Swami Keshvanand Institute of Technology, Management & Gramothan - Jaipur

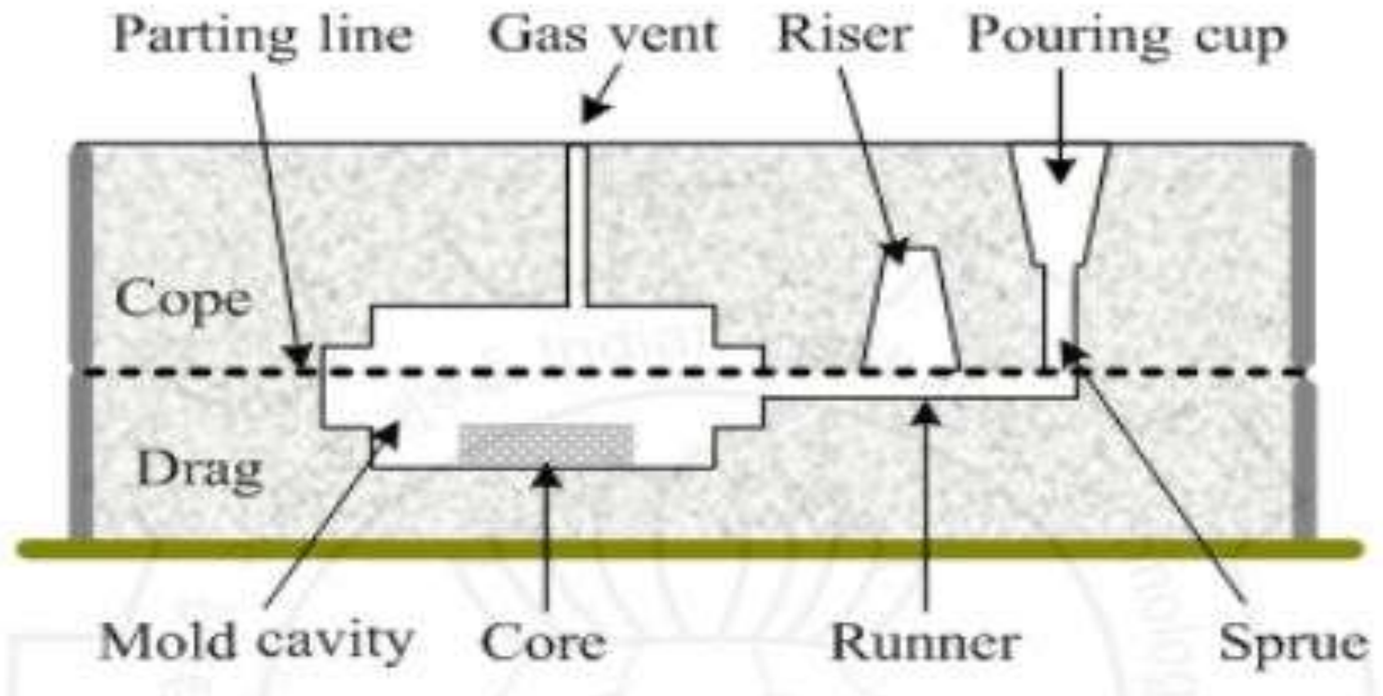
Course: Basic Mechanical Engineering
Lecture No.: 25
Topic: Metal Casting Processes
Sub topic: Introduction to casting process, advantages and limitations

Department of Mechanical Engineering

Casting

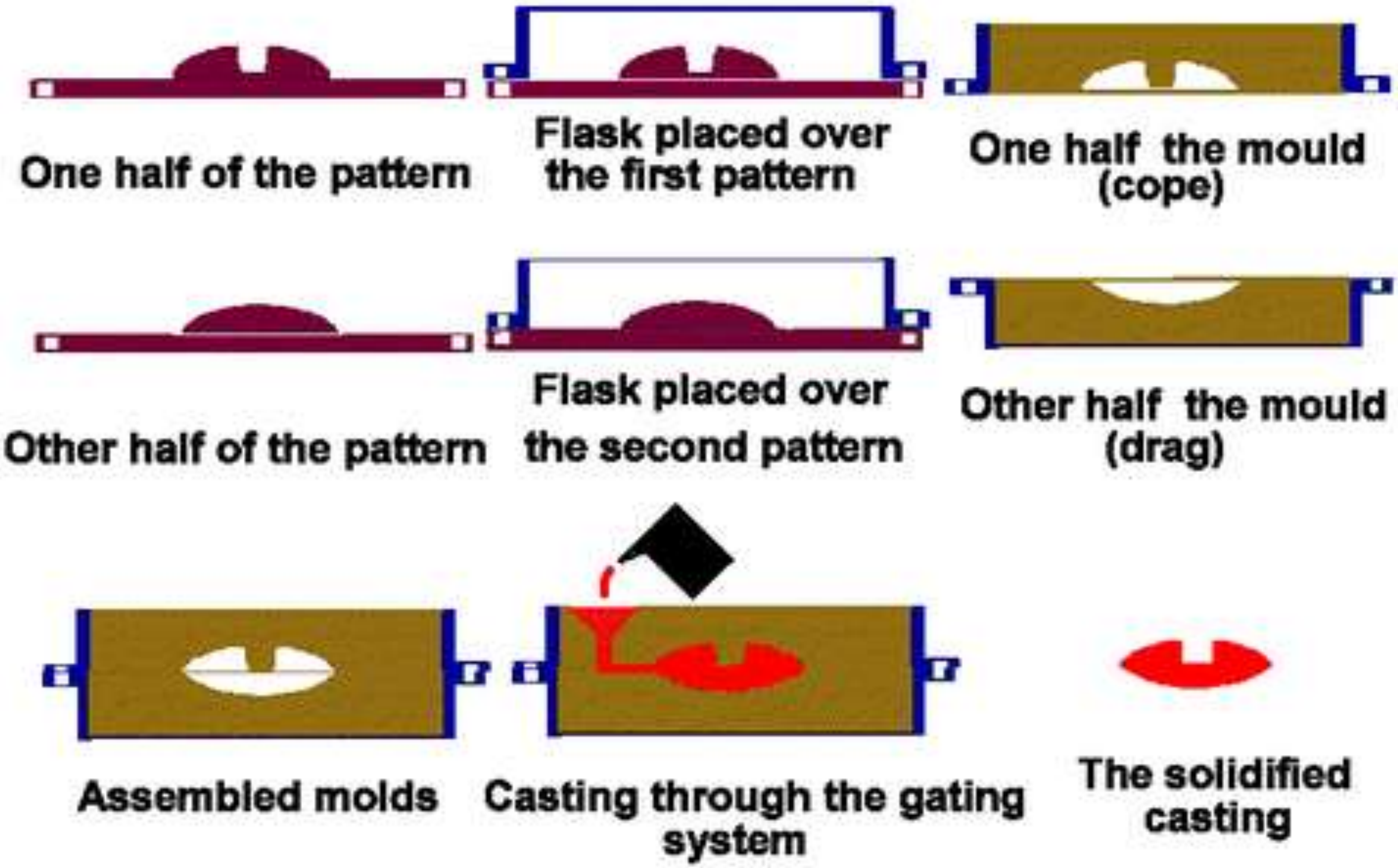
- Casting is a manufacturing process in which a liquid metal is poured into a predefined cavity (also known as mould) of desired shape.
- Then it is allowed to solidify.
- The solidified part is the final product,which is ejected or broken out of the mould to complete the process.

Metal-Casting Processes

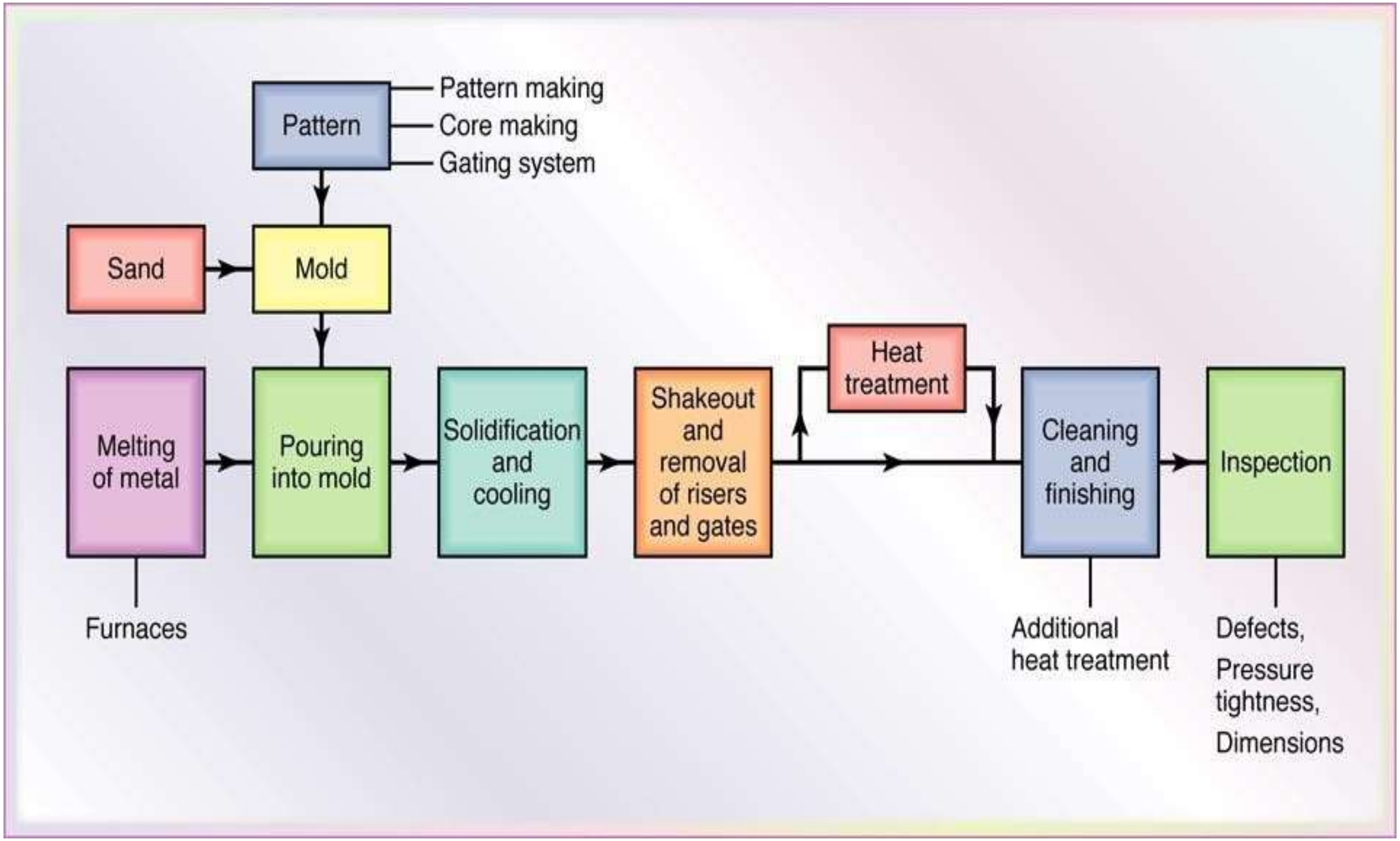


Schematic set-up of sand moulding / casting process

Step in sand moulding Process



Production Steps in Sand-Casting



Advantages of casting process:

- Molten metal can flow into any small section in mould cavity, hence very **complex shapes** can be casted easily.
- Practically **any** type of **material** can be casted.
- Due to uniform cooling from all the directions, the **properties** of casted parts are **homogenous**.
- **Huge sized** casting can be produced up to 200 tonnes.

Limitations

- Cating provides **poor surface** finish and mostly requires secondary surface finishing operations.
- Casting involves number of **defects** in this process.
- Casting gives very **low** fatigue **strength** compare to metal forming processes.
- It is **not economical** for mass production

Applications

- **Transport** : Automobile, aerospace, railways and shipping.
- **Heavy Equipment :** Construction, farming and mining.
- **Plant Machinery :** Chemical, petroleum, paper, sugar, textile, steel and thermal power plants.
- **Defense :** Vehicles, artillery, storage and supporting equipments.
- **Electrical Equipment Machines :** Motors, generators, pumps and compressors.
- **Household :** Home and kitchen appliances, gardening equipments and fittings etc.

Examples of Cast Parts

Crank handle formed by casting; some surfaces were machined and assembled after casting

C-clamps formed by casting (left) and machining (right)

Swami Keshvanand Institute of Technology, Management & Gramothan - Jaipur

Course: Basic Mechanical Engineering
Lecture No.: 26
Topic: Patterns, Types of Pattern, Pattern Allowances
Sub topic: Introduction to pattern types and various casting allowances.

Department of Mechanical Engineering

Pattern

Pattern is the replica of the final product.

The type of pattern to be used for a particular casting depends upon many factors like design of casting, complexity of shape, number of casting required, mould process, surface finish and accuracy.

Functions of the Pattern

1)A pattern prepares a mould cavity for the purpose of making a casting.

2)A pattern may contain projections known as core prints if the casting requires a core and need to be made hollow.

