B.E.

Fourth Semester Examination, Dec, 2008

Manufacturing Technology (ME-202-E)

Note : Attempt any ***FIVE*** questions. All questions carry equal marks.

Q. 1. (a) What are the main characteristics which a good moulding sand should posses? How these characteristics influence the performance of a moulding sand during moulding casting?

Ans. The main characteristics a good moulding sand should possess are :

(i) Good compressive strength.

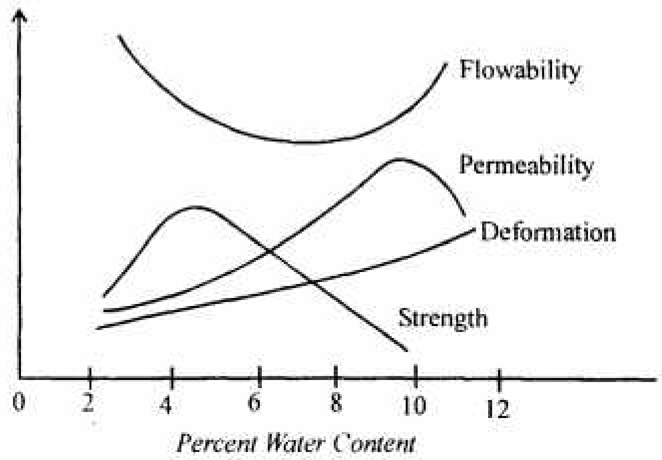
(ii) Good permeability to allow gas flow.

(iii) Good flowability so that sand spreads over pattern when mould is rammed.

(iv) Refratoriness so that sand remain solid at high temperatures.

(v) Good deformation properties.

For a given sand clay ratio, the variation of these properties with water content is shown as,



Higher permeability permits an easy outflow of the gases (produced during the casting operation) which may otherwise be entrapped within the casting leading to pores in the mould.

Sand having good compressive strengths have good binding properties leading to better and fine grains void in the mould to allow good solidification in moulding and casting.

Flowability refers to the ability of the sand to flow around and over the pattern when mould is rammed. It also reduces the unwanted void formation in the moulds.

Refractoriness allows the mould to work at higher temperatures and shows good heat insulation properties allowing a constant rate of solidification of the heated metal in the mould.

Q. 1. (b) What are the common defects of casting? State their causes and remedies.

Ans. The common defects of casting are :

(i) Below : It is a fairly large, well rounded cavity produced by the gases which displace the molten metal at the cope surface of a casting. Blows occurs on a convex casting surface.

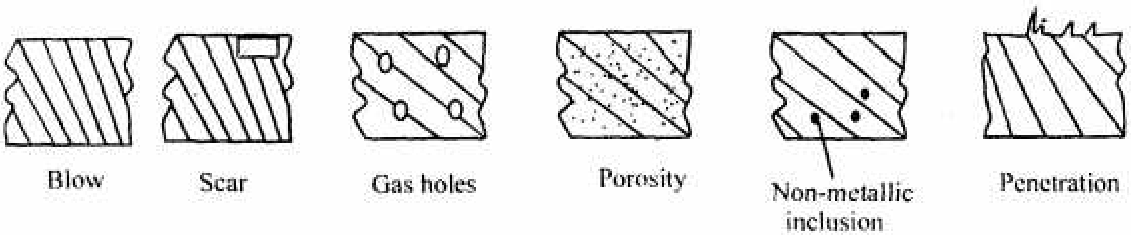
(ii) Scar : A shallow below, usually found on a flat casting surface, is referred to as a scar.

(iii) Gas Holes : These refer to the entrapped gas bubbles having a nearly spherical shape and occur when on excessive amount of gases is dissolved in the liquid metal.

(iv) Porosity : This indicates very small holes uniformly dispersed throughout a casting. It arises when there is a decrease in gas solubility during solidifications.

(v) Inclusion : In refers to a non-metallic particle in the metal matrix. It becomes highly undesirable when segregated.

(vi) Penetration : If the mould surface is too soft and porous, the liquid metal may flow between the sand particles upto distance, into a mould.



Causes :

(i) Defects in design of casting and pattern.

