SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE

www.sathyabama.ac.in

SCHOOL OF MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

UNIT – I – Metal Casting Process – SMEA1401

PREREQUISTE DISCUSSION

1.Manufacturing

Manufacturing in its broadest sense is the process of converting raw materials into useful products.

- IT Includes
  - i) Design of the product
  - ii) Selection of raw materials and
  - iii) The sequence of processes through which the product will be manufactured. Casting.

Any Product in the engineering industry will be manufactured in the below methods

1. By totally deforming the metal to the required shape. (Casting /Forming)
1. By joining two metals. (Welding)
2. By removing the excess material from the raw stock.(Machining)

1.1.1 Moulding .

It is the process of preparing the cavity required for casting using the pattern (Physical Model), Moulding sand, Moulding boxes,(Cope, Drag, cheek) and other tools.

1.1.2 Casting.

Casting is the process of producing metal parts by pouring molten metal into the mould cavity of the required shape and allowing the metal to solidify. The solidified metal piece is called as "casting".

1.1.3 Foundry

It is the place where both moulding and casting is done.

1.2. Sand Casting /Sand Moulding.

Sand Casting is simply melting the metal and pouring it into a preformed cavity, called mold, allowing (the metal to solidify and then breaking up the mold to remove casting. In sand casting expandable molds are used. So for each casting operation you have to form a new mold.

1.3 Types of sand

a) Green-sand - mixture of sand, clay, and water,Binders (Molases, Linseed oil); "Green" means mold contains moisture at time of pouring.
b) Dry-sand - organic binders rather than clay and mold is baked to improve strength
c) Skin-dried - drying mold cavity surface of a green-sand
- mold to a depth of u p t o 25 mm, using torches or heating

d)Core Sand
e)Baking sand
f)Loam Sand
g)Parting sand, Etc.,

1.4Patterns

Patterns are the replica or physical models of the final required shape of the casting, made by wood (teak,magony,pine), plastics, Metals, Plaster of paris etc.,

1.4.1 Types of patterns.

1. Solid pattern
2. Split piece pattern
3. Three piece pattern
4. Loose piece pattern
5. Match plate pattern
6. Segmental pattern
7. Sweep patten
8. skeleton Pattern
9. shell Pattern.

1.4.2 Pattern Allowance.

Allowance are the extra dimensional compensation give to the pattern in order to attain the correct shape and size of the final solidified metal casting.Five types of allowances were taken into consideration for various reasons. They are

1.4.2.1. Shrinkage allowance

Any metal when heated to liquid stage and solidified will undergo change in dimension. Mostly the dimension of the product will be reduced, then the actual size of the pattern. Hence the patterns are made slightly in larger dimensions.(3%-5%)

1.4.2.2. Draft allowance

It will be difficult to remove the pattern from the mould cavity (without disturbing the mould) after ramming of sand. Hence the pattern (wooden or metal pattern) is slightly given 2^{o}– 3^{o} TAPER in the z - axis or vertical direction.

1.4.2.3. Finish allowance

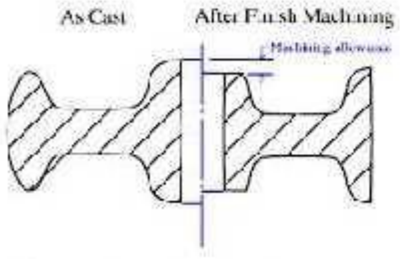
It is otherwise called as machining allowance .The pattern is made slightly 5mm -10mm large in dimension than the required final part dimension. After casting the extra material is removed from the solidified material by machining.

1.4.2.4. Shake or Rapping allowance.

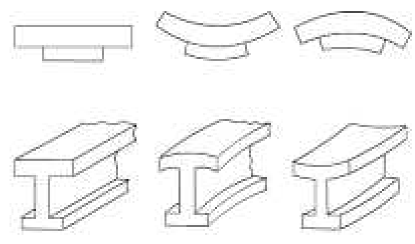
Before withdrawing the pattern it is rapped and thereby the size of the mould cavity increases. Actually by rapping , the external sections move outwards increasing the size and internal sections move inwards decreasing the size. This allowance is kept negative and hence the pattern is made slightly smaller in dimensions 05.1.0 mm.

1.4.2.5. Distortion allowance.

Some material might tend to bend or distort from the actual size or dimensions. Hence the pattern is give counter balance degree or angle of recess so that the material will be in the required dimension when solidified in the mould cavity.



Example of machining or "cleanup" allowance on hub face of a wheel casting



Required Shape of Casting | Distorted Casting | Cambered Pattern

1.5
Types of Moulding Sand:

According to the use, moulding sand may be classified as below:

1. Green Sand:

The green sand is the natural sand containing sufficient moisture in it. It is mixture of silica and 15 to 30% clay with about 8% water. Clay and water act as a bonding material to give strength. Molds made from this sand are known as green sand mould.

The green sand is used only for simple and rough casting products. It is used for both ferrous and non-ferrous metals.

2. Dry Sand:

When the moisture is removed from green sand, it is known as dry sand. The mould produced by dry sand has greater strength, rigidity and thermal stability. This sand is used for large and heavy castings.

3. Loam Sand:

Loam sand is a mixture of 50 percent sand and 50 percent clay. Water is added in sufficient amount. It is used for large and heavy moulds e.g., turbine parts, hoppers etc.

4. Facing Sand:

A sand used for facing of the mould is known as facing sand. It consists of silica sand and clay, without addition of used sand. It is used directly next to the surface of the pattern. Facing sand comes in direct contact with the hot molten metal; therefore it must have high refractoriness and strength. It has very fine grains.

5. Parting Sand:

A pure silica sand employed on the faces of the pattern before moulding is known as parting sand. When the pattern is withdrawn from the mould, the moulding sand sticks to it.

To avoid sticking, parting sand is sprinkled on the pattern before it is embedded in the moulding sand. Parting sand is also sprinkled on the contact surface of cope, drag and cheek.

6. Backing or Floor Sand:

The backing sand is old and repeatedly used sand of black colour. It is used to back up the facing sand and to fill the whole volume of the box. This sand is accumulated on the floor after casting and hence also known as floor sand.

7. System Sand:

The sand employed in mechanical heavy castings and has high strength, permeability and refractoriness, is known as system sand. It is used for machine moulding to fill the whole flask. In machine moulding no facing sand is used. The system sand is cleaned and has special additives.

8. Core Sand:

A sand used for making cores is known as core sand. It is silica sand mixed with core oil (linseed oil, resin, mineral oil) and other binding materials (dextrine, corn flour, sodium silicate). It has remarkable compressive strength.

9. Molasses Sand:

A sand which carries molasses as a binder is known as molasses sand. It is used for core making and small castings of intricate shapes.

Properties of Moulding Sand

Following are the important properties of moulding sand:

1. Porosity:

Porosity also known as permeability is the most important property of the moulding sand. It is the ability of the moulding sand to allow gasses to pass through. Gasses and steam are generated during the pouring of molten metal into the sand cavity. This property depends not only on the shape and size of the particles of the sand but also on the amount of the clay, binding material, and moisture contents in the mixture.

2. Cohesiveness:

Cohesiveness is the property of sand to hold its particles together. It may be defined as the strength of the moulding sand. This property plays a vital role in retaining intricate shapes of the mould.

Insufficient strength may lead to a collapse in the mould particles during handling, turning over, or closing. Clay and bentonite improves the cohesiveness.

3. Adhesiveness:

Adhesiveness is the property of sand due to which the sand particles sticks to the sides of the moulding box. Adhesiveness of sand enables the proper lifting of cope along with the sand.

4. Plasticity:

Plasticity is the property of the moulding sand by virtue of which it flows to all corners around the mould when rammed, thus not providing any possibility of left out spaces, and acquires a predetermined shape under ramming pressure.

5. Flow-Ability:

Flow-ability is the ability of moulding sand to free flow and fill the recesses and the fine details in the pattern. It varies with moisture content.

6. Collapsibility:

Collapsibility is the property of sand due to which the sand mould collapse automatically after the solidification of the casting. The mould should disintegrate into small particles of moulding sand with minimum force after the casting is removed from it.

7. Refractoriness:

Refractoriness is the property of sand to withstand high temperature of molten metal without fusion.

1.6

Main Types of Moulding Machines | Metallurgy

This article throws light upon the three main types of moulding machines. The types are: 1. Squeezers 2. Jolt Machines 3. Sand Slingers.

1. Squeezers:

The working principle of a squeezer type moulding machine is shown in Fig. 4.11 (a). The pattern plate is clamped on the machine table, and a flask is put into position. A sand frame is placed on the flask, and both are then filled with sand from a hopper.

Next, the machine table travels upward to squeeze the sand between the pattern plate and a stationary squeeze head. The squeeze head enters into the sand frame and compacts the sand so that it is level with the edge of the flask. These machines rammed the sand harder at the back of the mould and softer on the pattern face. Squeezer machines are very useful for shallow patterns.

2. Jolt Machines:

The working principle of jolt type of moulding machine is shown in Fig. 4.11 (b). As can be seen, compressed air admitted through the hose to a pressure cylinder to lift the plunger and the flask, which is full of sand, up to a certain height, where the side hole is uncovered to exhaust the compressed air.

The plunger then falls down and strikes the stationary guiding cylinder. The shock waves generating from each of successive impacts contributes to packing or ramming the moulding sand in the flask.

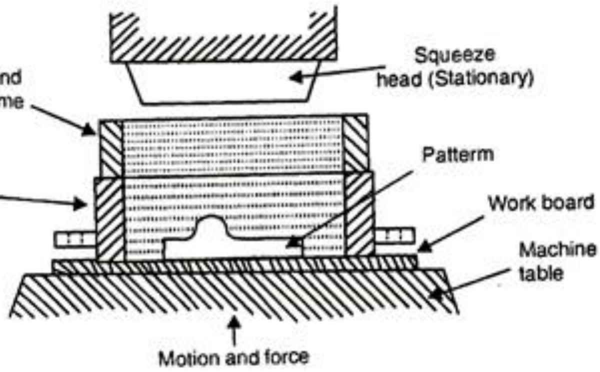
3. Sand Slingers:

The working principle of a sand slinger machine is shown in Fig. 4.11 (c). As can be seen, moulding sand is fed into a housing containing an impeller that rotates rapidly around a horizontal axis.

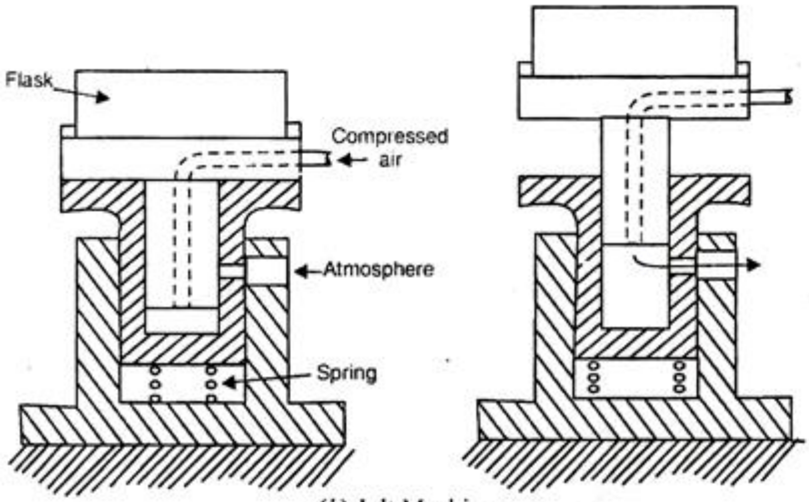
Sand particles are picked up by the rotating blades and thrown at a high speed through an opening onto the pattern, which is positioned in the flask. This type of machine is employed in moulding sand in flasks of any size, whether for mass production of moulds or individual mould.

There are also some machines, such as jolt-squeeze machines, that employ a combination of the working principles of two of the main types. No matter what type of moulding machine is used, special machines are used to draw the pattern out of the mould.