3)Patterns properly made and having finished and smooth surfaces reduce casting defects.

4)A properly constructed pattern minimizes the overall cost of the castings.

Pattern material

- Wood
- Metal
- Plastic
- Plaster of paris
- Wax

Properties of Pattern Material

- Easily worked, shaped and joined
- Light in weight
- Strong, hard and durable
- Resistant to wear and abrasion
- Resistant to corrosion and to chemical reactions
- Dimensionally stable and unaffected by variations in temperature and humidity
- Available at low cost

Wood

- Advantages

➢ Cheap, easily available, light, easiness in surfacing, workable, ease in joining, fabrication

- Disadvantages

➢ Moisture effects, wear by sand abrasion, warp during forming, not for rough use.

➢ Must be properly dried/ seasoned, free from knots, straight grained

Egs. Burma teak, pine wood, mahogany, Sal, Deodar, Shisham, Walnut, Apple tree

Metals

- Used for mass production castings
- For maintaining closer dimensional tolerances on casting.
- More life when compared to wooden patterns
- Few of the material used include CI, Al, Fe, Brass etc. Al is widely used.

- **Egs: Al alloys, Brass, Mg alloys, Steel, cast Iron for mass production**

Advantages of Metallic patterns

- Do not absorb moisture
- More stronger
- Possess much longer life
- Do not wrap, retain their shape
- Greater resistance to abrasion
- Accurate and smooth surface finish
- Good machinability

Plastics

- Low weight
- Easier formability
- Do not absorb moisture
- Good corrosion resistance

- The most generally used plastics are
  - Epoxy resins with fillers
  - PU foam

Plaster

- Plaster of Paris or gypsum cement is used as a pattern material
- Complicated shapes can be easily cast
- Has high compressive strength
- Used for making small and intricate patterns

Wax

- Wax is used in specialized applications such as **investment casting process** etc
- Wax provide **good surface finish**
- Provide high accuracy to the casting

Types of patterns

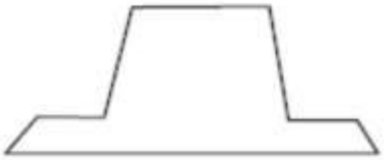
1. Single piece(Solid) pattern.
2. Split piece (Multipiece) pattern.
3. Loose piece pattern.
4. Match plate pattern.
5. Sweep pattern.
6. Gated pattern.
7. Follow board pattern.

1. Single piece (solid) pattern

- Made from one piece and does not contain loose pieces or joints.
- Inexpensive.
- Used for large size simple castings.
- Pattern is accommodated either in the cope or in the drag(but preferablly in drag box)

Examples:

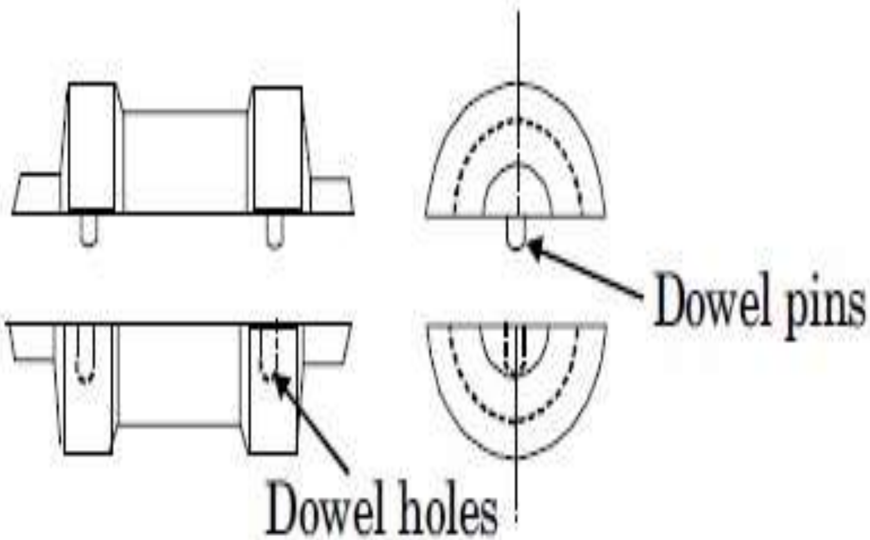
1. Bodies of regular shapes.
2. Stuffling box of steam engine.

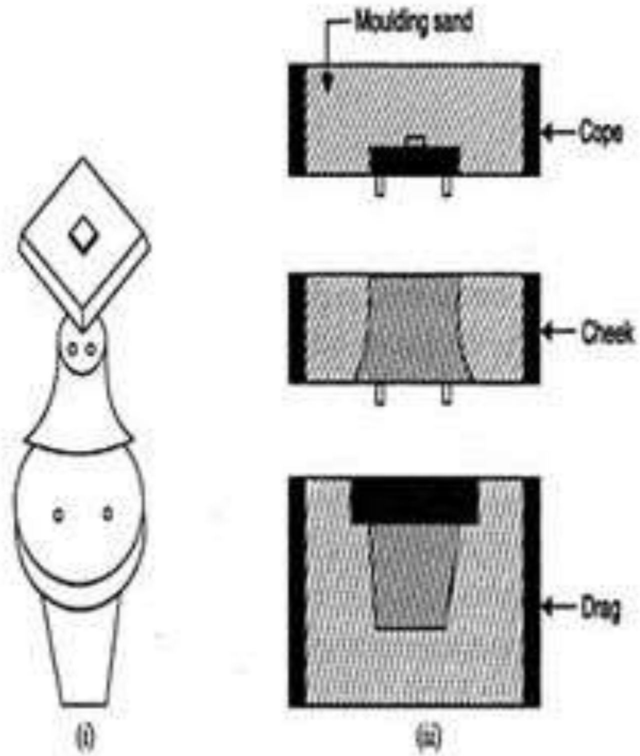


2. Split piece pattern

- Patterns of intricate shaped castings cannot be made in one piece because of the inherent difficulties associated with the molding operations (e.g. withdrawing pattern from mould).
- The upper and the lower parts of the split piece patterns are accommodated in the cope and drag portions of the mold respectively.

- **Dowel pins** are used for keeping the alignment between the two parts of the pattern.
- Examples:
    - Hollow cylinder
    - Water Taps and water, stop cocks etc.





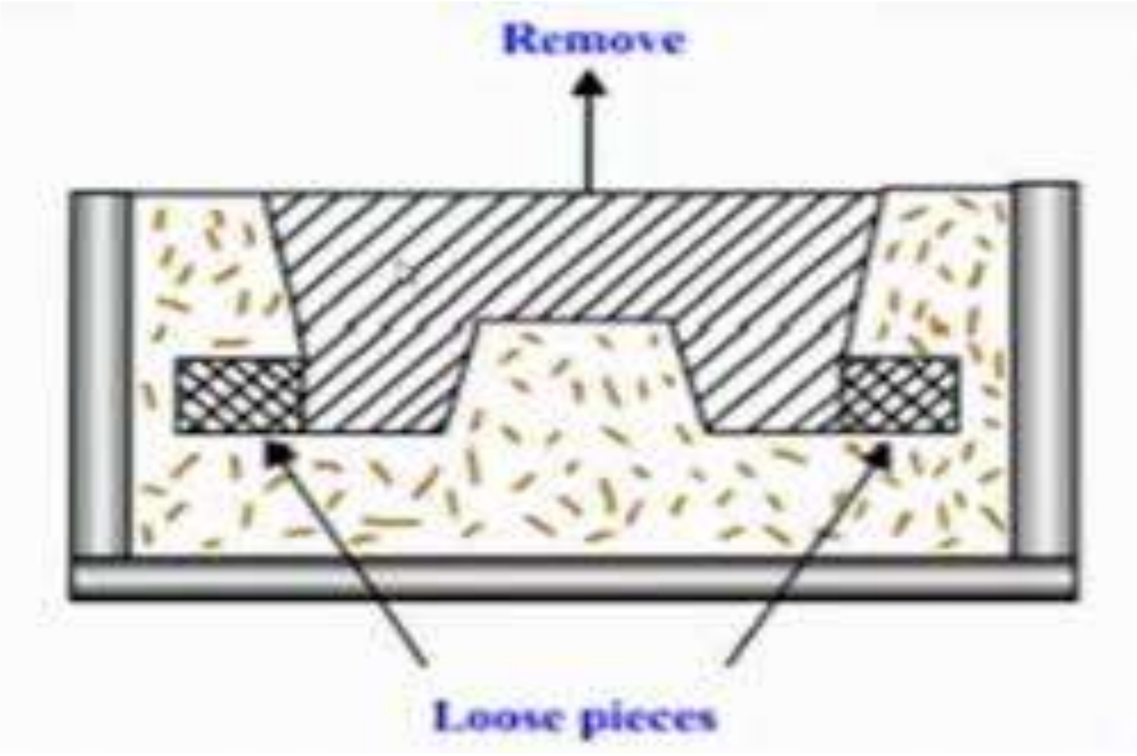
Two Piece Pattern

Three Piece pattern

3.Loose piece pattern

- Certain patterns cannot be withdrawn once they are embedded in the molding sand. Such patterns are usually made with one or more loose pieces for facilitating from the molding box and are known as loose piece patterns.
- Loose parts or pieces remain attached with the main body of the pattern, with the help of dowel pins.
- The main body of the pattern is drawn first from the molding box and thereafter as soon as the loose parts are removed, the result is the mold cavity.

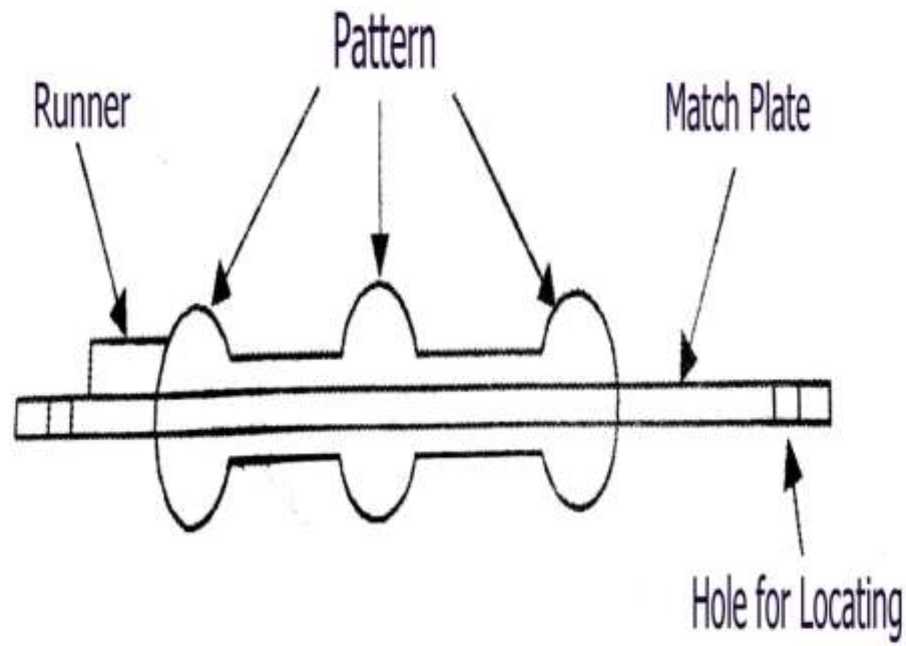
Loose piece pattern



4. Match plate pattern

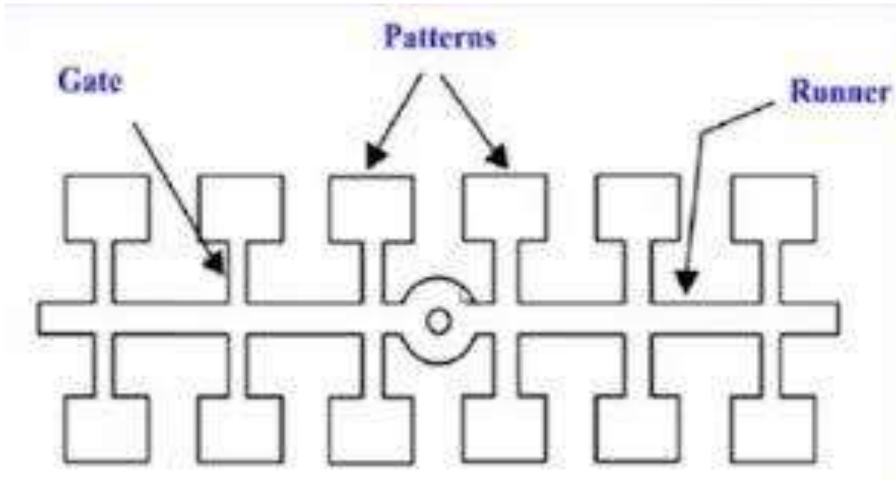
- It consists of a match plate, on either side of which each half of split patterns is fastened.
- **A no. of different sized** and **shaped** patterns may be mounted on one match plate.
- The match plate with the help of locator holes can be clamped with the drag.
- After the cope and drag have been rammed with the molding sand, the match plate pattern is removed from in between the cope and drag.

- By using this we can eliminate mismatch of cope and drag cavities.



