Unit 5 : Manufacturing Processes

1. Describe Sand Casting process with a labeled diagram of mould box, and state its advantages & disadvantages.
2. Define Forging. What are characteristics of forging? Compare Open die and Closed die Forging operations.
3. What are different operations carried out on sheet metal. Describe any three Shearing operations with neat sketches.
4. What is an Arc Welding? Describe with a sketch SMAW & its advantages & disadvantages.

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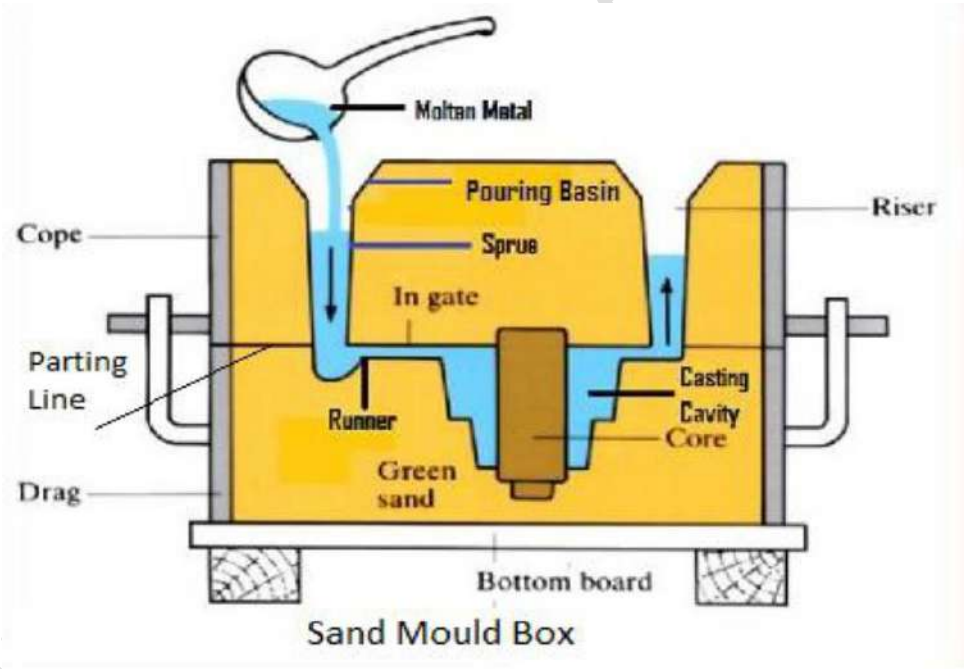
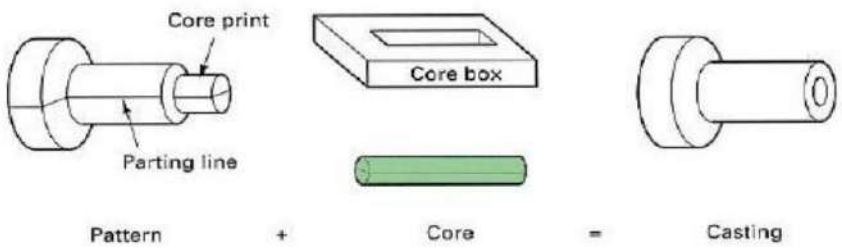
1) Describe Sand Casting process with a labeled diagram of mould box, and state its advantages & disadvantages.

Answer :

Casting : It is a manufacturing process in which part of desired shape is obtained by pouring molten metal into cavity of required shape



Sand Mould Box



- Steps in Sand Casting:

1. Pattern Making:

   Pattern is replica of the part to be casted. Commonly used materials for pattern making are- Wood, Plastic and metal. Pattern size is bigger than the cast part as Shrinkage and Machining Allowances are added to the dimensions of the part. Also, Draft/Taper is provided on pattern for its easy removal from sand mould. Pattern is split in two symmetrical parts.

1. Mould Making:

   Mould is a cavity in the green sand in which molten metal can poured. Mould box has two halves, the upper halve is called **cope** and lower halve is called **drag**. The mould / cavity is prepared using halves of pattern & light hammering sand and then removing the pattern to create desired hollow shape of part in the sand.

2. Core Making:

   Core is a device used in sand casting to produce hollow castings. Generally core is made from same material as that of the mould i.e. sand. Supporting elements called chaplets of the same metal of casting , are used to support core.