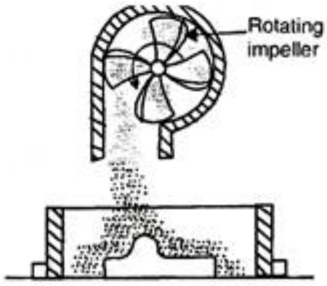
Basically, these machines achieve this by turning the flask (together with the pattern) upside, down and then lifting the pattern out of the mould. Roll-over moulding machines and rock-over pattern-draw machines, are some examples of this category.



(a) Squeezer.



(b) Jolt Machine.



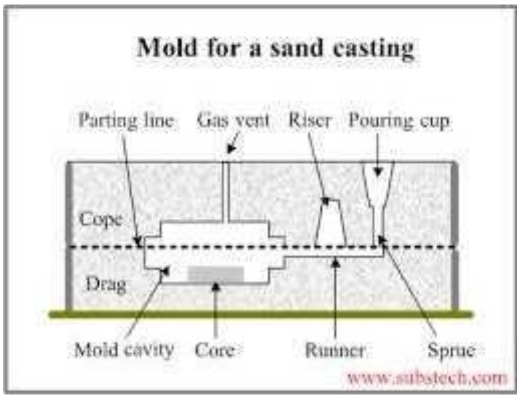
(c) Sand slinger.

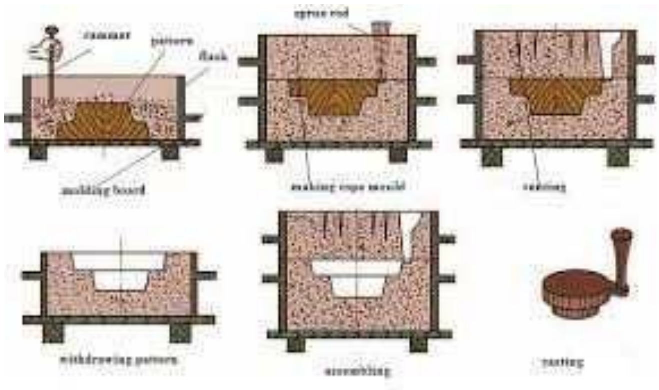
1.7 Steps in Sand Casting

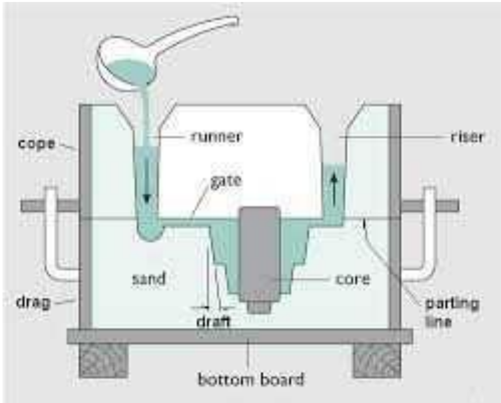
The cavity in the sand mold is formed by packing sand around a pattern, separating themold into two halves

- The mold must also contain gating and riser system
- For internal cavity, a core must be included in mold
- A new sand mold must be made for each part

1. Pour molten metal into sand mold
2. Allow metal to solidify
3. Break up the mold to remove casting
4. Clean and inspect casting
5. Heat treatment of casting is sometimes required to improve metallurgical properties.







1.6. FURNACES USED FOR MELTING METALS FOR CASTING.

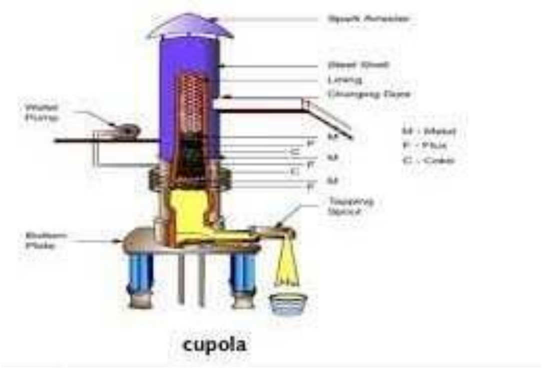
1.6.1 Types of furnace used in a casting industry.

–Crucible Furnace
– Electric-arc Furnace
– Induction Furnace
--Reverbratoryfurnace
Blast Furnace
- Cupola Furnace.

1.6.1.1. Cupola Furnace

- A continuous flow of iron emerges from the bottom of the furnace.
- Depending on the size of the furnace, the flow rate can be as high as 100 tones per hour.

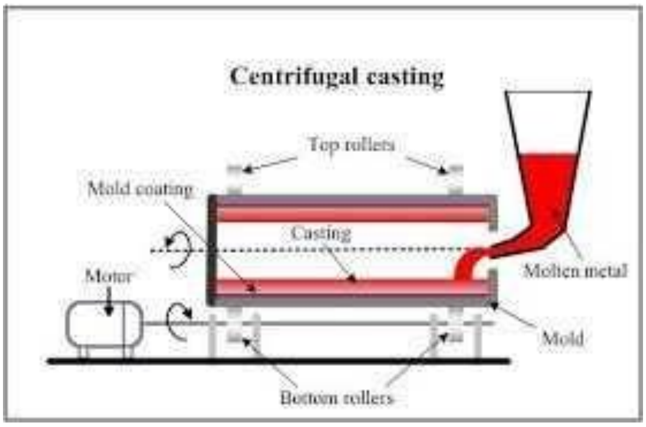
.At the metal melts it is refined to some extent, which removes contaminants. This makes this process more suitable than electric furnaces for dirty charges.



1.7. SPECIAL CASTING PROCESS.

1.7.1. Centrifugal casting

Centrifugal casting uses a permanent mold that is rotated about its axis at a speed between300 to 3000 rpm as the molten metal is poured.Centrifugal forces cause the metal to be pushed out towards the mold walls, where it solidifies after cooling.Centrifugal casting has greater reliability than static castings. They are relatively free from gas and shrinkage porosity. Surface treatments such as case carburizing, flame hardening and have to be used when a wear resistant surface must be combined with a hard tough exterior surface.One such application is bimetallic pipe consisting of two separate concentric layers ofdifferent alloys/metals bonded together.



1.7.2. CARBON DI OXIDE PROCESS MOULDING.

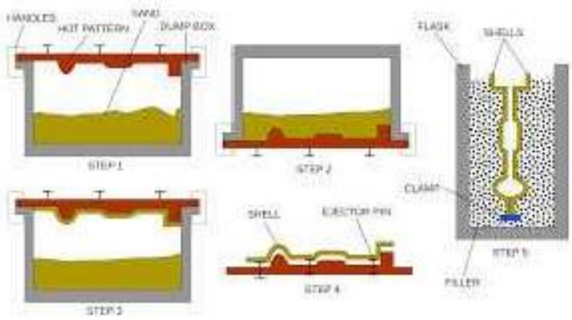
Working Principle

The highly flowable mixture of pure dry silica sand and sodium silicate binder is rammed or blown into the mould or core box. Carbon –dioxide gas at a pressure of about 1.5 bar is diffused through the mixture (of sand and sodium silicate) to initiate the hardening reaction which takes from a few seconds to a few minutes depending upon the size of core or mould.Passage of carbon-dioxide through the sand containing sodium silicate produces carbonic acid in the aqueous solution, this causes a rise in the SiO_2-Na_2O ratio and the formation of a colloidal silica gel which hardens and forms a bond between the sand grains. The reaction is represented by the following equation.

$NaSiO_3 + CO2$ --------- $\rightarrow$ $NaCO_3 + SiO_2$

(Sodium Silicate) (Silica Gel)

Carbon Dioxide Moulding Operation



This sand is mixed with 3 to 5 % sodium silicate liquid base binder in Muller for 3 to 4 minutes. Additives such as coal powder, wood flour sea coal, and dextrin may be added to b improve its properties. Aluminium oxide Kaolin clay may also added to the sand. Patterns used in this method may be coated with Zinc of 0.05 mm to 0.13 mm and then spraying a layer of aluminium or brass of about 0.25 mm thickness for good surface finish and good results.

Advantages

- Operation is speedy since we can use the mould and cores immediately after processing.
- Heavy and rush orders
- Floor space requirement is less
- Semi skilled labor may be used.

Disadvantages

Difficult in reusing the moulding sand.

1.7.3. Investment Casting

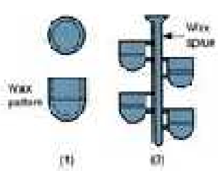
Investment casting produces very high surface quality and dimensional accuracy. Investment casting is commonly used for precision equipment such as surgical equipment, for complex geometries and for precious metals.

This process is commonly used by artisans to produce highly detailed artwork.

The first step is to produce a pattern or replica of the finished mould. Wax is most commonly used to form the pattern, although plastic is also used.

Patterns are typically mass-produced by injecting liquid or semi-liquid wax into a permanent die.

- Prototypes, small production runs and specialty projects can also be undertaken by carving wax models.
- Cores are typically unnecessary but can be used for complex internal structures. Rapid prototyping techniques have been developed to produce expendable patterns.
- Several replicas are often attached to a gating system constructed of the same material to form a tree assembly. In this way multiple castings can be produced in a single pouring.



Advantages
– Parts of great complexity and intricacy can be cast
– Close dimensional control and good surface finish
– Wax can usually be recovered for reuse
– Additional machining is not normally required - this is a net shape process

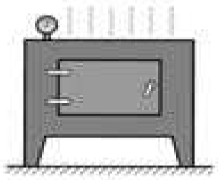
Disadvantages
– Many processing steps are required
– Relatively expensive process

1.7.4. Shell-molding
Shell-mold casting yields better surface quality and tolerances.
The 2-piece pattern is made of metal (e.g. aluminum or steel), it is heated to

between 175°C- 370°C, and coated with a lubricant, e.g. silicone spray. Each heated half-pattern is covered with a mixture of sand and a thermoset resin/epoxy binder. The binder glues a layer of sand to the pattern, forming a shell. The process may be repeated to get a thicker shell.The assembly is baked to cure it.The patterns are removed, and the two half-shells joined together to form the mold; metal is poured into the mold. When the metal solidifies, the shell is broken to get the part.

Advantages of shell moulding

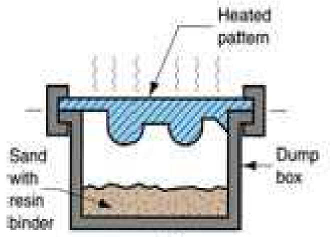
- Smoother cavity surface permits easier flow of molten metal and better surface finish on casting
- Good dimensional accuracy
- Machining often not required
- Mold collapsibility usually avoids cracks in casting
- Can be mechanized for mass production



(4)

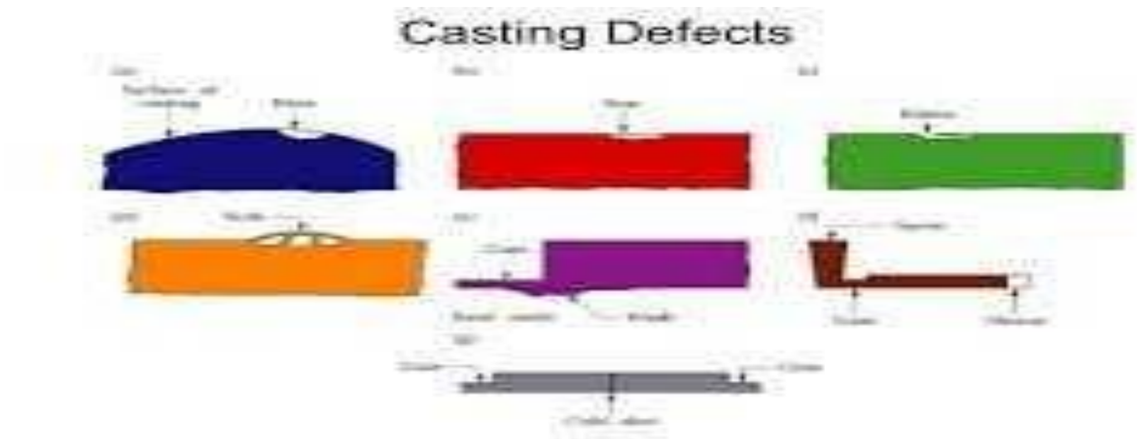
Disadvantages of shell moulding.