5.Gated pattern

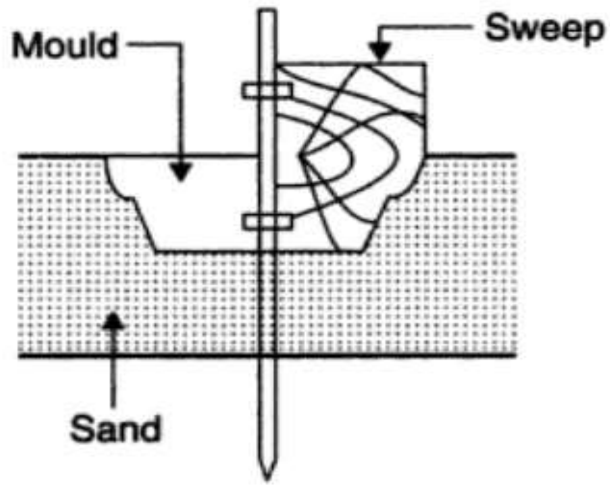
- The sections connecting different patterns serve as runner and gates.
- This facilitates filling of the mould with molten metal in a better manner and at the same time eliminates the time and labour otherwise consumed in cutting runners and gates.
- A gated pattern can manufacture many casting at one time and thus it is used in mass production systems.
- Gated patterns are employed for producing small castings.


Patterns
Gate
Runner

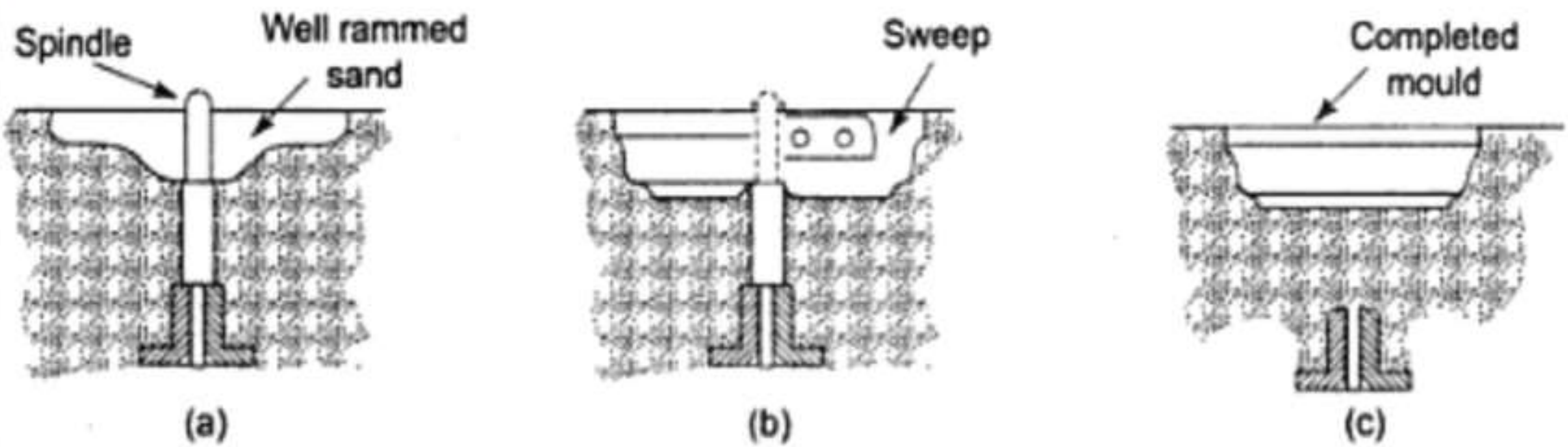
6.Sweep pattern

- **2D pattern and 3D Cavity.**
- A sweep pattern is just a form made on a wooden board which sweeps the shape of the casting into the sand all around the circumference. The sweep pattern rotates about the axis.
- Once the mold is ready, Sweep pattern is removed.
- Sweep pattern avoids the necessity of making a full, large circular and costly three-dimensional pattern.

- Making a sweep pattern saves a lot of time and labor as compared to making a full pattern.
- A sweep pattern is preferred for producing large casting of circular sections and symmetrical shapes.



Sweep pattern.

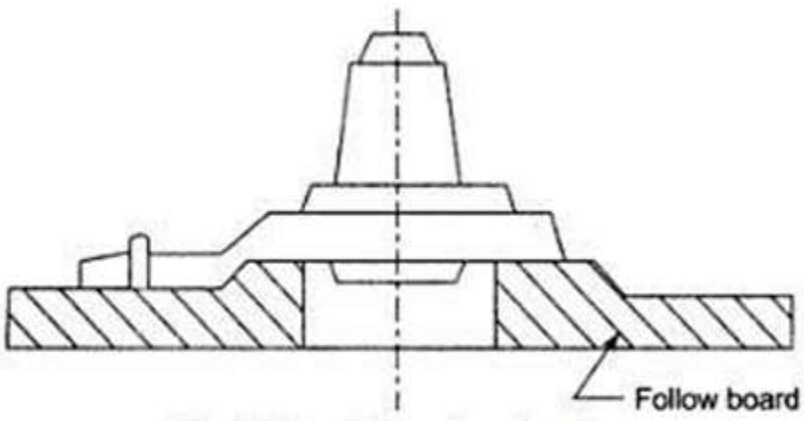


Sweep pattern

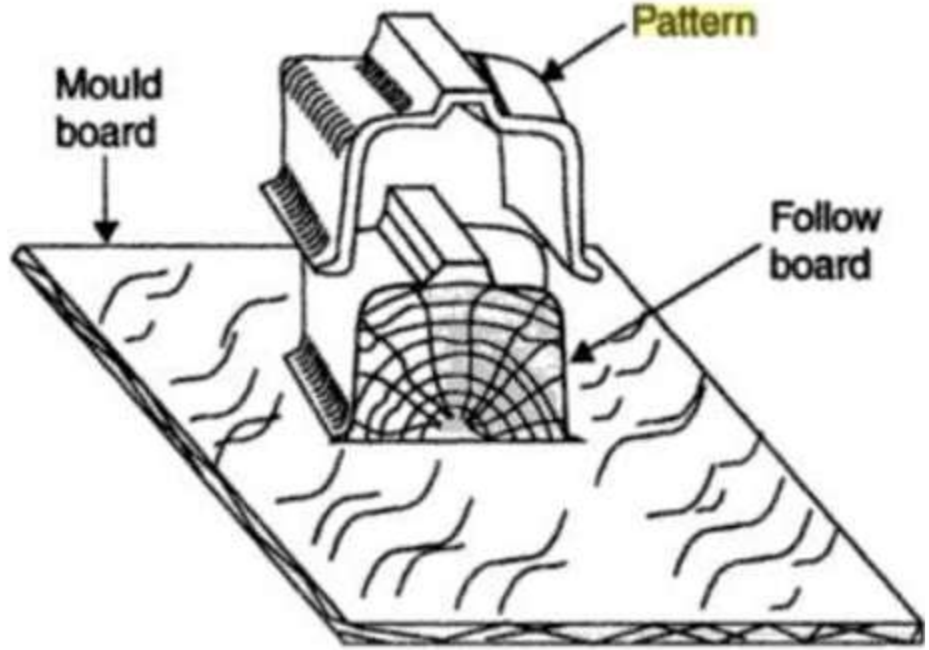
7. Follow board pattern

- A follow board is a wooden board and is used for supporting a **pattern** which is **very thin and fragile** and which may give way and collapse under pressure when the sand above the pattern is being rammed.
- With the **follow board support under the weak pattern.**

- Follow boards are also used for casting master patterns for many applications.



Follow board



Pattern
Mould board
Follow board

Pattern allowances

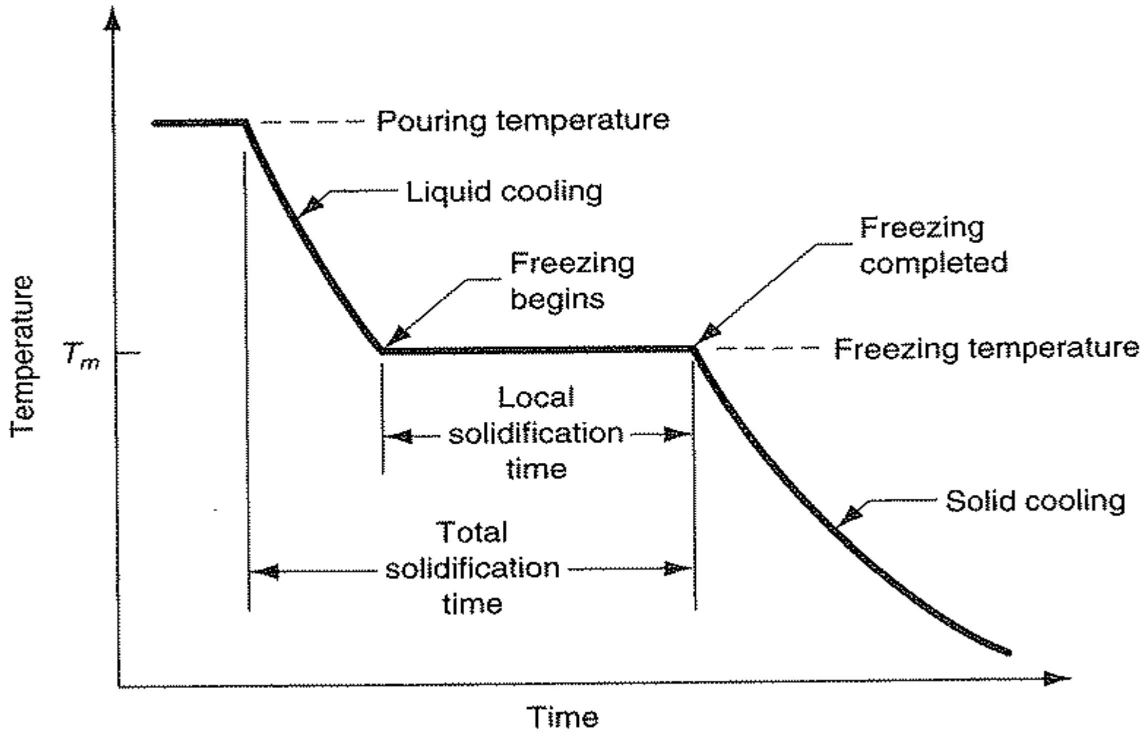
- Due to certain **metallurgical & mechanical** forces/reasons a pattern is always made larger than the final casting.
- **Types**

➢ Shrinkage or contraction allowance
➢ Draft or taper allowance
➢ Machining or finish allowance
➢ Distortion or camber allowance
➢ Shaking or Rapping allowance

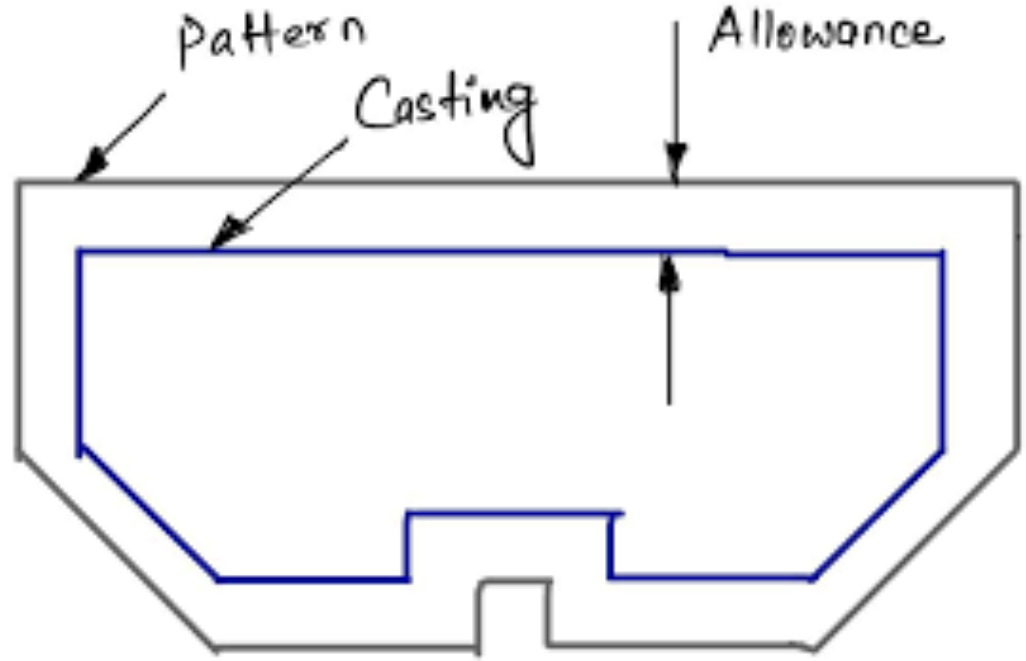
1. Shrinkage or contraction allowance

- Almost all metals shrink on solidification upon cooling after casting.
- shrinkage allowance is given to the pattern to compensate for the contraction of the liquid metal upon cooling.
- For this, the **dimensions** of the pattern is made slightly **oversize.**
- The shrinkage allowance will be different for different metals.
- The shrinkage allowance is greater for cast steel than that of other alloys.
- The shrinkage allowance is always added along the length than along the diameter (as metals shrink towards the centre).

