CASTING

Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting

Casting can enable a complex part to be made in one piece often eliminating machining, assembly and fabrication steps.

Steps in the casting process: pattern making, molding, melting and pouring, and inspection

Mainly there are 3 Different Types of Casting processes. They are Die casting, Investment casting, and Sand casting. Each of them provides its own unique fabrication benefits

There are four commonly used alloys for die casting, viz., aluminum-, copper-, magnesium- and zinc-based alloys, despite of the fact that some other ferrous alloys can also be also used for die casting.

Different Types of Casting Process

Sand Casting Process.

Gravity Die Casting.

Pressure Die Casting.

Investment Casting.

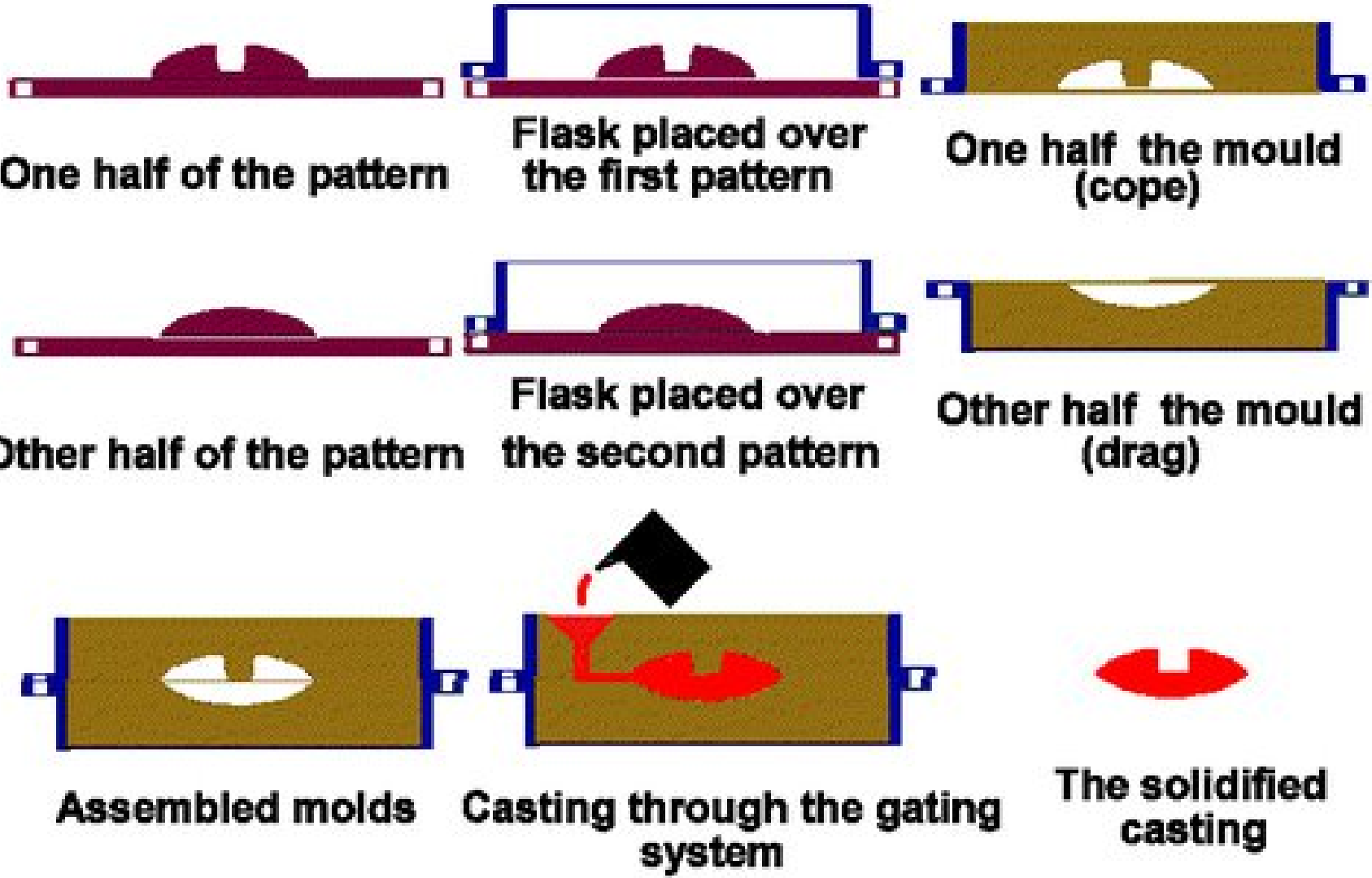
Centrifugal Casting.

Vacuum Casting.

There are three types of sand used in casting, **green sand, water glass or sodium silicate, and resin sand**. Over 70% of the world's metal castings are produced via the sand-casting process. Sand casting is highly efficient and cost-effective

STEPS INVOLVED IN MAKING CASTING

- Make Pattern out of wood, Metal or Plastic.
- In case of Sand Casting, select, test and prepare the necessary sand mixtures for mould and core making.
- With the help of patterns prepare the mould and necessary cores.
- Melt the metal/Alloy to be cast.
- Pour the molten metal/Alloy into the mould and remove the casting from the mould after metal solidifies.
- Clean and finish the casting.
- Test and inspect the casting.
- Remove the casting defects, if any.
- Relieve the casting stresses by Heat-treatment.
- Again inspect the casting.
- The casting is ready for shipping.


One half of the pattern
Flask placed over the first pattern
One half the mould (cope)
Other half of the pattern
Flask placed over the second pattern
Other half the mould (drag)
Assembled molds
Casting through the gating system
The solidified casting

ADVANTAGES OF CASTING PROCESS

- Process is cheap
- More suitable for mass production
- Most suitable for manufacturing complex/complicated/intricate shaped products.
- Large parts weighing several tonnes and also small components weighing a few grams can be cast.
- No limitation on the size of component.
- Directional properties absent in castings. Components with uniform properties as well as with varying properties at different locations can be cast.
- By use of cores, saving in machining of holes achieved.
- Internal stresses are relieved during solidification in many types of castings.
- Even some materials which cannot be made by other processes made by casting: eg. Phosphor-Bronze.

Automative Spare Parts




Home Appliances



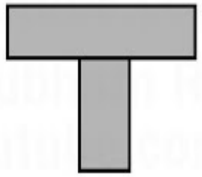

Industrial Spare Parts



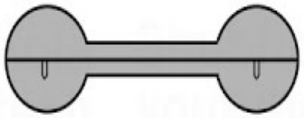

Lighting Accessories



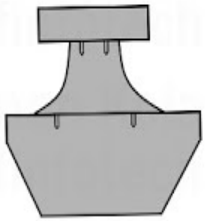

Types of Pattern



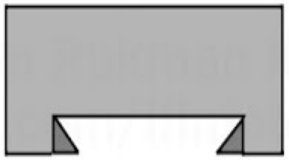
Single Piece



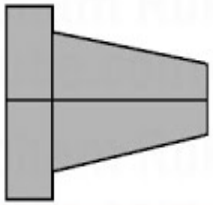
Two Piece



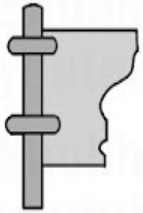
Multi Piece



Loose Piece

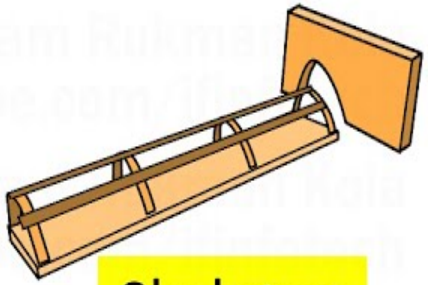


Cope and Drag

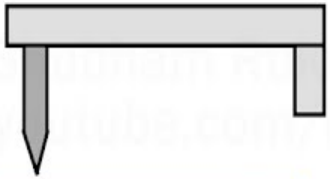


Sweep

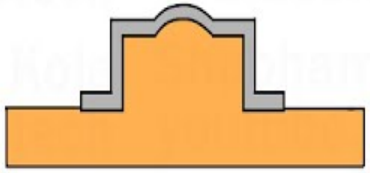
Shell



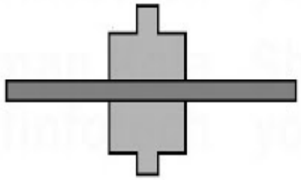
Skeleton



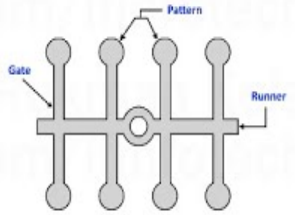
Segmental



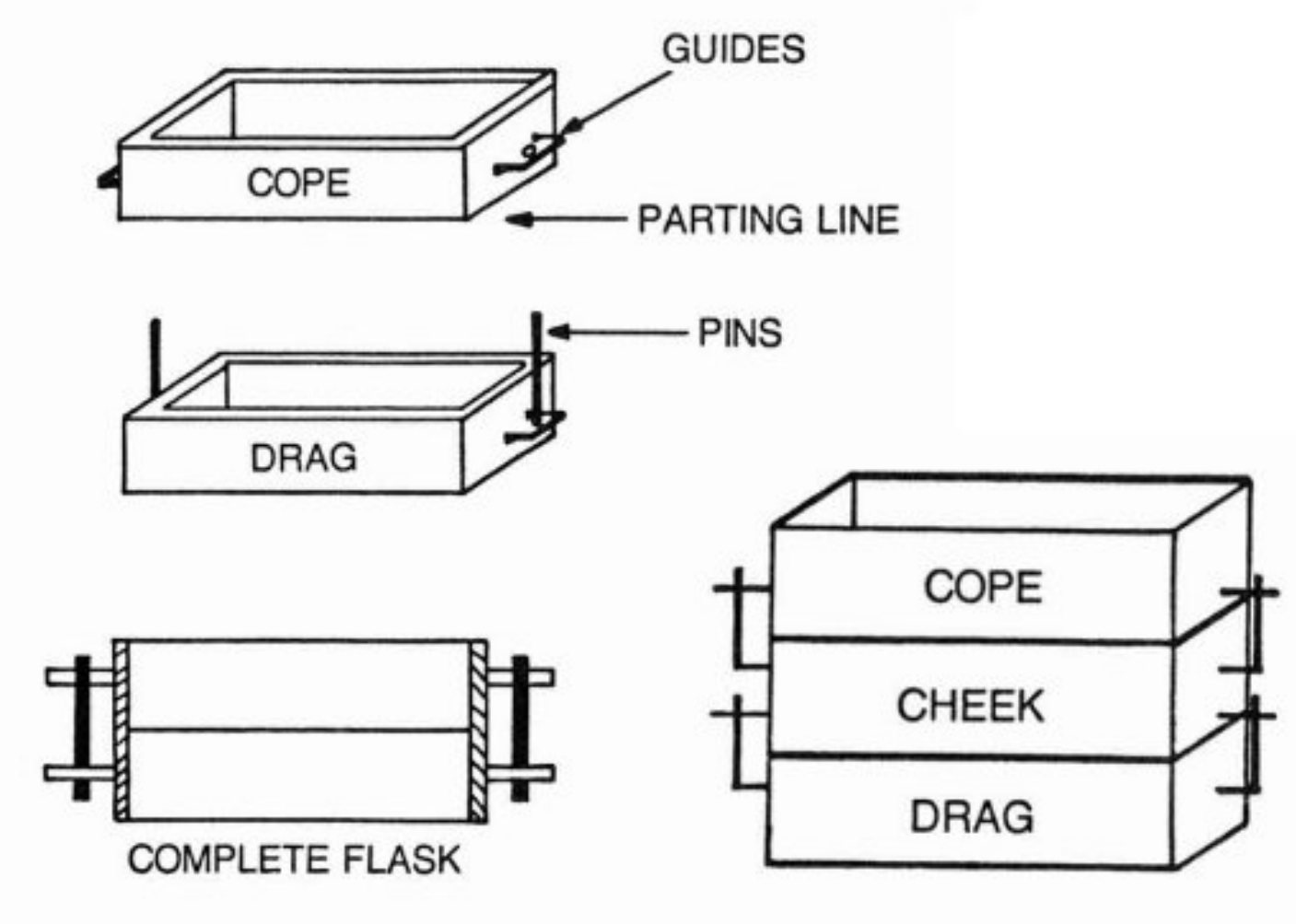
Follow Board



Match plate



Gated


GUIDES
COPE
PARTING LINE
PINS
DRAG
COPE
CHEEK
DRAG
COMPLETE FLASK

The main pattern materials are

- ✓ **wood,**
- ✓ **metal,**
- ✓ **plastic.**

The selection of pattern material depends on:

- ➢ **size**
- ➢ **Complexity**
- ➢ **dimensional accuracy**

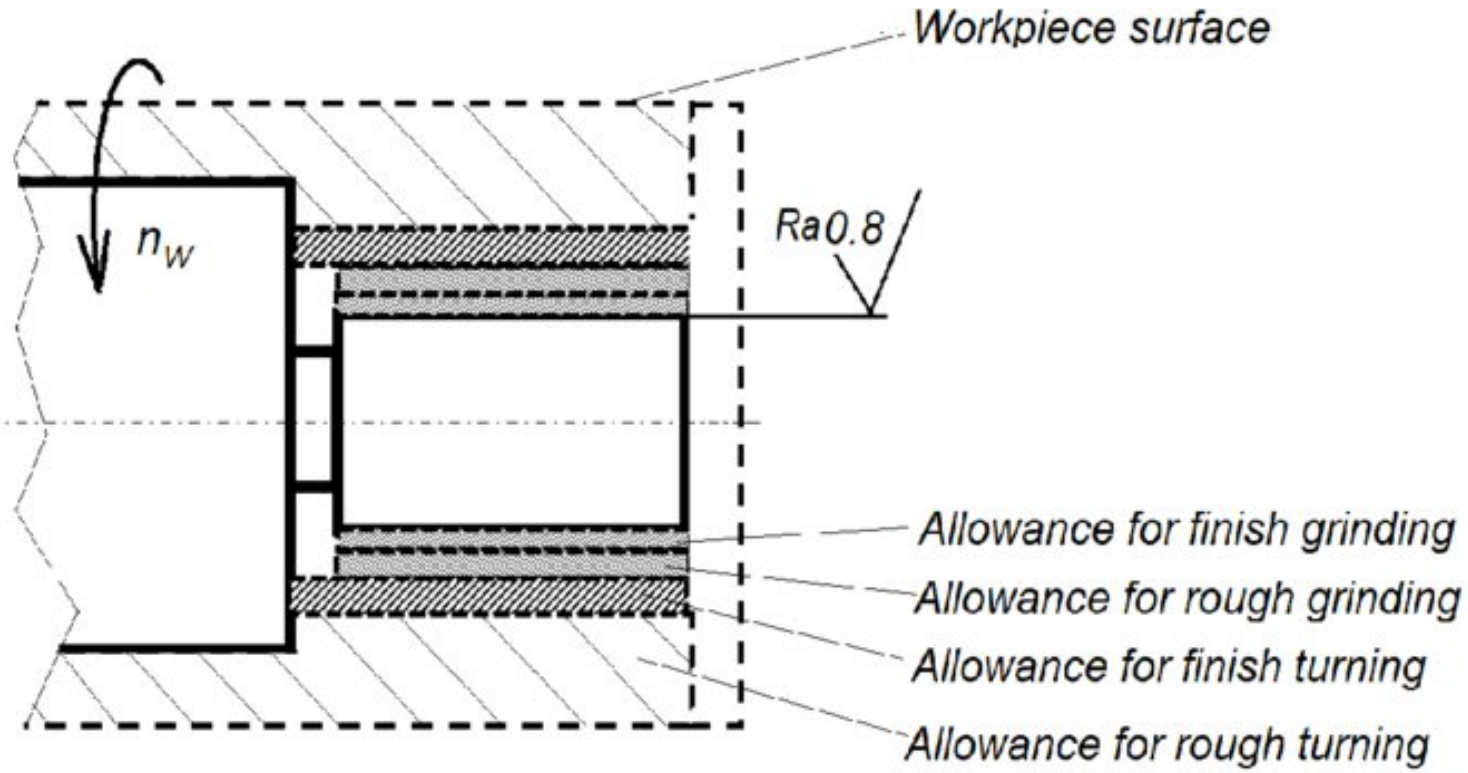
Types of Pattern Allowances:

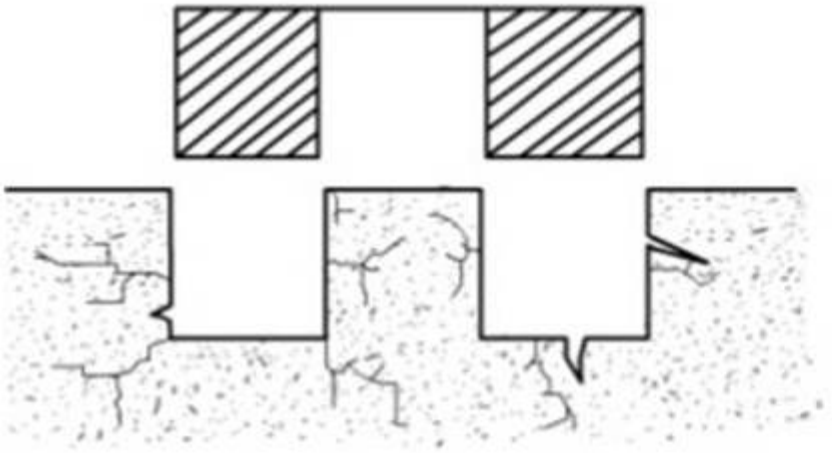
THE VARIOUS PATTERN ALLOWANCES ARE:

1. Shrinkage or contraction allowance.
2. Machining or finish allowance.
3. Draft of tapper allowances.
4. Distortion or chamber allowance.
5. Shake or rapping allowance.

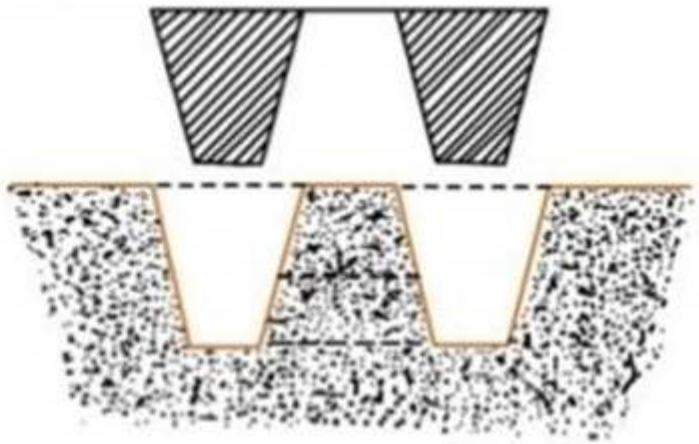
SHRINKAGE ALLOWANCE

MACHINING ALLOWANCE





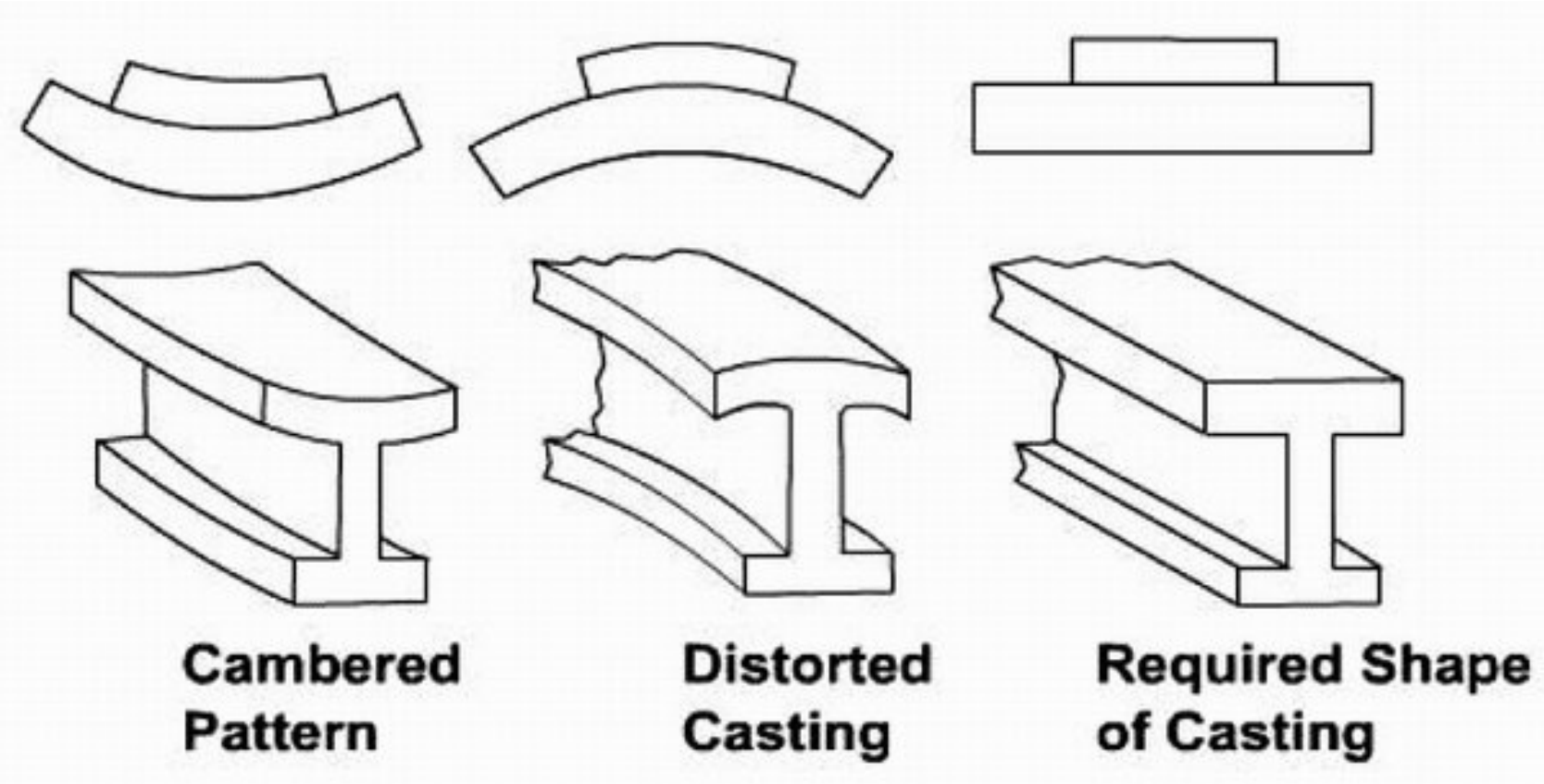
Distorted Casting



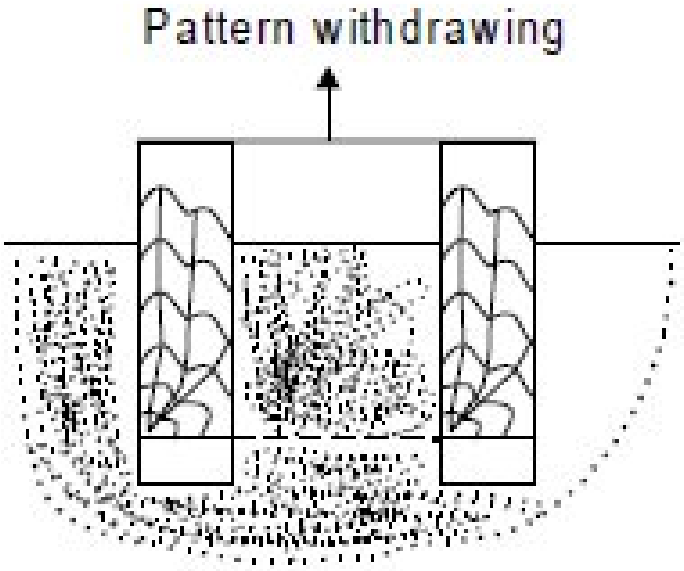
Taper Casting

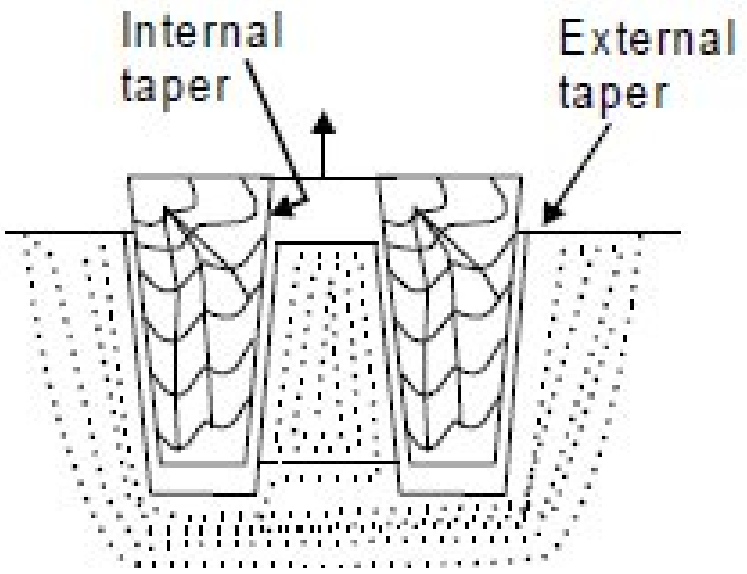
Draft Allowance

DISTORTION ALLOWANCE



SHAKE/RAPPING ALLOWANCE





Properties of moulding sand

Refractoriness : It is the ability of the moulding sand to with stand the high temperature of molten metal.

Strength: The moulding sand should have sufficient strength to retain mould.

Flowability: Flowability is the ability of the moulding sand to get compacted to take up the required shape

Permeability: the moulding sand should be porous enough to allow the gases picked up by the molten metal while transferring or gases generated in the mould to escape from mould

Cohesiveness: It is ability of the moulding sand grains to adhere to each other.

Adhesiveness: Adhesiveness is the property of moulding sand to adhere to the walls of moulding boxes

Collapsibility: Collapsibility is the readiness of the moulding sand to get collapsed after the solidification of the casting

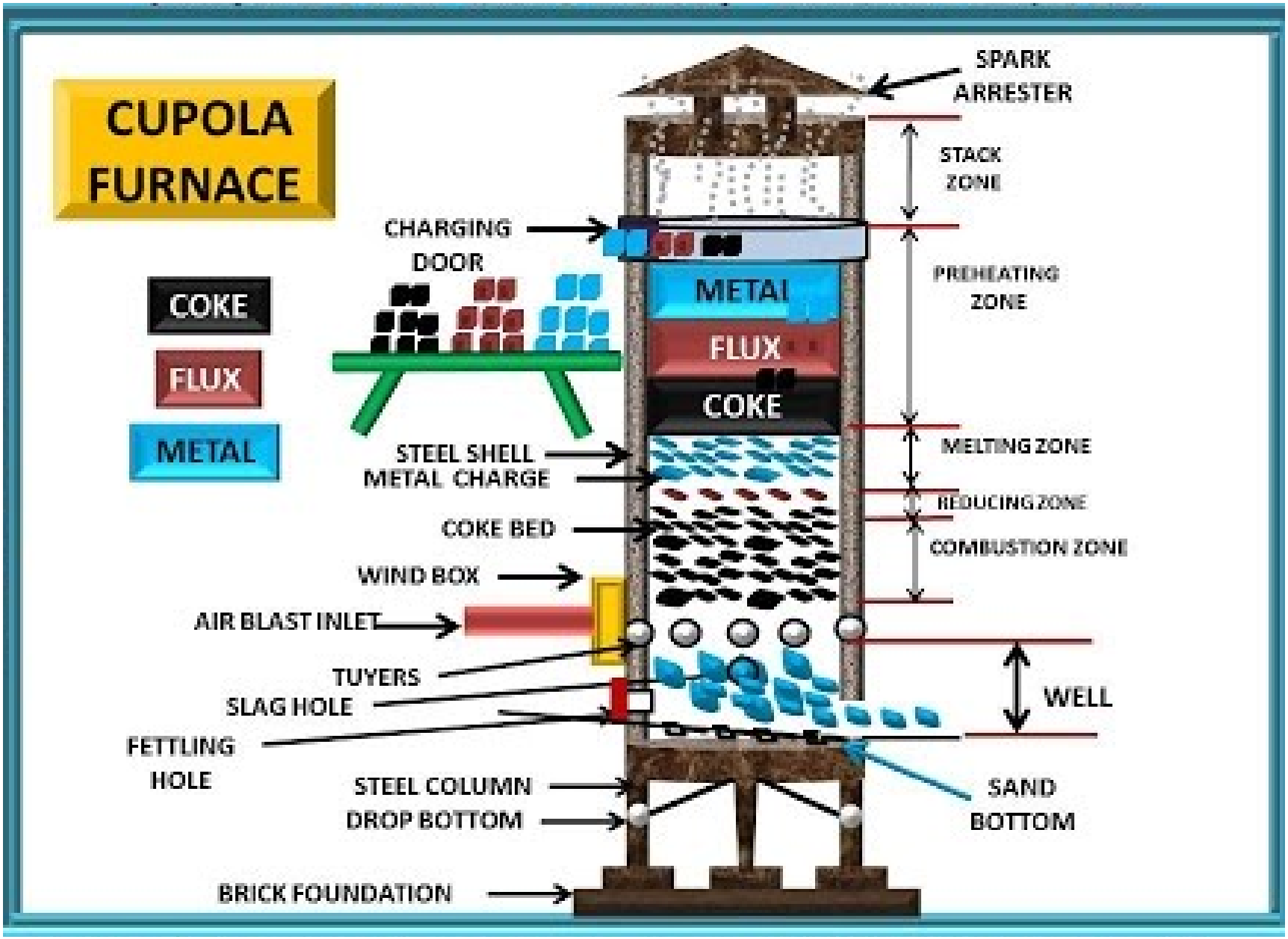
Durability: It is ability of the moulding sand to with stand the heating and coolong during repeated usage.