- More expensive metal pattern
- Difficult to justify for small quantities



(1)

1.8..Casting Defects.



Casting defects

Defects may occur due to one or more of the following reasons:

– Fault in design of casting pattern
– Fault in design on mold and core

- Fault in design of gating system and riser
- Improper choice of moulding sand
- Improper metal composition
- Inadequate melting temperature and rate of pouring

Some common defects in castings:
a) Misruns b) Cold Shut c) Cold Shot d) Shrinkage Cavity e) Microporosity f) Hot Tearing

a) Misruns

It is a casting that has solidified before completely filling the mold cavity.
Typical causes include
1) Fluidity of the molten metal is insufficient,
2) Pouring Temperature is too low,
3) Pouring is done too slowly and/or
4) Cross section of the mold cavity is too thin.

b) Cold Shut

A cold shut occurs when two portion of the metal flow together, but there is lack of fusion between them due to premature freezing, Its causes are similar to those of a Misruns.

c) Cold Shots

When splattering occurs during pouring, solid globules of the metal are formed that become entrapped in the casting. Poring procedures and gating system designs that avoid splattering can prevent these defects.

d) Shrinkage Cavity

This defects is a depression in the surface or an internal void in the casting caused by

solidification shrinkage that restricts the amount of the molten metal available
in the last region to freeze.

e) Microporosity

This refers to a network of a small voids distributed throughout the casting caused by
localized solidification shrinkage of the final molten metal in the dendritic structure.

f) Hot Tearing

This defect, also called hot cracking, occurs when the casting is restrained or early stages
of cooling after solidification.

1.9 Non-destructive methods used for finding casting Defects.

The various casting defects may be on the surface, under the surface of the solidified casting. These defects are found out by the below mentioned non-Destructive Inspection methods.

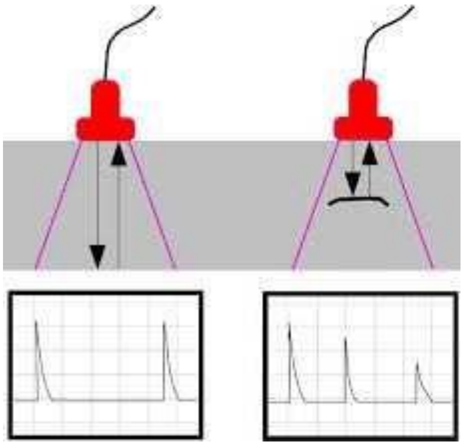
1. Ultra Sonic Inspection
2. Liquid Penetrant Inspection
3. Magnetic Particle Inspection

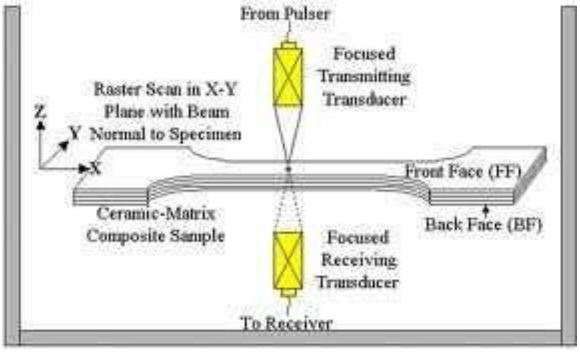
1.9.1. Ultra sonic Inspection.

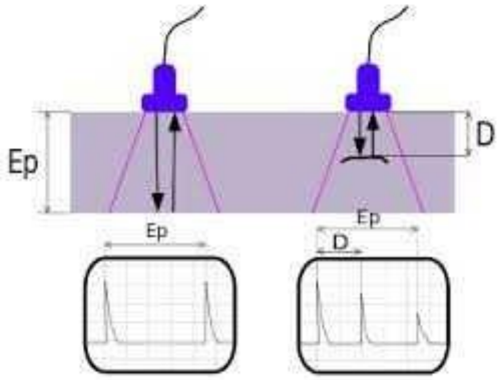
Ultrasonic sound waves are in the frequency decibel which cannot be heared by a human ear. The bats use this kind of sound waves in-order to find the obstacles while flying. These waves will be reflected back to the source when obstructed. Similarly, in ultrasonic testing there is a probe which sends the ultrasonic sound waves into the metal part that is to be inspected. The sound waves will be reflected back after hitting the other end of the metal.

If there is a crack in the middle of the metal part, then the sound waves will be reflected before in advance.

This process is shown in the monitor as a graph. Thus the crack is identified and decided wheather to rectify the crack or reject the metal part.







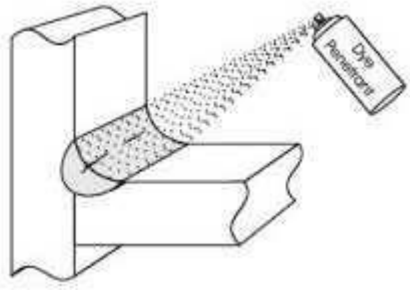
1.9.2. LPT (Liquid Penetrant Testing)

Chemicals Used.

1. Cleaner
2. Potassium Permanganate solution
3. Developer.

Initially the Casted Metal Part to be inspected is cleaned using Cleaner. Dust, oil, Grease etc are removed. Then potassium permanganate solution is sprayed over the surface of the metal part and allowed to remain for 5 – 7 mins. Then the potassium permanganate solution is cleaned.

Now developer is applied over the surface. Due to capillary action the rose/pink colour potassium permanganate liquid will reach the surface of the crack. And now the crack will be visible in pink/rose color.Thus the surface cracks are inspected on the casting.



ADVANTAGES & LIMITATIONS OF LPT

Cost of the chemicals is low when compared to UT & MPT.

Huge / Large size components can be inspected, only on the particular area, where it is required.

Time taken is less.

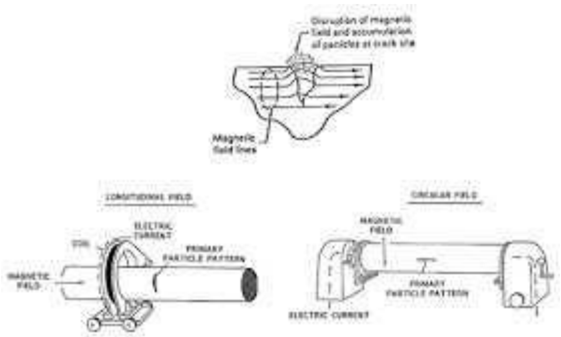
1.9.3. MPT Magnetic Particle testing.

This method of inspection is used on magnetic ferrous castings for detecting invisible surface or slightly subsurface defects. Deeper subsurface defects are not satisfactorily detected because the influence of the distorted lines of magnetic flux (owing to a Discontinuity) on the magnetic particles spread over the casting.

The defects commonly revealed by magnetic particle inspection are quenching cracks, overlaps, thermal cracks, seams , laps, grinding cracks, fatigue cracks, hot tears Etc,

Working Principle.

When a piece of metal is place in a magnetic field and the lines of magnetic flux get intersected by a discontinuity such as a crack or slag inclusion in a casting, magnetic poles are induced on either side of the discontinuity. The discontinuity causes an abrupt change in the path of magnetic flux flowing through the casting normal to the discontinuity, resulting in a local flux



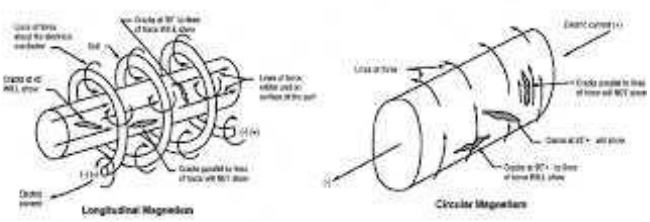


Figure 10.22—Longitudinal Magnetism   Figure 10.23—Circular Magnetism

leakage field and interference with the magnetic lines of force. This local flux disturbance can be detected by its effect upon magnetic particles which are attracted to the region of discontinuity and pile up and bridge over the discontinuity

UNIT – II – Joining Process – SMEA1401

UNIT - II

METAL JOINING PROCESS

PREREQUISTE DISCUSSION

2.1. Welding

Welding is a materials joining process which produces coalescence of materials by heating them to suitable temperatures with or without the pplication of pressure or by the application of pressure alone, and with or without the use of filler material. Welding is used for making permanent joints. It is used in the manufacture of automobile bodies, aircraft frames, railway wagons, machine frames, structural works, tanks, furniture, boilers, general repair work and ship building.

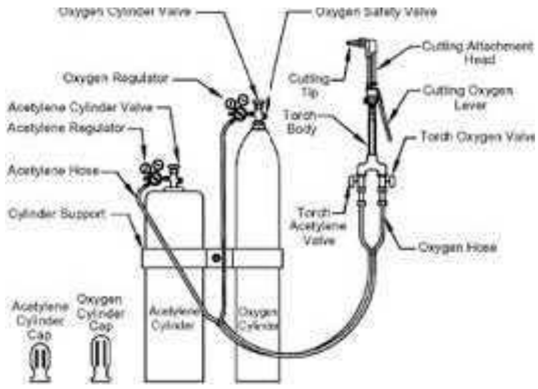
2.2. Types of welding

GAS Welding
ARC Welding

2.3 GAS WELDING

- Sound weld is obtained by selecting proper size of flame, filler material and method of moving torch
- The temperature generated during the process is 33000c.
- When the metal is fused, oxygen from the atmosphere and the torch combines with molten metal and forms oxides, results defective weld
- Fluxes are added to the welded metal to remove oxides
- Common fluxes used are made of sodium, potassium. Lithium and borax.
- Flux can be applied as paste, powder, liquid. solid coating or gas.

2.3.1 GAS WELDING EQUIPMENT

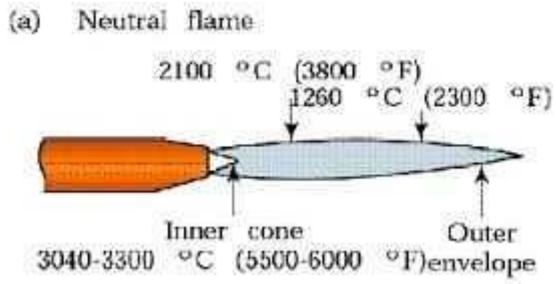


1. Gas Cylinders
Pressure
Oxygen – 125 kg/cm2
Acetylene – 16 kg/cm2
2. Regulators
Working pressure of oxygen 1 kg/cm2
Working pressure of acetylene 0.15 kg/cm2
Working pressure varies depends upon the thickness of the work pieces welded.
3. Pressure Gauges
4. Hoses
5. Welding torch
6. Check valve
7. Non return valve

2.3.2 FLAMES PRODUCED DURING GAS WELDING

Three basic types of oxyacetylene flames used in oxyfuel-gas welding and cutting operations:

(a) neutral flame; (b) oxidizing flame; (c) carburizing, or reducing flame.



