STELLA MARY'S COLLEGE OF ENGINEERING

(Accredited by NAAC, Approved by AICTE - New Delhi, Affiliated to Anna University Chennai)

Aruthenganvilai, Azhikal Post, Kanyalumari District, Tamilnadu - 629202.

ME8351 - MANUFACTURING TECHNOLOGY - I

(Anna University: R 2017)

Prepared By

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DEPARTMENT OF MECHANICAL ENGINEERING

2020-2021 (EVEN)

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DEPARTMENT OF MECHANICAL ENGINEERING

COURSE MATERIAL

REGULATION	**2017**
YEAR	**II**
SEMESTER	**03**
COURSE NAME	**Manufacturing Technology I**
COURSE CODE	**ME8351**
NAME OF THE COURSE INSTRUCTOR	**Dr.F.Michael Raj**

MANUFACTURING TECHNOLOGY - I

SYLLABUS:

UNIT - I METAL CASTING PROCESSES 9

Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances –Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting - CO_2 process – Stir casting; Defects in Sand casting

UNIT - II JOINING PROCESSES 9

Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of: Resistance welding - Plasma arc welding – Thermit welding – Electron beam welding – Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects: types, causes and cure.

UNIT - III METAL FORMING PROCESSES 9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion.

UNIT - IV SHEET METAL PROCESSES 9

Sheet metal characteristics – shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes-Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning– Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming

UNIT - V MANUFACTURE OF PLASTIC COMPONENTS 9

Types and characteristics of plastics – Moulding of thermoplastics – working principles and typical applications – injection moulding – Plunger and screw machines – Compression moulding, Transfer Moulding – Typical industrial applications – introduction to blow moulding –Rotational moulding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics.

TEXT BOOKS:

1. Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2008

2. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India Edition, 2013

REFERENCES:

1. Gowri P. Hariharan, A.Suresh Babu, "Manufacturing Technology I", Pearson Education, 2008.

2. Paul Degarma E, Black J.T and Ronald A. Kosher, "Materials and Processes, in Manufacturing" Eight Edition, Prentice – Hall of India, 1997.

3. Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 4th Edition, TMH-2013.

4. Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2006.

5. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2014.

Course Outcome Articulation Matrix

	Program Outcome												*PSO*		
Course Code / CO No	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***1***	***2***	***3***
ME8361 / C206.1	3	0	3	3	3	0	0	3	3	0	0	3	3	1	0
ME8361 / C206.2	3	3	3	3	3	0	0	3	3	0	0	3	3	2	2
ME8361 / C206.3	3	0	3	3	3	0	0	3	3	0	0	3	3	2	2
ME8361 / C206.4	3	3	3	3	3	0	0	3	3	0	0	3	3	2	2
ME8361 / C206.5	3	0	3	3	3	0	0	3	3	0	0	3	3	2	2
Average	3	1	3	3	3	0	0	3	3	0	0	3	3	2	2

UNIT - I

METAL CASTING PROCESSES

Sand Casting

* Casting is one of the Processes used for making Components of complicated shapes in larger Quantities.
* It is the process of producing metal parts by Pouring molten metal into mould cavity.
* The solidified metal piece is called as Casting.

Sand Mould:-

Mould is the cavity of the required shape made in moulding sand (or) in other material. The moulding process consists of all operations done to make a mould.

Types of pattern:-

Patterns are classified according to the usage and forms of the pattern. following factors are consider at the time of selection of pattern.

* Size and Complexity of the shape
* Number of Components to be produced
* method of castings to be used.

Types

* Solid pattern
* Split pattern
* Loose piece pattern
* match plate pattern
* sweep pattern
* skeleton pattern
* segmental pattern
* shell pattern

Pattern materials:-

Patterns are made by different materials which have their own advantages, limitations and their field of applications.

* wood (Teak wood, mahogany, white pine, etc...)
* metal (cast iron, Brass, aluminium, white metal etc)
* Plaster
* Plastics
* wax

The following factors are Consider for the selecting of pattern materials.

* Design of casting.
* Number of castings to be produced.
* Degree of accuracy and surface finish required.
* Shape, Complexity and size of the castings.
* Casting or moulding method adopted.

Pattern Allowances:

* Patterns are not made into the exact size of the castings to be Produced.
* Patterns are made slightly larger than the required castings.
* The extra size given on the Pattern is called Pattern allowances.

Types of Pattern allowances:-

* Shrinkage Allowance.
* Machining Allowance.
* Draft Allowance
* Distortion Allowance
* Rapping Allowance.

Moulding Sand:-

The special type of sand is used for making mould. Moulding sand essentially Contains the following three Constituents.

* Refractory sand
* Binder.
* Additive.

Types of Moulding Sand:-

*) Green Sand
* Dry sand
* facing sand
* Lean sand
* Backing Sand
* Parting Sand

Properties of Moulding sand:-

A good casting can be produced only with the use of good quality moulding sand. These properties are

* Porosity (or) Permeability
* Plasticity (or) flowability
* Adhesiveness
* Strength (or) Cohesiveness.
* Refractoriness
* Collapsibility

Testing of Moulding Sand:-

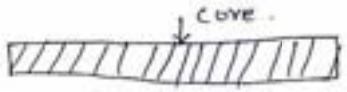
* Moulding Sands have to be correct in size to ensure the proper sand quality as per the required level of accuracy and good surface finished castings.
* Generally it contains silica and grains, clay content and moisture content.

The following Sand Control tests are carried out on moulding Sand.

* Moisture Content test.
* Clay Content test.
* Grain finess test.
* Permeability test.
* strength test.
* Deformation and toughness test.
* Hot strength test.
* Refractoriness test.
* Mould hardness test.

Cores:-

* A core is a body made of sand which is used to make a cavity (or) a hole in the casting.
* The shape of the core is similar to the required cavity in the casting to be made.
* It is also used to make recesses, projections, undercuts, and internal cavities.



Essential Qualities of a Core:-

* Permeability
* Refractoriness.
* Strength.
* Collapsibility.
* Stability.

Core Making Materials:-

* Core Sand Consists of refractories such as Silica Sand, zircon, olivin etc.
* Binders Contains of vegetable oil (or) mineral oil, Core flour, resins water, fire clay, bentonite, urea.
* Additives are wood flour, Coal powder, Sea Coal, graphite, Cow dung, straw etc.

Core Sand Preparation:-

* Sand Core is usually made of river Sand mixed with binders.
* Sand is weighed and put into the mullers.
* Core Sand must have the properties of strength, permeability, smooth surface and sufficient refractoriness.

Core Making Methods:

Cores are manually made (or) with machines. Cores are made by hand in core boxes (or) by using sweeps.

These methods are used to core making methods.

* shape and size of core
* Types of the binder used.

Types of Core:-

The Cores can be classified as follows.

(a.) According to the state of core

(i) Green sand core

(ii) Dry sand core

(b.) According to the position of the core in the mould.

(i) Horizontal core.

(ii) Vertical core

(iii) Balanced core

(iv) Hanging core

(v) Drop core.

Moulding methods:-

* Bench moulding.
* Plate moulding.
* floor moulding.
* Pit moulding.
* Sweep moulding.

Moulding Machines:-

* Moulding machine is used for mass production.
* for producing more castings, moulding is done by using moulding machines.

Moulding machines will do the following operation.

* Ramming the moulding sand.
* Rapping the pattern for easy removal.
* Removing the pattern from the sand.

These types of moulding machines are generally used.

* Jolting machine.
* squeezing machine.
* Sand slinger.

MELTING FURNACES:-

Various types or melting furnace are used in foundary shop. The type of furnace used depends upon the type of metal and the quantity of metal to be melted. The metal melting furnaces used in foundaries are,

* Blast furnace — for smelting iron to produce pig iron.
* Cupola furnace — for cast iron.
* Open hearth furnace — for steel.
* Crucible furnace — for non ferrous metal.
    * Pit type furnace.
    * Coke fired stationary furnace.
    * Oil fired tilting furnace.

Cupola furnace:-

It is a vertical, cylindrical shell made of 10mm thick steel plate. It is lined with refractory bricks inside.