Table 1. Standard composition of the green moulding sand used.

Materials	Weight composition (wt%)
Silica sand	82
Bentonite	7
Coal dust	5
Water	6

Crucible melting

- **The furnaces uses a refractory crucible which contains the metal charge.**
- **The charge is heated via conduction of heat through the walls of the crucible.**
- **The heating fuel is typically coke, oil, gas or electricity.**
- **A crucible is a ceramic or metal container in which metals or other substances may be melted or subjected to very high temperatures.**


CUPOLA FURNACE
COKE
FLUX
METAL
SPARK ARRESTER
STACK ZONE
CHARGING DOOR
PREHEATING ZONE
METAL
FLUX
COKE
STEEL SHELL
METAL CHARGE
MELTING ZONE
REDUCING ZONE
COKE BED
COMBUSTION ZONE
WIND BOX
AIR BLAST INLET
TUYERS
SLAG HOLE
WELL
FETTLING HOLE
STEEL COLUMN
DROP BOTTOM
SAND BOTTOM
BRICK FOUNDATION

- **Flux material is used to remove impurities and lowers the melting points of the metal**

- **Flux material also improves the fluidity of the molten metal**

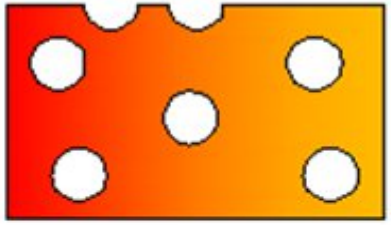

FIRE
CAUTION

- **A cupola or cupola furnace is a melting device used in foundries that can be used to melt cast iron, Ni-resist iron and some bronzes.**
- **The size of a cupola is expressed in diameters and can range from 1.5 to 13 feet**
- **Cupola operation is started by igniting the coke bed at its bottom.**

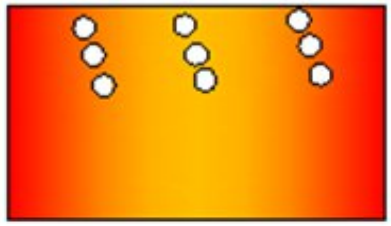
- **After the Coke bed is properly Ignited, alternate charges of limestone, pig iron, and coke are charged until the level of the charging Door.**
- **Then the air blast is turned on and combustion occurs rapidly within the coke bed.**

- **Scrap, alloys and coke are introduced at the top of the furnace**
- **The cupola is a tubular furnace which produces cast iron**
- **Cupola melt scrap and alloys using the energy generated from the combustion of coke, a coal derivative.**

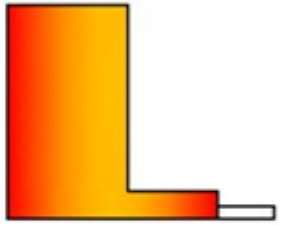
Casting Defects



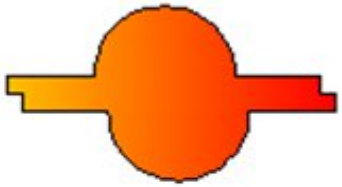
Blowholes



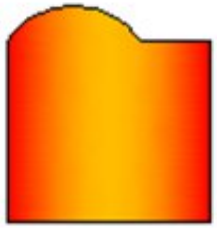
Pinholes



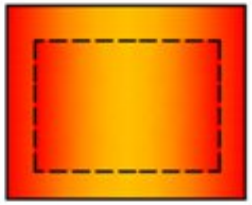
Misrun



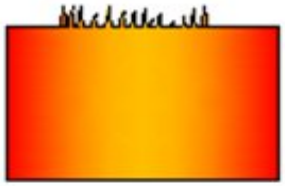
Shift or mismatch



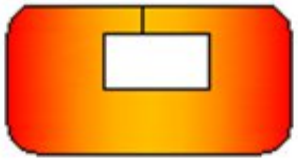
Drop



Swell



Metal penetration

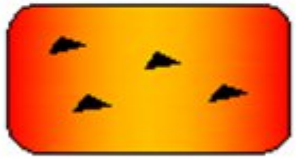


Cold shut

Hot tears

Shrinkage Cavity

Wash and cuts



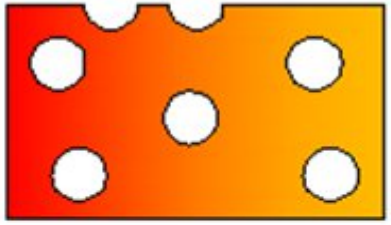
Slag inclusion

- **Blow holes are caused due to excessive gas content in the metal bath and rejection of dissolved gases during solidification. The gases involved in this defect are hydrogen and nitrogen.**

- **pin hole formation is on the surface caused by surface oxidation of the melt during casting and solidification**

- **A misrun occurs when the molten metal freezes before it reaches all parts of the mould cavity**

Casting Defects



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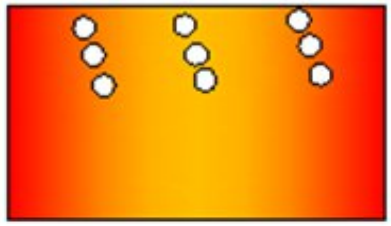
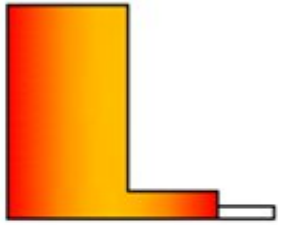
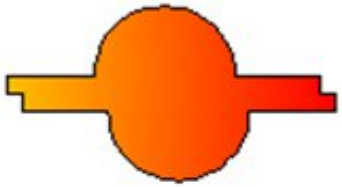


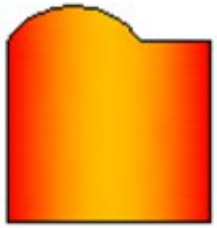
Pinholes



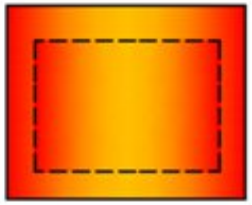
Misrun



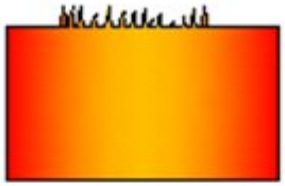
Shift or mismatch



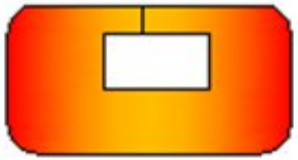
Drop



Swell



Metal penetration

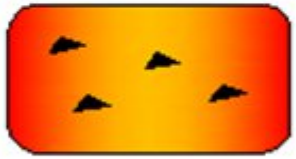


Cold shut

Hot tears

Shrinkage Cavity

Wash and cuts



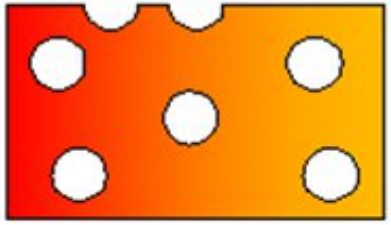
Slag inclusion

- **Mismatch could occur when the cope and drag of the mold are not properly aligned**

- **Drop is caused when pieces of loose molding sand lump drop from the surface of the cope into the mold cavity**

- **Swell is usually caused by improper or soft ramming of the mold or a low strength mold. Molds should be built to withstand liquid metal pressure**

Casting Defects



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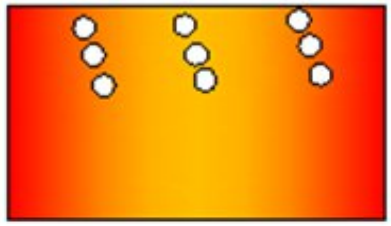
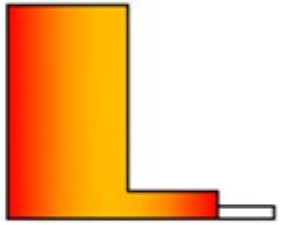


Pinholes



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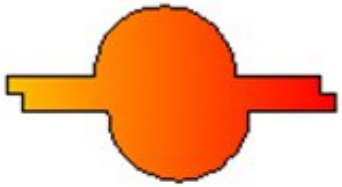

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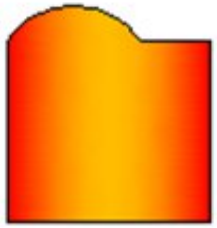
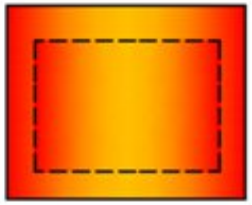
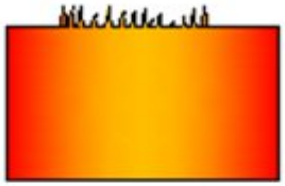


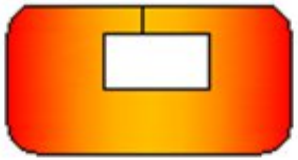
Drop



Swell



Metal penetration

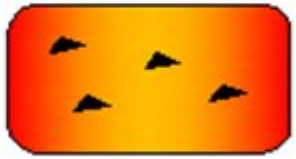


Cold shut

Hot tears

Shrinkage Cavity

Wash and cuts

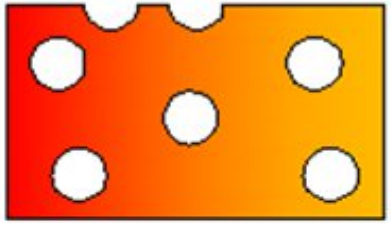


Slag inclusion

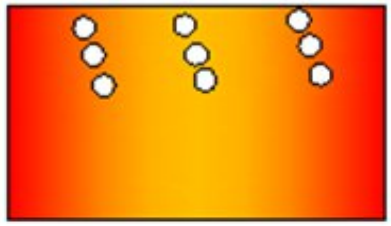
- **Metal penetration occurs in situations when the molten metal penetrates openings or gaps in the molding sand. The main reason for this is that the grain size of the molding sand is too coarse, preventing the proper flowing of the liquid metal.**

- **Cold shuts occur when two relatively cold streams of molten metal from different gates meet and do not fuse together properly during the casting process.**