- Shrinkage Allowance:



- Liquid Shrinkage
- Solid Shrinkage


Pattern
Casting
Allowance

2. Machining or finish allowance

- Pattern is made larger.
- This allowance is provided on the pattern if the casting is to be machined.
- This allowance is given in addition to shrinkage allowance.
- The amount of this allowance varies from 1.6 to 12.5 mm which depends upon the type of the casting metal, size and the shape of the casting.
- The ferrous metals require more machining allowance than non ferrous metals.

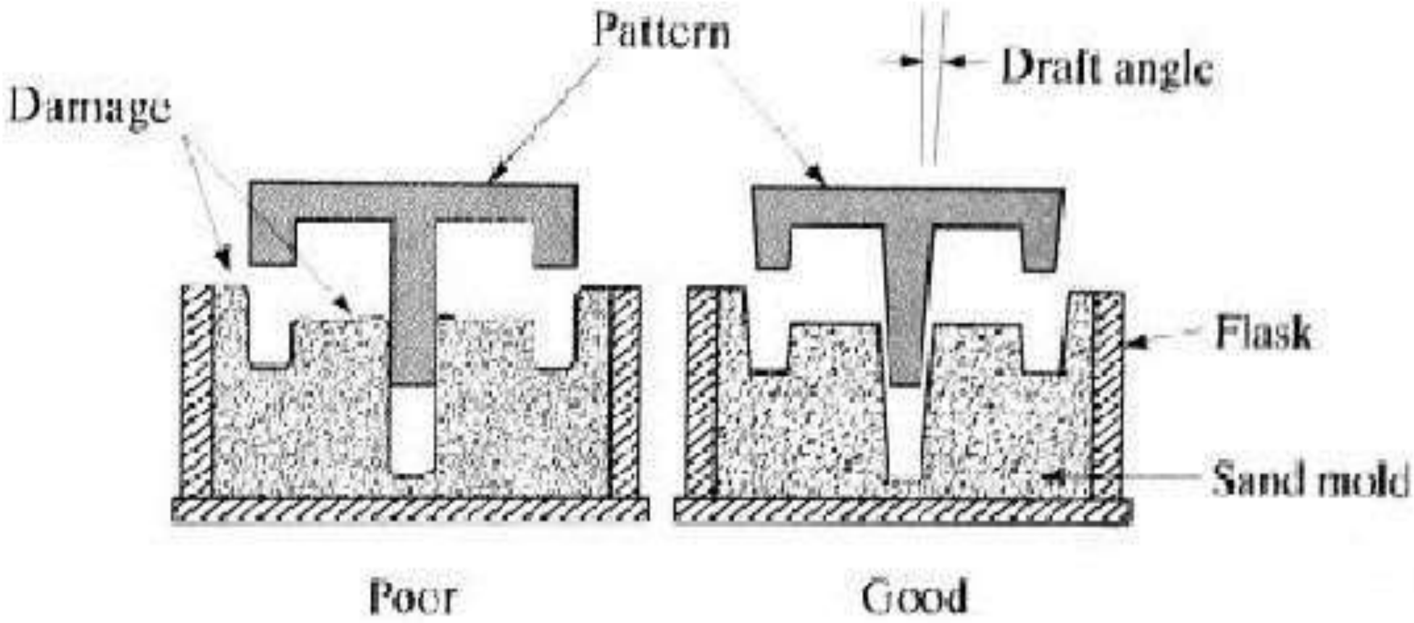
Is given due to the following reasons:

1. For removing surface roughness, Scale, slag, dirt and other imperfections from the casting.
2. For obtaining exact dimensions on the casting.
3. To achieve desired surface finish on the casting.

The dimension of the pattern to be increased depends upon the following factors:

1. Method of machining used (turning, grinding, boring, etc.).
2. Characteristics of metal
3. Method of casting used.
4. Size and shape of the casting.
5. Degree of finish required.

3. Draft or taper allowance



- Provided to facilitate easy withdrawal of the pattern.
- Typically it ranges **from 1 degree to 3 degree** for wooden patterns.

•The amount of draft required **depends upon the shape and size** of the casting, moulding method, intricacy of pattern, and whether moulded by hand or machine.

4. Distortion or Camber Allowance

- Sometimes castings, because of their size, shape and type of metal, tend to warp or distort during the cooling period depending on the cooling speed.
- Expecting the amount of warpage, a pattern may be made with allowance of warpage. It is called camber.
- For example, a U-shaped casting will be distorted during cooling with the legs converged, instead of parallel as shown in fig. For compensating this warpage, the pattern is made with the legs diverged but, as the casting cools, the legs straighten and remain parallel.

Pattern with camber allowance

Actual Casting

Casting without camber

5. Rapping or Shaking Allowance

- When the pattern is shaken for easy withdrawal, the mould cavity, hence the casting is slightly increased in size. In order to compensate for this increase, the pattern should be initially made slightly smaller.
- For small and medium sized castings, this allowance can be ignored.
- Large sized and precision castings, however, shaking allowance is to be considered.
- The amount of this allowance is given based on previous experience.

Swami Keshvanand Institute of Technology, Management & Gramothan - Jaipur

Course: Basic Mechanical Engineering
Lecture No.: 27
Topic: Moulding materials and their properties
Sub topic: Properties of moulding materials and basic casting tools.

Department of Mechanical Engineering

Types of Moulding Sands

Green Sand:

- Natural sand prepared as a mixture of silica sand with 18-30 % clay and 6-8 % moisture.
- Fine, soft, light and porous.
- The name 'Green sand' employs for damped i.e. it **contains moisture** and the mould made of this sand is used immediately to pour the molten metal.
- Easily available and has low cost.

Dry Sand:

- Green sand that has been **dried or baked** in between 250° to 550° in suitable oven after the making mould and cores, is called dry sand.
- More strength, rigidity and thermal stability.
- Suitable for larger castings.

Parting Sand:

- It is used to **keep away** the green sand **from sticking to the pattern** and to allow the sand on the parting surface of the flasks to separate without clinging.
- It is free from clay and is dry.
- It is washed and non sticky sand

Core Sand:

- Used to make core.
- Should be stronger than the moulding sand.
- It is made by mixing core linseed oil with silica sand,
- It is also called as soil sand

Backing sand
It usually contains burnt facing sand, moulding sand and clay.
It is old and repeatedly used sand and used for baking facing sand
It is **filled behind the facing sand** in the mould box or flask.

Characteristics of moulding sand

1) Green strength

- The green sand after water has been mixed into it, must have sufficient strength and toughness to permit the making and handling of the mold.
- It is the strength of sand in the green or moist condition.

2) Dry strength

- As soon as the molten metal is poured into the mold, the **moisture** in the sand layer adjacent to the hot metal gets **evaporated** and this dry sand layer must have sufficient strength to its shape in order **to avoid erosion of mold wall** during the flow of molten metal.

3) Flowability or plasticity

- It is the ability of the sand to get compacted and behave like a fluid.
- It increses with amount of clay and water

4) Permeability or porosity

- It is also termed as porosity of the molding sand in order **to allow the escape of any air, gases** present or generated in the mold when the molten metal is poured into it.
- All these gaseous generated during pouring and solidification process must escape otherwise the **casting becomes defective.**
- Permeability of mold can be further increased by venting using vent rods

5) Refractoriness

- Refractoriness is defined as the ability of molding sand **to withstand high temperatures without breaking down** or fusing thus facilitating to get sound casting. It is a highly important characteristic of molding sands. Refractoriness can only be increased to a limited extent.
- Molding sand with poor refractoriness may burn on to the casting surface and no smooth casting surface can be obtained.

6) Adhesiveness

- It is property of molding sand to get stick or adhere with foreign material such sticking of molding sand with inner wall of molding box.

7) Cohesiveness

- It is property of molding sand by virtue which the **sand grain particles interact and attract each other within the molding sand**. Thus, the **binding capability** of the molding sand gets enhanced to increase the green, dry and hot strength property of molding and core sand.

8)Thermal stability

- Heat from the casting causes rapid expansion of the sand surface at the mold- metal interface.
- The mold surface may then crack, buckle, or flake off (scab) unless the molding sand is relatively stable dimensionally under rapid heating.

CONSTITUENTS OF MOLDING SAND

- The main constituents of molding sand involve silica sand, binder, moisture content and additives.

1)Silica sand

- Silica sand is the main constituent of molding sand having enough refractoriness which can impart strength, stability and permeability to molding and core sand.
- Along with silica small amounts **of iron oxide, alumina, lime stone, magnesia, soda and potash are present as impurities.**

- The silica sand can be specified according to the size (small, medium and large silica sand grain) and the shape (angular, sub-angular and rounded).

2) Additives

- Additives are the materials generally added to the molding and core sand **mixture to develop some special property in the sand**. Some common used additives for enhancing the properties of molding and core sands are

(i) Coal dust

Coal dust is added mainly for producing a reducing atmosphere during casting. This reducing atmosphere results in any oxygen in the poles becoming chemically bound so **that it cannot oxidize the metal**.

It absobs the excess air.

(ii) Dextrin

- Dextrin belongs to starch family of carbohydrates. It **increases dry strength** of the molds.

(iii) Pitch

- It is distilled form of soft coal. It can be added from 0.02 % to 2% in mold and core sand.
- It enhances **hot strengths, surface finish** on mold surfaces.

(iii) Binders

- Binders are **added to give cohesion to molding sands**.
- Binders provide strength to the molding sand and enable it to retain its shape as mold cavity.
- Binders should be added in **optimum quantity** as they reduce refractoriness and permeability.
- An optimal quantity of binders is needed, as further increases have no effect on properties of foundry sand.
- The following binders are available

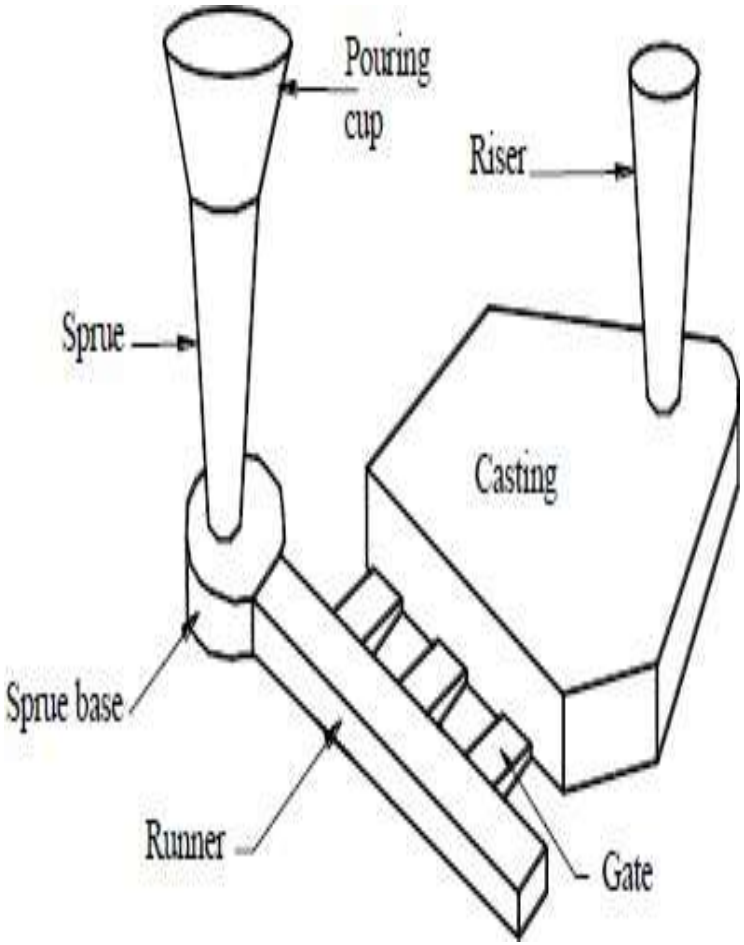
(i)   Fireclay (ii) Illite (iii) **Bentonite(clay binders)**

iv) Limonite (iv) Kaolinite

(iv) Moisture(Water)

- The amount of moisture content in the molding sand varies generally between **2 to 8 percent**.
- This amount is added to the mixture of clay and silica sand **for developing bonds.**
- This is the amount of water required to fill the pores between the particles of clay without separating them.
- This amount of water is held rigidly by the clay and is mainly responsible for developing the strength in the sand.
- The effect of clay and water decreases permeability with increasing clay and moisture content.

Gating system



Hand moulding equipments

1.Shovel

- It is just like **rectangular pan** fitted with a **handle**. It is used **for mixing the moulding sand** and for moving it from one place to the other.

2. Riddle:

- It is used for **removing foreign materials** like nails, shot metal splinters of wood etc from the moulding sand.

3. Rammer:

- It is a wooden tool **used for ramming or packing the sand** in the mould. Rammers are made in different shapes.

4. Strike-off bar:

- It is used **to remove the surplus sand** from the mould after the ramming has been completed.