Addition of more oxygen give a bright whitish cone surrounded by the transparent blue envelope is called **Neutral flame** (It has a balance of fuel gas and oxygen) (32000c)

- Used for welding steels, aluminium, copper and cast iron

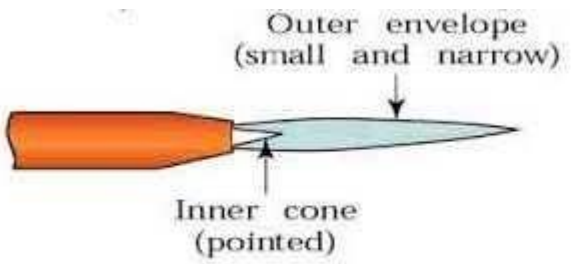
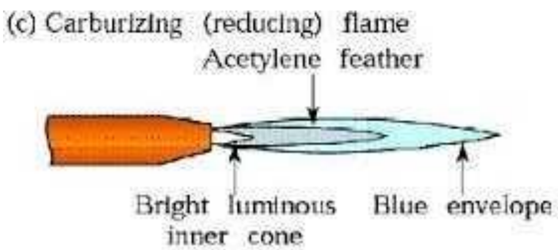


Figure3: Oxidizirg Flame

oxygen give a bright whitish cone surrounded by the transparent blue envelope is called **Neutral flame** (It has a balance of fuel gas and oxygen) (32000c)

- Used for welding steels, Aluminium, copper and cast iron.



Oxygen is turned on, flame immediately changes into a long white inner area (Feather) surrounded by a transparent blue envelope is called **Carburizing flame** (30000c)

Advantages of Gas welding.

1. Simple Equipment
2. Portable
3. Inexpensive
4. Easy for maintenance and repair

Disadvantages Of Gas welding

1. Limited power Density
2. Very low welding speed.
3. High total heat input per unit length
4. Large Heat affected Zone
5. Severe Distortion
6. Not recommended for welding reactive metals such as titanium and Zirconium.

2.3.3. Difference between Gas Welding and Arc Welding.

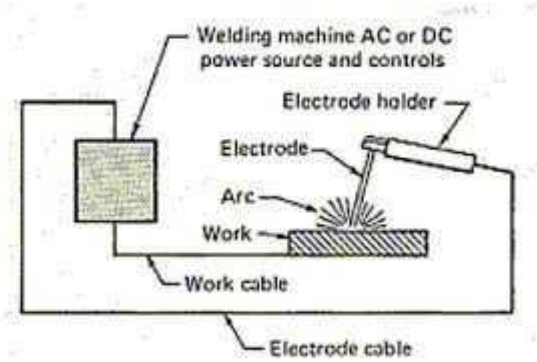
Sr No	GAS WELDING	ARC WELDING
1.	Heat is produced by the Gas Flame	Heat is produced by Electric Arc
2.	The flame temperature is about 3200^{o}C	The temperature of Arc is about 4000^{o}C
3.	Separate Filler rod introduced	Arc Producing as well as filler rod material is the electrode.
4.	Suggested for thin materials	Suggested for medium and thick materials
5.	Gas welded parts do not have much strength	Arc welded parts have very high strength
6.	Filler metal may not be the same parent metal	Filler metal must be same or an alloy of the parent metal
7.	Brazing and soldering are done using gas	Brazing and soldering can’t be carried out by electric arc.

2.4. ARC WELDING

Uses an electric arc to coalesce metals
Arc welding is the most common method of welding metals
Electricity travels from electrode to base metal to ground

2.4.1. Arc welding Equipments

- A welding generator (D.C.) or Transformer (A.C.)
- Two cables- one for work and one for electrode
- Electrode holder
- Electrode
- Protective shield
- Gloves
- Wire brush
- Chipping hammer
- Goggles



2.4.2. Electrode

Electrode is a thin rod made up of same as that of parent material. Flux is coated over the electrode to avoid oxidation. It is mostly connected to the negative polarity.

Two Basic Types of AW Electrodes

- Consumable – consumed during welding process
  - Source of filler metal in arc welding
- Nonconsumable – not consumed during welding process
  - Filler metal must be added separately

Consumable Electrodes

Forms of consumable electrodes

- Welding rods (a.k.a. sticks) are 9 to 18 inches and 3/8 inch or less in diameter and must be changed frequently
- Weld wire can be continuously fed from spools with long lengths of wire, avoiding frequent interruptions

In both rod and wire forms, electrode is consumed by arc and added to weld joint as filler metal.

Nonconsumable Electrodes

- Made of tungsten which resists melting
- Gradually depleted during welding (vaporization is principal mechanism)
- Any filler metal must be supplied by a separate wire fed into weld pool

2.4.3. Flux

A substance that prevents formation of oxides and other contaminants in welding, or dissolves them and facilitates removal

- Provides protective atmosphere for welding
- Stabilizes arc
- Reduces spattering

2.4.4. STEPS FOLOWED IN ARC WELDING :

- Prepare the edges to be joined and maintain the proper position
- Open the acetylene valve and ignite the gas at tip of the torch
- Hold the torch at about 45deg to the work piece plane
- Inner flame near the work piece and filler rod at about 30 – 40 deg
- Touch filler rod at the joint and control the movement according to the flow of the material

Advantages

Most efficient way to join metals
Lowest-cost joining method
Affords lighter weight through better utilization of materials
Joins all commercial metals
Provides design flexibility

Disadvantages

- Manually applied, therefore high labor cost.
- Need high energy causing danger
- Not convenient for disassembly.
- Defects are hard to detect at joints.

2.5. SPECIAL WELDING PROCESS

2.5.1. Submerged arc welding

- Weld arc is shielded by a granular flux , consisting of silica, lime, manganese oxide, calcium fluoride and other compounds.
- Flux is fed into the weld zone by gravity flow through nozzle

Thick layer of flux covers molten metal

- Flux acts as a thermal insulator ,promoting deep penetration of heat into the work piece
- Consumable electrode is a coil of bare round wire fed automatically through a tube
- Power is supplied by 3-phase or 2-phase power lines

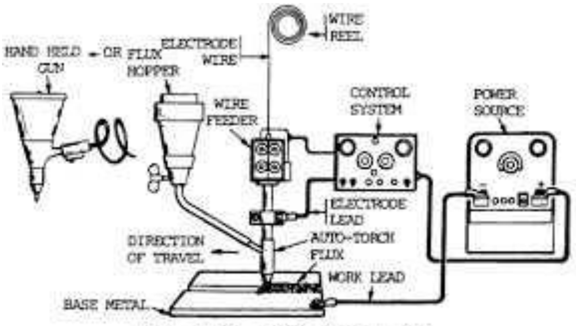


Figure 10-59. Block diagram - SAW.

2.5.2. Laser Beam Welding (LBW)

Fusion welding process in which coalescence is achieved by energy of a highly concentrated, coherent light beam focused on joint

- Laser = "light amplification by stimulated emission of radiation"
- LBW normally performed with shielding gases to prevent oxidation
- Filler metal not usually added
- High power density in small area, so LBW often used for small parts

Working

The laser WELDING system consists of a power source, a flash lamp filled with Xenon, lasing material, focusing lens mechanism and worktable. The flash tube flashes at a rate of thousands per second. As a result of multiple reflections, Beam power is built up to enormous level.

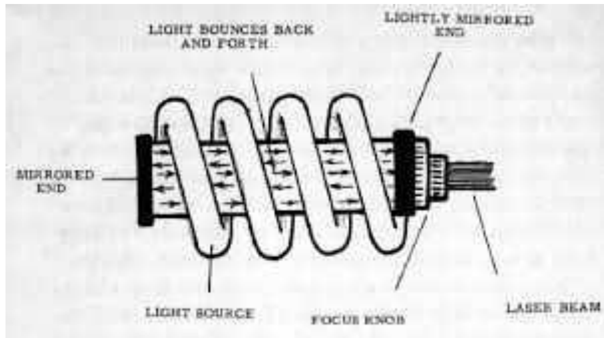
The output laser beam is highly directional and strong, coherent and unicromatic with a wavelength of 6934^{o}A. It goes through a focusing device where it is pinpointed on the work piece, fusion takes place and the weld is accomplished due to concentrated heat produced. Laser beam welding process is shown in the figure.

Advantages.

1. Wide variety of metals can be welded.
2. Thermal damage is minimum.
3. Weld metal is purified.
4. Good ductility and mechanical properties.
5. Welds are vaccum tight.
6. filler metal is not used.

7. No effect on heat treated components.

Limitations.



1. Low welding Speed.
2. Limited to thickness of 1.5mm.
3. Materials like Mg cannot be welded.

APPLICATIONS

Radio Engineering and Microelectronics.

2.5.3. Electron Beam Welding (EBW)

Fusion welding process in which heat for welding is provided by a highly-focused, high-intensity stream of electrons striking work surface

- Electron beam gun operates at:
  - High voltage (e.g., 10 to 150 kV typical) to accelerate electrons
  - Beam currents are low (measured in milliamps)
- Power in EBW not exceptional, but power density is

Working

The Kinetic energy of the electrons is converted into intense heat energy when the electrons are absorbed by the metal piece over a small area of the weld, producing deep penetration weld with a depth/width ratio as high as 15. This results in a narrow, almost parallel weld with very little distortion and a small width of the heat affected zone. There is no possibility of contamination by atmospheric gases because process is carried out in vaccum.

Advantages

- High-quality welds, deep and narrow profiles
- Limited heat affected zone, low thermal distortion
- High welding speeds
- No flux or shielding gases needed

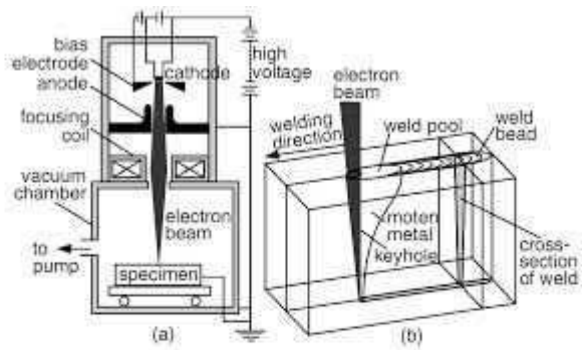
Disadvantages

- High equipment cost
- Precise joint preparation & alignment required
- Vacuum chamber required
- Safety concern: EBW generates x-rays

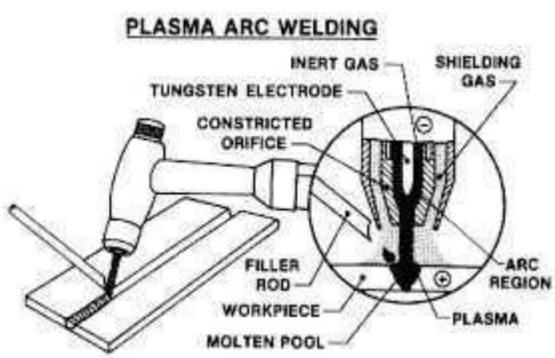
Comparison: LBW vs. EBW

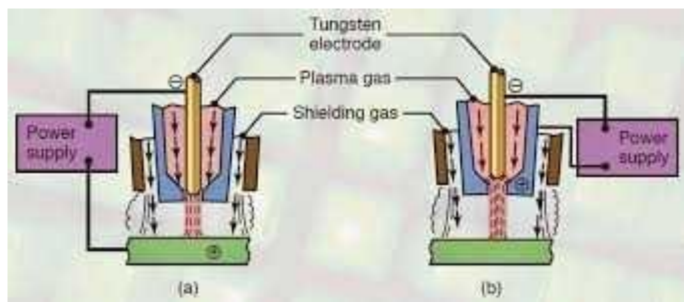
- No vacuum chamber required for LBW
- No x-rays emitted in LBW
- Laser beams can be focused and directed by optical lenses and mirrors
- LBW not capable of the deep welds and high depth-to-width ratios of EBW

 Maximum LBW depth = ~ 19 mm (3/4 in), whereas EBW depths = 50 mm (2 in)



2.5.4. PLASMA ARC WELDING





Principle:

Plasma Arc welding is a constricted arc process. The arc is constrained with the help of a water cooled small diameter nozzle which squeezes the arc, increases its pressure, temperature and heat intensely and thus improves stability, arc shape and heat transfer, characteristics

There are two methods of Plasma Arc Welding

(A) Transferred Arc
(B)Non- Transferred Arc.