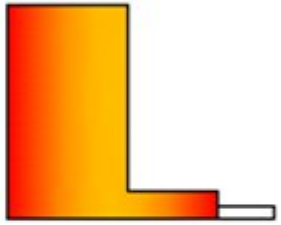
Casting Defects



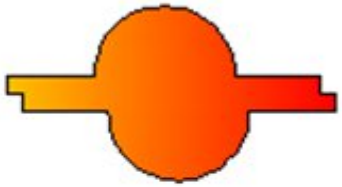
Blowholes



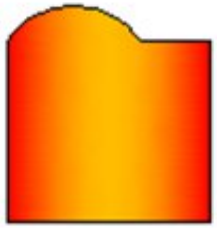
Pinholes



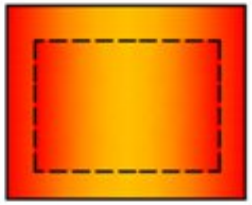
Misrun



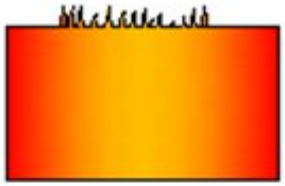
Shift or mismatch



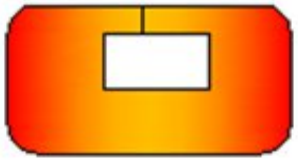
Drop



Swell



Metal penetration

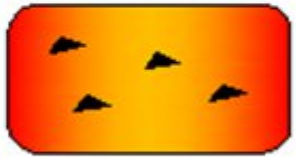


Cold shut

Hot tears

Shrinkage Cavity

Wash and cuts



Slag inclusion

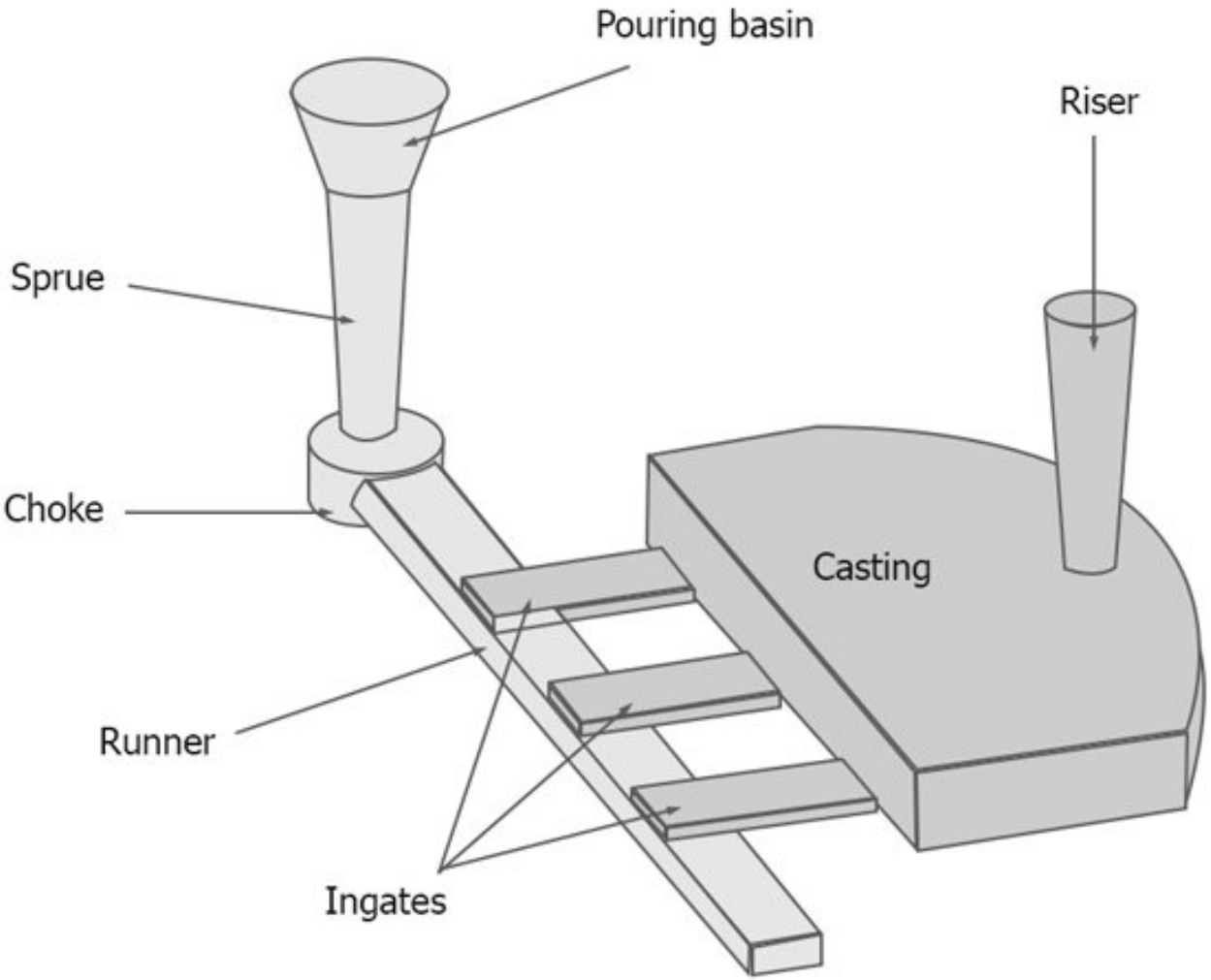
- **Hot tears are caused because of the low strength of metal after solidification**

- **Shrinkage cavity is due to hot metal solidifying unevenly.**

- **Cuts and washes are areas of excess metal. These appear when the molten metal erodes the molding sand.**

- **Slag inclusion is caused when molten metal containing slag particles is poured into the mold cavities and solidifies.**

GATING SYSTEM

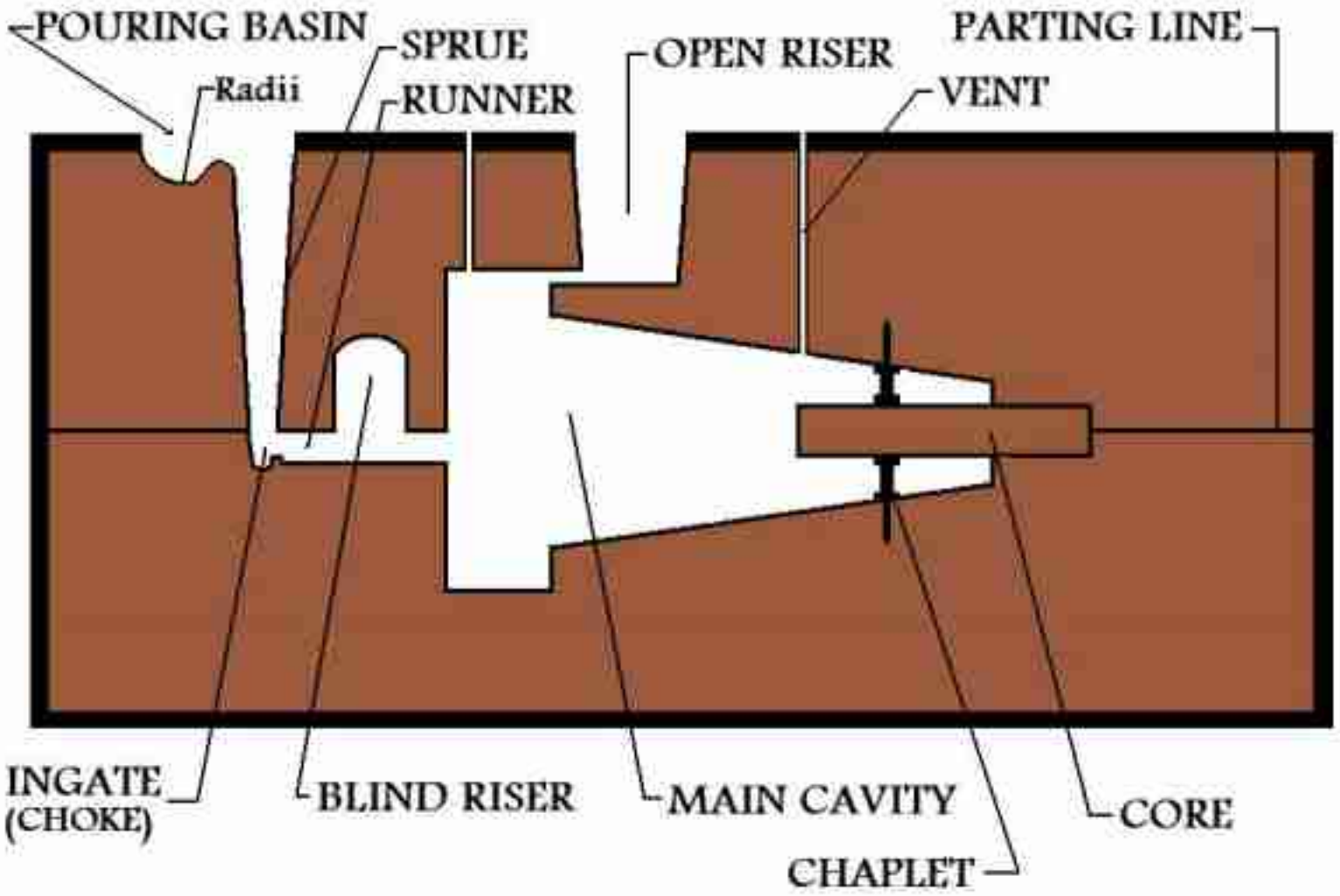


GATING SYSTEM

- Gating system are channels through which molten metal flows into the die cavity.

- The primary purpose is to ensure a smooth and complete flow into the mold cavity.

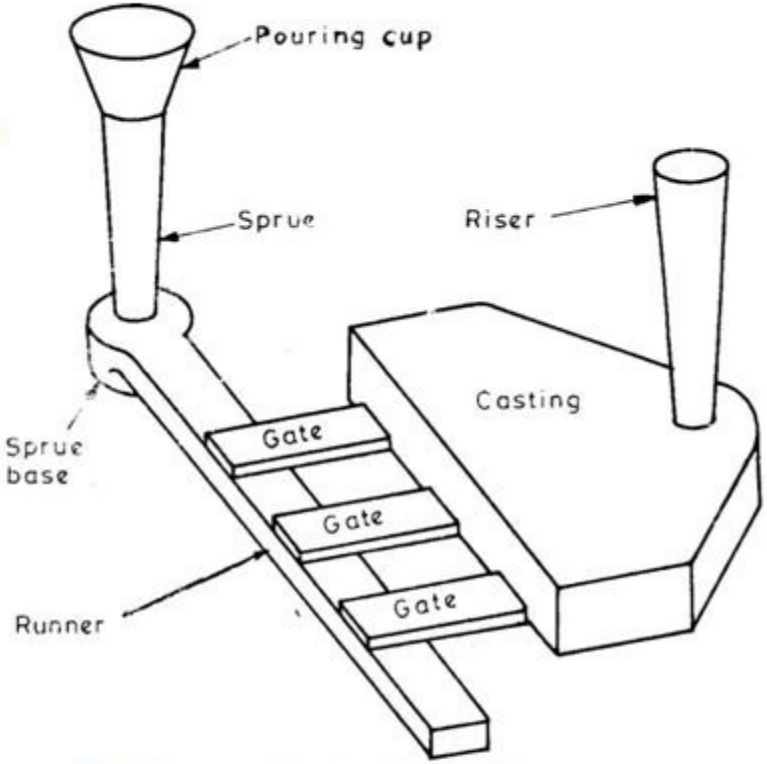
- It is important to have a well-designed gating system in order to achieve perfect castings



GATING SYSTEM FOR CASTING

PRINCIPLES OF GATING SYSTEM

- The term gating system refers to all passageways through which the molten meta passes to enter the mold cavity.
- *The gating system is composed of*
  - *Pouring cups and basins*
  - *Sprue*
  - *Runner*
  - *Gates*
  - *Risers.*
- *Fig. shows the various components of the gating system.*



- *Since the way in which liquid metal enters the mold has a decided influence upon the quality and soundness of a casting, the different passages for the molten metal are carefully designed and produced.*
- A gating system should avoid sudden or right angle changes in direction.
- *Sudden change in direction causes mold erosion, turbulence and gas pick-up.*
- *If possible the gating system should form a part of the pattern*

❖Gating systems can be classified as Pressurised system and Unpressurised system.

❖ Gating ratio depends on the nature of the molten metal.

❖Pressurized system is used for reactive metals like magnesium alloy etc.

❖Unpressurised gating system is used for normal metals such as brass, steel, aluminium alloy, etc

❖The gating system includes all those elements which connect the pouring ladle to the mould.

GATING RATIO

- It is defined as the ratio of the sprue area (a) to runner area (b) to the total gate area (c)

a : b : c = Sprue area : Runner area : Ingate area

- Pressurized Gating System, the gating ratio is usually 1: 2: 1 or 1: 0.75: 0.5.

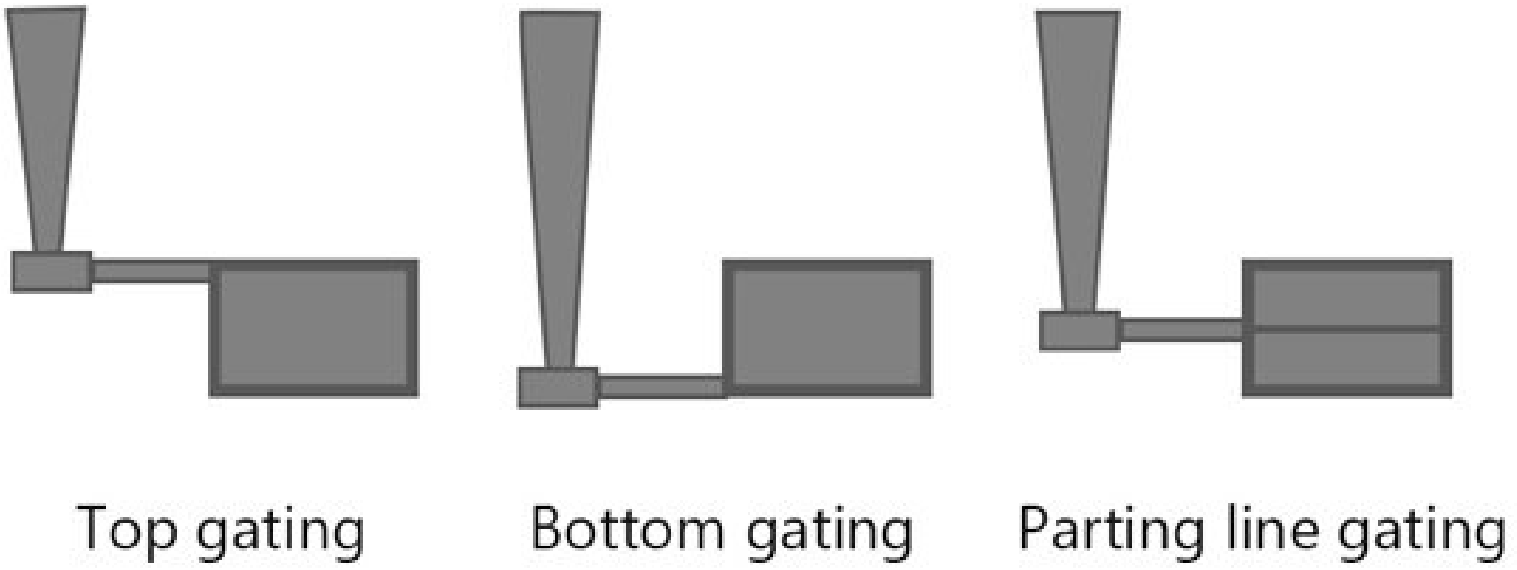
- Unpressurized Gating System, the gating ratio is usually 1: 2: 2 or 1: 3: 3 or 1: 1: 3

❖**The various elements include: Pouring Basin or cup, Sprue, Sprue Base, Runner, In-gate and Riser**

❖**A riser, also known as a feeder, is a reservoir built into a metal casting mold to prevent cavities due to shrinkage.**

❖**Most metals are less dense as a liquid than as a solid so castings shrink upon cooling, which can leave a void at the last point to solidify.**

Types of gating system in casting



TOP GATING SYSTEM:

- **It is applied in processes where the metal in molten form is poured from the top space.**

- **It promotes directional solidification. The system suits merely flat casting to limit the metal's damage, during the filling process.**