5. Vent wire:

- It is a mild steel wire used for **making vents** or openings in the mould.

6. Lifter:

- It is a metal piece used for patching deep section of the mould and **removing loose sand from pockets of the mould.**

7. Trowel:

- It contains of a flat and thick metal sheet with upwards projected handle at one end. It is used for making joints and finishing flat surface of a mould.

8. Swab:

- It is made of flax or hemp. It is used for applying water to the mould around the edge of the pattern.

9. Draw spike:

- It is a metal rod with a pointed or screwed end. It is used **for removing the pattern from the mould**.


Finishing Trowel
Lifter / Cleaner
Swab
Vent Wire
Square and Heart Slick

Swami Keshvanand Institute of Technology, Management & Gramothan - Jaipur

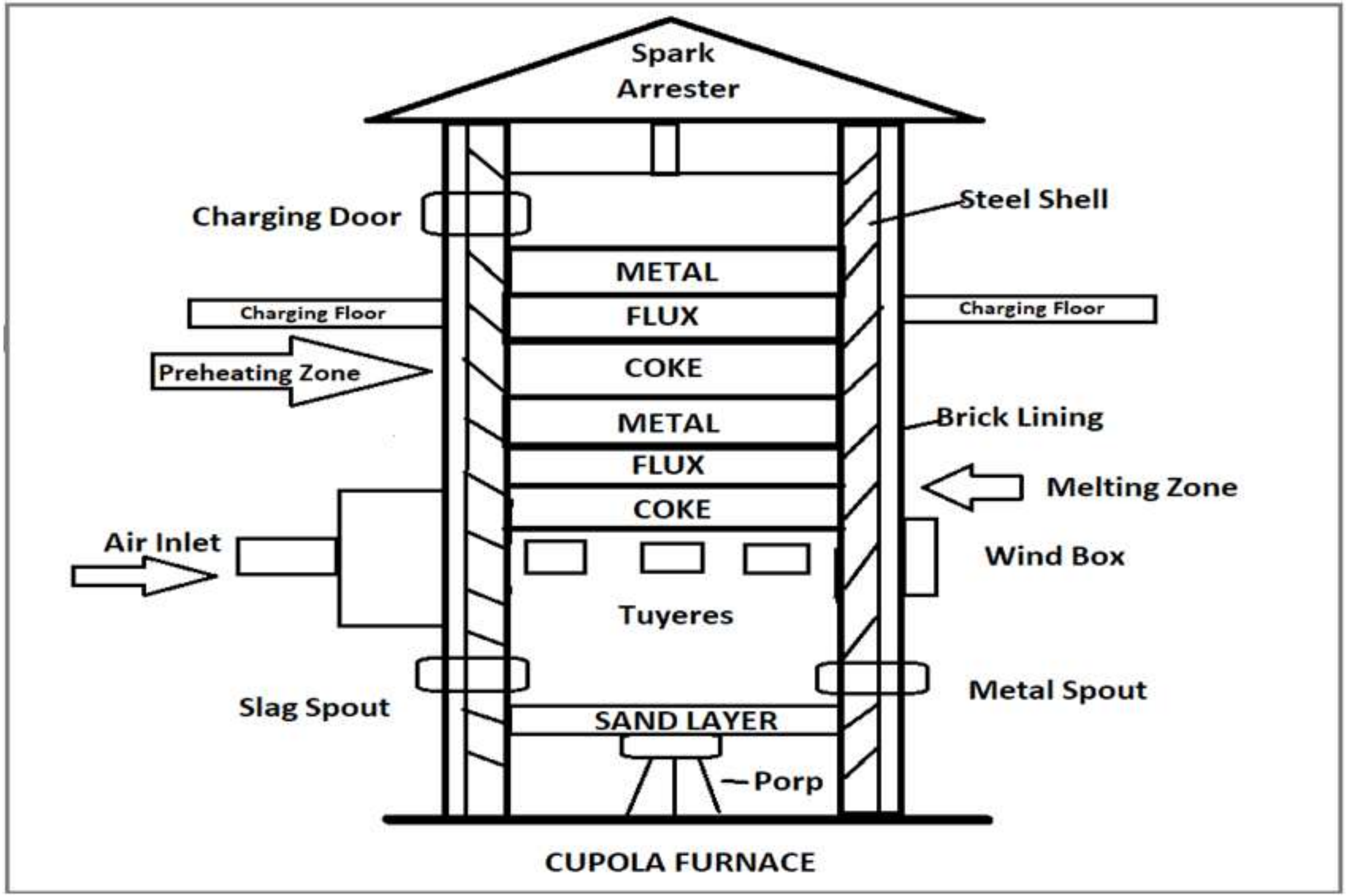
Course: Basic Mechanical Engineering
Lecture No.: 28
Topic: Casting Furnaces
Sub topic: Introduction to Casting Furnaces and types of Furnaces

Department of Mechanical Engineering

Melting Furnaces

- **Cupola Furnace:** They are used for producing molten cast iron
- **Electric Arc Furnace:** They are alsp used to melt ferrous like steel and iron alloys.

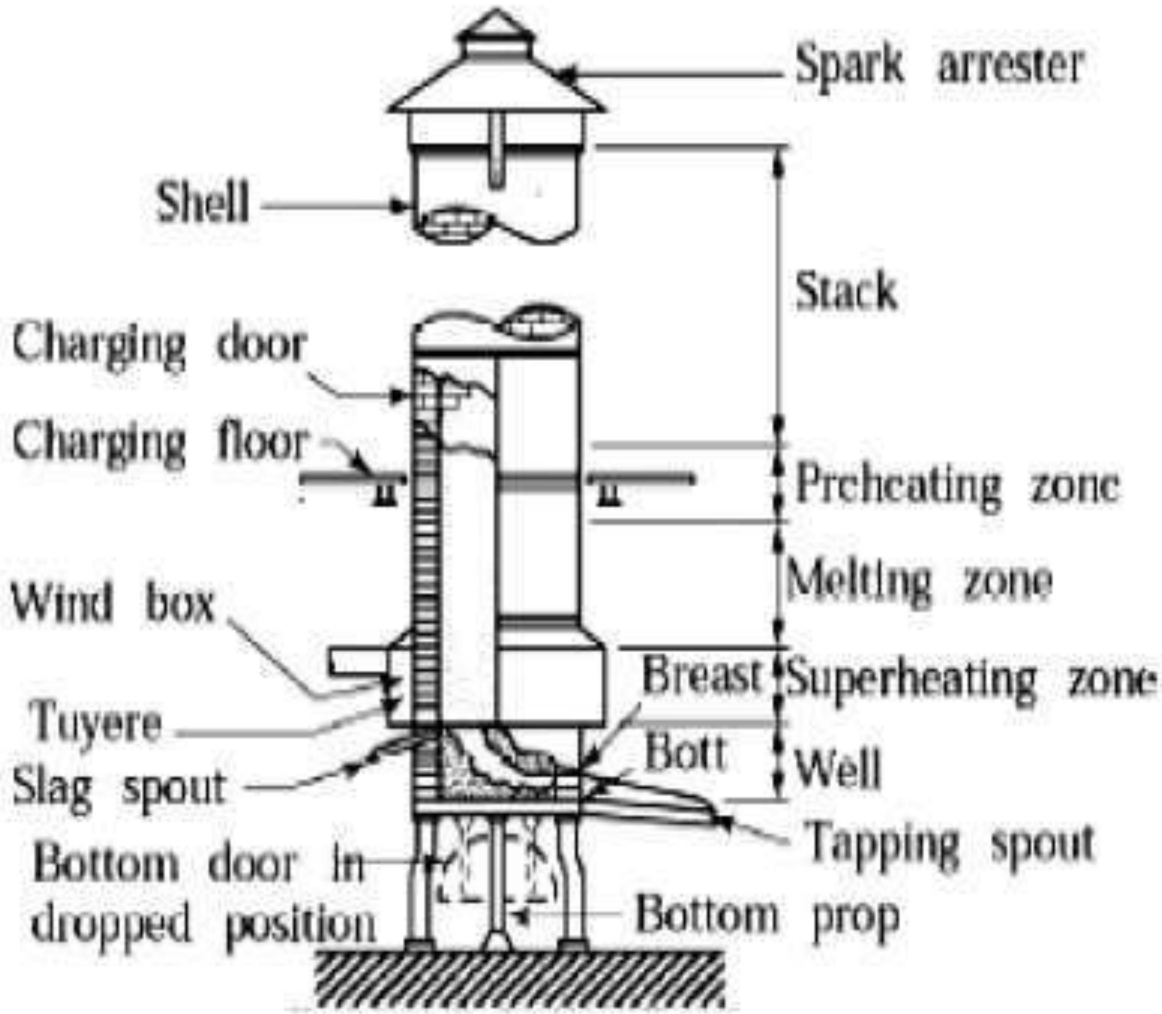
Cupola Furnace



Cupola Furnace

- A **cupola** or **cupola furnace** is a melting device used in foundries that can be used to melt cast iron, Ni-iron and some bronzes.
- The size of a cupola is expressed in diameters and can range from 1.5 to 13 feet (0.5 to 4.0 m)
- The overall shape is cylindrical and the equipment is arranged vertically, usually supported by four legs

Cupola



Spark arrester
Shell
Stack
Charging door
Charging floor
Preheating zone
Melting zone
Wind box
Breast
Superheating zone
Tuyere
Bott
Well
Slag spout
Tapping spout
Bottom door in dropped position
Bottom prop

Construction of Cupola

The cupola is a shaft type furnace for producing molten cast iron.

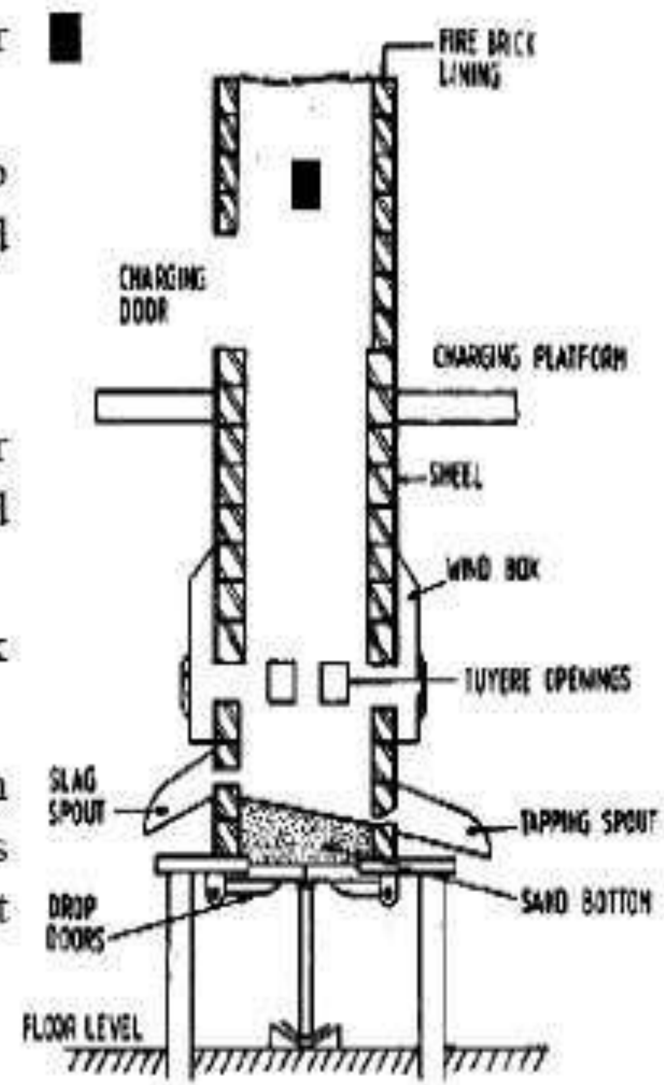
It is a vertical cylindrical shell made of 6 to 12 mm thick steel sheets or plates riveted and lined inside with refractory bricks.

Diameters vary from 1 to 2 meters.

The lining is generally thicker in the lower region, where the temperatures encountered are very high than in the upper region.

The shell is mounted either on a brick work foundation or on a steel column.

The bottom of the shell is provided with drop-bottom doors, through which debris consists of slag, coke etc. can be removed at the end of the melt.



In cupolas the working bottom is built up with molding sand, which covers the drop doors.

This bottom sand slopes towards the metal tapping hole situated at the lowest point at the front of the cupola.

The tap hole is used to tap molten metal.

Opposite to this tap hole, and slightly above, is another hole, called the slag hole, which enables the slag to be taken out.

The air for combustion is blown with the help of a motorized blower, through a pipe called wind pipe to a circular jacket wound around the shell called wind box. And finally the air goes in to the shell through a number of openings called tuyeres, which are provided at above the bed of the cupola.

The tuyeres are generally 4,6, or 8 in numbers depending on the size of the cupola. They may be fitted in one or more number of rows.

A charging door is provided through which metal, coke and flux are fed into the furnace, and this is situated 3 to 6 m above the tuyerers, according to the size of the cupola.

At the top of the furnace a conical cap called the spark arrester, prevents the sparks from emerging outside.

The spark arrester cools down the sparks and allows only smoke to escape from the opening.