(a) Transfered Arc

Here the electrical circuit is between the tungsten electode and the work piece. Work piece acts as anode and the tungsten electrode as cathode. The arc is transferred from the electrode to the work piece and hence the term transferred. Here the arc force is directed away from the plasma torch and into the work piece, hence capable of heating the work piece to a higher temperature.

(b) NON-Transferred Arc.

In Non-transferreed type, power is directly connected with the electrode and the torch of nozzle. The electrode carries the same current. Thus ,ionizing a high velocity gas that is strewing towards the workpiece. The main advantage of this type is that the spot moves inside the wall and heat the incoming gas and outer layer remains cool. This type of plasma has low thermal efficiency.

Advantages

1. Ensures arc stability.
2. Produces less thermal distortion
3. The process is readily automated.

Disadvantages.

1. Excessive noise is produced.
2. Equipment is complicated and expensive.
3. Large amount of ultraviolet and infrared rays are emitted.

2.5.5. THERMIT WELDING.

FW process in which heat for coalescence is produced by superheated molten metal from the chemical reaction of thermite

- Thermite = mixture of Al and $Fe3O4$ fine powders that produce an exothermic reaction when ignited
- Also used for incendiary bombs
- Filler metal obtained from liquid metal
- Process used for joining, but has more in common with casting than welding

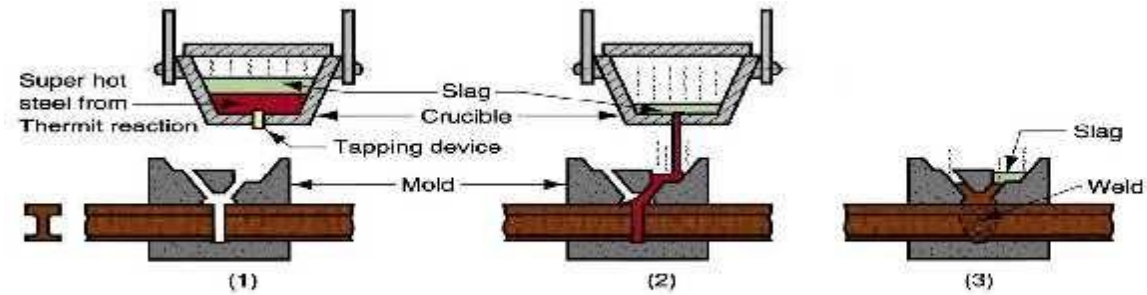
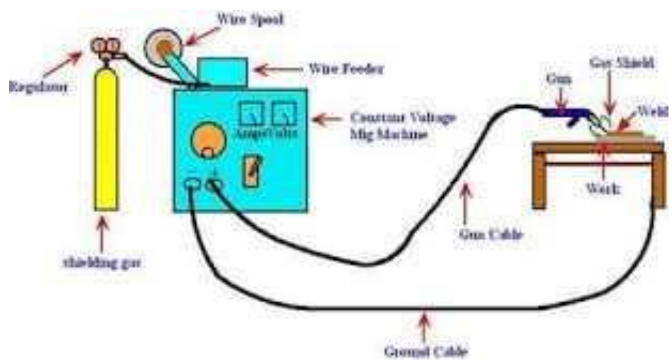


Fig: Thermit welding: (1) Thermit ignited; (2) crucible tapped, superheated metal flows into mold; (3) metal solidifies to produce weld joint.

Applications

- joining of railroad rails
- Repair of cracks in large steel castings and forgings
- Weld surface is often smooth enough that no finishing is required

2.5.6. TIG WELDING



Inert Gas Welding

For materials such as Al or Ti which quickly form oxide layers, a method to place an inert atmosphere around the weld puddle had to be developed

Metal Inert Gas (MIG)

- Uses a consumable electrode (filler wire made of the base metal)
- Inert gas is typically Argon

Gas Tungsten Arc Welding (GTAW)

Gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG) welding, is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area and electrode is protected from oxidation or other atmospheric contamination by an inert shielding gas (argon or helium), and a filler metal is normally used, though some welds, known as autogenous welds, do not require it. When helium is used, this is known as heliarc welding. A constant-current welding power supply produces electrical energy, which is conducted across the arc through a column of highly ionized gas and metal vapors known as a plasma.

GTAW is most commonly used to weld thin sections of stainless steel and non-ferrous metals such as aluminum, magnesium, and copper alloys. The process grants the operator greater control over the weld than competing processes such as shielded metal arc welding and gas metal arc welding, allowing for stronger, higher quality welds. However, GTAW is comparatively more complex and difficult to master, and furthermore, it is significantly slower than most other welding techniques. A related process, plasma arc welding, uses a slightly different welding torch to create a more focused welding arc and as a result is often automated

Uses a non-consumable tungsten electrode and an inert gas for arc shielding

- Melting point of tungsten = 3410 C (6170 F)
- A.k.a. Tungsten Inert Gas (TIG) welding
  - In Europe, called "WIG welding"
- Used with or without a filler metal
- When filler metal used, it is added to weld pool from separate rod or wire
- Applications: aluminum and stainless steel most common

Advantages

- High quality welds for suitable applications
- No spatter because no filler metal through arc
- Little or no post-weld cleaning because no flux

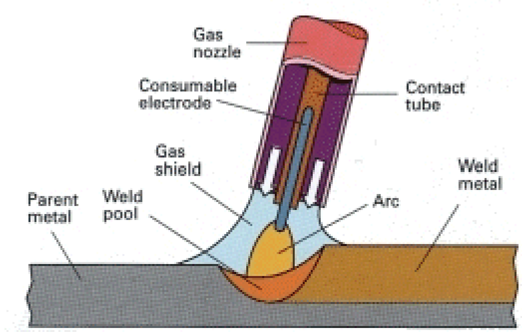
Disadvantages

- Generally slower and more costly than consumable electrode AW processes

Gas Metal Arc Welding (GMAW)

Gas metal arc welding (GMAW), sometimes referred to by its subtypes metal inert gas (MIG) welding or metal active gas (MAG) welding, is a welding process in which an electric arc forms between a consumable MIG wire electrode and the workpiece metal(s), which heats the workpiece metal(s), causing them to melt and join. Along with the wire electrode, a shielding gas feeds through the welding gun, which shields the process from atmospheric contamination.

The process can be semi-automatic or automatic. A constant voltage, direct current power source is most commonly used with GMAW, but constant current systems, as well as alternating current, can be used. There are four primary methods of metal transfer in GMAW, called globular, short-circuiting, spray, and pulsed-spray, each of which has distinct properties and corresponding advantages and limitations.

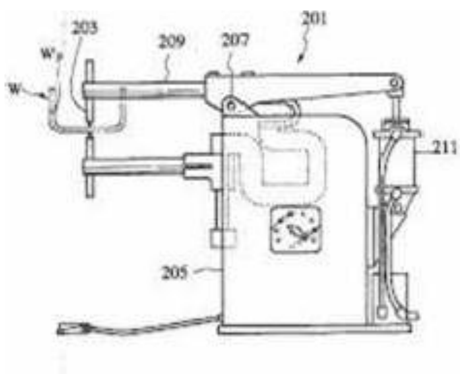


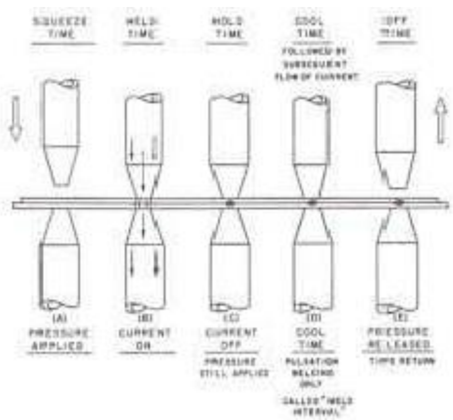
2.5.7. RESISTANCE WELDING.

Resistance Welding (RW)

A group of fusion welding processes that use a combination of heat and pressure to accomplish coalescence

Heat generated by electrical resistance to current flow at junction to be welded
Principal RW process is resistance spot welding (RSW





Components in Resistance Spot Welding

- Parts to be welded (usually sheet metal)
- Two opposing electrodes
- Means of applying pressure to squeeze parts between electrodes
- Power supply from which a controlled current can be applied for a specified time duration

Advantages

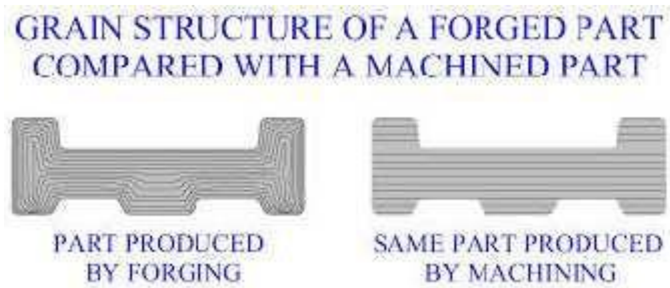
- No filler metal required
- High production rates possible
- Lends itself to mechanization and automation
- Lower operator skill level than for arc welding

Good repeatability and reliability.

UNIT – III – Bulk Deformation Processes – SMEA1401

UNIT III

METAL FORMING PROCESS



3. PREREQUISTE DISCUSSION

The Materails to be used in places where the component is subjected to very high Impact load, Shock Load, intermittant load and in Power transmission lines, Need to be produced with dense grain structure. This requirement can be acheived by manufacturing process such as Forging, Rolling,Extrusion and Drawing.

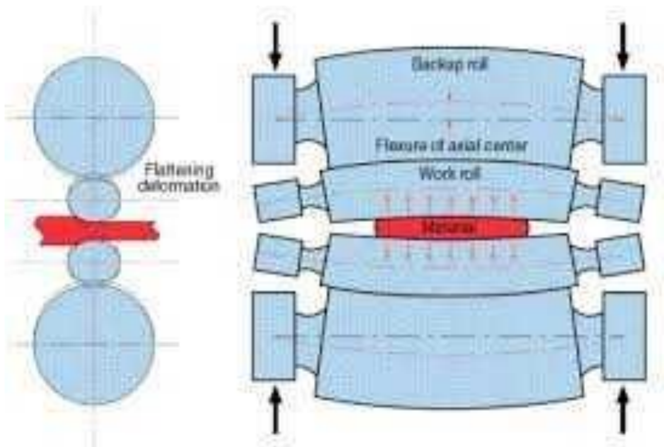
3.1. COMPARISION BETWEEN HOT WORKING AND COLD WORKING

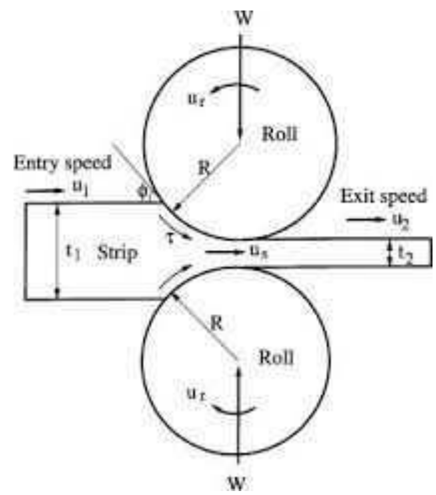
SR NO	HOT WORKING	COLD WORKING
1.	Hot working is done above recrystallisation temperature	Cold working isdone below recrystallisation temperature.
2.	Refinement of grains takes place	Grain structure is distorted.
3.	Impurities and porosity are removed from metals after hot working.	Impurities and porosities exist in metal after cold working.
4.	Residual stresses are eliminated.	Residual stresses are not eliminated.
5.	Rapid oxidation or scaling of surfaces occurs which results in poor surface finish.	No oxidation and hence good surface finish is obtained.
6.	Close dimensional tolerances cannot be maintained.	Close dimensional tolerances can be obtained.
7	Toolling and handling costs are more.	Tooling and handling costs are less
8.	Mecanical properties such as Toughness,ductility,elongation are improved.	Cold w2orking decreases elongation,reduction in area , hardness, tensile strength. Fatigue strength are improved.