Two bottom doors close the bottom of the cupola.

The slag floating over the molten metal is removed through this slag hole. The opening called tuyeres are provided one meter above the bottom.

fuel is supplied through these tuyeres for making complete combustion of fuel.

Application:-

Cupola is used to melt cast iron.

Advantages.

Initial cost is comparatively less than other type of furnace.

It is simple in design.

It requires less floor area.

operation and maintenance are simple.

It can be operated continuously for many hours.

Blast furnace:-

Blast furnace is named so because very high temperature developed inside the furnace by means of forcing a blast of heated air. It's height is about 30 m and interior diameter is of 8m.

Investment Casting:-

The castings obtained by this method have very smooth surfaces and possesses high dimensional accuracy. Hence it is called as precision Investment castings. Here the Investment means or, layer of refractory material with which the pattern is covered to make the mould.

Applications:-

* Production of nozzles, buckets, vanes, and blades for gas turbine.
* Parts for producing aerospace industry such as aircraftengine,
* frames, fuel systems.
* This process is applied in Costume Jewellery.

Advantages:-

* Complex shapes can be cast accurately.
* Surface finish is very good.
* High accuracy can be maintained.

Limitations.

* Only small size of the casting can be made.
* This process is more extensive
* Location of holes is impossible.

Principle of Special casting Processes.

Shell mould casting:

The shell mould casting is a semi-precise method for producing small castings in large numbers. The process involves the use of a match plate pattern similar to cope and drag patterns which are used in green sand mould casting.

Applications:-

* It is used for making brake drums & bushings.
* Cams, camshaft, Piston and Piston rings can be made.
* It is used for making small pulleys, motor housing, fan blades.
* Air Compressor crankcases and cylinders, Conveyor, rollers etc..

Advantages:

* A high accuracy casting with tolerances.
* Good surface finish can be obtained.
* Complex parts can be made by this method.

Limitations:-

* Cost is more.
* Only small size of the castings can be made.
* serious dust and fume problem during sand and resin mixing will occur

Pressure Die Casting:-

* In the previous casting processes, expandable moulds are used.

* In the die casting process, the mould used for making a casting is permanent is called die.

* In this processes the molten metal is forced into the mould cavity under high pressure. The process is used for casting a low melting temperature materials.

Eg:- Aluminium, zinc alloys, brass etc ...

These are two types.

* Hot chamber die casting.
* cold chamber die casting.

Centrifugal Casting:-

* This type of casting is primarily used for making Hollow type of castings.

* The rotating mould is mounted on a trolley. and it moves over the rails.

* The end of the mould is closed by end cores to prevent the flow of metal.

* The metal is poured into the mould through a long spout. The mould is rotated by electric motor.

Ceramic mould casting:-

The ceramic slurry is 1st prepared by mixing fine grained refractory powders of zircon, alumina, fused silica, and patented bending agents.

This slurry is applied over the pattern surfaces to form thin coating around it. After applying the coating on the pattern is removed out from the mould and it is transferred to an oven for further heating.

Lost wax process:-

* Investment casting method is also named as lost wax process (or) precision lost wax casting process.
* This method is mainly used for preparing brass and bronze statues of required (or) religious images.
* It also has been used by jewelers and dentists.
* When the wax pattern is heated, it will be melted and disposed of from the mould called "Lost wax process".

Application:-

* Aerospace industries such as engines, frames, fuel systems and instruments.
* Food and beverage industries.
* Nozzle, buckets vanes for gas turbines.
* Rock drill threads charger holder blocks etc.

· Applications:

* Components such as water pipes, gears, bush bearings, fly wheels, piston rings, brake drums, Gun barrels etc..

Advantages:

* Core is not required to produce hollow components.
* Rate of production is high.
* Pattern runner & risers are not required.
* Thin castings can be made.

Limitations:

* It is suitable only for cylindrical and symmetrical shaped castings.
* The cost of equipment is high.

STIR casting:-

It is a liquid state method of composite materials fabrication in which a dispersed is mixed with a molten metal matrix.

Among the variety of manufacturing processes available for discontinuous metal matrix composites, stir casting is generally accepted, and currently practised commercially.

Defects in Sand castings

Because of some reasons, castings may have some defects. The defects in a casting may arise due to the defects in one (or) more of the following.

* Design of casting and pattern.
* Moulding & design of mould and Core.
* metal Composition.
* Melting and pouring.
* Gating and risering.

These defects may be reduced by a proper Control of manufacturing cycle and proper foundry techniques.

UNIT-2

Joining Processes :-

The Process of Joining Similar metals by the application of heat is called welding. Welding can be obtained with (or) without application of pressure and with (or) without addition of filler metal, which is known as "electrode". The heat may be developed in several ways for welding operation. A good welded joint is as strong as the parent metal.

Classification of welding Process :-

* Fusion welding
* Plastic welding

Fusion welding :-

In fusion welding the metal at the joint is heated to a molten state and then it is allowed to solidify. Pressure is not applied during the welding process and hence, it is also called as non-pressure welding. filler material may be required during this type of welding.

Eg:- Gas welding, Arc welding, Thermit welding.

Gas welding Technique:-

In a gas welding, the speed and quality of the welding can be improved by the proper selection of torch size, filler material, method of moving the torch along the weld and the angle at which the torch is held. There are two techniques commonly used dependent on the movement of torch along the weld.

Gas welding Types:

There are three types of gas welding processes used in industries. such as.

* oxy - acetylene welding.
* oxy - hydrogen welding.
* Air - hydrogen welding.

oxy- Acetylene welding:-

Gas welding is one type of welding process in which the edges of the metals to be welded are melted by using gas flame. No pressure is applied during welding expect pressure gas welding.

The flame is produced at the tip of a welding torch. The welding heat is obtained by burning a mixture of oxygen and Combustible gas.

The gases are mixed in the required proportion in a welding torch which provides a Control for the welding flame.

There are two types of oxy-acetylene systems employed depending upon the manner in which acetylene is supplied for welding. These are.

* High pressure system.
* Low pressure system.

Air-Acetylene welding:-

Here the air is used instead of oxygen. The air taken from the atmosphere is compressed in a compressor. and mixed with acetylene to the required proportion in the torch. This type of welding has limited use. It is most successfully used in lead welding and many low melting temperature metals and alloy.

oxy-Hydrogen welding:-

Hence the oxygen & hydrogen gases are mixed with the required proportion for producing heat. In this process, special regulator is used in metering the hydrogen gas. It was once used extensively to weld low temperature metals such as aluminium, lead and magnesium but it is not in use today.

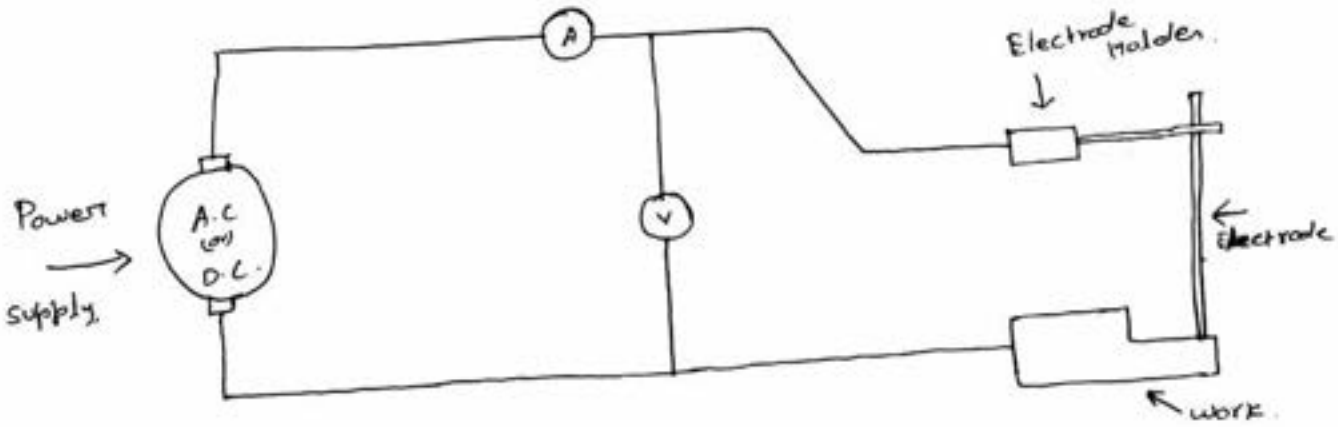
Flame characteristics:-

It is very important to adjust the flame to suit the welding conditions. It is done by regulating the supply of oxygen and acetylene.