(ii) Poor moulding sand and design of mould and core.

(iii) Bad metal composition.

(iv) Defects in melting and pouring.

(v) Poor gating and risering.

Remedies :

(i) Providing proper venting of gases.

(ii) Adequate permeability.

(iii) Adequate sand strength.

(iv) Providing gaggers.

(v) Using strainer and skim bob.

(vi) Adding proper volatile additives.

Q. 2. (a) Classify different types of moulds and state the advantages of the following :

(i) Dry sand moulds over green sand moulds

(ii) Loan moulds over dry sand moulds.

Ans. Different types of moulds are :

(i) Green sand mould

(ii) Dry sand mould

(iii) Loam mould.

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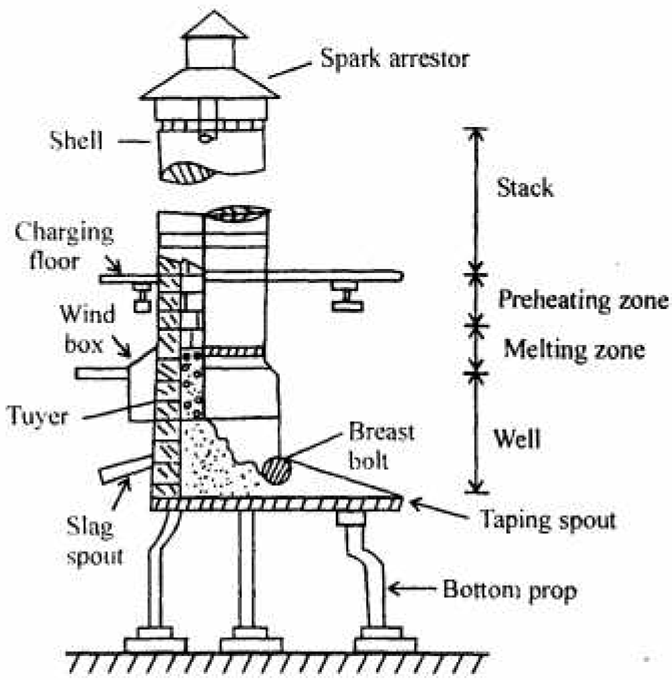
(i) Green sand mould is a mixture of sand, clay, water and some organic additives. The percentage of these ingredients on weight basis is approximately 70–85% sand, 10–20% clay, 3–6% water and 1–6% additives. Whereas dry sand mould has higher clay content than required around 30–35% leading to lesser strength and deformation properties and loss of refractioness.

(ii) Loam sand moulds have good clay content around 35% which acts as a bonding agent and imparts tensile and shear strength to the moulding sand more than in dry sand moulds. Also, loam sand moulds have good organic additives which burn out at high temperatures and make room for the moulding sand to expand and thus save the mould from crumbling.

Q. 2. (b) Sketch a cupola and label the essential parts.

Ans.



Cupola

Q. 2. (c) Describe the operation of a cupola.

Ans. Cupola Operation : Cupola is thoroughly dried before firing. The bottom doors are then closed and held shut by means of vertical prop. A layer of sand about 150mm thick is placed over the doors and sloped towards the tap hole. Coke is then added in several portions to a level slightly above the tuyers and then air blast is turned on at a lower than normal blowing rate. This intensifies coke combustion. Then new portions of coke are charged into the cupola. As soon as the coke bed in thoroughly ignited, alternate charges of limestone, iron and coke are added.

Limestone	= 2 to 4% by weight
Coke	= 8 to 12% of metal charge

Various zones of cupola are :

1. Well
2. Tayer zone.

3. **Combustion Zone :** Extends from top of the tuyers to a surface boundary below. Temperature of this zone is 1600°C–1700°C.

$$C + O_2 \rightarrow CO_2 + \text{Heat}$$

4. Reducing Zone : This zone is above combustion zone upto a height of initial coke bed charge.

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

Temperature of this zone is 1200°C.

5. Melting Zone : In this zone charge begins to melting and trickling through the coke to the bottom of the cupola.

$$3Fe + 2CO \rightarrow Fe_3C + CO_2$$

6. Preheating Zone : This zone includes the first layer of cupola charges above the melting zone to the top of the last charge temperature of this zone is around 1090°C.