3.2. ROLLING

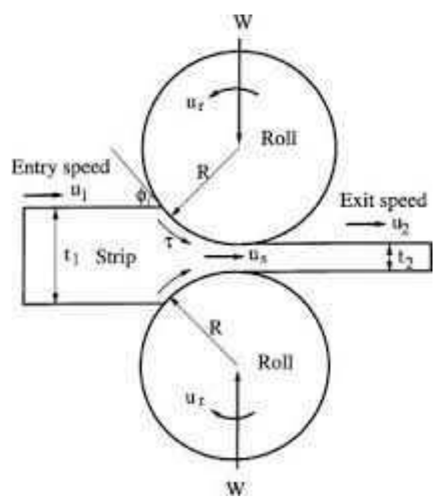
Rolling is the most rapid method of forming metals into desired shapes by plastic deformation in between rolls.

The forming of bars, plates , sheets, rails and other steel sections are produced by rolling.





3.2.1. Classification of Rolling mill based on number of rolls.



1.Two High Rolling Mill.

2.Three high Rolling Mill

3.Four high Rolling Mill

4. Multi Rolling Mill.

5.Universal Rolling Mill

6.Planetary Rolling Mill.

1.Two High Rolling Mill.

3.2.2. DEFECTS IN ROLLED PARTS

There are two types of major defects on the rolled products.

(a) SURFACE DEFECTS
(b) INTERNAL SURFACE DETECTS.

(a) **SURFACE DEFECTS** Major surface defects on rolled products are scales, rust, scratches,cracks, and pits. These defects occurs on the rolled products due to the impurities and inclusions present in the original cast materials.,

(b).INTERNAL SURFACE DEFECTS

i. WAVINESS OR WAVY EDGES.

It occurs due to the bending of rolls. The rolls acts as a straight beam. If the material flow is continuous and to maintain this continuity, strains with in the material should adjust with itself. There are compressive strain on the edges and tensile strain at the centre. The edges are restrained from expanding freely in the longitudinal direction because of which wavy edges on the sheet will be produced.

ii. Zipper Cracks

It occurs due to poor material ductility, at the rolling temperatureCamber is provided to avoid this defect., Camber is providing slightly large diameter at the center of rolls than that at the edges.

iii. FOLDS

Folds occur if the reduction per pass is very less.

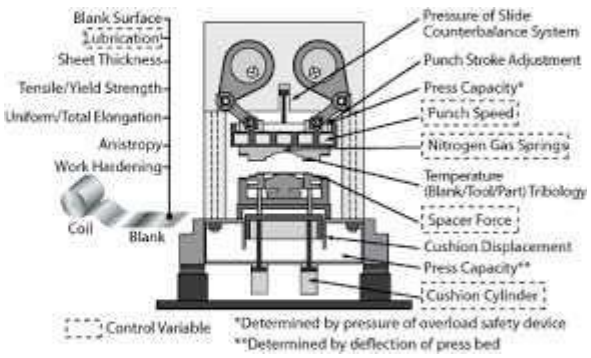
iv. Alligatoring.

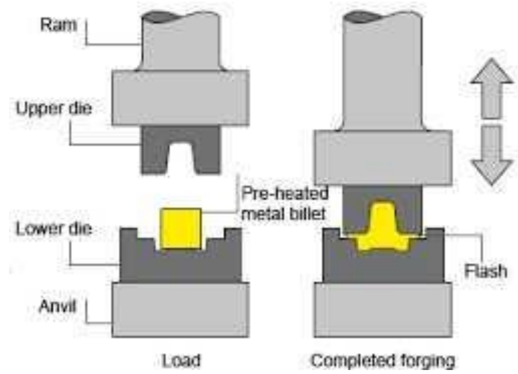
It is the splitting of work piece along the horizontal plane on exit, with top and bottom part following the rotation of their respective rolls.

v. Lamination.

These are small cracks which may develop when reduction in thickness is excessive.

3.3. FORGING





3.3.1. COMPARISON BETWEEN PRESS FORGING AND DROP FORGING.

SR NO	Press forging	Drop Forging
1.	It is a Faster process	Slow Process
2.	Die alignment is easier	Die alignment is difficult
3.	Operation is quite	Noisy operation
4.	Quality of product is good	Quality of product is fair.
5.	Stroke and ram speed is high	It is low.
6.	It is one stroke operation	Multiple stroke operation.
7.	Range is 20 tons to 1500 tons.	Range upto 10 tons
8.	Shapes formed are dense and homogeneous in structure.	Coarse and not homogenous in structure.

3.3.2. Forging operations

Forging is a process in which the work piece is shaped by compressive forces applied through various dies and tools. It is one of the oldest metalworking operations. Most forgings require a set of dies and a press or a forging hammer. A Forged metal can result in the following: -

- Decrease in height, increase in section - open die forging
- Increase length, decrease cross-section, called **drawing out**.
- Decrease length, increase in cross-section on a portion of the length **- upsetting**
- Change length, change cross-section, by squeezing in closed impression dies - closed die forging. This results in favorable grain flow for strong parts

3.3.3. Types of forging

- Closed/impression die forging
- Electro-upsetting
- Forward extrusion
- Backward extrusion
- Radial forging
- Hobbing

- Isothermal forging
- Open-die forgig
- Upsetting
- Nosing
- Coining

Commonly used materials include

- Ferrous materials: low carbon steels
- Nonferrous materials: copper, aluminum and their alloys

3.3.3.1Open-Die Forging

Open-die forging is a hot forging process in which metal is shaped by hammering or pressing between flat or simple contoured dies.

Equipment. Hydraulic presses, hammers.

Materials. Carbon and alloy steels, aluminum alloys, copper alloys, titanium alloys, all forgeable materials.

Process Variations. Slab forging, shaft forging, mandrel forging, ring forging, upsetting between flat or curved dies, drawing out.

Application. Forging ingots, large and bulky forgings, preforms for finished forgings.

Closed Die Forging

In this process, a billet is formed (hot) in dies (usually with two halves) such that the flow of metal from the die cavity is restricted. The excess material is extruded through a restrictive narrow gap and appears as flash around the forging at the die parting line.

Equipment. Anvil and counterblow hammers, hydraulic, mechanical, and screw presses.

Materials. Carbon and alloy steels, aluminum alloys, copper alloys, magnesium alloys, beryllium, stainless steels, nickel alloys, titanium and titanium alloys, iron and nickel and cobalt super alloys.

Process Variations. Closed-die forging with lateral flash, closed-die forging with longitudinal flash, closed-die forging without flash.

Application. Production of forgings for automobiles, trucks, tractors, off-highway equipment, aircraft, railroad and mining equipment, general mechanical industry, and energy-related engineering production.

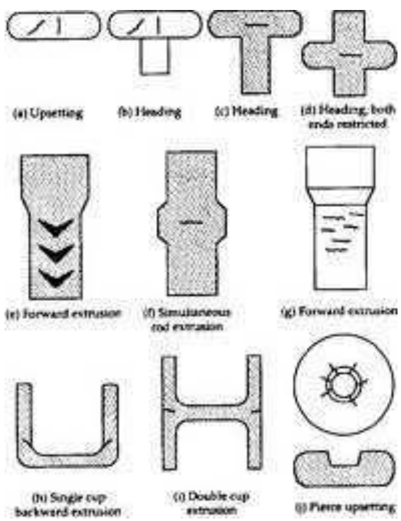
3.3.4. DEFECTS IN FORGED PARTS

1.**Unfilled Sections**.

In this some of the die cavity are not completely filled by the flowing metal.

2.**Cold Shuts.**

This appears as small cracks at the corners of the forging. Caused due to improper design of die.



3. Scale Pits.

This is seen as irregular depositions on the surface of forging. This is primarily caused because of improper cleaning of the stock used for forging.

The oxides and scales gets embedded into the finish forging surface.

When the forging is cleaned by pickling, these are seen as deputations on the forging surfaces.

4. Die Shifts.

This is caused by the mis-alignment of the half dies, making the two halves of te forging to be of improper shape. It is also called as mismatch.

5..Flakes.

These are basically ruptures caused by the improper cooling of the large forging. Rapid cooling causes the exterior to cool quickly causing internal fractures.

6. Improper Grain Flow.

Due to improper design of the die, which makes the flow of the metal to be not in the final intended direction?

7. Laps.

Laps are formed by webbuckling during forging. To avoid laps web thickness should be increased and properly edesigned.

UNIT – IV – Sheet Metal Processes – SMEA1401

UNIT IV

SHEET METAL PROCESS

PREREQUISITE DISCUSSION

Now a day the automobile component, aircraft and ship building involves the usage of thin sheets of various metals. If the thickness of the metal is less than six 'mm' then it is called as sheet. Hence the knowledge about the sheet metal processing is necessary. This unit deals how the sheet metals are processed for meeting the requirement & Involves methods in which sheet metal is cut into required dimensions and shape; and/or forming by stamping, drawing, or pressing to the final shape. The surface finish of the sheet metals processed by this methods are good when compared to other process like welding, machining etc., A special class of metal forming where the thickness of the piece of material is small compared to the other dimensions. Cutting into shape involve shear forces Forming Processes involve tensile stresses.

4. The Major operations of sheet Metal are;

(A) Shearing,
(B) Bending,
(C) Drawing and
(D) Squeezing

4.1. Shearing

The mechanical cutting of materials without the information of chips or the use of Burning or melting for straight cutting blades: shearing for curved blades: blanking, piercing, notching, trimming

Classifications of Shearing Processes

Blanking
Punching
Piercing
Trimming
Slitting
Notching
Nibbling
Shaving
Dinking
Perforating
Lancing
Cutoff
Spring Back


Production Shearing Services

Blanking.

Cutting a piece from the sheet metal by leaving enough scrap around the opening to assure that the punch has enough metal to cut along its entire edge, during which a metal work piece is removed from the primary metal strip or sheet when it is punched.

Punching.

It is the operation to produce circular holes on a sheet metal by a punch and a die. Here the pierced metal is the final product then the operation is called as punching.

Piercing.

It is an operation to produce holes of any desired shape. Piercing produces a raised hole rather than a cut hole. Piercing refers to punching a hole.

Trimming.

It is the operation of cutting and removing unwanted excess metal from the periphery of a previously formed /forged/cast component.

Slitting

Shearing process used to cut rolls of sheet metal into several rolls of narrower width used to cut a wide coil of metal into a number of narrower coils as the main coil is moved through the slitter. Shearing operations can be carried by means of a pair of circular blades.

Notching

Same as piercing- edge of the strip or black forms part of the punch-out perimeter. In this process the metal is removed from the side (OR) EDGE of a sheet to get the desired shape.

Nibbling

Produces a series of overlapping slits/notches. A machine called nibbler moves a small straight punch up and down rapidly into a die.

Shaving

Finishing operation in which a small amount of metal is sheared away from the edge of an already blanked part .can be used to produce a smoother edge. The rough edges of a blanked part are removed by cutting thin strip of metal along the edge on the periphery.

Dinking

Used to blank shapes from low-strength materials such as rubber, fiber and cloth

Perforating.

Process of making multiple holes which are small in diameter and closed together.

Lancing.

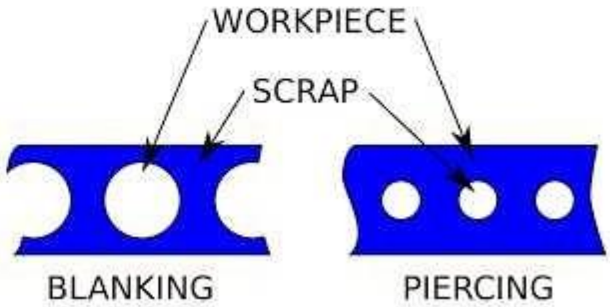
Lancing refers to leaving a tab without removing any material. It is an operationof cutting on one side and bending on the other side to form a sort of tab (or) Louver. No metal is removed in this operation.
Lancing refers to leaving a tab without removing any material. It is an operationof cutting on one side and bending on the other side to form a sort of tab (or) Louver. No metal is removed in this operation.