* Neutral flame
* carburising flame
* oxidising flame.

Manual Metal Arc welding:-

In arc welding process, the heat is developed by an electric arc. The arc is produced between an electrode and the work. Here the electrical energy is converted into heat energy. The electrode and workpiece are brought near to each other with a small air gap of 3mm approximately. Then the current is passed through the workpiece and the electrode to produce an electric arc.



Electro Slag Welding:-

Electro slag is a welding process in which the coalescence is formed by molten slag and molten metal pool remains shielded by the molten slag.

In this welding process, the electric arc is struck between the electrode and work jointed by the use of steel wood. welding flux is added and melted by the use of heat flux added.

The action is stopped until the molten slag is formed and molten slag remains between the electrode and the work. The welding flux used in electro slag welding should be cleared from impurities and oxidation.

Application:-

* Forgings and castings are welded.
* Heavy plates can be welded.

Advantages:-

* Heavy thickness metals can be welded economically.
* Low stress formation.
* Preparation of joints is easier.

Disadvantages:-

* Hot Cracking may occur.
* Grain size becomes larger.
* The cost is high.

Resistance Welding:-

In these welding, the parts to be joined are heated to plastic state by their resistance to the flow of electric current and mechanical pressure is applied to complete the weld. There are two copper electrodes in a circuit of low resistance. The metal parts to be welded are placed between the electrodes.

Various types of resistance welding:-

* Spot welding.
* Seam welding.
* Butt. welding.
* Projection welding.
* Stud welding.
* Percussion Butt-welding.

Plasma Arc-welding:-

Conventional types are not suitable for machining metals such as cast alloy, wasp alloy, carbides having promising applications in various industries also machining these materials in Conventional methods causing increased machining cost. So these type's of materials in special welding methods are preferred. It will increase the productivity. and reduce the rejection components. So its helps to achieve the close tolerance.

Principle

Plasma is high temperature ionized gas. It is a mixture of neutral atoms, positively charged atoms and free elements. When this high temperature plasma is passed through the orifice, the proportion of the ionized gas increases and plasma arc welding is formed.

Applications.

* It is used in aerospace applications.
* It is used for melting high melting point metals.
* It is used in welding nickel alloys.
* It is used for tube mill applications.

Advantages.

* Penetration is uniform
* Arc stability is good.
* fully penetrated key holes can be obtained.

Dis advantages.

* Huge noise occurs during welding.
* chances of electric hazards may occur during welding.
* It is limited to high thickness applications.

THERMIT WELDING:-

Welding the parts by using liquid thermit steel around the portions to be welded is called Thermit welding. It is also called as fusion welding process. In this process neither arc is produced to heat parts nor flames are used. for getting the high temperature, the exothermic reaction is used. Thermit reaction used for welding in plastic state and mechanical pressure is applied for the joint.

It is depending on the chemical reaction b/w iron oxide and aluminium. The reaction in thermit welding is

$$8AL + 3Fe_3O_4 = 4Al_2O_3 + 9Fe.$$

Applications:

* It is used in steel rolling mills.
* It is used to weld non-ferrous metals.
* Automobile parts are welded by this process.

Electron Beam Welding: (EBM)

Beam of electron is used for producing high temperatures and melting the work piece to be welded.

When tungsten filement is electrically heated in vacuum, it will emit the electrons. These electrons carry a negative charge which is passed through the anode hole. The electron beam is focused by the focusing lens. Heat energy is used to weld the metals. The operation is carried out in vacuum. So, it is possible to weld holes.

Advantages

* High Quality weld is produced.
* Deep welding is possible.
* Energy loss is very less.

Dis advantages:-

* The cost is high
* Skilled persons are required.
* It is a time Consuming process.

Applications.

* It is used in aircrafts.
* It is suitable for large scale.
* It is used in cams.

Laser Beam Welding:

Here Light energy is Converted in to heat energy. The light energy is produced from the laser source such as ruby rod in the form of monochromatic light.

The laser light is not only intense but also can be readily focused without loss of intensity. The laser light is focused by the focusing lens to the work piece in the form of Coherent monochromatic light.

Advantages:-

* It is used in glass and plastics.
* There is no need of electrodes and power.
* Even very small holes can also be welded.

Disadvantages:

* Welding process is slow.
* Limited depth of weld can be done.
* It is not suitable for large production.

Applications:

* It is used in aircraft components joining.
* It can joint dissimilar metals.
* It is very much useful in joining metal alloys.

Friction Welding:

It is a solid state welding process wherein coalescence is formed by the heat which is obtained from mechanically induced sliding motion b/w rubbing surfaces.

The components to be welded are held under preccure. one part is rotated at high speed and other part is held stationary. In this welding the movable clamp is moved and contacted with the rotating component. The metal is slowly extruded from the weld region to form an upset. For stopping the relative motion, the brake systems is applied.

These materials that can be welded:

* Brass of Bronze
* Nickel.
* Titanium alloys.
* Stainless steel.

Applications:-

It is used in super alloys.

It is used in produce axle shafts.

	Friction Welding	Inertia Welding
1.	Power from electric motor.	Power from flywheel.
2.	Heat is produced by sliding motion.	Heat is produced by intermolecular bonding.
3.	friction speed is very important.	Speed of the flywheel is very important.

Friction Stir Welding:

It is a solid state welding process in which a rotating tool is fed along the joint line between two workpieces. During welding, the heat is generated due to friction and the metal is mechanically stirring to form the weld seam. It is differs from normal friction welding in such a way by generating friction heat by a seperate wear-resistant tool instead of the parts between them.

FSW is mainly used in Aerospace, automotive, railway and ship building Industries.

Advantages:

* It permits less distortion.
* It provides good weld appearance.
* It avoids toxic fumes.

Disadvantages:

* Heavy duty clamping of the parts is required.
* An exit hole remains the same after the tool is withdrawn from the

Brazing Methods:-

* Torch brazing
* furnace brazing
* Induction brazing
* Dip brazing
* Resistance brazing.
* Laser & Electron beam brazing.

Soldering:-

The process of joining of two dissimilar metals by means of filler metal called solder is known as soldering whose melting temperature is below 430°C. Soft soldering being a low temperature process does not bring distortion. The soldering joints are weaker when compared to brazed joints.

Solder should have following characteristics:-

* It acts as a good adhering film.
* It wets the base metal.
* It freely flows over surfaces.

Soldering Methods:-

* Hard Soldering.
* Soft Soldering.
* Dip Soldering.
* Wave Soldering.

Filler Material:-

Filler is used already given in the tabular column in Soldering methods.

Flux Materials:-

Inorganic acids (or) salts such as zinc ammonium solutions, non-Corrosive resin-based fluxes.

Defects in Welding:-

The Improper welding parameters, the base metal and the selection of method introduce defects in the weld metal. So the defective weld causes failure in service conditions and damages to the properties the defects in weld depending on thickness, load, environment and size of the weld.

* In Complete fusion.
* cracks
* Porosity
* Undercut
* Distortion
* Slag inclusion
* lamellar teaming
* overlapping.

UNIT-2

METAL FORMING PROCESSES

A product is produced by shaping the metal into the required shape and size. "No machining process" is carried out but it is used to achieve optimum mechanical properties in the metal. By applying the force, the metal is plastically deformed into the required shape. The mechanical working reduces the cavities present in the metal and also used to remove the impurities.

Hot working and cold working of metals:

The metal forming (or) working processes are mainly classified into hot working and cold working processes. The above division is on the basis of working temperature.