3. Metal Melting and Pouring:

   The raw material is melted using furnace. Furnace may be operated on electricity or fuel. The molten metal is poured into mould using ladle. Pouring basin, sprue, runner, gate are used to guide molten metal into the cavity

4. Solidification

   Metal is allowed to cool to room temperature. During solidification the metal shrinks and the extra metal required compensate this shrinkage is obtained from the riser.

5. Finishing

   Undesired part which corresponds to gating system and riser has to be cut from main casting. The casted surface generally is rough and some finishing operation like grinding, machining, polishing are required.

6. Inspection

   Before dispatching the casted part has to be checked for desired dimensions. The part which doesn't meet expected dimensions has to be scraped. Castings are also checked for various undesirable defects.

Advantages of Sand Casting:

- Casting can be used to create complicated shapes
- Casting can be used to manufacture components made from brittle as well as ductile material
- Casting can be used economically to create small as well as large components
- Casting is a primary manufacturing process. Raw material supplied to various other manufacturing process is obtained through the casting

Disadvantages of Sand Casting:

- Casting can not be used to create very thin components (thickness < 6mm)
- Casting contains various defects such cracks, voids, foreign particle inclusions which reduces strength of the component
- Casted components are brittle in nature as compared forged components
- Surface finish of sand casted component is poor
- Man power and space requirement is high
- Risk of injury in metal handling is high

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2) Define Forging. What are characteristics of forging? Compare Open die and Closed die Forging operations.

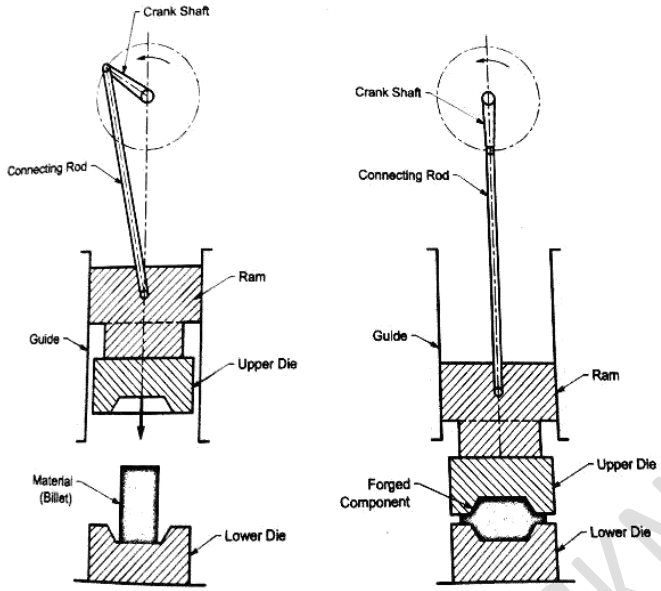
- Forging is the process of shaping heated metal by the application of sudden blows (hammer forging) or steady pressure (press forging) and makes use of the characteristic plasticity of the material.
- In forging process the material is heated to a temperature at which its elastic properties completely disappear. This temperature is known as forging temperature and it varies from material to material.
- In forging process, the material (billet) is deformed into the desired shape between two parts called dies. The shape of the dies matches with desired shape of the forged component.
- The forging press shown in figure consists of a lower die fixed to the frame (Anvil) while upper die is connected to the ram. The hot material is kept on the lower die.
- In mechanical press the ram is driven by the crank shaft through the connecting rod where as in hydraulic press the ram is driven by the hydraulic cylinder.
- During the downward stroke of the ram, the upper die exerts sudden compressive force on the hot material. Due to this sudden compressive force the hot material is converted into the desired shape.

Materials used for forging:

- Must be ductile material.
- Examples: low and medium carbon steels, alloy steels, stainless steels, copper alloys, aluminum alloys etc.

Based on types of dies used forging process are classified as:

1. Open die forging
2. Closed die forging



Open Die Forging process:

In open die forging, the material or work piece is deformed between two flat dies or dies of very simple shape.

Closed Die Forging process:

In closed die forging, the material or work piece is deformed between two dies which have the impression of the desired shape.

when the two cavities are closed, the cavity formed is of the desired final shape.