Cutting Off.

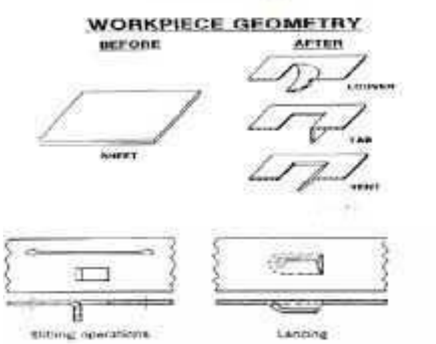
In this operation a piece is removed from a strip by cutting along a single line.Parting The sheet is sheared into two (Or) more pieces.

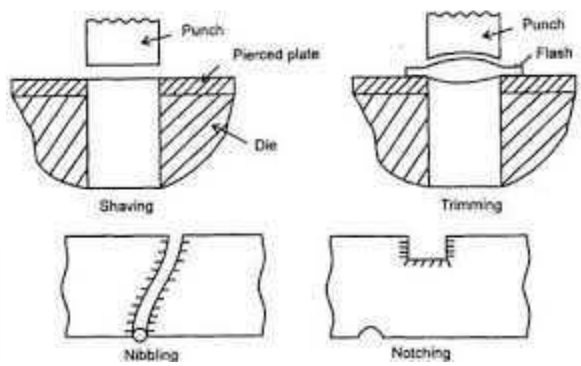
Spring back

The elastic recovery of the material after unloading of the tools.

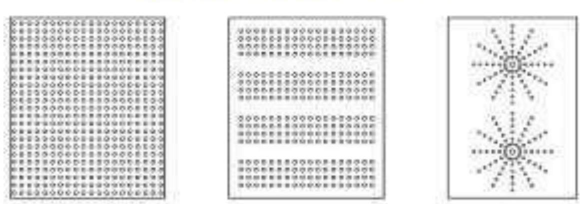


Lancing





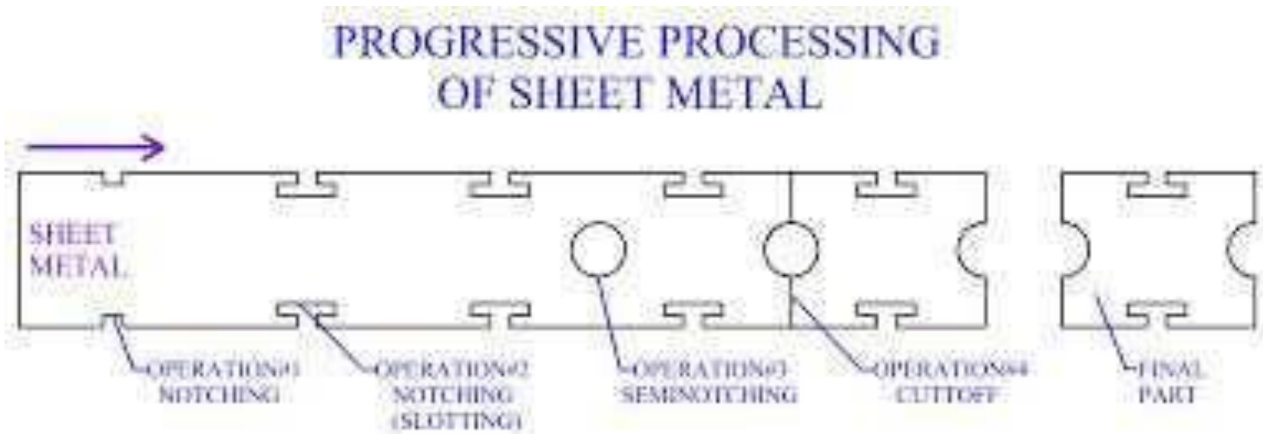
PERFORATING



METAL SHEETS
WITH HOLES

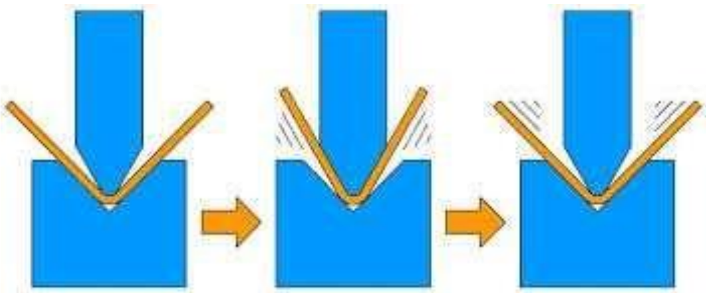
Embossing

- Certain designs are embossed on the sheet metal.
- Punch and die are of the same contour but in opposite direction.

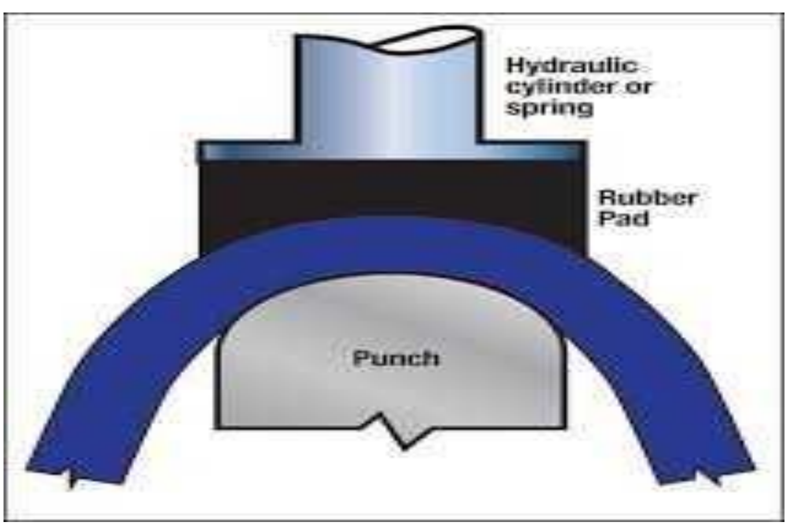


4.2. Bending

The plastic deformation of metals about a linear axis with little or no change in the surface area. The purpose of bending is to form sheet metal along a straight line



4.3. STRETCH FORMING OPERATIONS



In this process, the sheet metal is clamped along the edges and then stretched over a die (OR) FORM BLOCK, which moves upward, downward (or) side ways, depending on the particular machine.

It is used to make aircraft wing-skin panels, automobile door panels and window frames.
The desirable qualities in the metal for maximum strechability are as follows.

1. Fine grain structure.
2. toughness.
3. LARGE SPREAD between the tensile yield and ultimate strength.

Working.

It consists of placing the sheet –metal under a tensile load over a forming block and stretching it beyond its elastic limit and to te plastic range, thus cause a permanent set to take place.

Two Basic Forms of Stretch forming are,

1. Stretch forming,
2. Stretch – Wrap forming.

Advantages

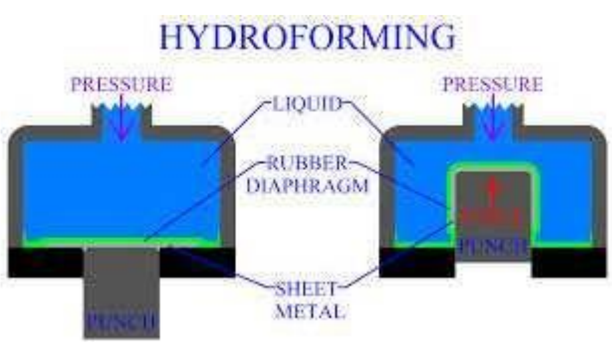
1. In a single operation, blanks can be stretched.
2. Heat treatment before and after stretching process is not required.
3. Spring back effect is minimized.
4. Tooling cost is low.
5. Direct bending is not introduced, and plastic deformation is due to pure tension.
6. It is suitable for low volume production.

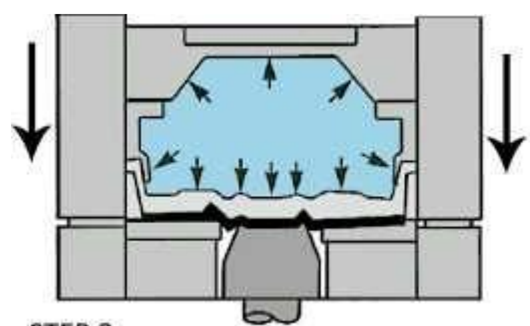
Disadvantages.

1. uneven thickness of blank cannot be stretched.
2. The maintanence cost of the hydraulic cylinders is high.

4.4. SPECIAL FORMING PROCESS.

4.4.1. HYDRO FORMING PROCESS





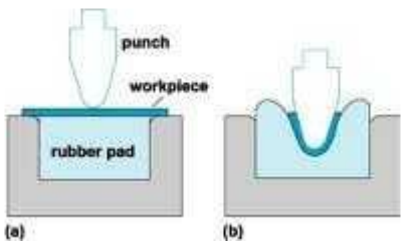
STEP 2
Top of press lowered and fluid chamber pressurized.

In this process te pressure over the rubber membraneis controlled throughout the forming cycle, with maximum pressure upto- 100 Mpa.This procedure allows close control of the part during forming, to prevent wrinkling (or) tearing. This process is called hydroform or fluif – Forming Process.Hydro forming is a Drawing process.

Advantages of Hydro-formimg Process.

1.It is used for Mass production.
2.Tools can be quickly changed.
3.Complicted shapes , sharp corners can be made by this method.
4.Spring back, Thining off metals are removed.

4.4.2. RUBBER PAD FORMING



One of the die material is made up of a flexible material (ex. Rubber) Or (poly-urethane material.In bending and embossing of sheet metal , the female die is replaced with a rubber pad.Pressure in the rubber pad forming is usually in the order of10Mpa.

The blank is placed under the punch called male die.Then the ram (femal part) is moved so that punch touches the top surface of the work. Then the force is appled and gradually. increased on the blank through the rubber pad.

The blank holder ring is used to distribute uniform pressure throughout the blank.

Thus the required shape is formed on the sheet metal between male and female parts.

Advantages of rubber pad forming.

1.Number of shapes can be formed on one rubber pad.
2.Thining in metal balank does not take place.\
3.setting time of the tool is less.
4.Wrinkle – free , shrink flanges can be produced.

Disadvantages

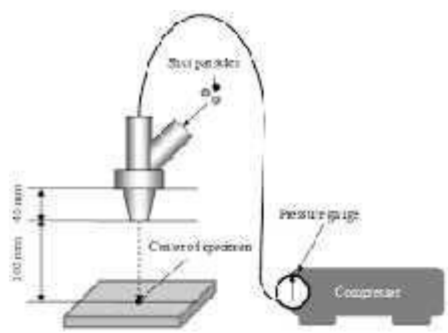
1.Rapid wearing of rubber Pads is a problem in this process.
2.Accurate sharp corners cannot be made by this process.
3.Loss of pressure between hydraulic fluid and rubber pad which is a major problem

Aplications.

Flanged Cylinders.
Rectangular cups,
Spherical Domes.
Unsymmetrical shaped components can be made.

4.4.3. PEEN FORMING PROCESS.

This process is used to produce curvature on thin sheet metals by shot peening on surface of the sheet.
A stream of metal shots is blasted against the surface of the blank.
This process is also called as peen forming technique.



Peening is done with cast- iron (or) Steel shot discharged either from a rotating wheel by an air blast made from a nozzle.

Advantages of Peen forming

Complex shapes can be easily produced .
Die and Punch is not used.
Peening is used as a salvage operations for distorted parts (OR) correcting part.

Disadvantages of peen forming.

This process requires longer time for forming the required shape.

Requires additional devices for forcing out metal shots.