BOTTOM GATING SYSTEM :

- **Molten metal is poured from bottom in tall castings .**
- **This minimizes oxidation and splashing while pouring.**

PARTING LINE GATE SYSTEM

- **one of the simplest types of gate in which molten metal enters the mold cavity at the parting line.**

- **Parting line gate can be cut with the help of hand also when the cope and drag portion of the mold are opened.**

Design requirements of the gating system

- **Good control of metal flow.**
- **No impact,**
- **no splashes,**
- **smooth and steady continuity.**
- **Do not carry slag, impurities and gases into the mold cavity.**
- **Fills the mold cavity quickly**

Risers and Riser Design

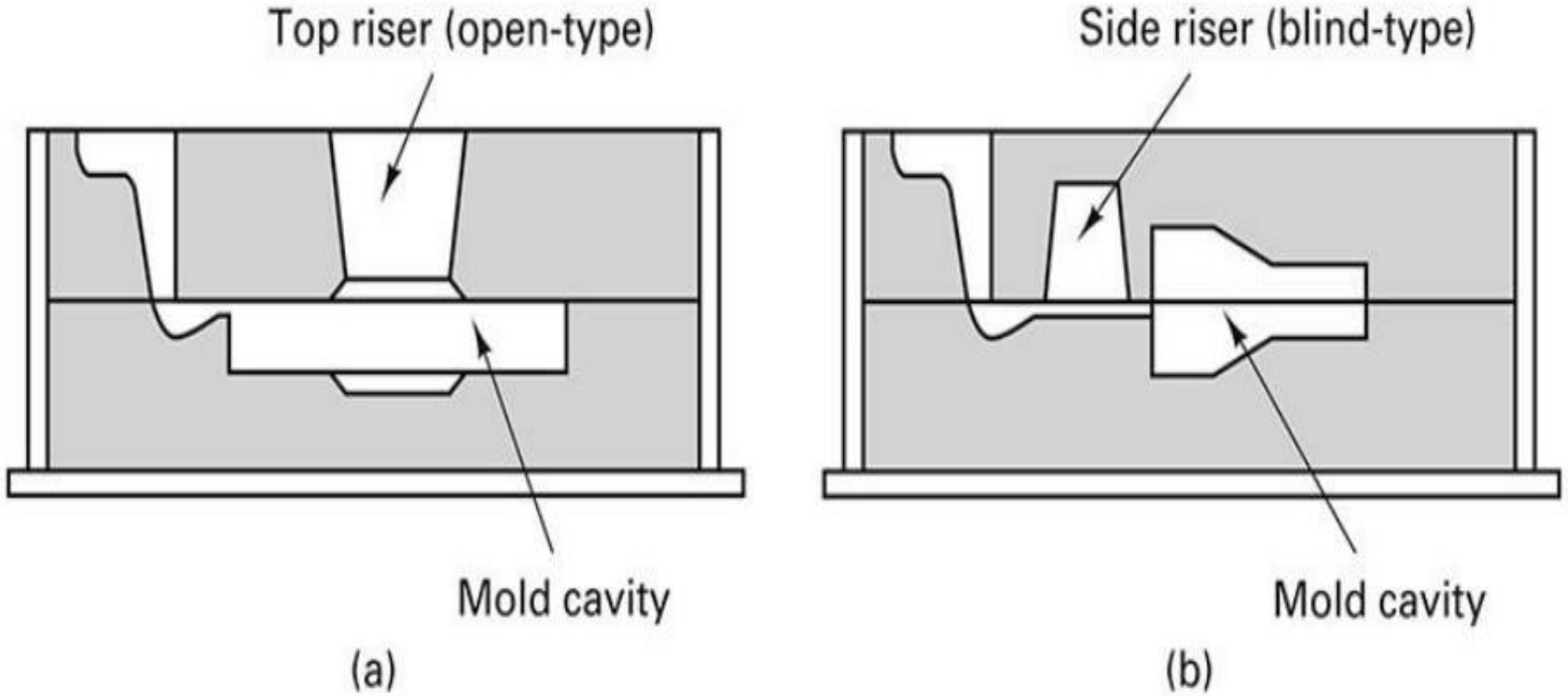


Figure 11-13 Schematic of a sand casting mold, showing a) an open-type top riser and b) a blind-type side riser. The side riser is a live riser, receiving the last hot metal to enter the mold. The top riser is a dead riser, receiving metal that has flowed through the mold cavity.

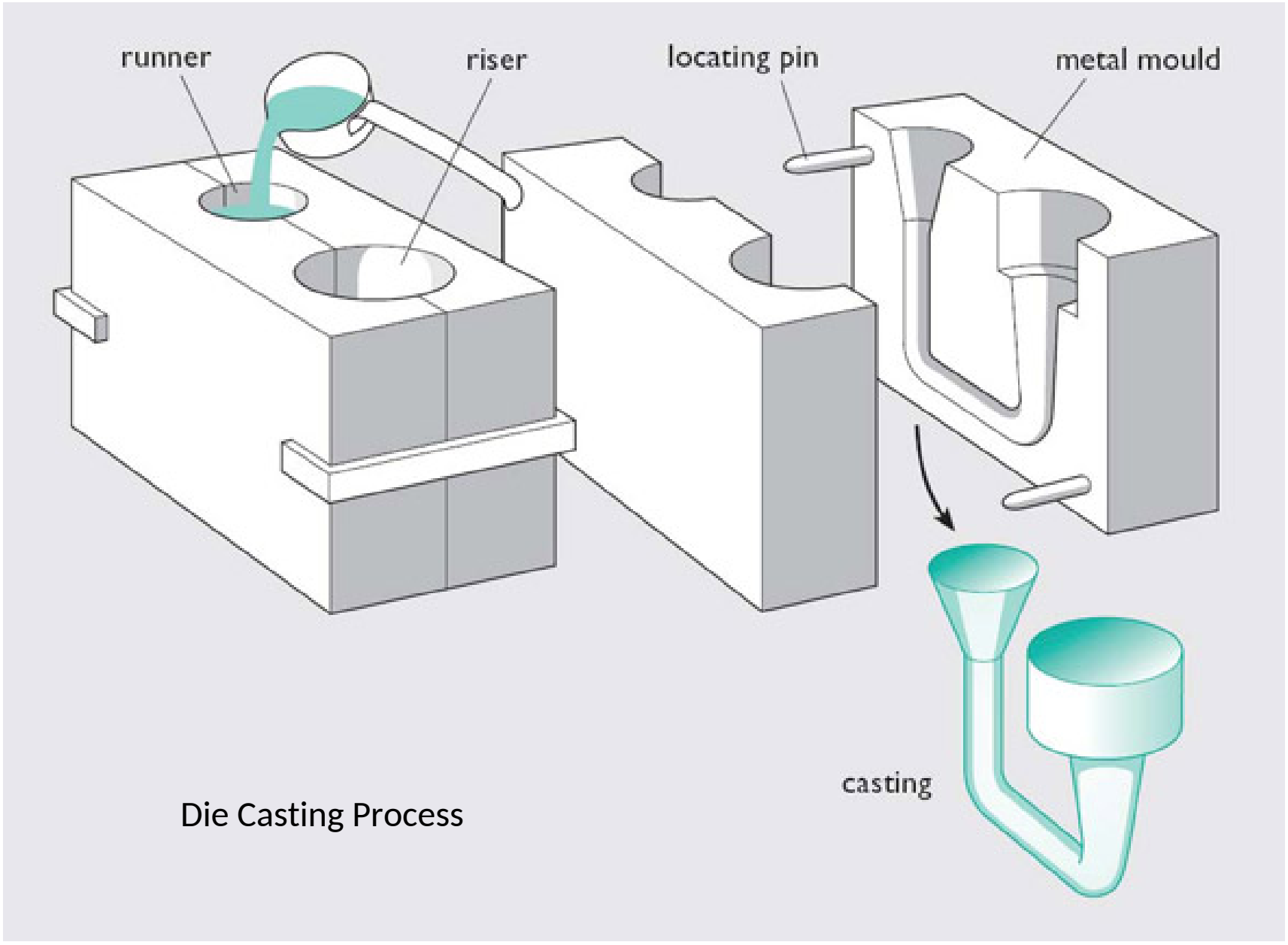
CHAPLETS

✓**Chaplets are used to support the core inside the mould cavity.**

✓**Chaplets are often required to be placed between the mould wall or base and core, in order to avoid deflection of the core and achieve the exact section thickness of the casting.**

TYPES OF CASTING PROCESSES

- Sand Casting Process.
- Gravity Die Casting.
- Pressure Die Casting.
- Investment Casting.
- Centrifugal Casting.
- Vacuum Casting.
- Shell moulding



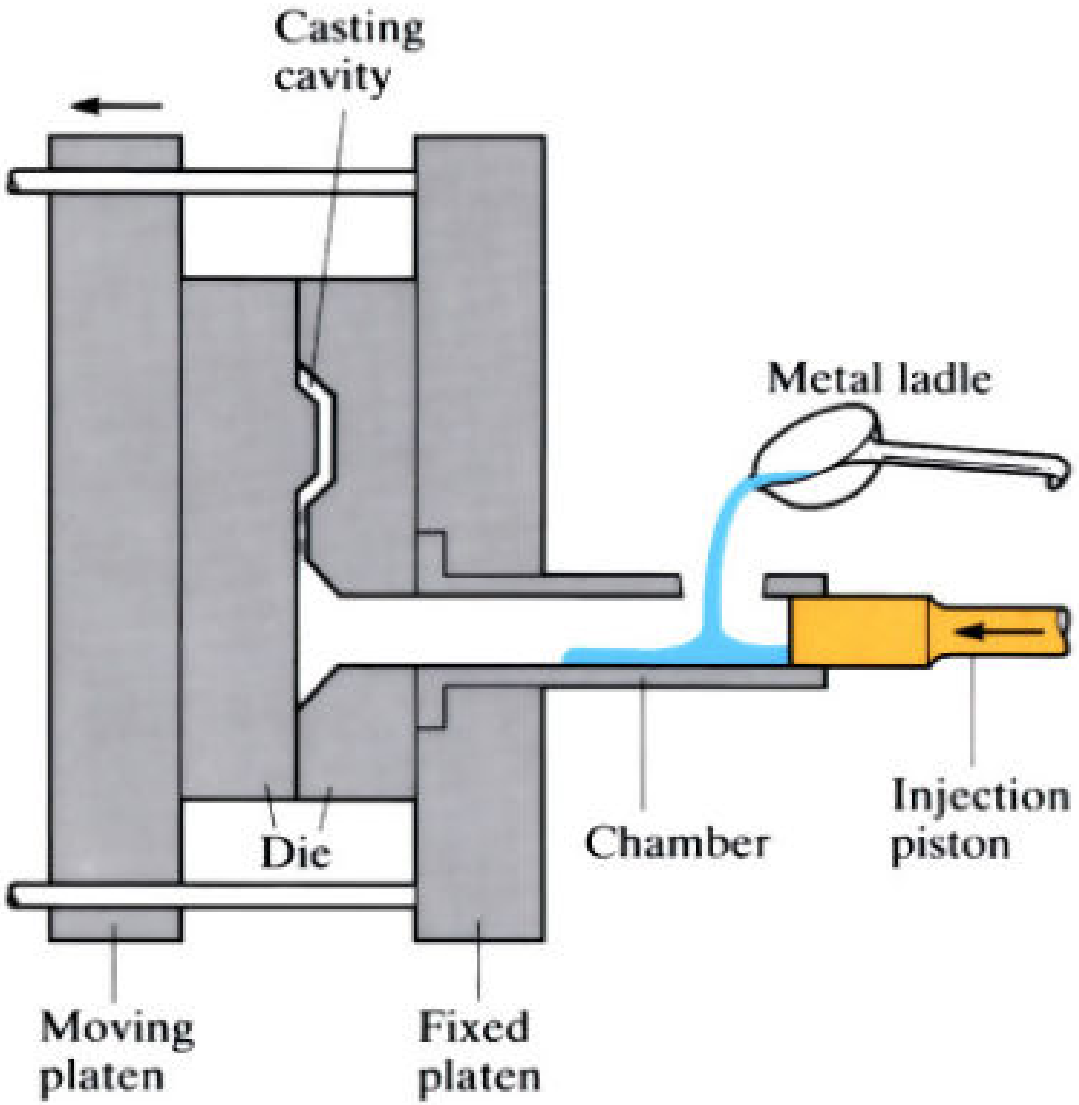
Die Casting Process

- **The metal alloys used for die casting are copper, brass, tin and lead and other metals.**