Q. 3. What are the main advantages and disadvantages of die casting? How does a cold chamber die casting machine differ from a hot chamber machine? Describe the various alloys commonly cast in die casting processes.

Ans. Advantages of Die Castings are :

1. Dimensional tolerances can be held to remarkably close limits which reduces or sometimes completely eliminates subsequent machining operations. For small castings, the tolerance range can be ±0.03 to 0.25mm.
2. Surfaces are smooth and clean and require a minimum of preparation for chrome plating, anodising, painting.
3. A casting with walls of varying thickness can be produced.
4. Intricate castings with high tensile strength can be obtained, resulting in reduced raw material input.
5. The production rate is rapid.
6. Cored holes down to 0.75mm diameter at accurate locations are possible.
7. The sprue, runner and gates can be remelted, resulting in low scrap loss.
8. Die casting dies retain their usefulness and accuracy over a long time of production.

Disadvantages of Die Casting :

1. Only small parts can be made. The maximum practical weight for a die casting is about 200N for zinc.
2. Only non-farrous metals and alloys can be commercially cast. For ferrous metals it is rarely used.
3. Because of the high cost of equipment and dies, the process is economical only for mass production where the number of parts produced is 1000 or more.
4. Because of some entrapped air, the die castings are usually porous, resulting in reduced mechanical properties.

Hot Chamber Die Casting Machine	Cold Chamber Die Casting Machine
(a) In hot chamber machines, the metal pot and furnace are an integral part of the machine. The injection ram and cylinder are submerged in molten metal.	(a) In cold chamber system, the molten metal is contained in a separate holding furnace. It is ladled in the cold chamber and then forced into the die by a ram.
(b) In hot chamber machine, the melting pot is usually made of steel. So, this method is not suitable for casting high melting point metals. Such Al, Mg.	(b) Cold chamber system is used to higher melting point non-ferrous metals like Al, Mg.
(c) Hot chamber systems are faster.	(c) Cold chamber systems are slower than not chamber systems.
(d) Metal injection pressure in hot chamber system is below $14\ N/mm^2$.	(d) In cold chamber system, it may range from 35 to $175 N/mm^2$.

Various Alloys Commonly Cast in Die Casting Processes are :

Hot Chamber Die Casting Machine : Aluminium Alloys like (Duralium) Magnesium alloys (Electro)

Copper alloys (Cartridge Brass).

Cold Chamber Die Casting Machine :

Zinc alloys (Ounce metal)

Lead Alloys (Phosphor Bronze)

Tin Alloys (Bronze).

Q. 4. Describe how flame cutting is done stating its principle. Describe fully the method of oxygen cutting. State the difference in oxygen and arc cutting? Which one is preferred and why?

Ans. Flame Cutting :

Principle : Metal removal with the help of vapourisation of metal by high density heat flame is called flame cutting.

Procedure : Oxygen or acetylene flame is used to vapourise the metal to be cut. The temperature of the flame is more than 1200°C. The heat evolved is generated over a large volume. This heat is concentrated with the help nozzle. The concentrated are is then moved along the line of cut. Due to high heat metal doesn't liquidifies or melts but vapourises and hence cutting is done. It is high energy rate process having high energy density around $1000 J/mm^2$.

Oxygen Cutting : In this cutting process oxygen torch is used. The oxygen is poured in the torch through a heating filament. The oxygen breaks down in free oxygen radicals which is endothermic reaction.