Hot working of metals:

The mechanical working of a metal above the recrystallization temperature but below the melting point is known as "hot working". It may also be defined as the plastic deformation of metals and alloys under the conditions of temperature and strain rate.

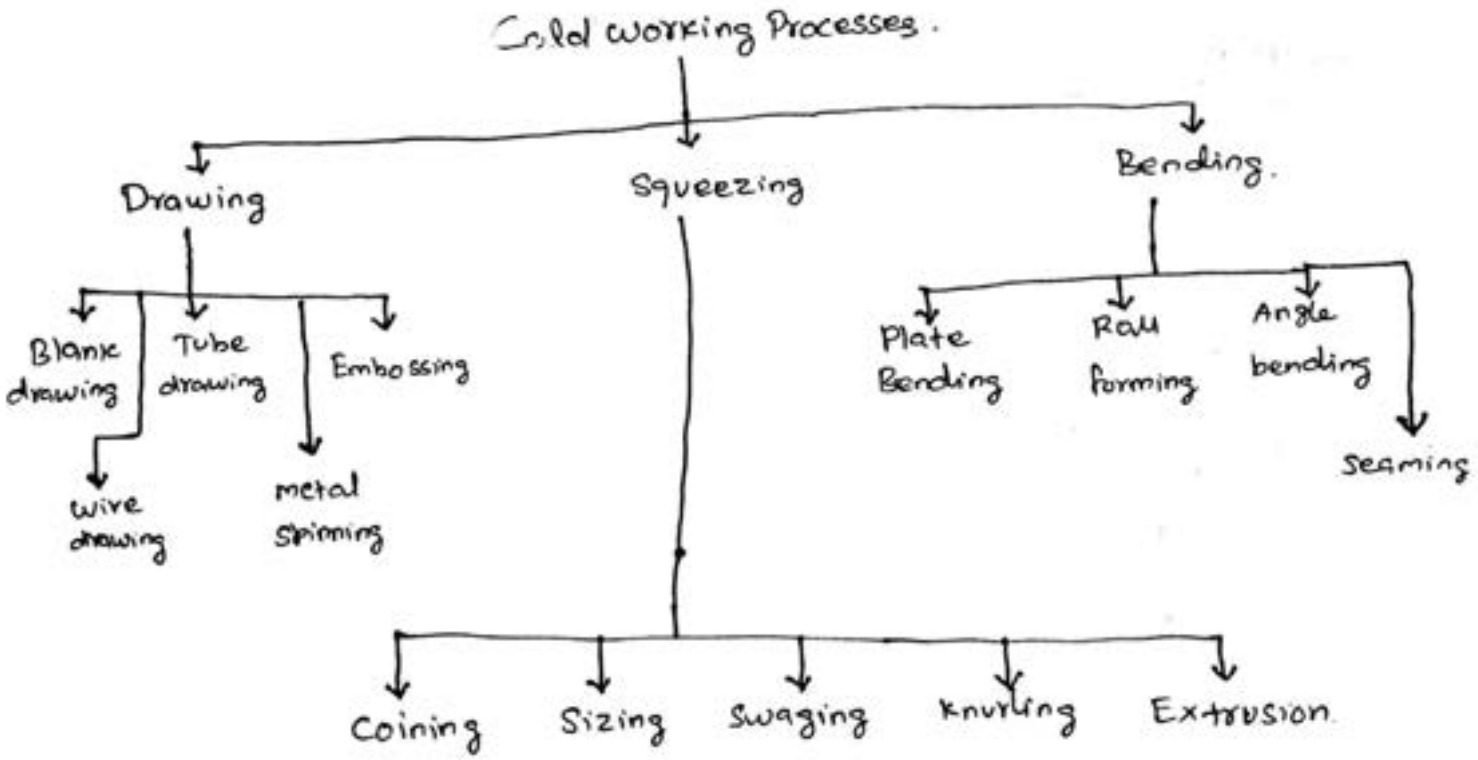
Types of Hot working:

* Hot forging ⟶
  * Hammer forging.
  * Drop forging.
  * Upset forging.
* Hot Rolling
* Hot extrusion
* Drawing.

Cold working:-

The plastic deformation of a metal to the required shape being performed below the recrystallization temperature is known as Cold working process. The recrystallization temperature is defined as the minimum temperature at which the complete recrystallization of a metal takes place within a specified time".

Classification of Cold working process:-



Materials used for Cold working process:-

* Low and medium Carbon steel.
* Copper and light alloys
* Materials such as Al, Mg, Titanium.

Forging Processes:-

Forging is the process of mechanical working of metals. In this process, the desired shape is obtained by the application of a compressive force. In hot forging, the metal is heated above the recrystallization temperature. Then it is compressed and squeezed to the required shape by using hammer (or) press tool.

Classification of forging:-

1.) Smith forging (or) open die forging.

a.) Hand forging b.) Power forging.

2.) closed die (or) impression forging.

* Drop forging
* Press forging.
* Upset forging.

3.) Roll forging.

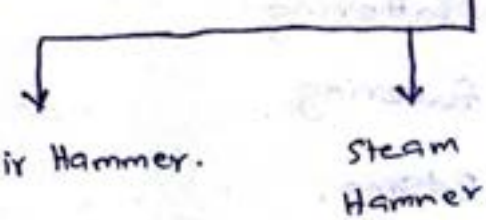
Types of forging machines:-

Power Hammer.

(i) Mechanical Hammer. ——→ * Helve Hammer.

(ii) Air and steam Hammer

* Trip Hammer.
* Lever spring Hammer.
* Pneumatic Hammer.



Open die forging:-

In this processes, the forging is done in a heated work at the proper temperature by placing on flat surface of anvil through hammering the metal price. Hammering is done by giving repeated blows manually using a hammer.

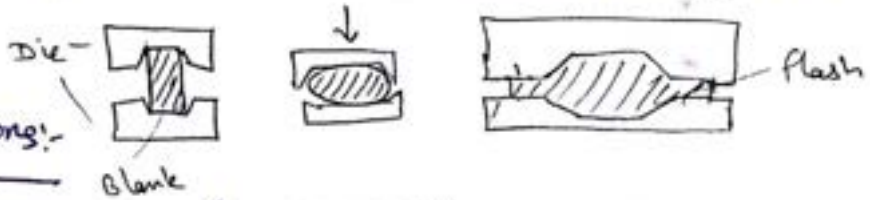
This forging is very simple and flexible. It is very much useful for producing simple shapes such as "U" bolts.

Closed Die forging:-

In drop forging, impression dies called closed dies are used. The upper die is fitted on the ram and the lower die is fitted on the anvil. Both the dies have impressions. Two Rollers are fixed on the board when both rolls rotate opposite to each other. It drives the board upward and lifting the ram. when the rolls are released, the ram will fall down and produce a working stroke.

Applications

It is used for making spanner, automobile parts, and machine parts.



Types of forging operations:-

* Upsetting
* Drawing Down.
* Punching
* Bending
* Cutting
* forge welding.
* Piercing
* Swaging
* flattering
* fullering
* Edging.

Applications of forged Components:-

(i) Automobile & truck.
(ii) Aerospace
(iii) Agricultural machinery and equipment.
(iv) Valves and fittings.
(v) Hand tools and hardware.

forging Defects:-

* Cold shuts (or) Laps – short cracks occurs at Corner.
* Pitting – It is caused by scale.
* Die shift – It is caused by misalignment of dies.
* Incomplete filling of dies.
* Dents –
* Cracks – It is due to bad quality of ingot, improper heating.

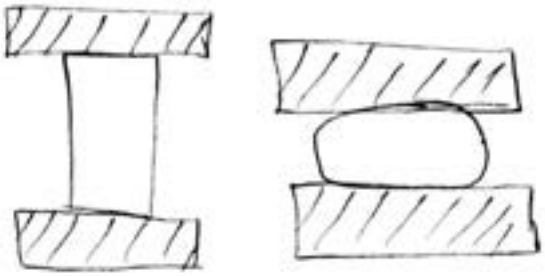
Rolling of metals:-

Deforming the metal into semi finished (or) finished Condition by passing the metal piece b/w two rollers called rolling process. Rolling is done by both hot and Cold working processes. In hot rolling the metal is heated to a plastic state and it is passed between two rollers which are operated in the opposite direction, whereas in Cold rolling the metal is not heated and it retains the given shape by the action of the rolls.