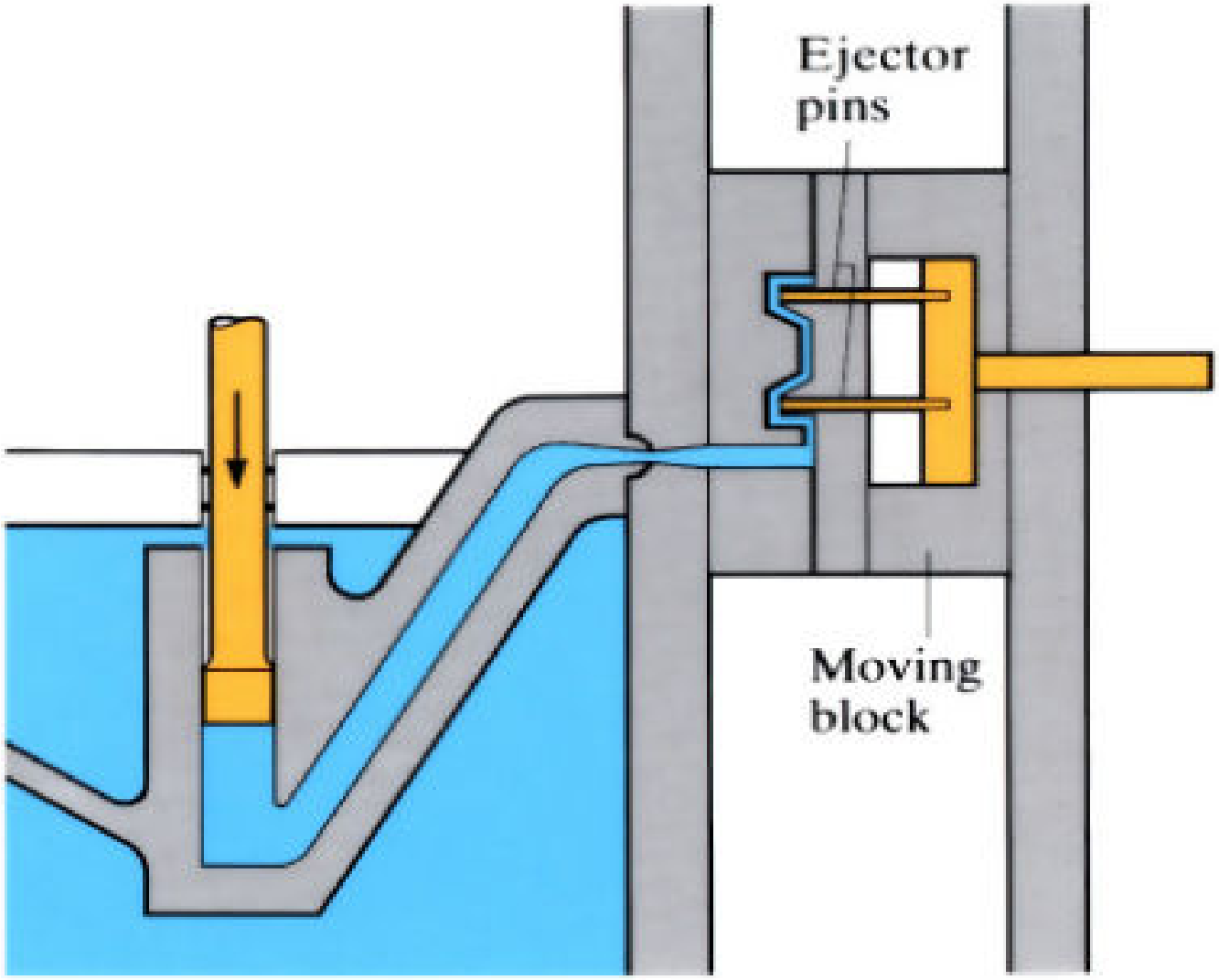
- **For gravity die casting, the metal is poured into the mould from above.**

- **The only force which fills the mould is gravity.**

PRESSURE DIE CASTING (Cold Chamber Die Casting)



PRESSURE DIE CASTING (Hot Chamber Die Casting)

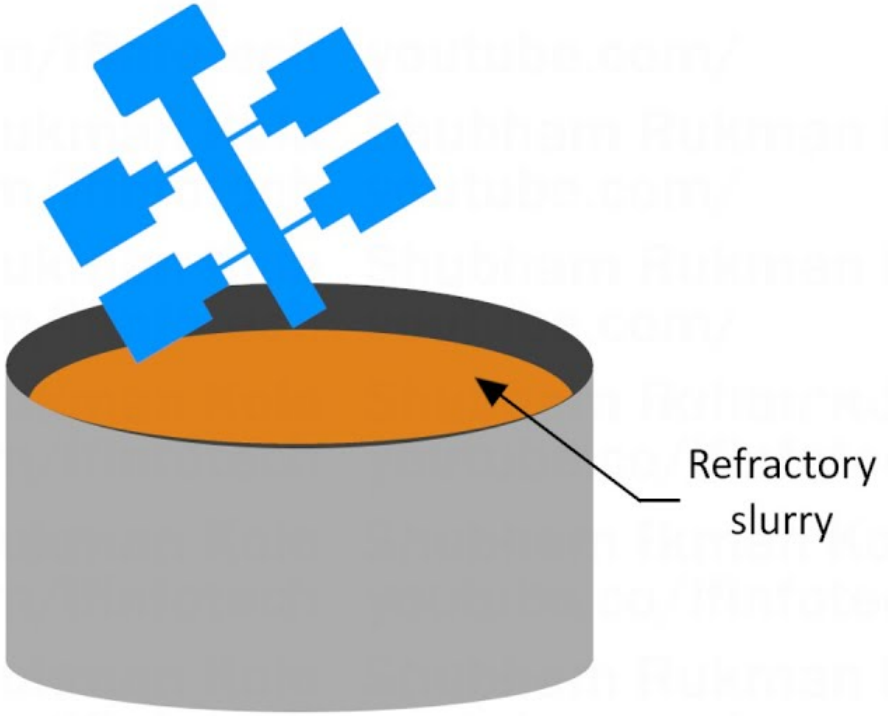


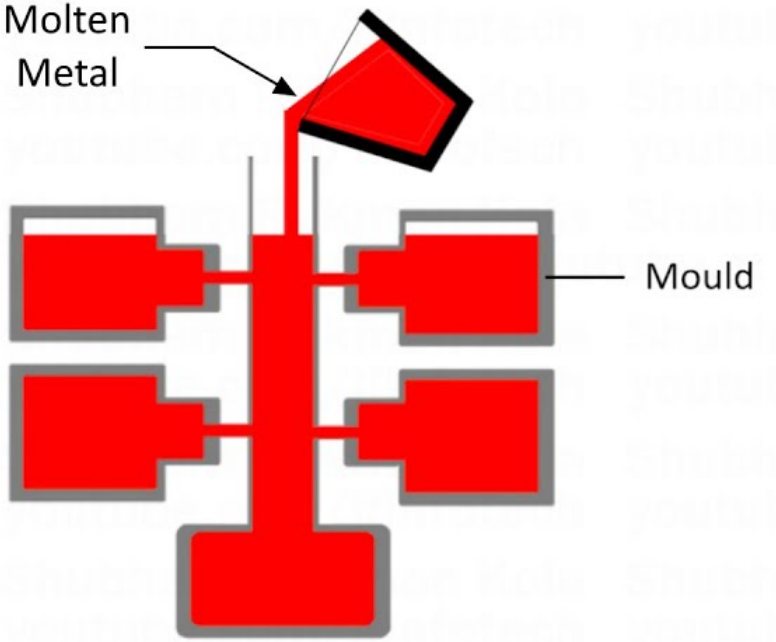
- **Pressure Die casting is a metal casting process that involves feeding molten nonferrous alloys into dies under high pressure and at high speed to rapidly create molded products.**

- **Examples are hooks, toys, door handles, pumps, power tool housing, golf clubs and general engineering castings.**

- **Pressure die casting, however, uses molten metal which is injected into the mould by force (between 1500 and 25,400 psi).**

Investment Casting Process



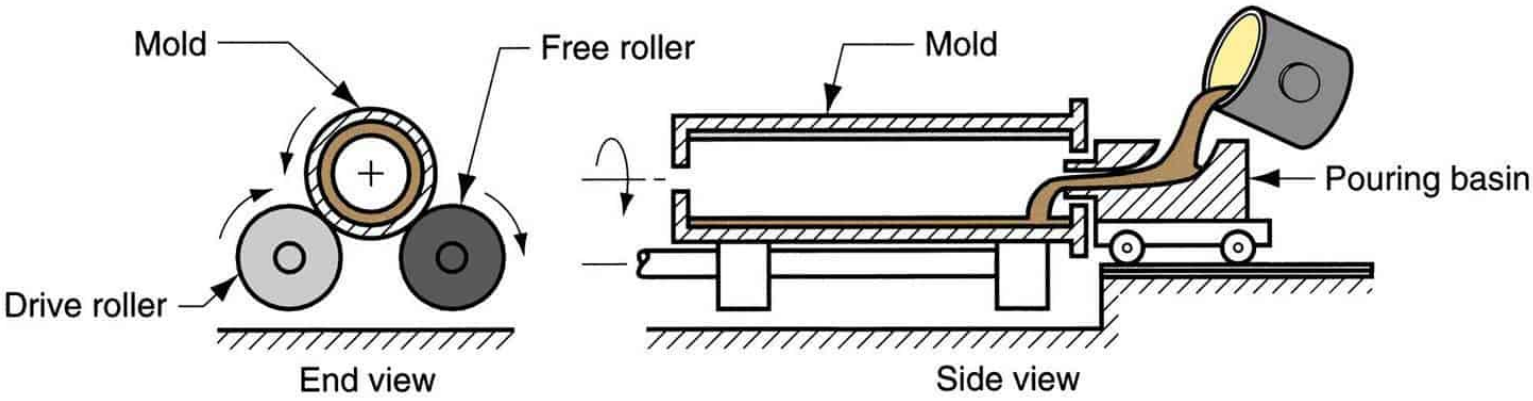


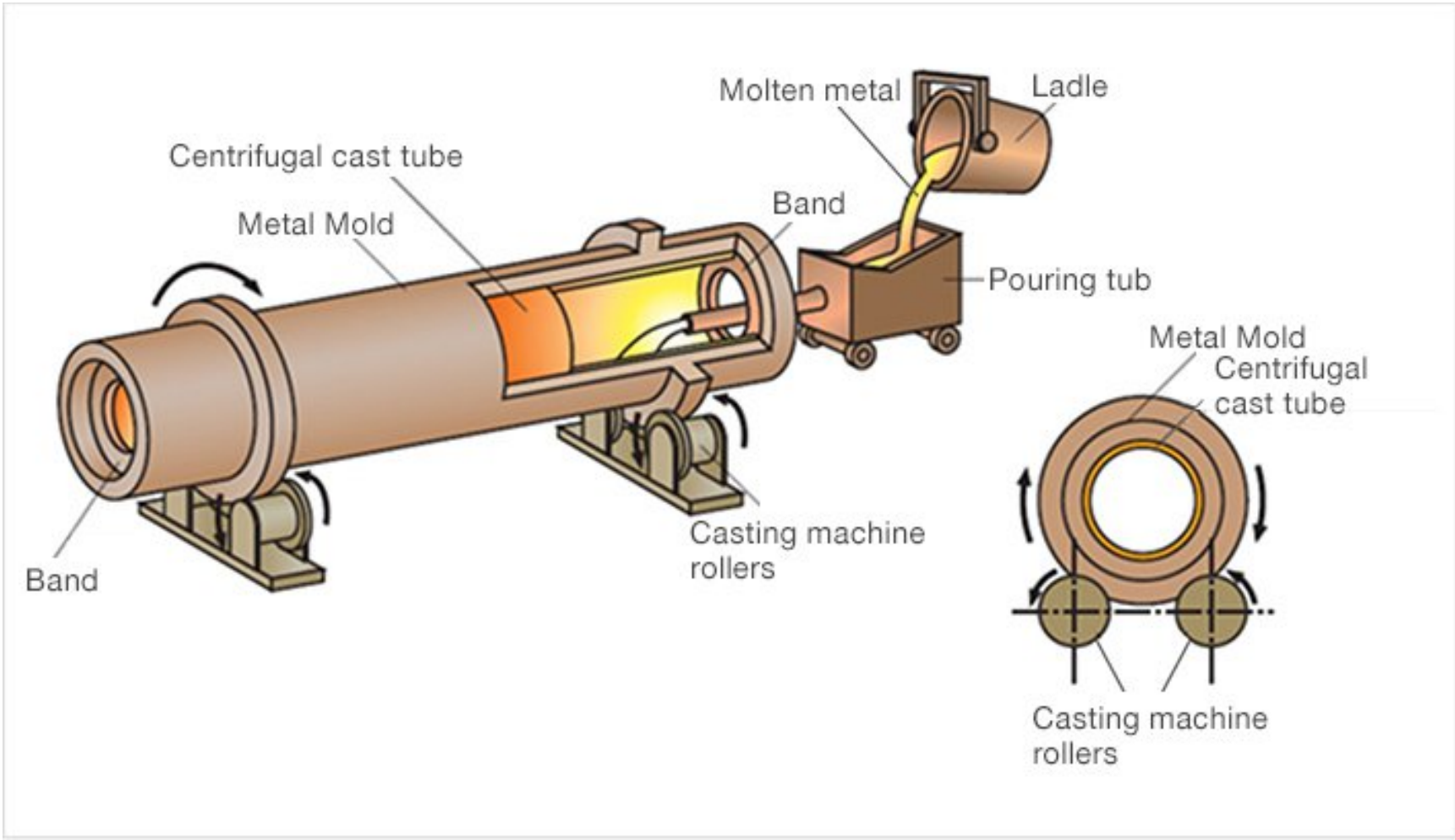
YouTube/Ifinfotech

- **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.**
- **A wax pattern is made in the exact shape of the item to be cast.**
- **This pattern is coated with a refractory ceramic material.**