Zones in Cupola

Crucible Zone: It is between the top of the sand and the bottom of the tuyeres. The molten metal comes here.

Tuyeres Zone: It is between the bottom of tuyeres to the top of tuyeres.

Combustion or oxidizing Zone: This zone is located above the tuyeres where the combustion of the fuel occurs by oxygen of the air blast and produces lot of heat in the cupola. Heat is also evolved due to oxidation of silicon and manganese. The chemical reactions which occurs in this zone are:

- $C + O_2 \longrightarrow CO_2 + \text{Heat}$
- $Si + O_2 \longrightarrow SiO_2 + \text{Heat}$
- $2Mn + O_2 \longrightarrow 2MnO_2 + \text{Heat}$

Preheating Zone or Charging Zone: It is located above the melting zone to the charging door. Iron and coke are preheated in this zone.

Reduction Zone: This zone extends from the top of the combustion zone to the top of the coke bed. CO2 produced in combustion zone comes in contact with hot coke and is reduced to CO. The reaction taking place in this zone is:

- $CO_2 + C \text{ (coke)} \rightarrow 2CO - \text{Heat}$

Melting Zone: It is the first layer of iron above the coke bed. The temperature in this zone is as high as 17000c. Iron is meted in this zone. A considerable carbon is picked up by the molten metal in this zone according to the following reactions;

- $3Fe + 2CO \longrightarrow Fe_3c + CO_2$

Stack zone: This zone carries gases from preheating zone to atmosphere and arrests sparks.

Working of Cupola

Preparation of Cupola:

After each heat, the slag and refuse are cleaned as soon as the patching of the lining is completed; the bottom doors are raised and held in position by metal props. The sand bottom is made such that it slopes towards the tap hole.

Firing the Cupola:

Small pieces of wood are ignited on the sand bottom when the wood burns well. Coke is then added. Air necessary for combustion is fed from the tuyeres. Coke is added until the desired height is reached

Charging of the Cupola:

After the coke bed is properly ignited, coke and pig iron are charged in alternative layers until the cupola is full.

In addition of iron and coke, a certain amount of limestone is added to first metal charge. Besides that fluorspar (CaF2) and soda ash (Na2CO3) are also used as fluxing materials. A flux removes the impurities in the iron and protects the iron from oxidation. Limestone reduces the meting point of the slag and increases fluidity. Sometimes ferro-manganese is also used as deoxidizer.

Soaking of Iron:

After the cupola is fully charged up to the charging door, the charge should soak in the heat for about 45 minutes. The charge gets slowly heated since the air blast is kept at a lower than normal blowing rate during this time. This causes the iron to get soaked

Opening the air blast:

At the end of soaking full blast is turned on. After the blast has been on for a few minutes, molten metal starts accumulating in the hearth.

Tapping and Slagging:

The first tapping can be made 40 to 50 minutes after the full blast is turned on. Slag is first removed through the slag hole and then the molten metal is collected in ladles and is carried to the moulds for pouring.

Closing the Cupola:

When the operation is over, the blast is shut off and the prop under the bottom door is knocked down so that the bottom plates swing open. This enables the cupola remains to drop on the floor or in to a bucket. They are then quenched and removed from underneath the cupola.

Electric Arc Furnace

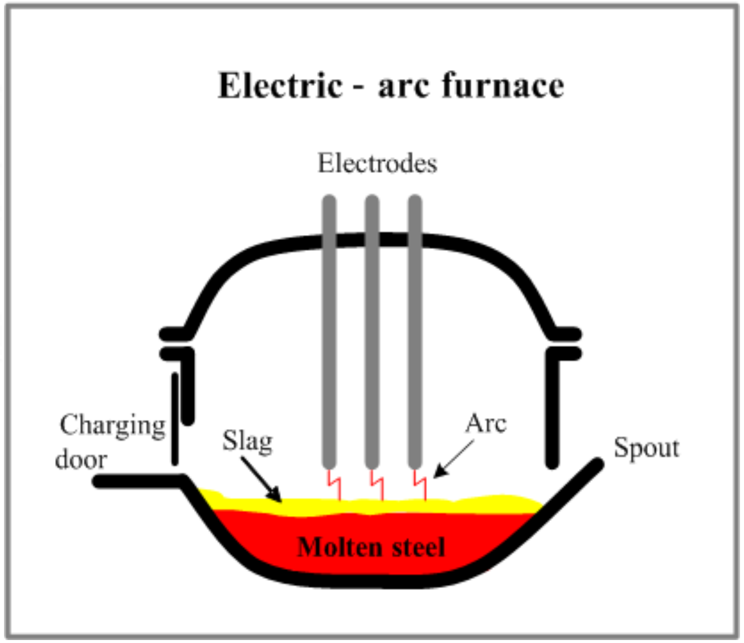
Three-phase Direct arc furnace is the most popular one for melting steel in the foundry. In operation, scrape steel is placed on the hearth of the furnace. An arc is drawn between the electrodes and the surface of the metal charge by lowering the electrodes down till current jumps. Slag is maintained on the molten metal to reduce oxidation. Before pouring liquid metal into the ladle, the furnace is tilted back and the slag is removed from the charging doors. Now the furnace is tilted forward to pour the molten metal into ladle.

Advantages:

- The main advantage of this furnace over cupola furnace is that purer production is obtained and composition can be exactly controlled during refining process.
- This furnace can operate on 100% scrape steel which is cheaper than pig iron.

Disadvantage:

- This furnace involves high initial cost



Swami Keshvanand Institute of Technology, Management & Gramothan - Jaipur

Course: Basic Mechanical Engineering

Lecture No.: 29

Topic: Metal Forming Processes

Sub topic: Introduction to Metal Forming processes and Rolling Process

Department of Mechanical Engineering

Metal Forming Processes

Classification

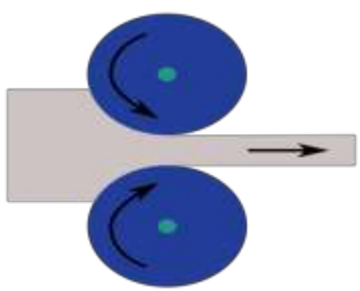
a) Rolling
b) Forging
c) Extrusion
d) Drawing

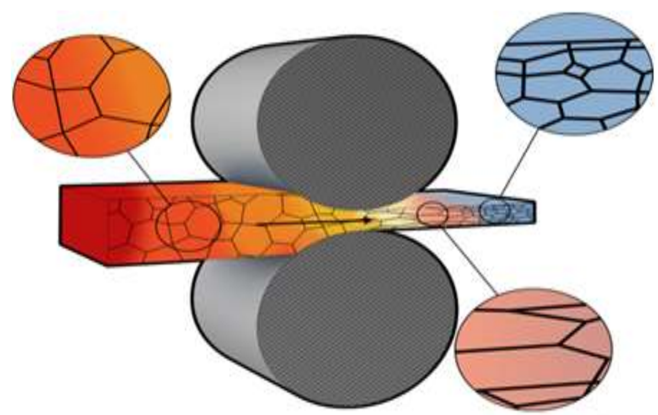
Hot vs cold Working

Hot Working	Cold Working
1. Process is done above recrystallisation temperature	1. Below recrystallisation temperature.
2. Process is done on hot metal.	2. Process is done on metals at room temperature.
3. Less force is required.	3. More force is required.
4. No residual stress is formed in the metal.	4. Residual stresses formed is more.

Rolling

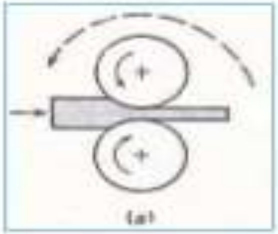
In metal working, **rolling** is a metal forming process in which metal stock is passed through one or more pairs of rolls to reduce the thickness, to make the thickness uniform, and/or to impart a desired mechanical property.





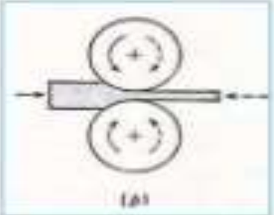
Types of Rolling Mills

Typical arrangement of rollers for rolling mills



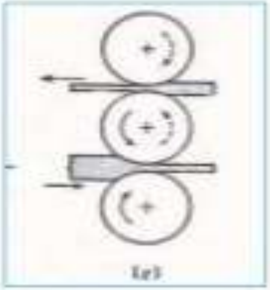
Two-high mill, pullover

The stock is returned to the entrance for further reduction.



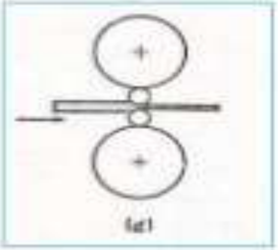
Two-high mill, reversing

The work can be passed back and forth through the rolls by reversing their direction of rotation.



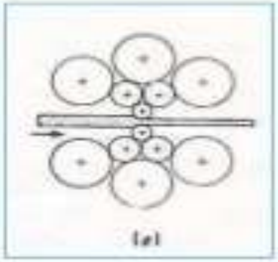
Three-high mill

Consist of upper and lower driven rolls and a middle roll, which rotates by friction.



Four-high mill

Small-diameter rolls (less strength & rigidity) are supported by larger-diameter backup rolls



Cluster mill or Sendzimir mill

Each of the work rolls is supported by two backing rolls.

Application of Rolling Process

- Rods, seamless hollow tubes are made by rolling.
- Rolling is used to cutting the gears on the gear blank.
- In automotive industries, various parts are manufactured by the rolling process.
- The rolling process is used to made plates, steel sheets, Rails and Plates etc.

Swami Keshvanand Institute of Technology, Management & Gramothan - Jaipur

Course: Basic Mechanical Engineering
Lecture No.: 30
Topic: Metal Forming Processes
Sub topic: Introduction to Forging Process and its Types

Department of Mechanical Engineering

Metal Forming Processes

Classification

a) Rolling
b) Forging
c) Extrusion
d) Drawing

Forging

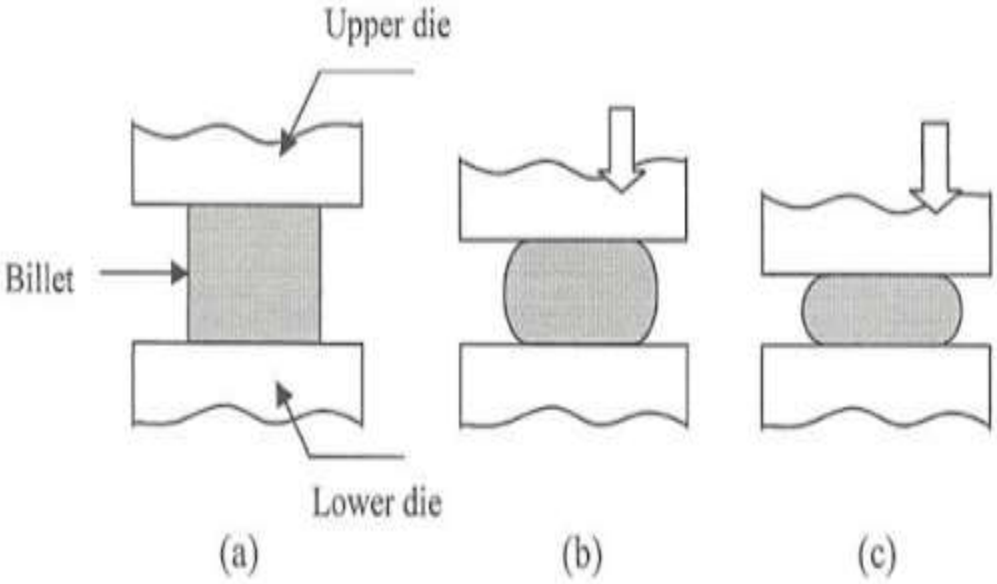
Forging is a manufacturing process involving the shaping of a metal through **hammering or pressing.** These compressive forces are delivered with a **hammer or a die.**
Forging is often categorized according to the temperature at which it is performed—cold or hot forging. A wide range of metals can be **forged**.