Applications of Forging process:

1. Car axles, crankshafts, **connecting rods**, leaf springs, crane hooks, jet engine turbine dies and blades.
2. Levers, flanges, propellers, hollow bodies, railway wheel disks, tank bottoms.
3. Aircraft and rocket parts, knife blades, bolts, nuts, washers, collars, gear blanks, etc.

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3) What are different operations carried out on sheet metal. Describe any three Shearing operations with neat sketches.

Sheet metal working is the process of manufacturing the components from the sheet metal of thickness ranging from 0.1 mm to about 8 mm. It is carried out by a machine tool called press (Press working).

Sheet Metal Working operations have two types : Shearing (Cutting) and Forming (non-cutting).

Sheet Metal Cutting (Shearing) Operations

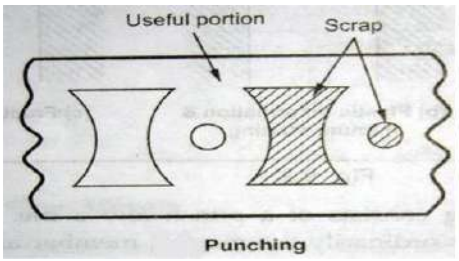
Piercing , Punching, Blanking, Perforating, Notching, Lancing, Slitting

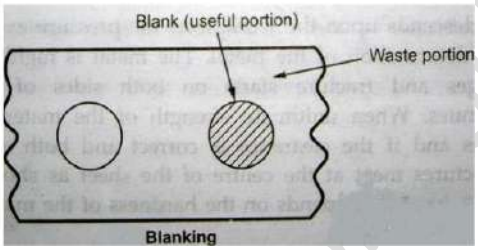
Sheet Metal Forming Operations : Process of flat metal sheet into a surface of a desired profile.

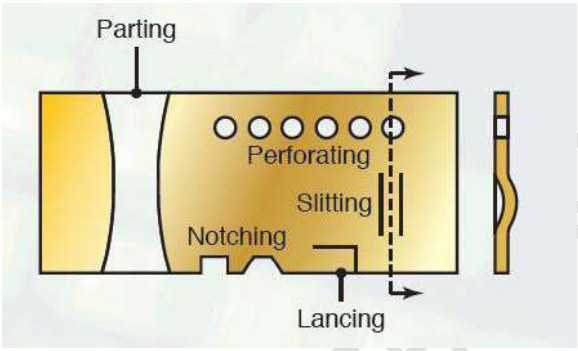
Bending, Embossing, Forming, Coining (Squeezing), Drawing & Deep Drawing

Metal Cutting (Shearing) Processes:

- **Piercing-** Producing a hole of any desired shape in metal.
- **Punching-** Producing a circular hole in metal.
- **Blanking-** The metal punched out is the required component, called blank**.**







- **Perforating** : Production of number of holes or patterns.
- **Slitting** : Making a straight line cut on sheet metal
- **Lancing** : punching a partial hole or partially slitting and then bending one side down as louver.
- **Notchting** :to remove metal of required shape from the sheet metal along the edges.

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4) What is an Arc Welding? Describe with a sketch SMAW & its advantages & disadvantages.

Ans : Electric Arc Welding is a fusion welding process in which welding heat is obtained from an electric arc. A high current of order 50A to 1000A with low voltage between 20V to 40V either DC or AC, is passed through circuit and a small gap of 2 to 4 mm is created manually between electrode and the workpiece to produce an arc of temperature about 5000 deg C which melts the metal locally & fuses to form a weld. No pressure is applied.

In case of Shielded Metal arc Welding (SMAW) a consumable electrode of mild steel with coating of Shielding flux (Borax of suitable composition) is used. This electrode acts as a filler as it melts and gets deposited into the weld. An inert atmosphere is required around the weld joint.

Consumable electrodes usually have a coating on its outer surface which on melting release gases like **hydrogen or carbon dioxide** to form a protective covering around the molten pool from atmosphere contamination or to prevent oxidation of weld metals which is nothing but rust (iron oxide).

However, the decomposition deposits hard layer over the weld, which needs to be removed by chipping & cleaning by wire brush.

The SMAW is cheaper and fast but depends on skill of the welder. As electrode have short length welding is intermittent to load new electrode, produces harmful gases and needs cleaning the joint after welding.