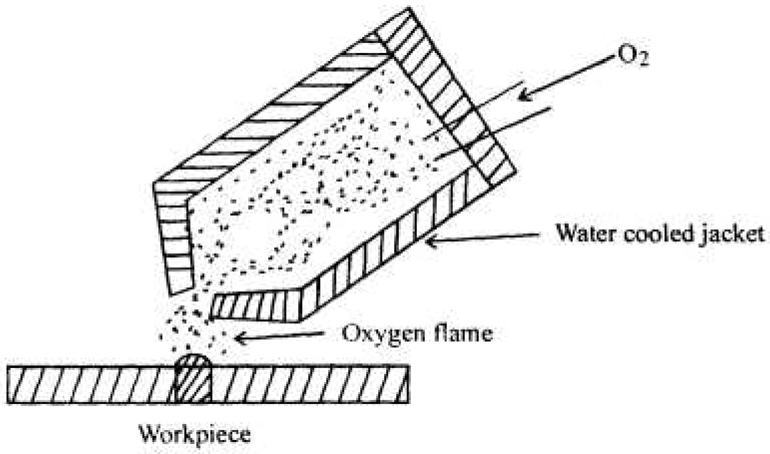
$$O_2 \rightarrow 2[\dot{O}] \text{ (Endothermic reaction)}$$

Oxygen radical

These radical moves towards the tip of the torch where two radicals combines to form oxygen gas. This reaction is highly exothermic which produces high heat.

$$2[\dot{O}] \rightarrow O_2 \text{ (Exothermic reaction)}$$

This heat comes out of the torch with the oxygen and collides at the metal to be cut with high pressure and hence the metal vapourises and cutting is obtained along the line.



Oxygen cutting

Difference between Oxygen Cutting and Arc Cutting :

1. Energy density in oxygen cutting is higher than the are cutting. In oxygen cutting temperature of the flame is around 2100°C which in arc cutting it is around 1200°C.
2. In arc cutting consumption of electrodes is occured while there is no such phenomenon in oxygen cutting.
3. Oxygen cutting is faster than arc cutting.
4. Oxygen cutting requires highly skilled workers while are cutting is simpler.
5. Oxygen cutting is comparatively economical for cutting ferrous materials then are cutting.

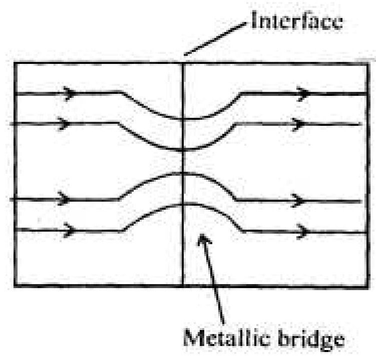
Generally, oxygen cutting is used against arc cutting process.

Q. 5. What are principles of operation of resistance welding? Describe

(i) Upset butt (ii) Flash butt (iii) spot

(iv) projection (v) percussion, welding giving their relative merits and limitations.

Ans. Principle of Operation of Resistance Welding :



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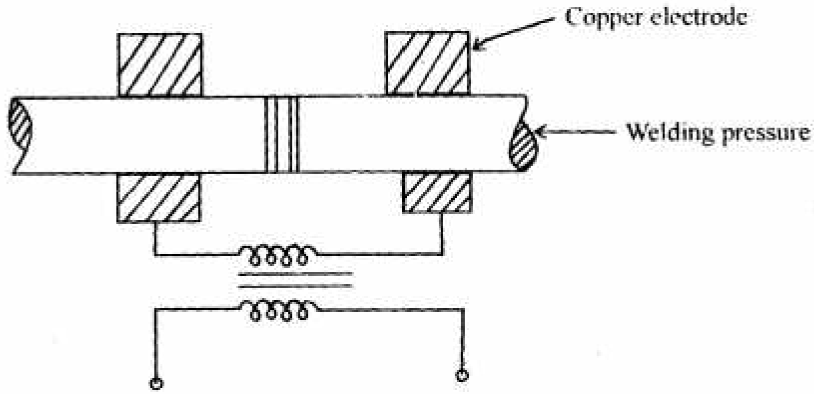
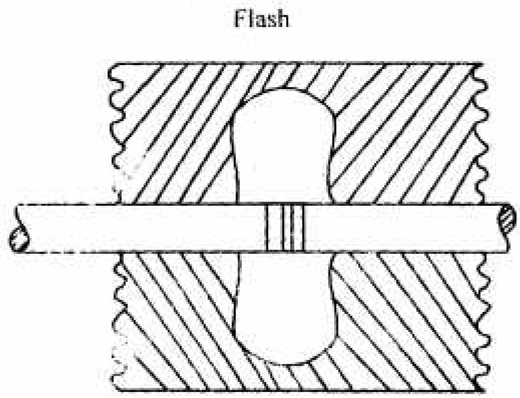
This welding process utilizes the contact resistance of the interfaces or by resistance of a molten flux and slag. When two metallic surfaces are brought into contact, only a small fraction of the apparent area is in actual metal to metal contact. When a current is sent through such an interface, all of it is carried by these tiny metallic bridges. As a result, the current flow is constricted. Due to this constriction, the resistance to the flow of current increases and this increment is termed as contact resistance.