Forging operations

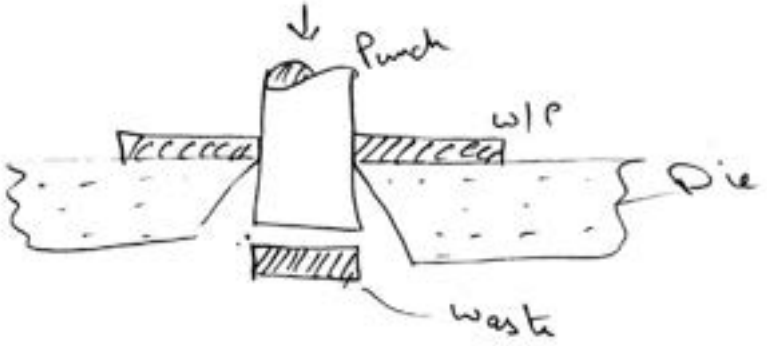
Upsetting

- Process of increasing the cross-sectional area of the bar, at the expense of its height



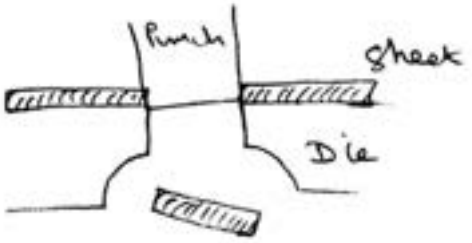
Punching

- Process of producing holes in the workpiece
- Here hot punch of the required hole size is placed over the w/p and hammered



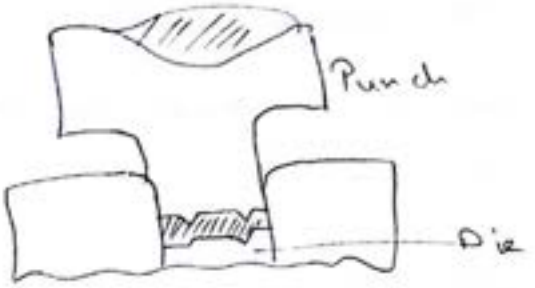
Cutting

- Process used to cut large pieces into small pieces
- for fast operations, the metal is heated to recrystallization temperature & ~~heave~~ then the hammer blows are given directly on the chisel head



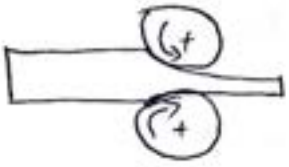
Coining

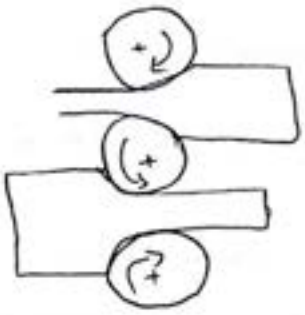
- Sizing process to attain the close tolerances & smoother surface on the part.

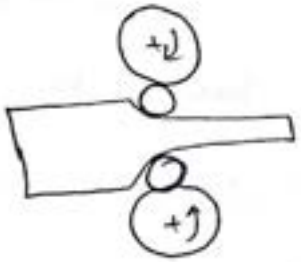


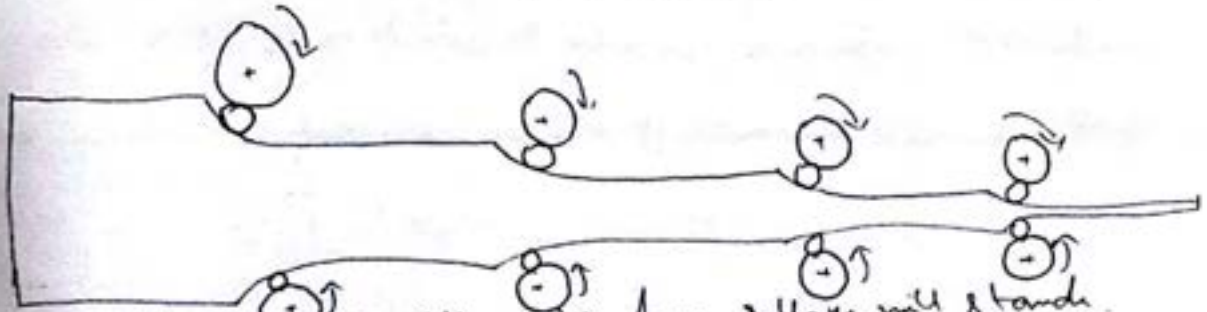
Types of Rolling mills

- Rolling mills consists basically of roll mills, bearings, housing for containing these parts and a drive for applying power to the rolls & controlling the speed.
- Rolls - made of cast steel - with or w/o alloys
- finishing rolls - made of chilled cast iron
- Simplest & most common type of roll mill is 2 high non reversing rolling stand arrangement.


2 high roll mill


3 high roll mill

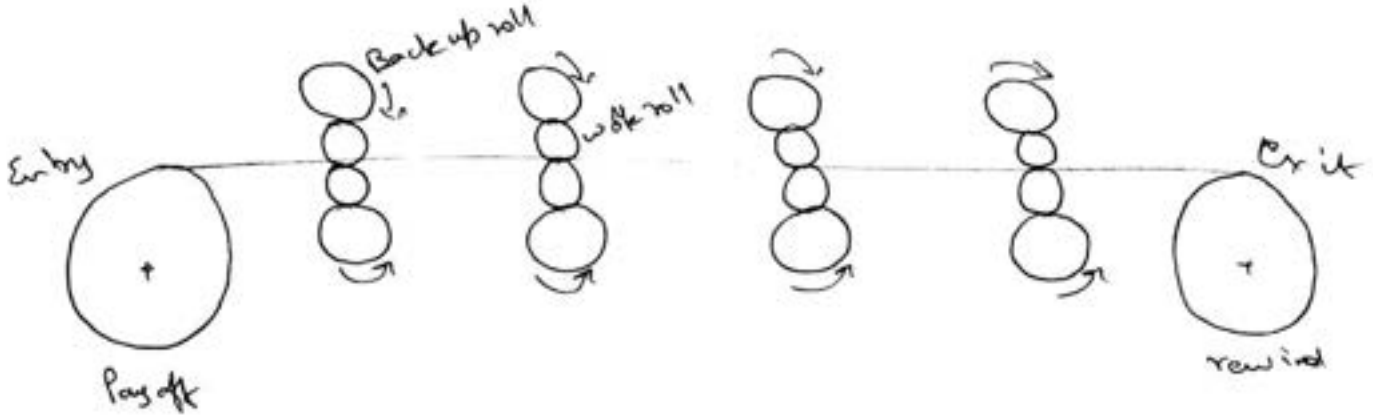

four high roll mill


Continuous roll mill with four rolling mill stands.

Flat Strip Rolling

- utilises a series of rolls to change the shape of the metal gradually.
- The forces are limited in variation.
- auxillary operations may be synchronized with flat strip rolling operations
- intricacy of shape
  size of section
  thickness & type of mtl.

