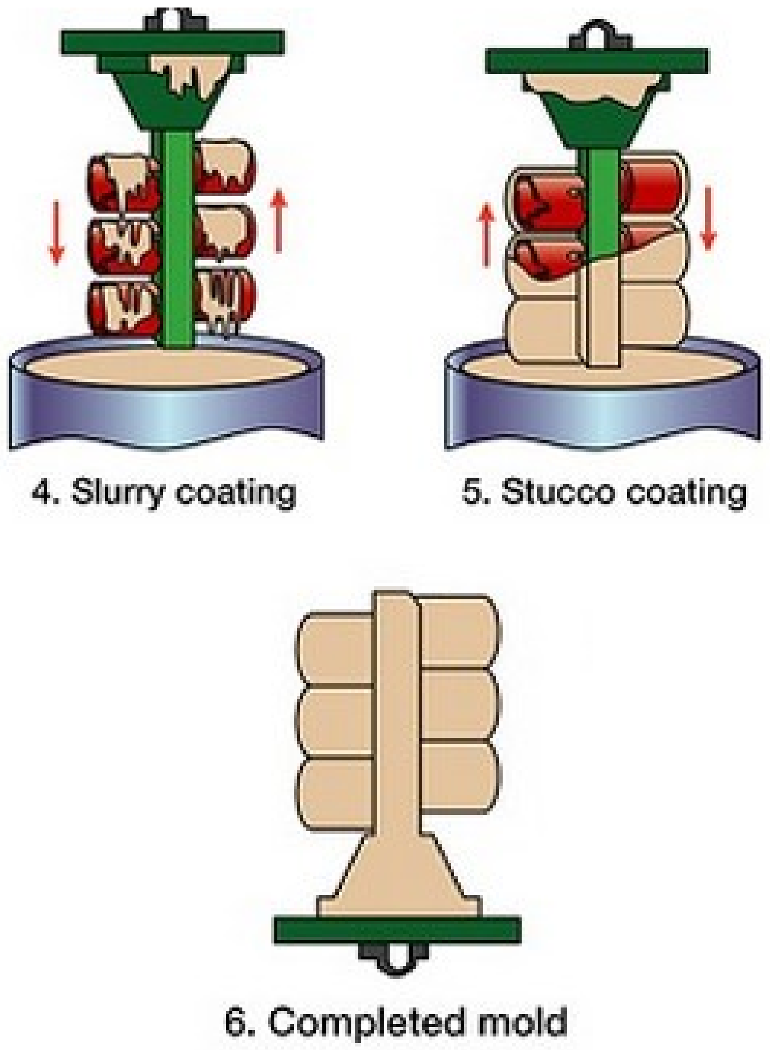
Special Casting Processes

Precision Investment Casting

- To make the mould, the prepared pattern is dipped into a slurry made by suspending fine ceramic materials in a liquid such as ethyl silicate or sodium silicate (step 4). The excess liquid is allowed to drain off from the pattern.

- Dry refractory grains such as fused silica or zircon are "stuccoed" on this liquid ceramic coating (step 5). Thus a small shell is formed around the wax pattern.

- The shell is cured and then the process of dipping and stuccoing is continued with ceramic slurries of gradually increasing grain sizes. Finally when a shell thickness of 6 to 15 mm is reached, the mould is ready for further processing.



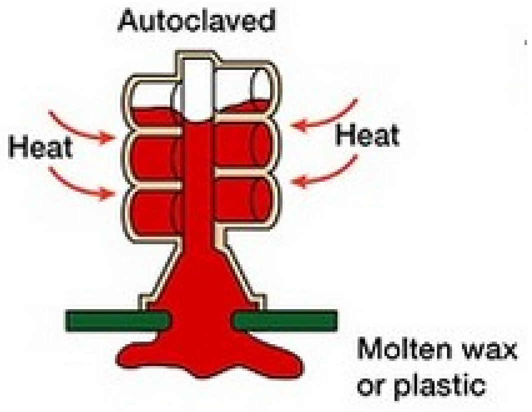
Special Casting Processes

Precision Investment Casting

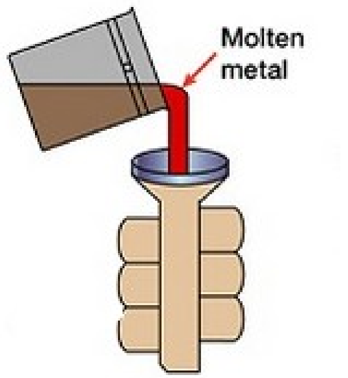
- The next step in the process is to remove the pattern from the mould which is done by heating the mould to melt the pattern (step 6). The melted wax is completely drained through the sprue by inverting the mould.