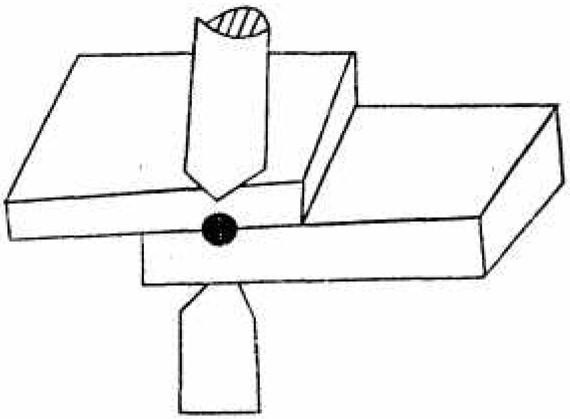
(i) Upset Butt : In upset butt welding, the surfaces to be joined are first brought in contact. Then, they are heated by the passage of an electric current. Once the required temperature is attained, the parts are subjected to an axial compression. This upsets the layers and forms a joint.



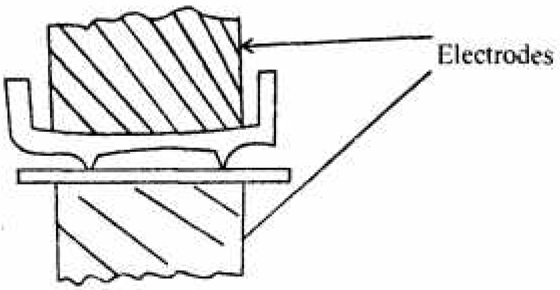
(ii) Flash Butt : In flash butt welding, the parts are brought in contact with a light pressure. The interface is heated by the passage of current. Heating is continued till interface melts and faces are inserted into a die and pressed producing flash. Flash is removed and joint is done.



(iii) Spot Welding : In spot welding, the parts to be joined are normally overlapped. The workpiece are clamped between two copper electrode. On passage of current the interface melts over a spot and welding is done.



(iv) Projection Welding : It is variation of spot welding in which small projections are made in one of the surfaces. Then, the parts to be welded are clamped between the flat copper alloy electrodes. On passage of current welding is done.



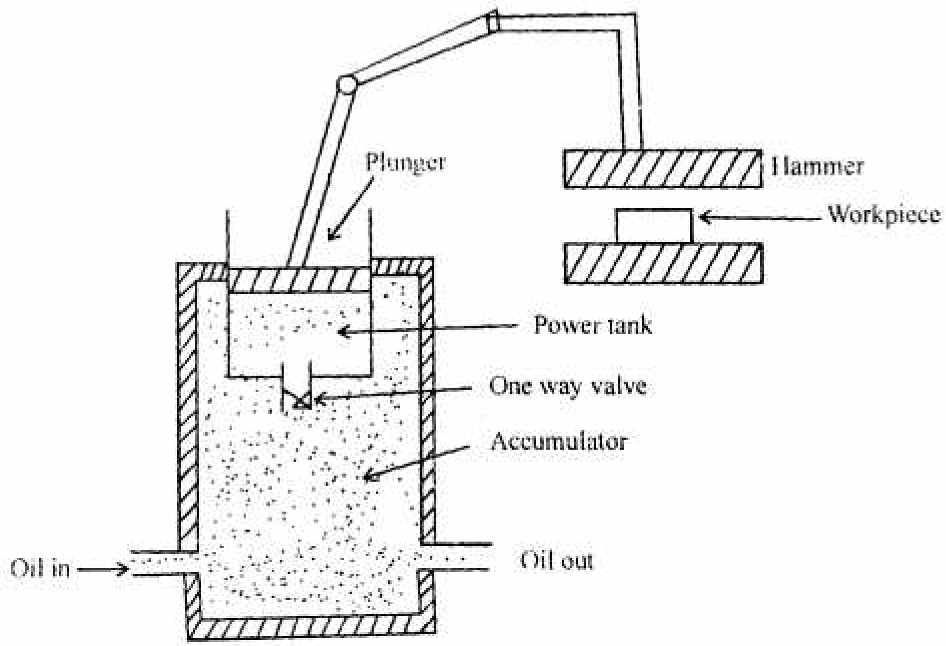
Q. 6. What are the different types of power hammer you know? Sketch and describe any one.