Applications of peen forming.
Specific portions on crankshafts , connecting rods, gears
Honey comb panels like aircraft wings and large tubular shapes can be produced.

UNIT – V – Manufacturing of Plastic Components – SMEA1401

MANUFACTURING OF PLASTIC COMPONENTS

PREREQUISITE DISCUSSION

Plastics are the best alternatives used in the areas where the component size is very small and weight reduction is required in order to minimize the cost of material. Hence knowledge about various types of plastics, its properties, production method etc is very important.

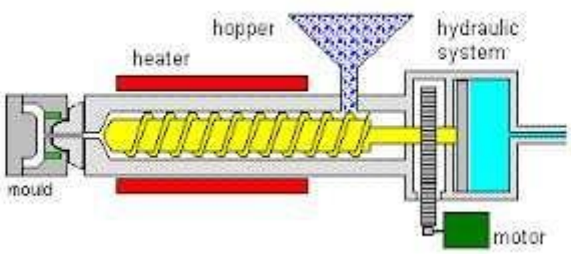
5.1. TYPES OF PLASTICS

Plastics are of two types
1.Thermo plastics
2.Thermosetting Plastics

Common plastics USED in molding are

- HDPE (stiff bottle, toys, cases, drum)
- LDPE (flexible bottle)
- PP (higher temperature bottle)
- PVC (clear bottle, oil resistant containers)
- PET (soda pop bottle)
- Nylon (automotive coolant bottle, power steering reservoir)

5.2. INJECTION MOULDING.



Injection Molding

Most widely used process. Suitable for high production of thermoplastics. Charge fed from a hopper is heated in a barrel and forced under high pressure into a mold cavity. Several types. Variety of parts can be made.

Basic components:
mold pieces (define the geometry of the part), and sprue, gates, runners, vents, ejection pins, cooling system

There are two types of injection moulding.

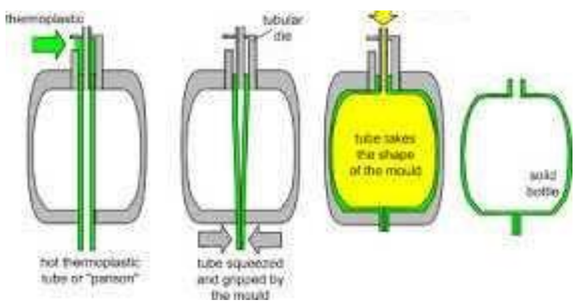
1. Plunger type injection moulding.
2. Screw type injection moulding.

In screw type injection moulding machine the plunger is replaced by a screw.A receiprocating screw now forces the material into the mould.since the screw action generally helps to pack the materials better , a given plunger travel will push more material into the cavity. Finally the action of the screw , as it rotates and mixes, adds energy to the melt.

Band heaters are still needed to fully heat the melt. All of this results in a much better and more consistent part.

Virtually all industrial presses are screw type presses.

5.3. BLOW MOULDING



Blow Molding

used to make thermoplastic bottles and hollow sections. Starting material is a round heated solid-bottom hollow tube – perform.
Perform inserted into two die halves and air is blown inside to complete the process

General steps

- Melting the resin- done in extruder
- Form the molten resin into a cylinder or tube (this tube is called parison)
- The parison is placed inside a mold, and inflated so that the plastic is pushed outward against the cavity wall
- The part is allowed to cool in the mold and is then ejected
- The part is trimmed

The parison can be formed by

A)Extrusion process
B)Injection molding process

(A) Extrusion blow molding

- Parison is formed from by forcing the plastic through an extrusion die.

Material enters the die, flow around the mandrel so that extrudate would be cylindrical

- The die would have a hole at the center so that air could be blown into the cylinder
- In some blow molding operations, the air is introduced from the bottom through an inlet

This process can be;

- continuous extrusion blow molding
  - During the process, the extrusion runs continuously, thus making a continuous parison.
  - using multiple mold to match the mold cycle to the extrusion speed
- Intermittent extrusion blow molding
  - During the process, the extruder is stopped during the time that the molding occur
  - use either reciprocating screw or an accumulator system

- In this system, the output of the extruder is matched by having multiple molds which seal and blow the parison and then move away from extruder to cool and eject
- In practical case, the mold cycle is longer than time required to extrude a new parison
- If the mold cycle is twice than time needed for creating a parison, a two mold system can be used
- The method is sometimes called rising mold system - system of which two or more molds are used to mold parts from one extruder during continuous process

b) Injection Blow Molding

- The parison is formed by the injection of molten resin into a mold cavity and around a core pin
- The parison is not a finished product, but it is subjected to subsequent step to form the final shape
- Second step, blowing of the intermediate part in a second mold
- Because of distinct separation of the two steps, the parison made by injection molding is called a perform

Process

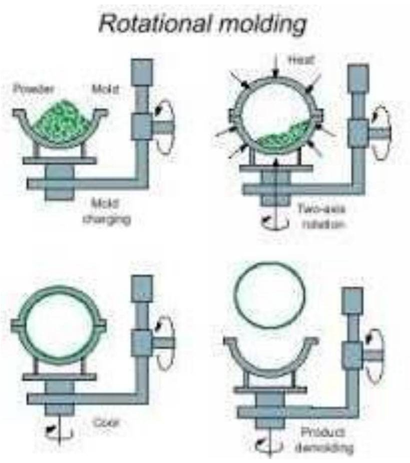
- The mold is closed
- Resin is then injected to form a cylindrical part
- The mold is opened and perform is ejected

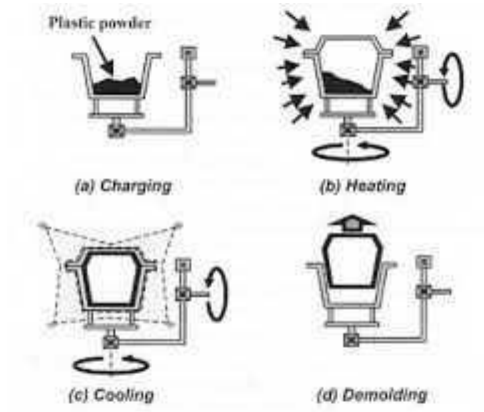
The perform can be stored until the finished blow molded is needed.
The flexibility of separating the two cycles has proven useful in manufacture of soda pop bottle.

Comparison of extrusion and injection blow molding

Sr no	**(a)Extrusion blow molding**	**(b)Injection blow molding**
1.	– It is best suited for bottle over 200g in weight, shorter runs and quick tool changeover	• Best suited for long runs and smaller bottles • No trim scrap
	– Machine costs are comparable to injection blow molding	• Higher accuracy in final part
	Tooling costs are 50% to 75% less than injection machine It requires sprue and head trimming	Better transparencies with injection blow molding, because crystallization can be better controlled
	Total cycle is shorter than injection (since the parison and blowing can be done u sing the same machine)	• Can lead to improve mechanical properties from improved parison design.
	Wider choice of resin	• Uniform wall thickness

5.4. ROTATIONAL MOULDING.





It is also known as Rotomoulding, rotocasting or spin casting.

The thin walled metal mould is a split female mould made of two pieces and is designed to be rotated about two perpendicular axes. The steps followed in rotational moulding are.

STEP-1

A predetermined amount of plastic , powder or liquid form , is deposited in one half of a mould.

STEP – 2

The mould is closed.

STEP -3

The mould is rotated biaxially inside an oven. The hollow part should be rotated through two or more axes, rotating at different speeds, in order to avoid the accumulatiuon of polymer powder.

STEP – 4

The plastic melts and forms a coating over the inside surface of the mould.

STEP -5

The mould is removed from the oven and cooled usually by fan. The polymer must be cooled so that it solidifies and can be handled safely by the operator.The part will shrink on cooling, coming away from the mould and facilitating easy removal of the part.

STEP-6

The part is removed from the mould.

Advantages of rotational moulding

1. Moulds are relatively inexpensive.

2. Different parts can be moulded at same time.

3.Very large hollow parts can be made.

4.Parts are stress free.

5.Very little scrap is produced.

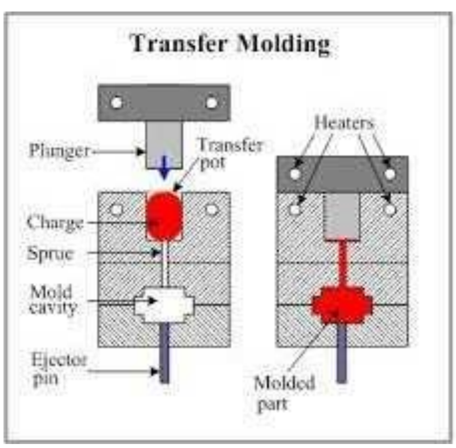
Limitations of rotational moulding.

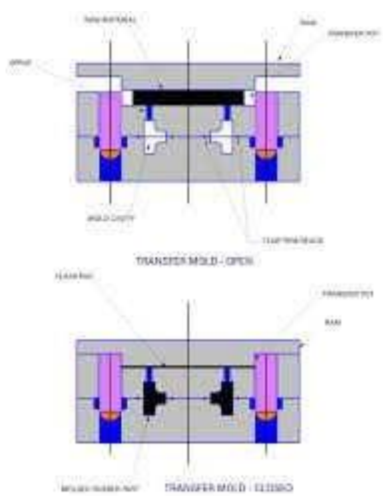
1.Moulding Cycles are long 10-20 mins

2.It is not possible to make some sharp threads.

3.Cannot make parts with tight tolerance.

5.5. TRANSFER MOULDING.





Transfer Molding

- A process of forming articles by fusing a plastic material in a chamber then forcing the whole mass into a hot mold to solidify.
- Used to make products such as electrical wall receptacles and circuit breakers
- Similar to compression molding except thermosetting charge is forced into a heated mold cavity using a ram or plunger.

  Examples: electrical switchgear, structural parts

Process Variables

- Amount of charge
- Molding pressure
- Closing speed
- Mold temperature
- Charge temperature
- Cycle time

Advantages

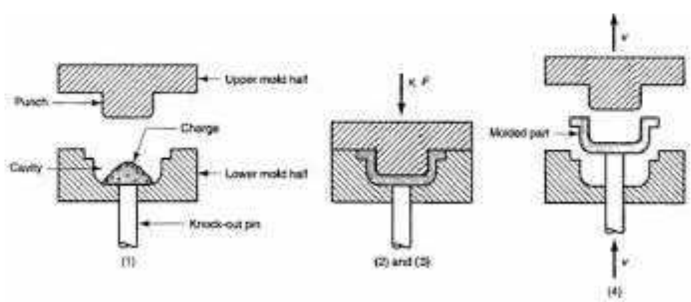
- Little waste (no gates, sprues, or runners in many molds)
- Lower tooling cost than injection molding
- Good surface finish
- Less damage to fibers
- Process may be automated or hand-operated

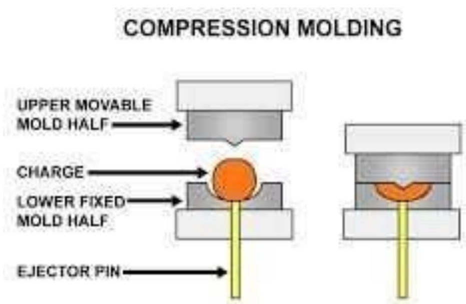
- Material flow is short, less

Disadvantages

- High initial capital investment
- Labor intensive
- Secondary operations maybe required
- Long molding cycles may be needed.

5. 6.COMPRESSION MOULDING.





Compression Molding

- The process of molding a material in a confined shape by applying pressure and usually heat.
- Almost exclusively for thermoset materials
- Used to produce mainly electrical products

Thermoset granules are “compressed” in a heated mold to shape required.

Examples: plugs, pot handles, dishware

Applications of compression moulding.

1.Dishes , Handles , container caps, fittings, electrical and electronic components. 2.Scoops, spoilers, hoods, fenders.

3.Polyester fiber glass resin systems (SMC/BMC)