  } determines the no. of rolls required



Shape rolling

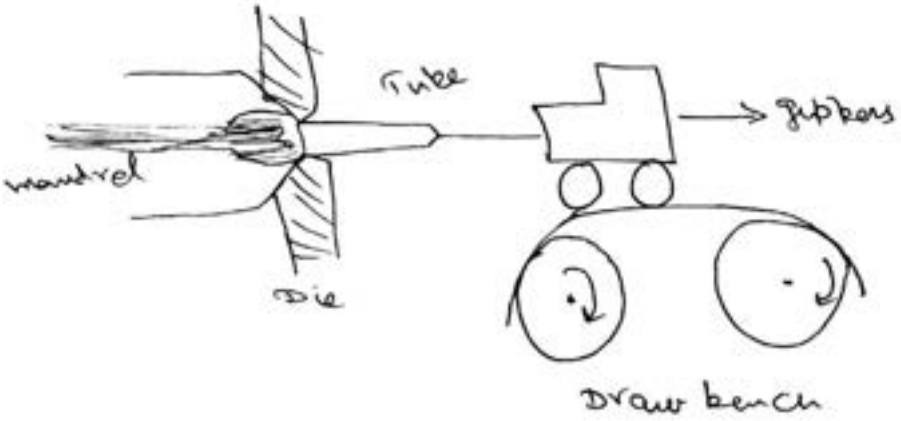
- Straight & long structural shapes such as solid bars with various cross-sections, channels, I beams & rails, are rolled by passing the stock through a set of specially designed rolls.
- Because of the large deformation & non-uniform flows of mtl. requirement the design of a series of rolls requires considerable experience in order to avoid external & internal defects to hold dimensional tolerances, and to reduce roll wear

Defects in Rolling

1. wavy edges - due to poor ductility of mtl. & barelling.
2. Zipper cracks - at the centre of strip - due to low ductility of mtl.
3. Edge cracks - Edges are elongated to a greater extent than the centre
4. alligatoring - non uniform deformation that occurs typically in nose & tail of plate due to piping

Rod drawing

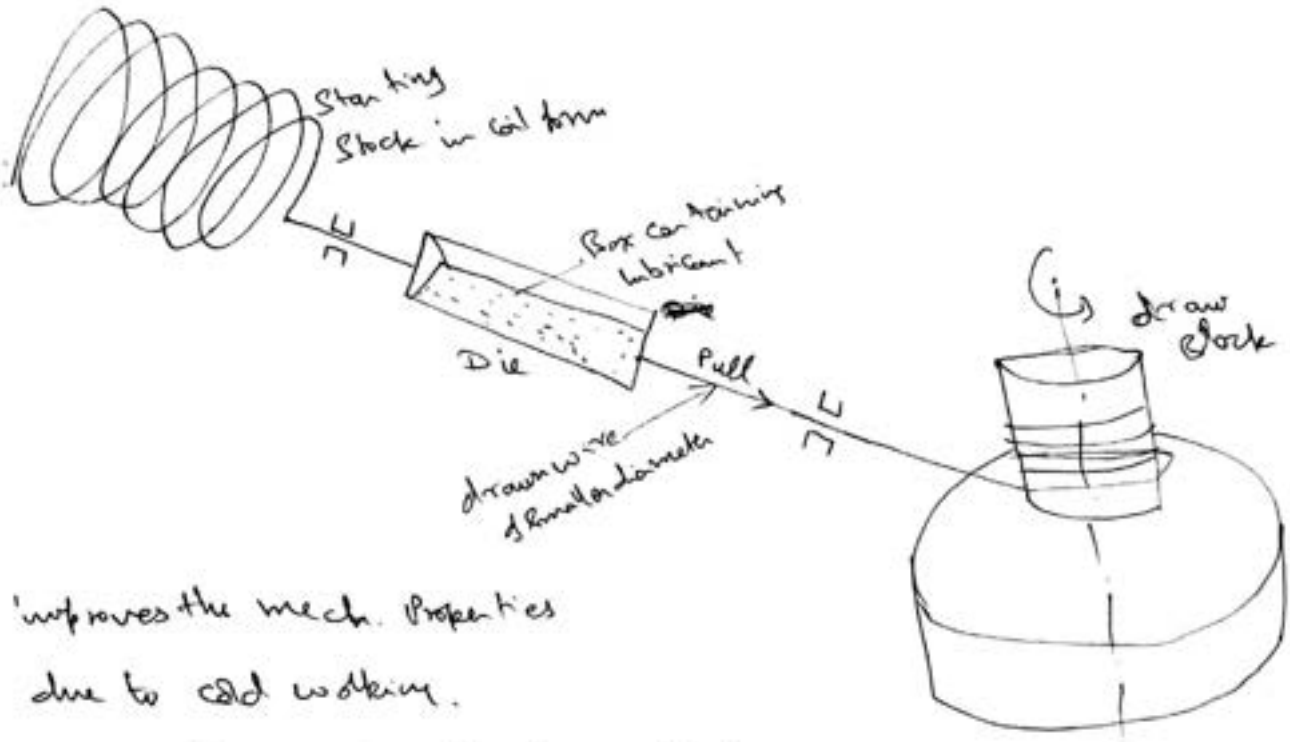
- involves drawing of a bar rod
- rods & tubes cannot be produced on draw benches
- consists of a die, gripper & a lever for pulling the rod.



- Before the rod is drawn, its surfaces must be cleaned thoroughly, which involves immersing the rods in a solution containing 3 - 10 % H_2SO_4 in H_2O.
- In order to remove the traces of acid, the rods are immersed in emulsion of slaked lime & water.
- Pointed end of rod is reduced for easy insertion & holding in gripper jaws.

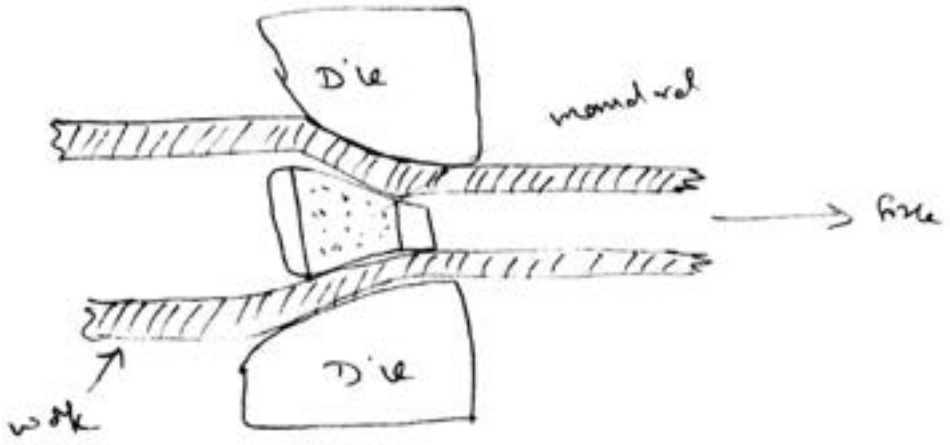
wire drawing

- Basically a cold working process.
- The stock end should be pointed by hand hammering to facilitate easy entry of the mtl. into conical die, before the wire is drawn.
- cleaning & lubrication of the stock is necessary to remove the rust & scales, which may affect the die.



- improves the mech. properties due to cold working.
- The mtl loses its ductility during the process, hence intermediate annealing is required
- For obtaining significant changes in the size, multiple passes are required

Tube drawing



- Tubes can be produced with greater accuracy in tube drawing
- Friction b/w tube & mandrel leads to the reduction in area seldom exceeds 45:1
- Problems with friction in tube drawing are minimized in drawing with a long mandrel which moves along with the tube.
- After drawing, the mandrel must be removed by rolling, which increases the tube diameter slightly & disturbs the dimensional tolerances.

Extrusion

- manufacturing process in which long objects of fixed cross section are produced from the raw mtl. in the form of billet by forcing it to flow through a shaped opening in a die.