Ans. The different types of power hammers are :

1. Mechanical power hammers.
2. Hydraulic power hammers.
3. Pneumatic power hammers.
4. Spring controlled power hammers.

Hydraulic Power Hammer :

Hydraulic power is very quick response and accurate timing power hammer. It consist of an accumulator tank where oil enters at the one end and comes out at the other end. There is a power tank in which oil enters through a one way valve. The power tank also contains a plunger which reciprocates inside the power tank. When the fluid pressure is sufficient in the accumulator the one way valve allows the oil to flow through the power tank quickly. As the power tank is floating in accumulator, it increased weight further pressurize the accumulator allowing more oil inside in it. This allows the plunger to move up rapidly. This rapid motion is transferred to the heavy weight hammer through a connecting rod mechanisms. The heavy weight hammer falls down rapidly and is retraced back caused high impact on the workpiece. During retracing plunger moves own allowing the oil to flow out to the accumulator.



Hydraulic Power Hammer

Q. 7. (a) State the advantages of both mechanical and hydraulic presses for press-forging applications.

Ans. Advantages of Mechanical Presses for Press Forging Applications :

1. Flow of metals around the corners are eased with the help of fillets. They avoid fracture of metals near the corners.
2. Suitable drafting allows easy removal of the job from the die.
3. Arrangements of the flash removal are also provided.
4. Better surface finish are also obtained.
5. Power driven hammers allows better flattening and desired shape (with limited varieties).
6. Instead of repeated blows, a gradual force can be applied.
7. Die designing is easier.
8. Easy control and inspection.

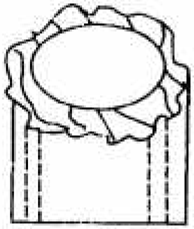
Advantages of Hydraulic Presses for Press Forging Applications :

1. Uniform pressure can be applied by hydraulic presses.
2. Easy removal of the job from the die.
3. They have capability of storing power for the duration between the blows.
4. Accuracy is better than other presses.
5. Swagging is easily down with the help of hydraulic presses.
6. Overall finishing is good.
7. Can apply high loads.

Q. 7. (b) What are the common forging defects, and what are they due to?

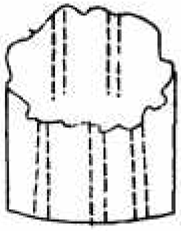
Ans. The common forging defects are :

1. **Flange Wrinkles :** An insufficients die pressure causes wrinkles to develop on the flanges, which may also extend to the wall.



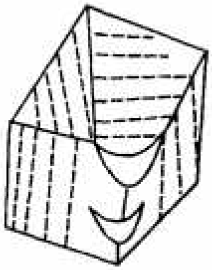
Flange Wrinkles

2. **Wall Wrinkles :** An insufficient die pressure may also causes wrinkles at the walls called wall wrinkles.



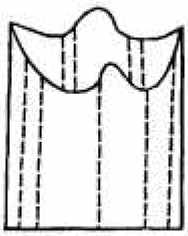
Wall W inkles

3. **Fracture :** Too much or high die pressure may lead to the fracture at the flange, bottom and the corners.



Corner Fracture

4. **Directional Earning :** While forging, ears or lobes tend to occur because of the ahrisotropy induced by the rolling by the dies.