Types of Forging

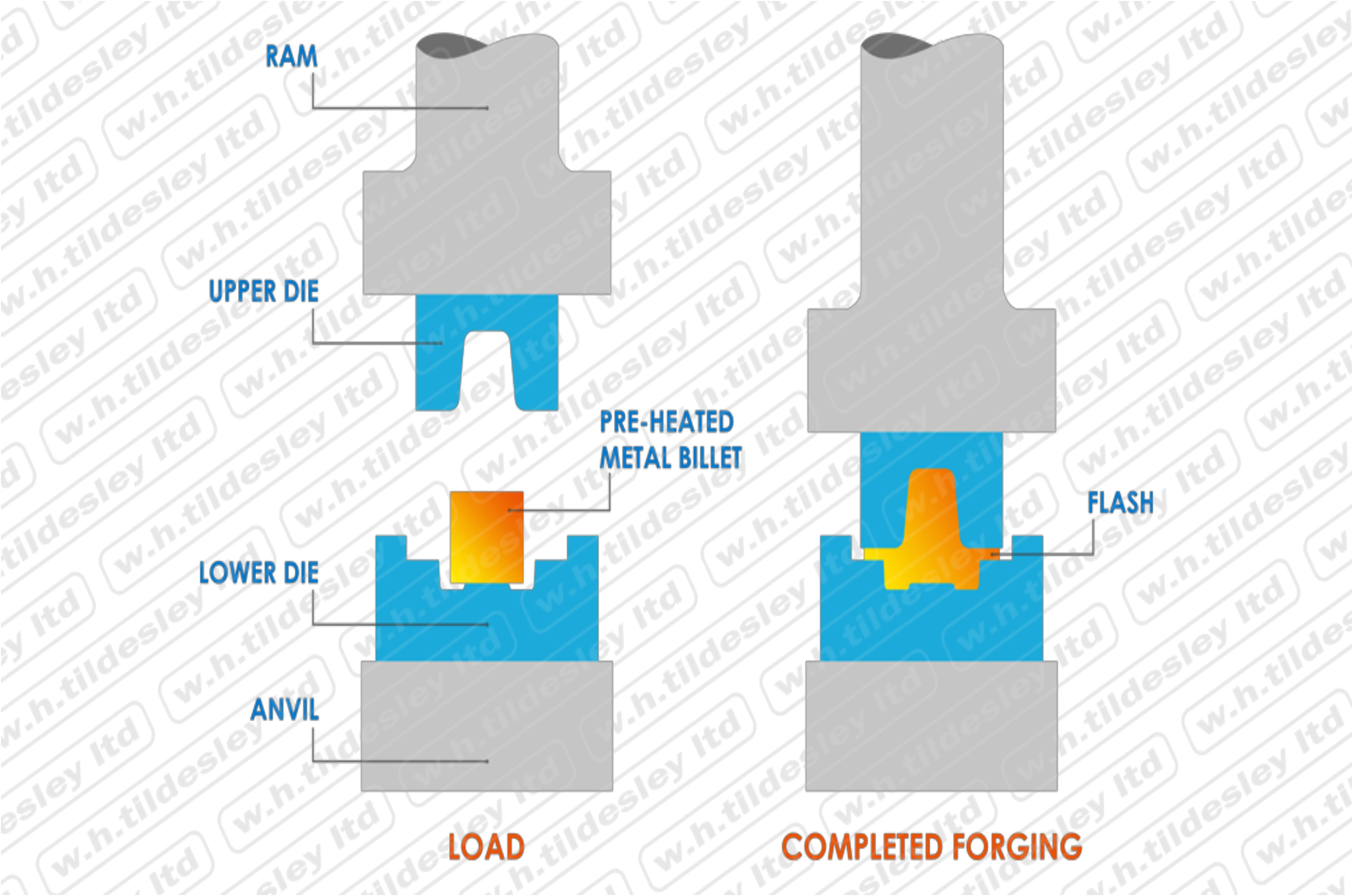
Following are the main types of forging processes:

A. Smith Forging (Open Die Forging)
B. Drop Forging (Closed Die Forging)
C. Press Forging (Closed Die Forging)

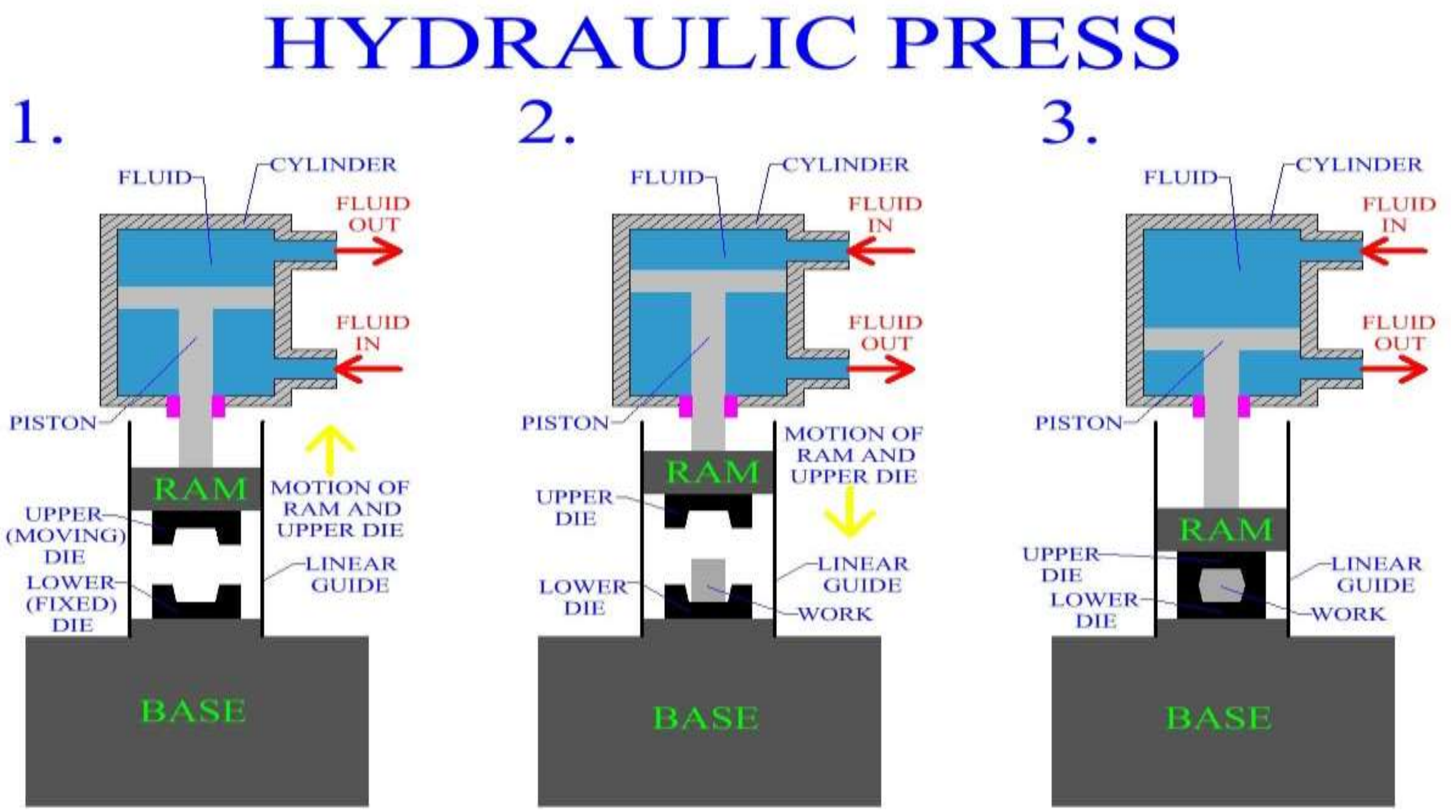
Smith Forging (Open Die Forging)



Drop Forging (Closed Die Forging)



Press Forging (Closed Die Forging)



Steps in Forging

Forging is generally defined as the working of metal into a desired shape using compressive forces.

1. Heating. Pre-forged metal starts with metal blocks called "ingots," which come in a variety of shapes and sizes depending on the part or component to be produced. These ingots are heated to a near molten state where the metal still retains its shape but can be altered easily with force.

2. Preforming. In order to form a piece of the ingot to be pressed between the closed dies, the heated ingot is edged and blocked with a press or hammer. Edging is done to increase the working cross section and blocking is implemented to refine the shape for finish forging.

3. Finish Forging. o complete the shape, the preformed metal is forced into an impression between two dies; this is where the metal takes on the general shape of the end product. Simple items may only need one press, but more complicated items may require multiple strokes at different pressures or even different dies to design the final product.

4. Cooling. By coordinating the cooling of the metal, forgers can increase the strength of the final product by deforming and optimizing the grain flow within the metal. A unique aspect of impression die forging is the "flash," which is the excess metal that flows outside of the dies.

5. Finishing. Once a forged product has gone through the pressing process, trimming and other surface treatment operations are performed in order to improve the dimensional accuracy of the forged product. Surface treatment can be completed to enhance corrosion resistance and improve the appearance of the finished forged product.

Applications of Forging Process

- **Automotive & truck:**forged components are commonly found at points of shock and stress such as wheel spindles, kingpins, axle beams and shafts, torsion bars, studs, idler arms and steering arms
- **Agricultural machinery & equipmentshafts:** levers and spindlesand cultivator shafts.
- **Hand tools & hardware:** pliers, hammers, sledges, wrenches and garden tools, as well as wire-rope clips, sockets, hooks.
- **Aerospace**
- **Valves, fittings, oil field applications etc.**

Swami Keshvanand Institute of Technology, Management & Gramothan - Jaipur

Course: Basic Mechanical Engineering
Lecture No.: 31
Topic: Metal Forming Processes
Sub topic: Introduction to Extrusion and Drawing Processes.

Department of Mechanical Engineering

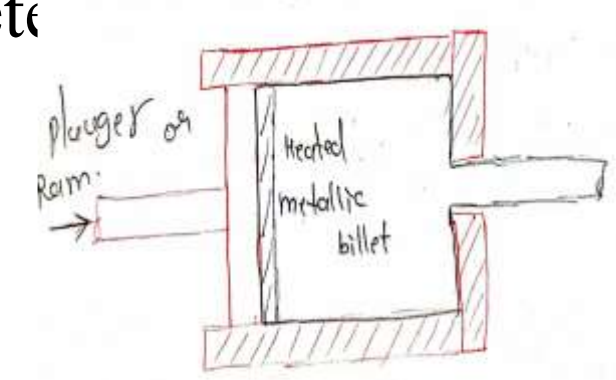
Metal Forming Processes

Classification

a) Rolling
b) Forging
c) Extrusion
d) Drawing

Extrusion

Extrusion is a process used to create objects of a fixed cross-sectional profile.
A material is **pushed** through a die of the desired cross-section.
The **extrusion process** can be done with the material hot or cold.
Commonly **extruded** materials include metals, polymers, ceramics, and concrete



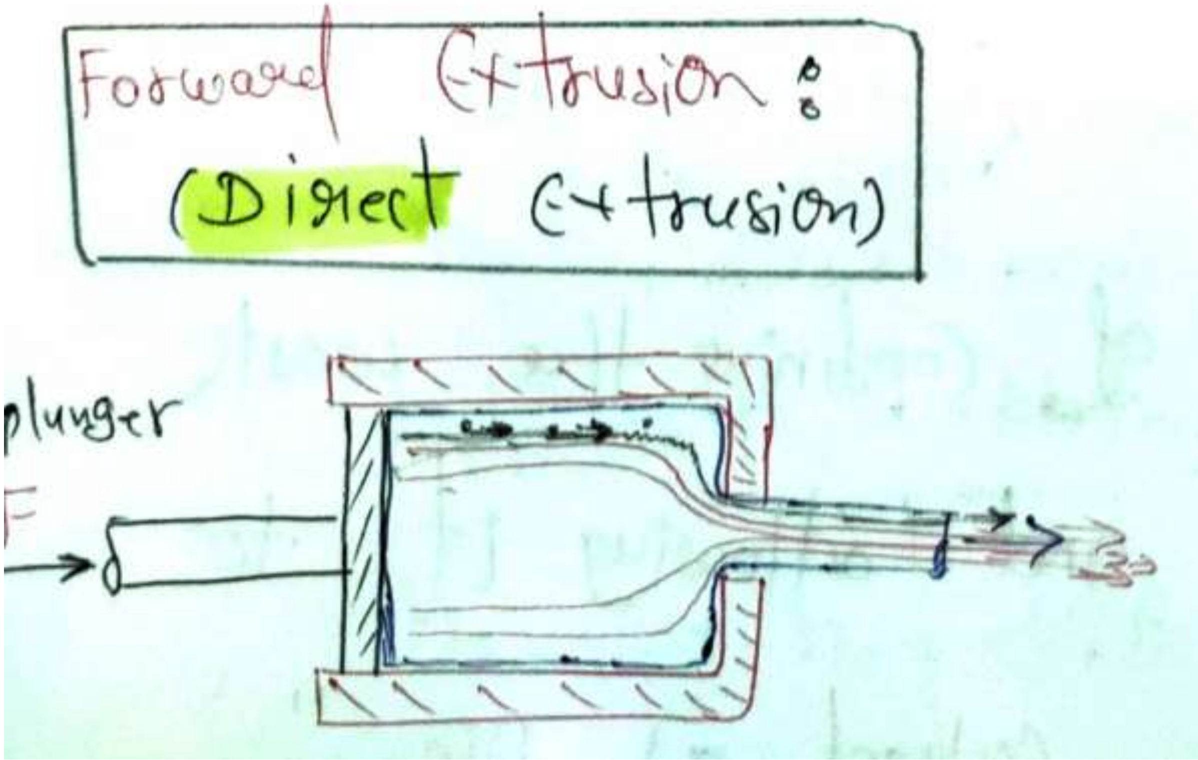
Types of Extrusion

Following are the types of forging processes:

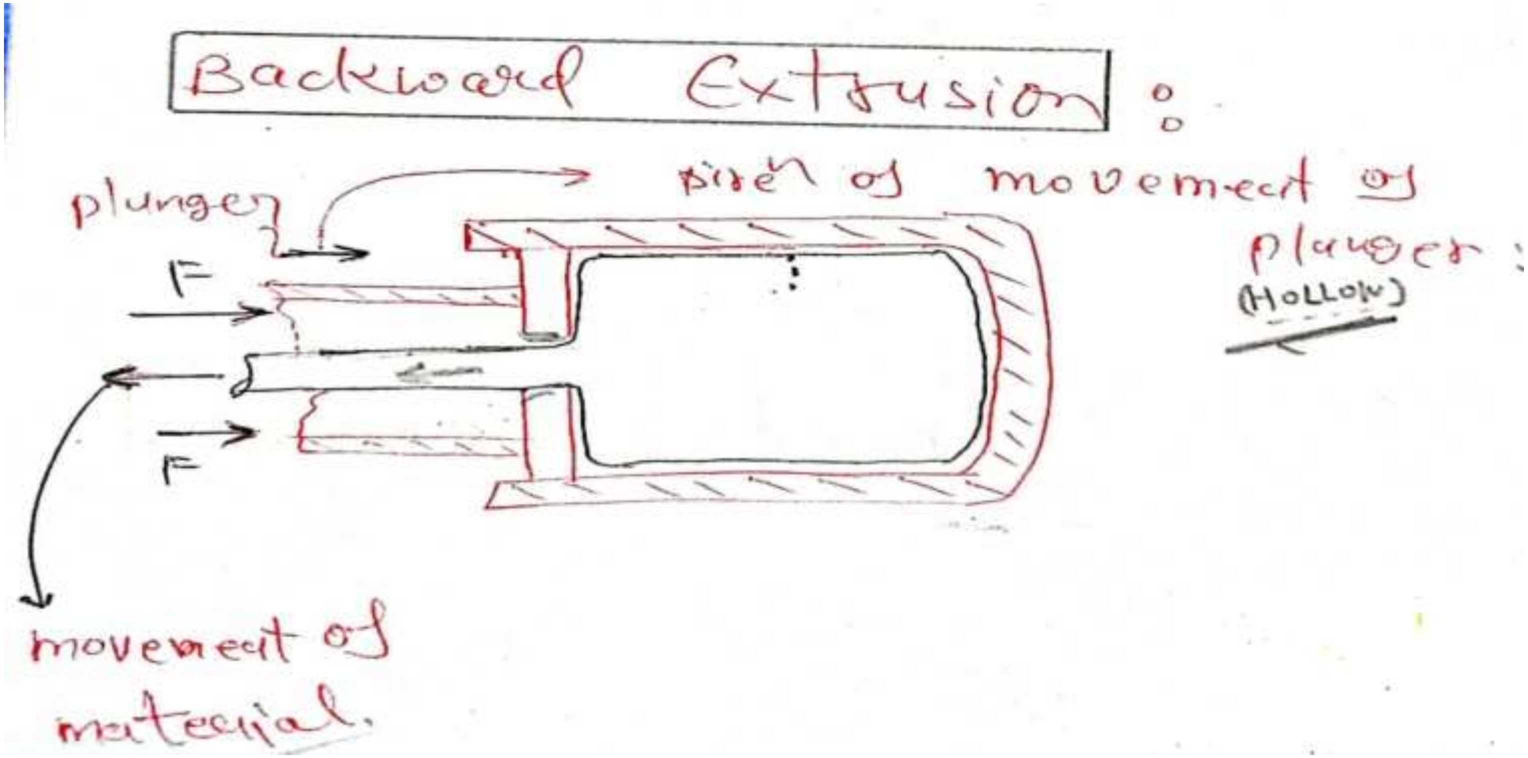
A. Forward Extrusion
B. Backward Extrusion
C. Impact Extrusion
D. Hydrstatic Extrusion

Forward Extrusion

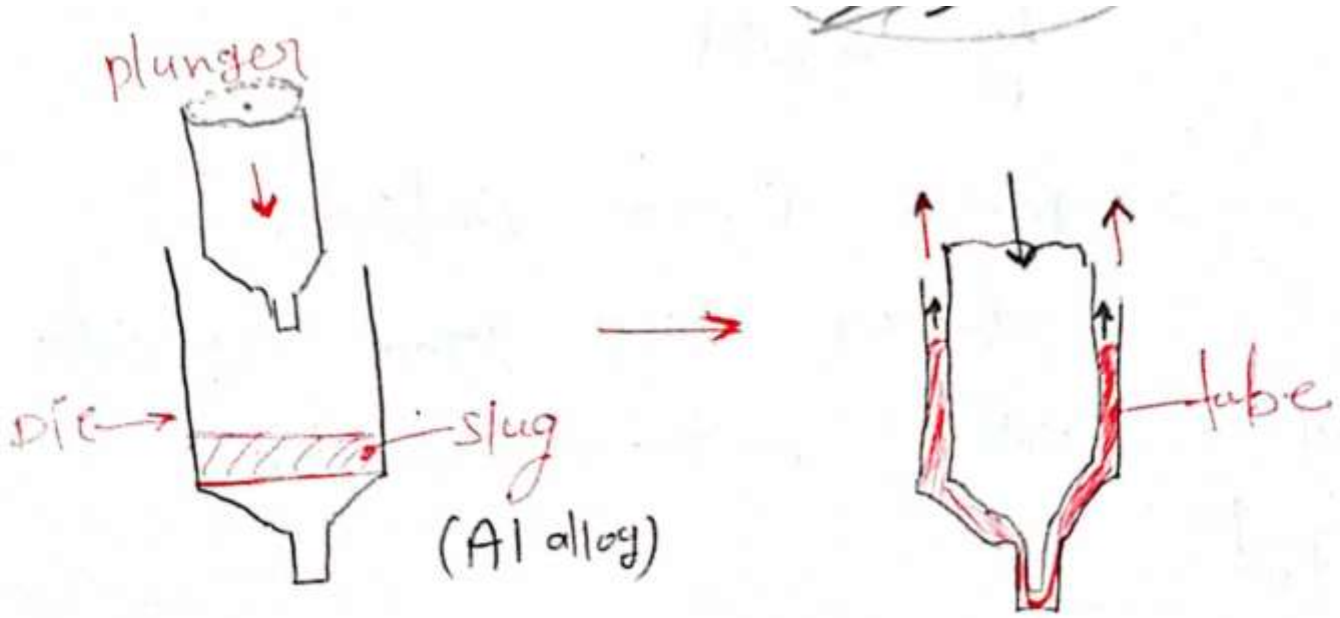
Poor surface finish
More forces needed
More chances of cracks



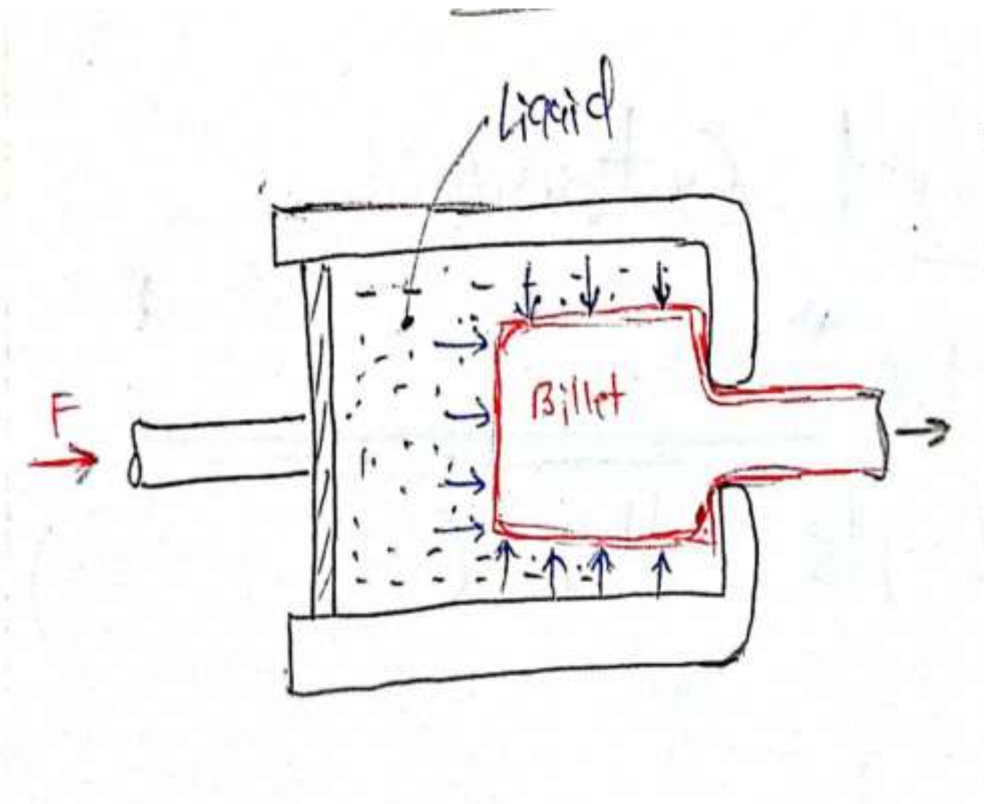
Backward Extrusion



Impact Extrusion



Hydrstatic Extrusion

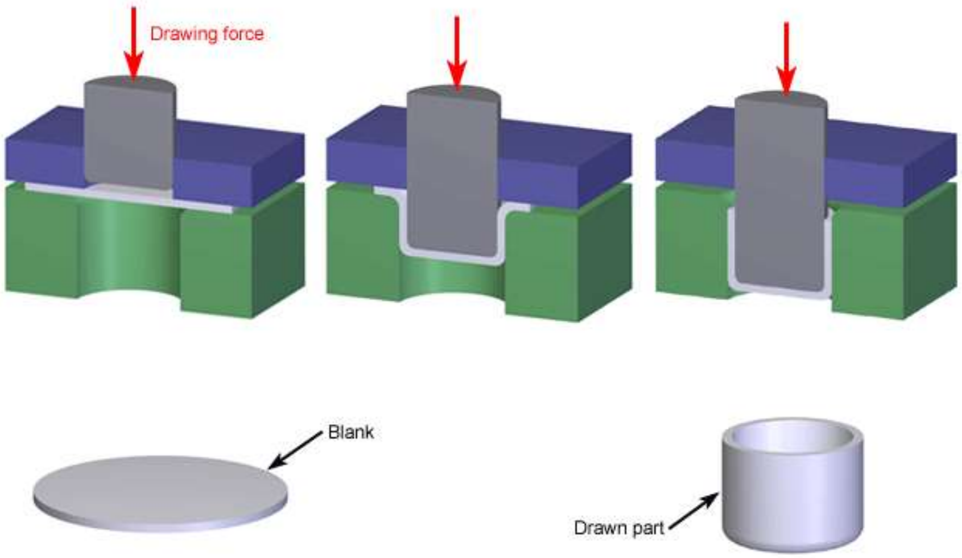


Drawing

Drawing is a metalworking **process** which uses tensile forces to stretch **metal**, glass, or plastic. As the **metal** is **drawn** (pulled), it stretches thinner, into a desired shape and thickness. **Drawing** is classified in two types: sheet **metal drawing** and wire and tube **drawing**.

Sheet Metal Forming

Sheet metal forming is a process where pieces of **sheet metal** are modified to its geometry rather than removing any materials. The applied process generates a force that stresses the material to deform. This in turn gives the possibility to bend or stretch the **sheet** to a variety of complex shapes.



Wire Drawing

Wire drawing is the process of of obtaining thin wires from thick wires or metallic rods

Always a cold working process

Steps in Wire Drawing:

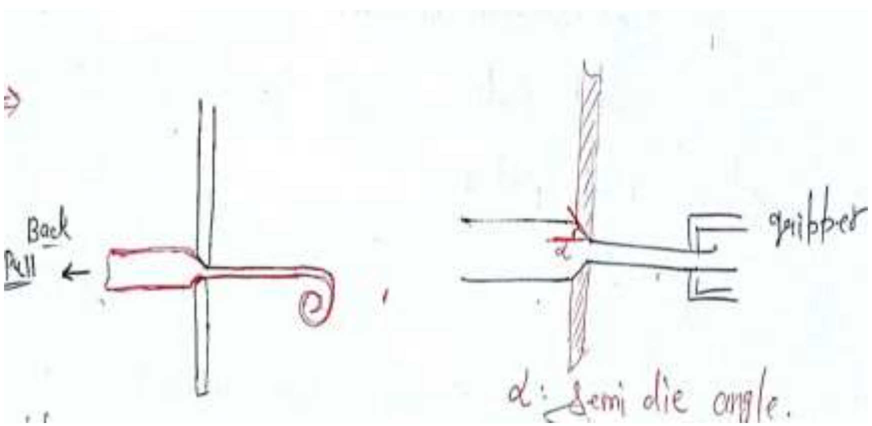
Process annealing: To make wire suitable for further plastic deformation

Bending or twisting: To remove dust

Acid pickling: To remove extra rust or scale

Lubrication: To reduce the friction between wire &die

Back pull: Although this increase the drawing load but required to save the dye and increase the life of die



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Thanks

Happy Learning

For any queries please contact at:

vishnu.jangid@skit.ac.in

+919680130905