Types of Extrusion

1. Hot Extrusion
   a. Forward / Direct
   b. Backward / Indirect

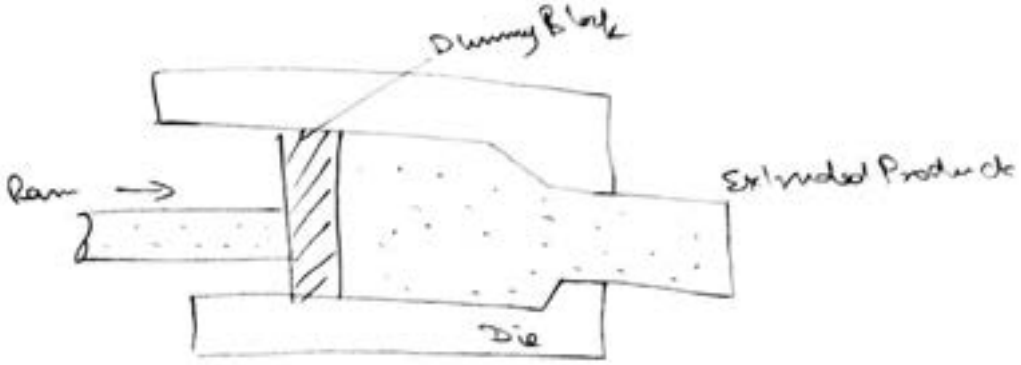
2. Cold Extrusion
   a. Forward
      (i) Hydrostatic
   b. Backward
      (i) Cold Extrusion forging
      (ii) Impact Extrusion

Hot Extrusion

- works above recrystallization temp. @ 50 to 75 % of the melting point of met
- Pressure can range from 35 - 700 MPa
- Typical hot extruded products are automotive & construction applications, window frame members, railings and structural parts of aircraft

Direct / Forward Extrusion

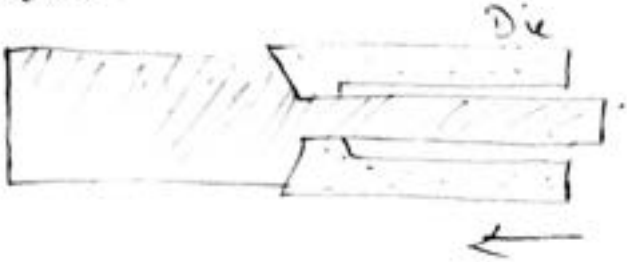
- a round billet is placed in a die chamber



- with the application of pr. the ram pushes the metal & forces it fills the cylinder Hard walls
- Then, it is forced out through the die opening.
- Here, the problem of friction is prevalent because of the relative motion blw hot metal billet & the cylinder walls
- To reduce this, lubricants can be used
- Also necessary heat insulation should be used to keep the billet in liquid form

Indirect / Backward Extrusion

- Here less force is required, since there is no friction b/w billet & container wall



- limitation is that the surface defects of billet would end up in the final product unlike direct Extrusion.

- It is not extensively used due to the problem of handling the extruded metal.

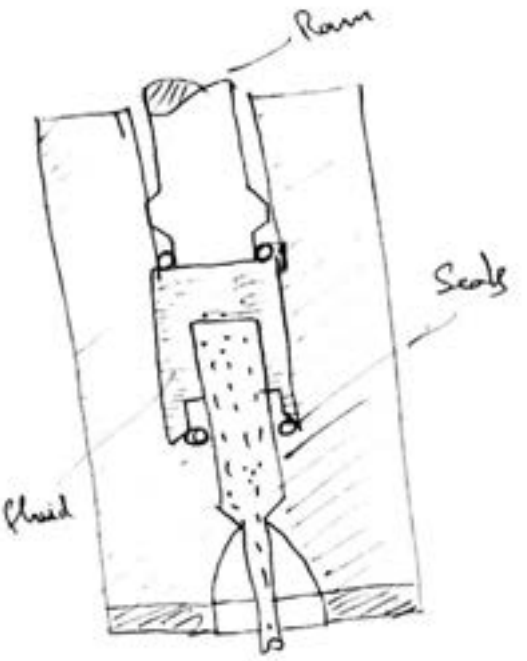
Cold Extrusion

- Process done @ room temperature.
- Some products which are cold Extruded are collapsible tubes, Al. cans, cylinders & gear Blanks.

Advantages

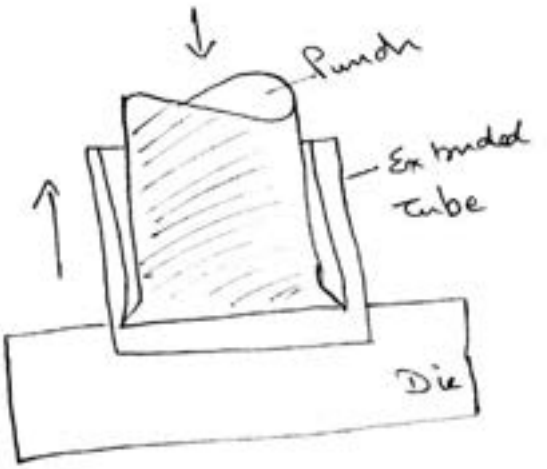
1. Improved mech. Properties
2. Good control of dimensional tolerances
3. Improved Surface finish
4. Elimination of the need of billet heating & Pre-heating of dies
5. No oxidation takes Place
6. Production rate & costs are competitive with those of other methods.

Hydrostatic Extrusion



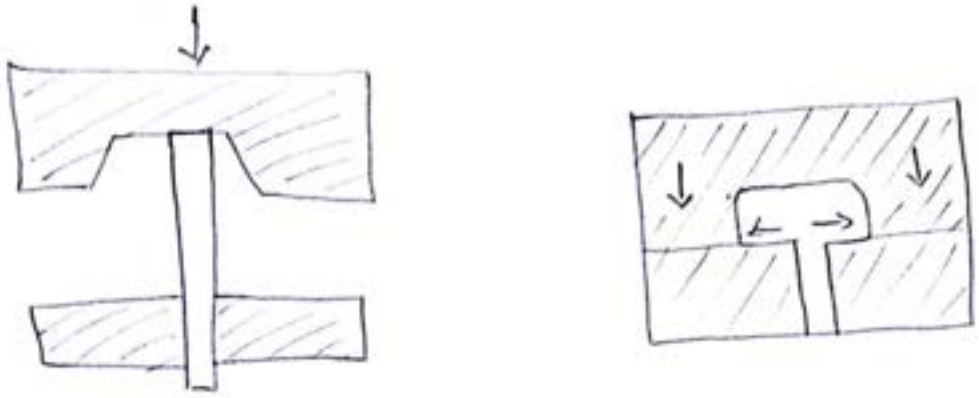
- used for special applications like fuel rods in reactors, making wires of less ductile metals
- Here, the billet is compressed using a pressure transmitting liquid rather than a ram.
- Metal is more uniformly compressed from all sides throughout the deformation zone.
- Cartridges could also be extruded

Impact Extrusion



- mostly used in producing small w/p from ductile materials
- Blank is placed inside the die & Pressure is applied by the punch to extrude the soft metal.
- used to make collapsible tubes like tooth paste, shaving cream
- During upstroke, the tube is blown from the ram by compressed air.
- The operation is automatic & hence, it can be produced 35 - 40 tubes/min.
- They give low cost (manufacture) & good surface finish

Cold Extrusion forging



- Combination of forging & extrusion
- Blank is placed inside the die & pressure is applied by the punch to extrude the metal along the punch wall.
- The component is ejected by means of ejector pin provided in the die.

Unit-4

Sheet Metal Processes

- working of metal thickness from 3mm to 5mm
- funnels, bends, boxes, bike covers etc.. are some eg
- metals used are generally CI, SS, Cu, Br, Zn, Al, Pb..

Sheet metal characteristics:

1. Roll forming - high Production rates
2. Stretch forming - low quantity production
3. Drawing - Simple shapes
4. Stamping - punching, Blanking, Embossing, Bending
5. Rubber forming - flexibility of operation, low tooling cost
6. Spinning - large axis symmetric Parts
7. Peen forming - Shallow contours on large sheets
8. Explosive forming - complex shapes
9. Magnetic Pulse forming - low strength sheet

Types of Shearing Operations

1. Shearing
2. Bending
3. Drawing
4. Squeezing

Bending

- Opn. of forming the metal b/w a suitably shaped punch and a forming block

Types of Bending Operations

1. Angle Bending
2. Roll Bending
3. Roll forming
4. Seaming

Drawing

- punch forcing of a sheet metal blank to flow plastically into the clearance available b/w the punch & die surfaces so as to achieve an open shape, a cylindrical shape or a box shape.

Types

1. Deep drawing
2. Shallow or Box drawing

Stretch forming operations

- used for producing large separately contoured sheets
- Stretching is the process of stressing the work beyond the elastic limit by moving a form block towards the blank or sheet metal.