Directional Earing

Causes :

1. Non-uniform die.
2. Non-uniform die pressure applied.
3. Misplacement of die.
4. Misplacement of the object.
5. Improper heating.
6. Scales on the die surface.
7. Insufficient lubrication.

Q. 8. Write short notes on following :

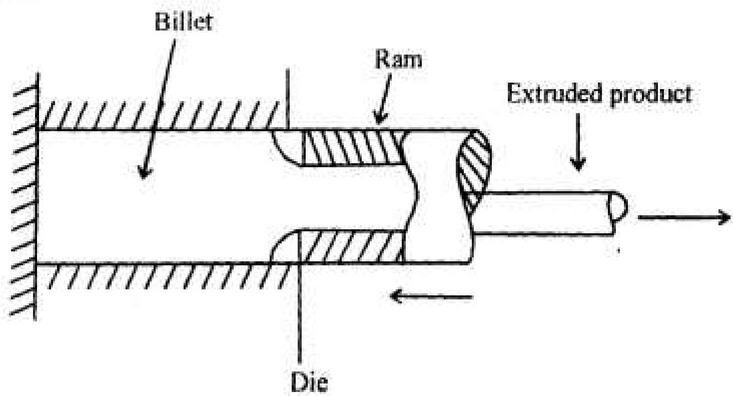
(i) **Extrusion**

(ii) **Submerged arc welding**

(iii) **Centrifugal casting.**

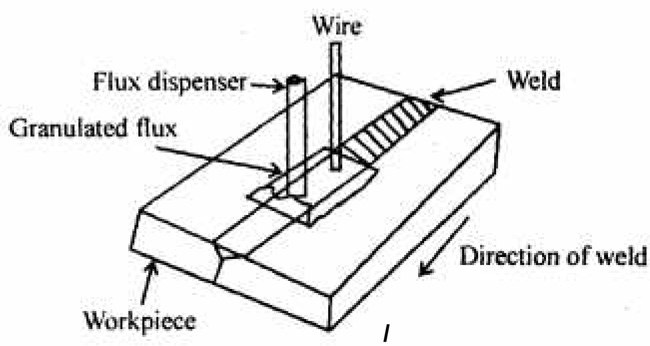
Ans. (i) Extrusion : The basic nature of the deformation in extrusion is tearing failure. In extrusion we apply a tensile load at the exit end, a compressive load is applied at the other end. However, a number of complexities arise as the die is commonly flat face. Consequently, the results become inaccurate.

- Extrusion can be performed under both hot and cold conditions. In extrusion billet is required to move forward, resulting in a large frictional loss and high working load. The work is heated and then product is extruded by applying pressure with ram.



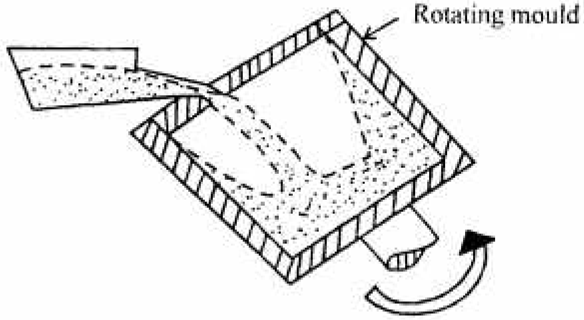
Extrusion

(ii) Submerged Arc Welding :



In submerged arc welding, the arc is maintained underneath a mass of fusible, granular flux. The process is schematically shown. First the flux containing calcium oxide, calcium fluoride, silica is sintered to form a coarse powder. This granulated flux is then spread over the joint to be made. The consumable electrode is fed into this flux. A portion of the flux melts to protect the liquid weld poor, whereas rest shields the arc. The process is used to have a thick welding in single run.

(iii) Centrifugal Casting : The centrifugal casting process is normally carried out in a permanent mould which is rotated during solidification of a casting. For producing a hollow part, the axis of rotation is placed at the centre of the desired casting. The speed of rotation is maintained high so as to produce a centripetal acceleration of the order of 60g to 75g. The centrifuge action segregates the less dense non-metallic inclusions near the centre of rotation. Solid parts can be cost by this process by placing the entire mould cavity on one side of the axis of rotation.



Centrifugal Casting