- The moulds are then pre heated to a temperature of 100 to 1000°C, depending on the size, complexity and the metal of the casting. This is done to reduce any last traces of wax left off and permit proper filling of all mould sections which are too thin to be filled in a cold mould.

- The molten metal is poured into the mould under gravity and under slight pressure, by evacuating the mould first (step 7). The method chosen depends on the type of casting.



7. Pattern meltout



8. Pouring

Special Casting Processes

Precision Investment Casting

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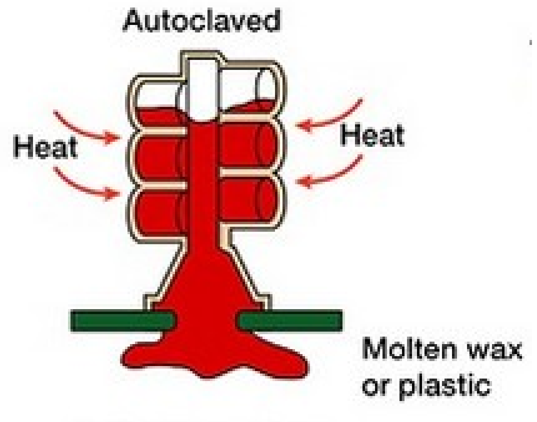

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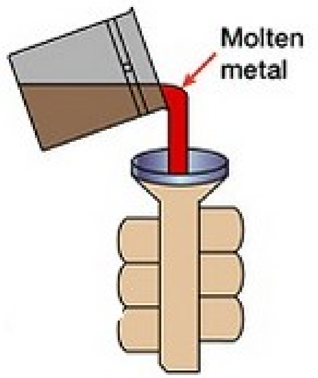
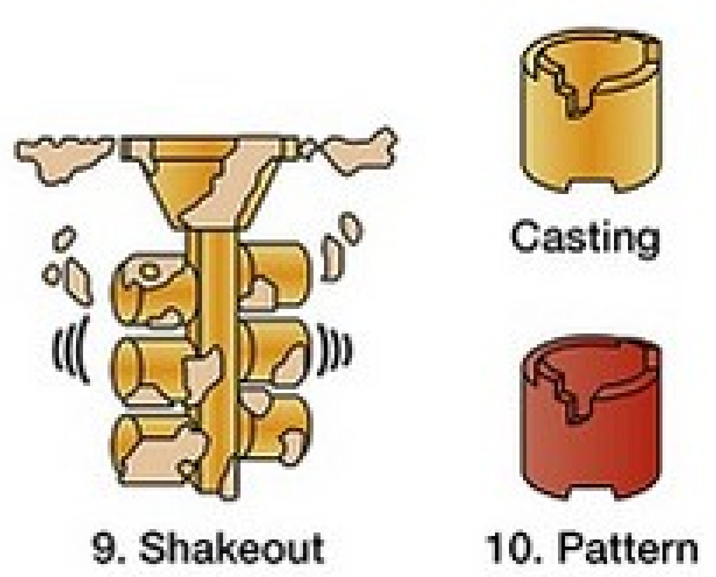


8. Pouring

Special Casting Processes

Precision Investment Casting

- Finally the molten metal is cooled and solidified. Then the moulds are subjected to shakeout using vibratory tables to remove the casting.



Special Casting Processes

Precision Investment Casting

Applications –

- This process was used in the olden days for the preparation of artefacts, jewellery and surgical instruments.

- Presently the products made by this process are vanes and blades for gas turbines, shuttle eyes for weaving, pawls and claws for movie cameras, wave guides for radars, bolts and triggers for fire arms, stain less steel valve bodies and impellers for turbo chargers.