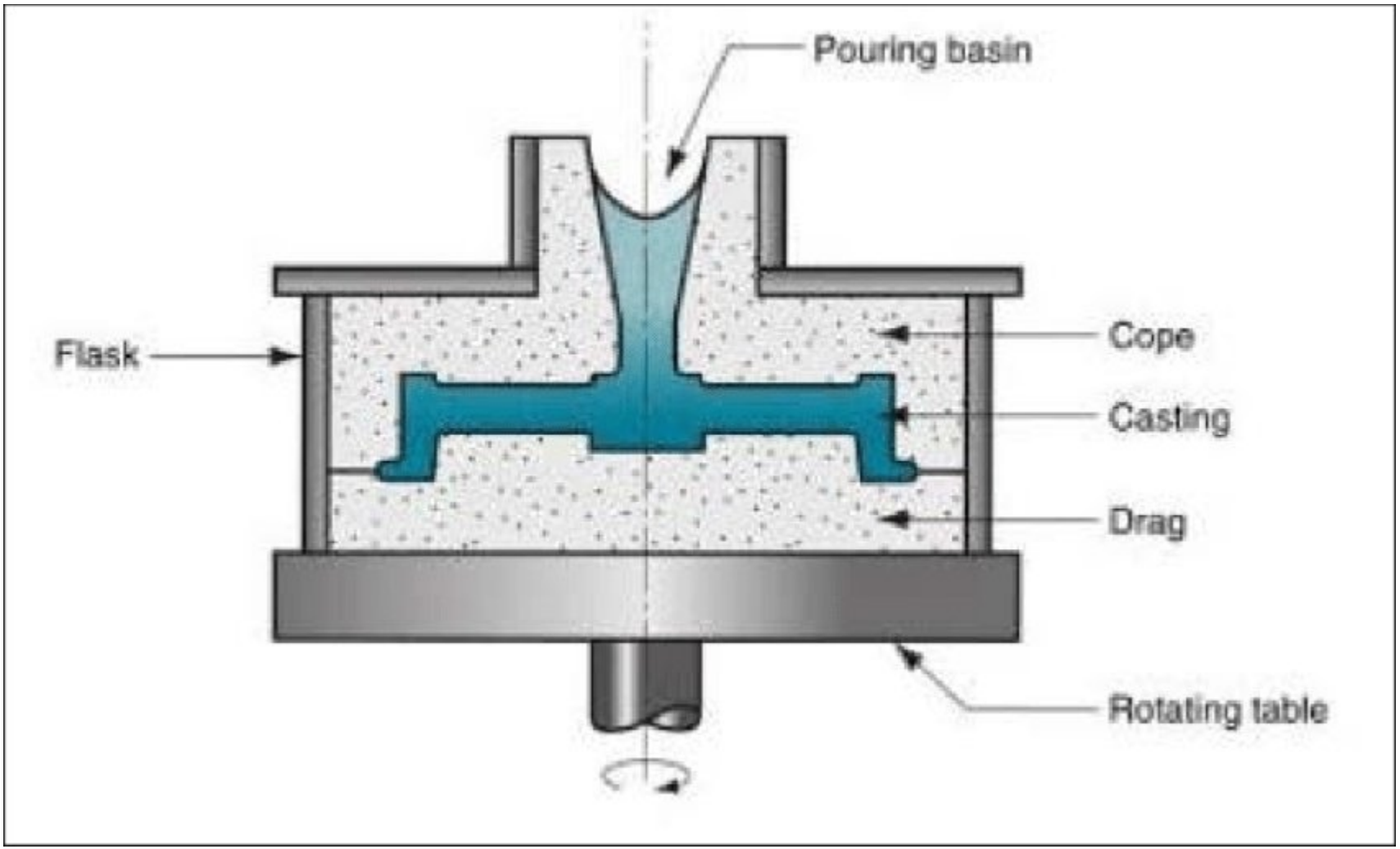
- **Investment casting is generally used for making complex-shaped components that require tighter tolerances, thinner walls and better surface finish than can be obtained with sand casting.**
- **Materials that can be cast include stainless steel alloys, brass, aluminium, carbon steel**

TRUE CENTRIFUGAL CASTING

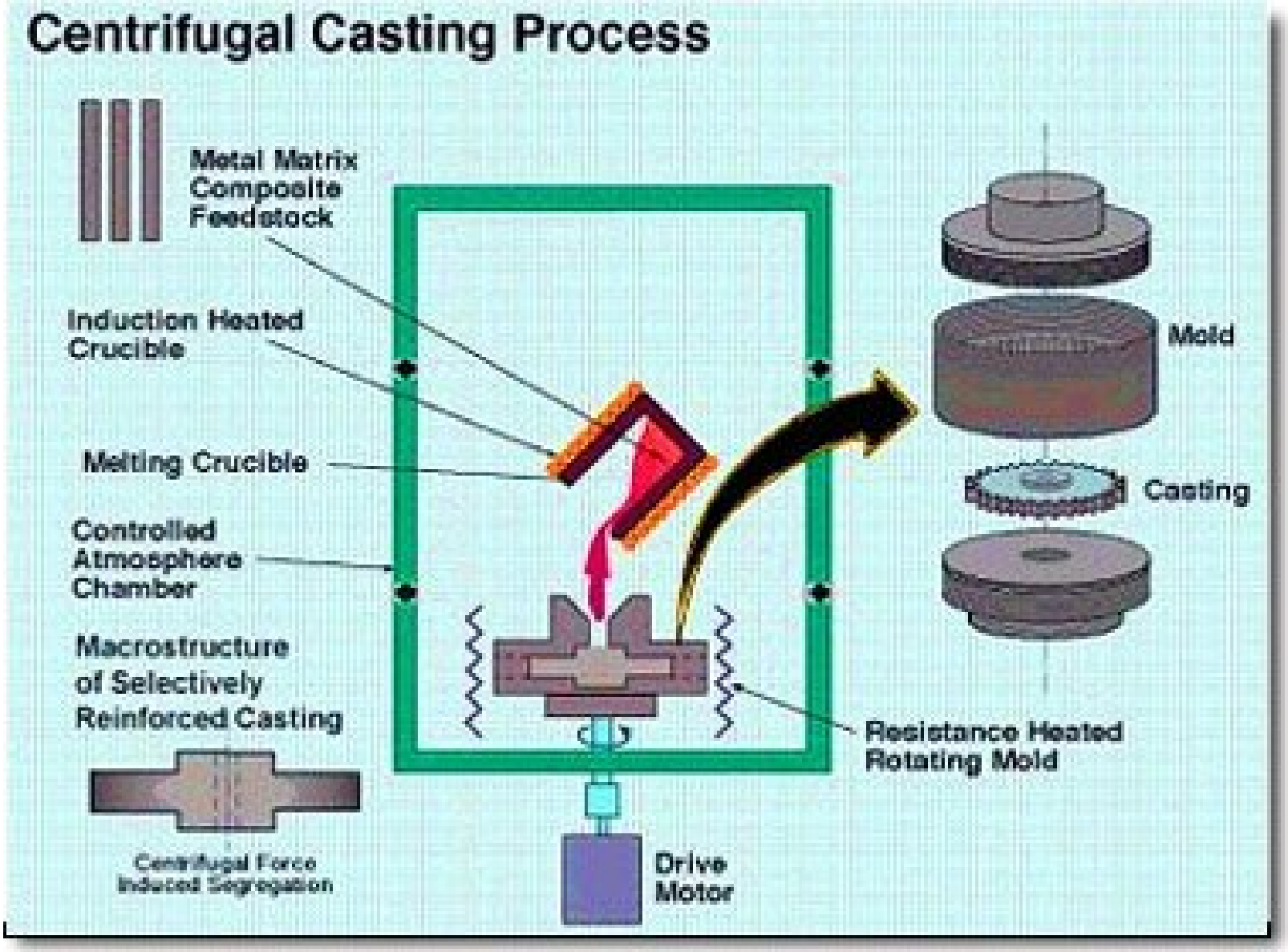



Molten metal
Ladle
Centrifugal cast tube
Band
Metal Mold
Pouring tub
Metal Mold
Centrifugal
cast tube
Band
Casting machine
rollers
Casting machine
rollers

SEMI-CENTRIFUGAL CASTING



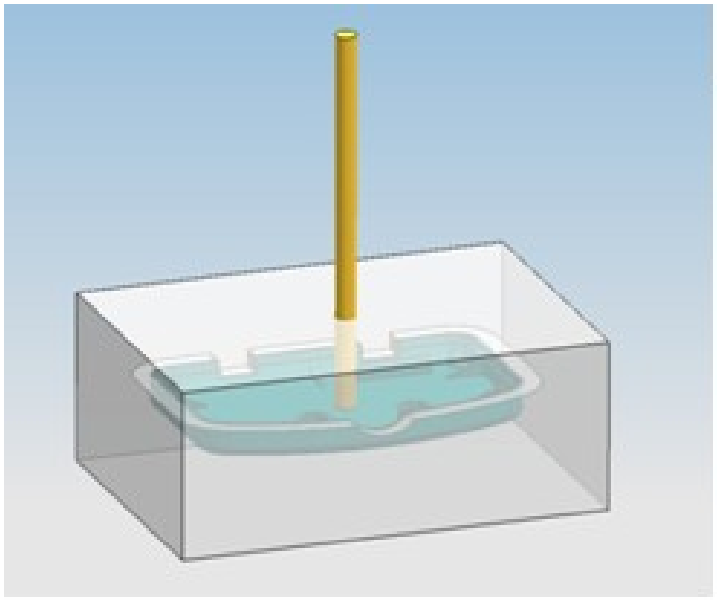
Centrifugal Casting Process

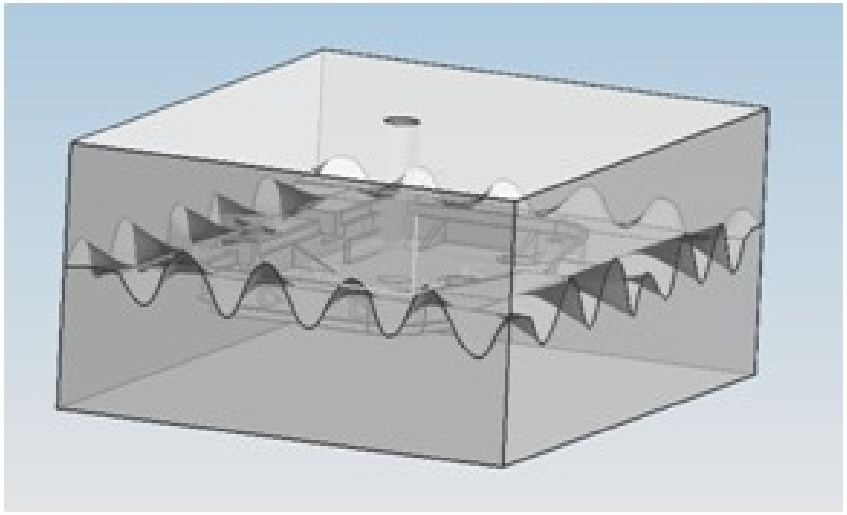


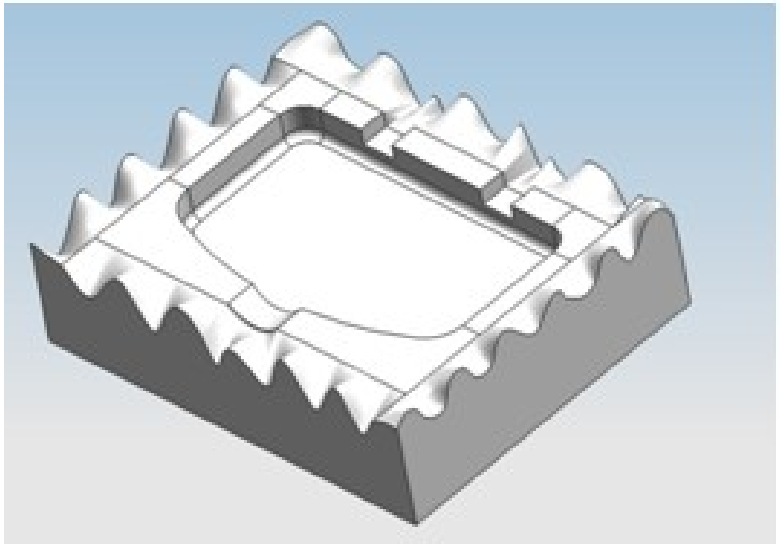
➢**The centrifugal casting is the method to produce pipes, by pouring molten metal into a rapidly spinning cylindrical mold in which centrifugal force from the rotation exerts pressure on the molten metal and cylindrical shapes casting is obtained.**

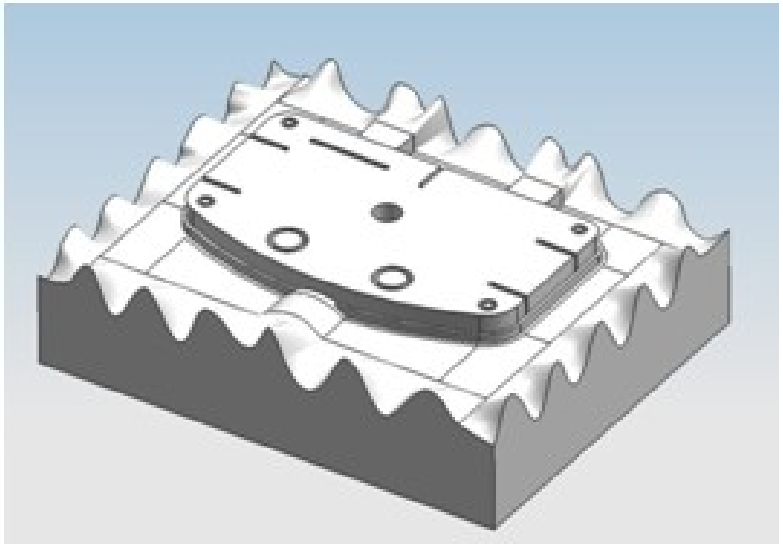
- **Centrifugal casting provides high product quality**
- **Casting are used for jet engine compressor cases, petrochemical furnace tubes, many military and defense components, and other applications requiring high reliability.**

Vacuum Casting Process



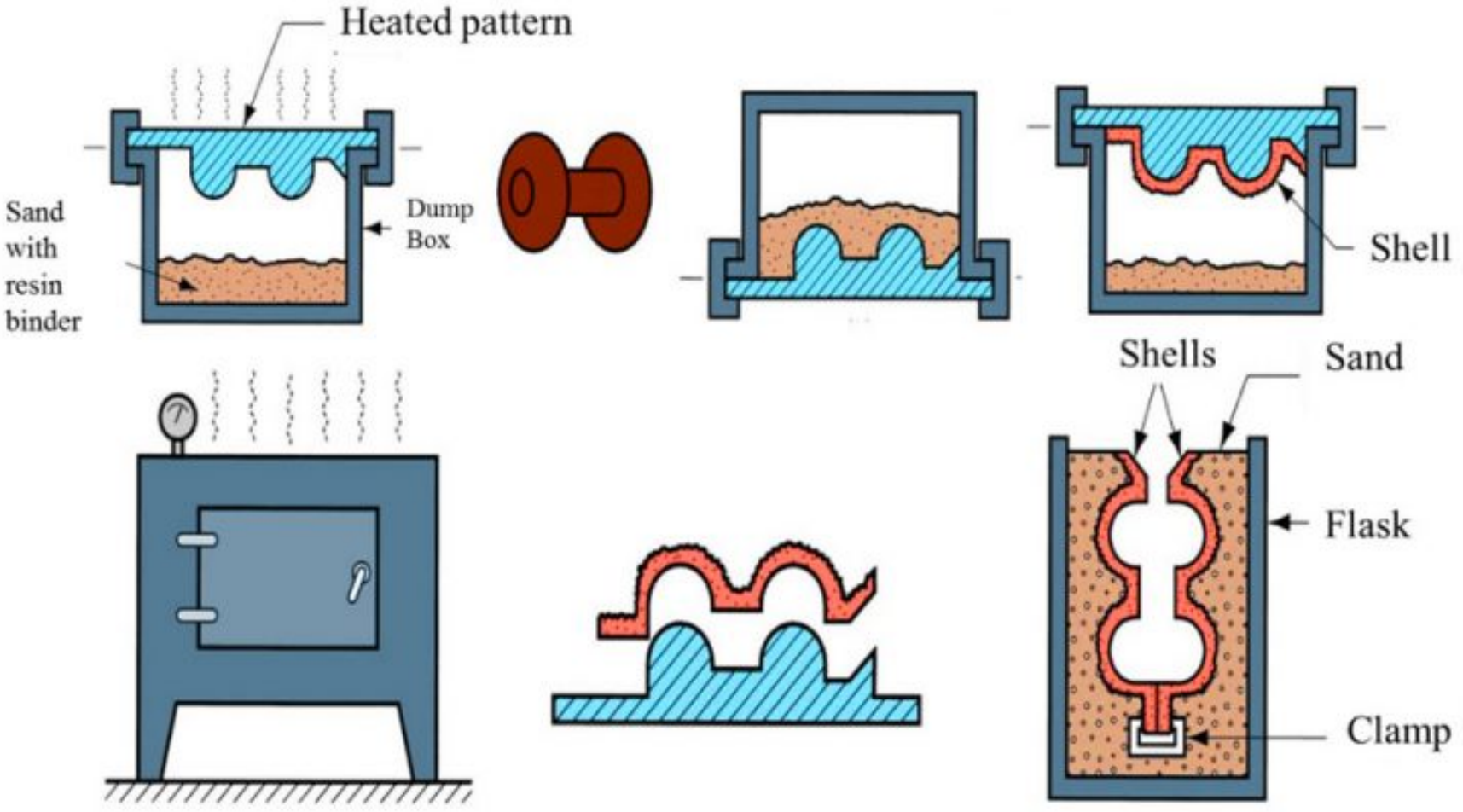




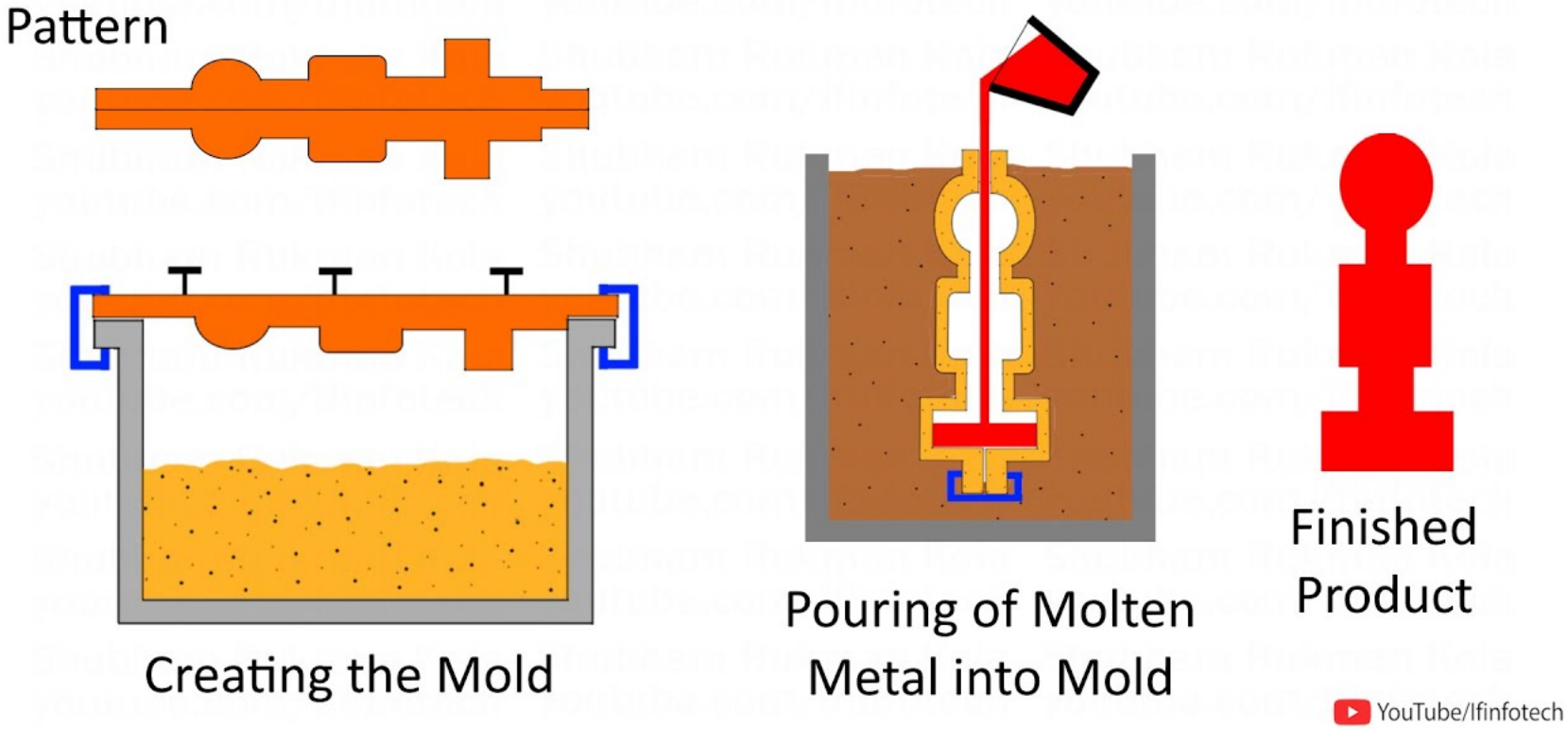


- **Vacuum Casting is a casting process in which a liquid material is drawn into a silicone mold using a vacuum to create complex components.**
- **The liquid materials used for vacuum casting are elastomers such as plastic and rubber.**

Shell Casting Process



Shell Moulding Process



- **As compared to sand casting, shell casting process has better dimensional accuracy, a higher productivity rate, and lower labour requirements.**

- **It is typically used to make small to medium-sized parts that require high dimensional accuracy and thin sections.**

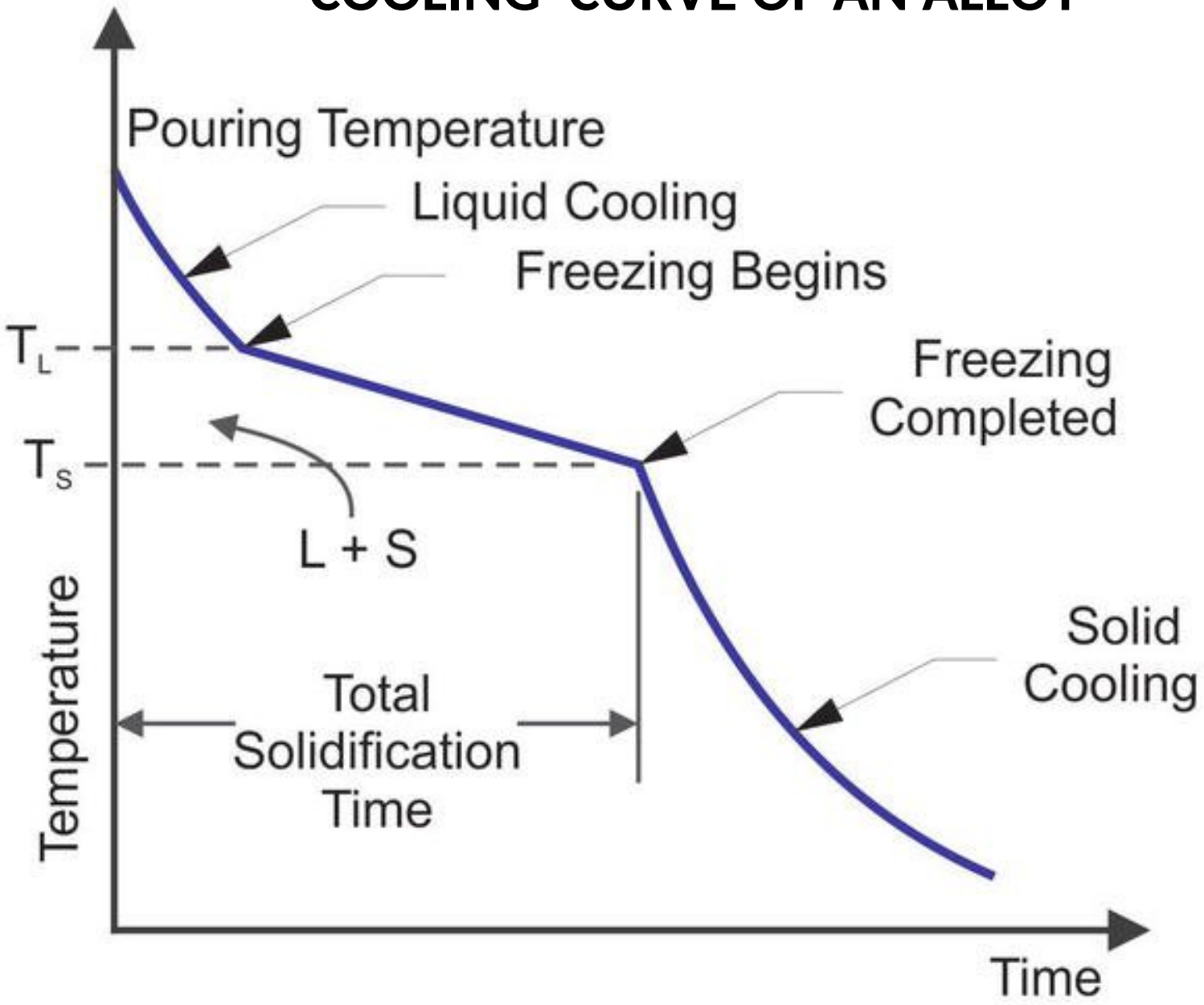
- **Common parts made with shell molding include: Gear housings. Connecting rods.**

- **Green sand casting process uses wet clay as the bonded material, so its material cost is very low.**

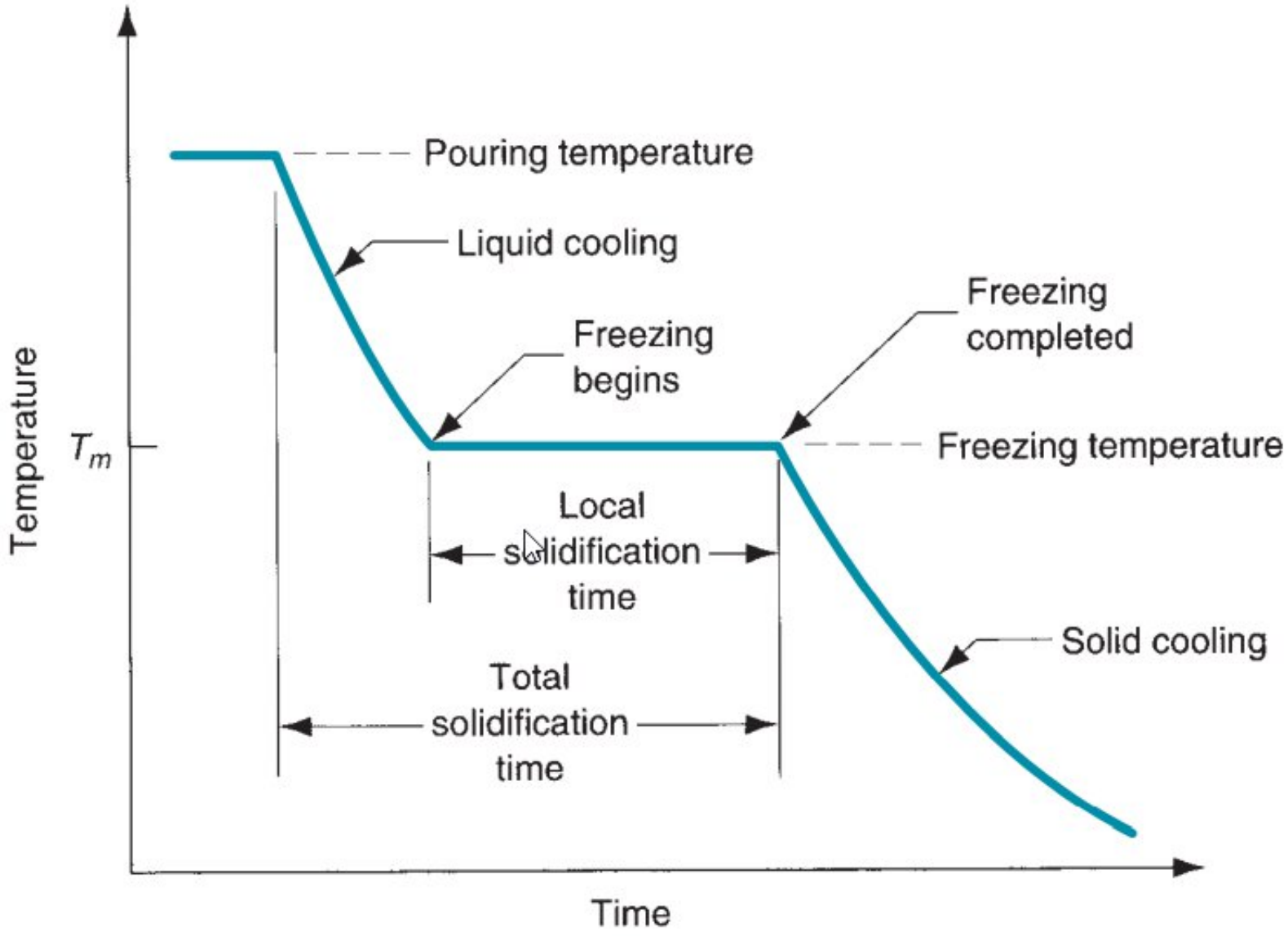
- **However, shell molding process uses phenolic resin as the bonded material, which will be more costly**

- **metal is the most used material to make patterns for a process of shell moulding.**

COOLING CURVE OF AN ALLOY



COOLING CURVE OF A PURE METAL



SOLIDIFICATION OF A CASTING