Types

1. Form Block method
2. Mating-die method

Applications

1. Production of air craft wings
2. Production of contoured panels for truck trailer & bus bodies in automobile industry

Formability of Sheet metal

- formability is a function of material variables and process variables.

$$\text{Formability} = f(f_1, f_2)$$

where f_1 = mtl. variables

f_2 = Process variables.

Law:

- Ductility of the same mtl. is lower if the section size is larger

Law 2:

- this law is applicable to fabrication of sheet & strip expressed by few processes.

Test methods:

1. formability test for bulk deformation
2. formability test for elastic- plastic deformation
3. Simulative test for forming operation
4. Full scale forming test

Special forming Processes

- If the upper die is actuated by any other means except hydraulic fluid contained in the cylinder in forming process called special forming process.

  Eg: Hydroforming, Explosive forming, metal spinning, Rubber pad forming, Magnetic pulse forming, Peen forming, Superplastic forming.

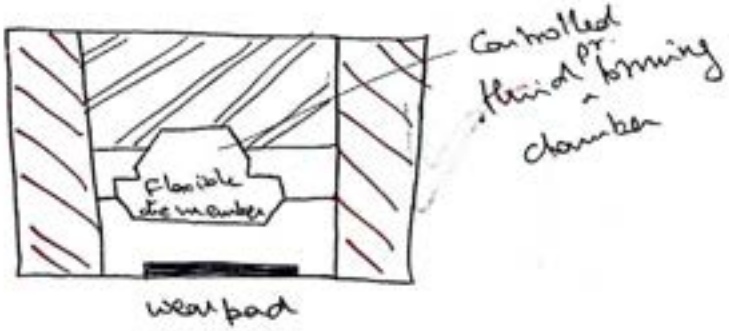
Hydro forming:

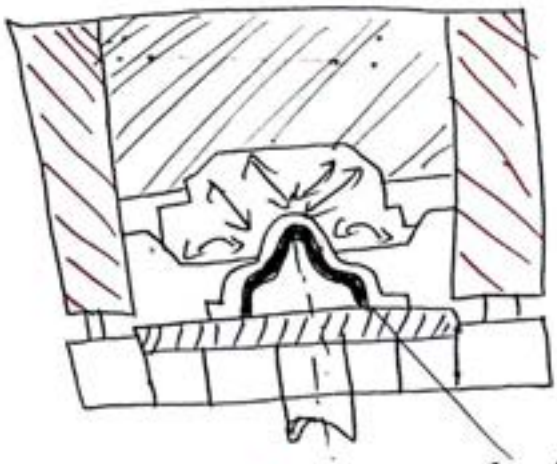
- It is a drawing Process.

  It is of 2 types 1. Hydro mechanical forming
  2. Electro hydraulic forming

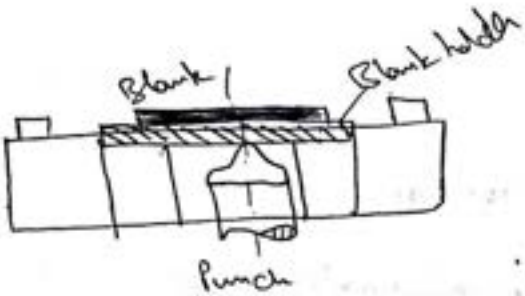
Hydromechanical forming

- Here Punch is connected to the lower die called male die
- A rubber diaphragm is used for making perfect sealing b/w male & female die.
- The hr. forming chamber is filled with a hydraulic liquid
- Now, the blank is positioned over the male die & the dome is made to just contact with the blank.
- Hence, the hydraulic hr. is applied over the blank continuously, and hence the blank metal flows around the punch to form the required shape.
- After this, the chamber hr. is released.





after forming



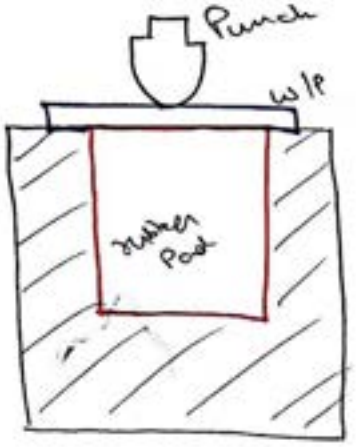
Before forming

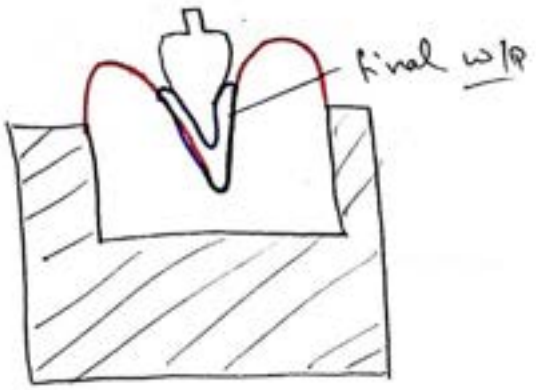
advantages

- Tool changing can be done rapidly
- complicated contours can also be made
- Sharp corners are also possible
- All type of sheet metals can be formed

Rubber Pad forming

- also called as marform process
- mainly used for bending & stretching or drawing form.
- this process is preferred when different shaped machine parts needed at regular intervals
- the Pad is made of rubber or polyurethane





Limitations

- Rubber Pads will wear out rapidly
- Sharp corners cannot be made accurately

Advantages

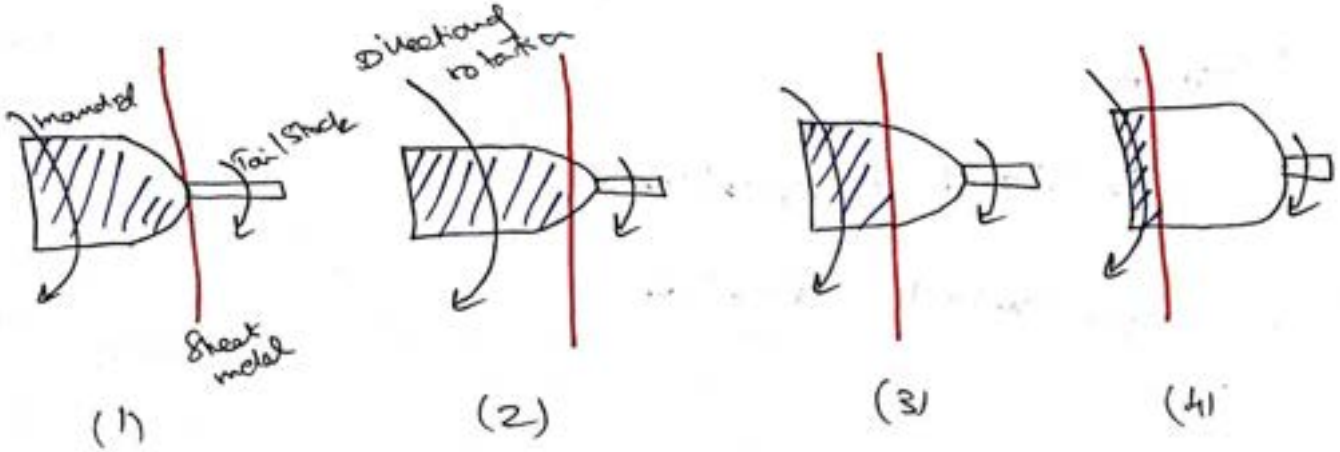
- more economical & tooling cost is less
- no need of lubricants
- tool setting time is less
- Deeper shells can be drawn
- No thinning metal blank takes places

Applications :

1. Production of flanged cylindrical & rectangular cups
2. Production of spherical domes
3. Production of parallel & tapered wall shells
4. Production of unsymmetrical shape components

Metal Spinning Process

- Process of forming seamless metal parts from a circular sheet metal or from a tube length on a lathe is called as spinning process.



- Symmetrical parts only can be produced from metal spinning process.

methods

1. manual spinning
2. Power spinning

Applications

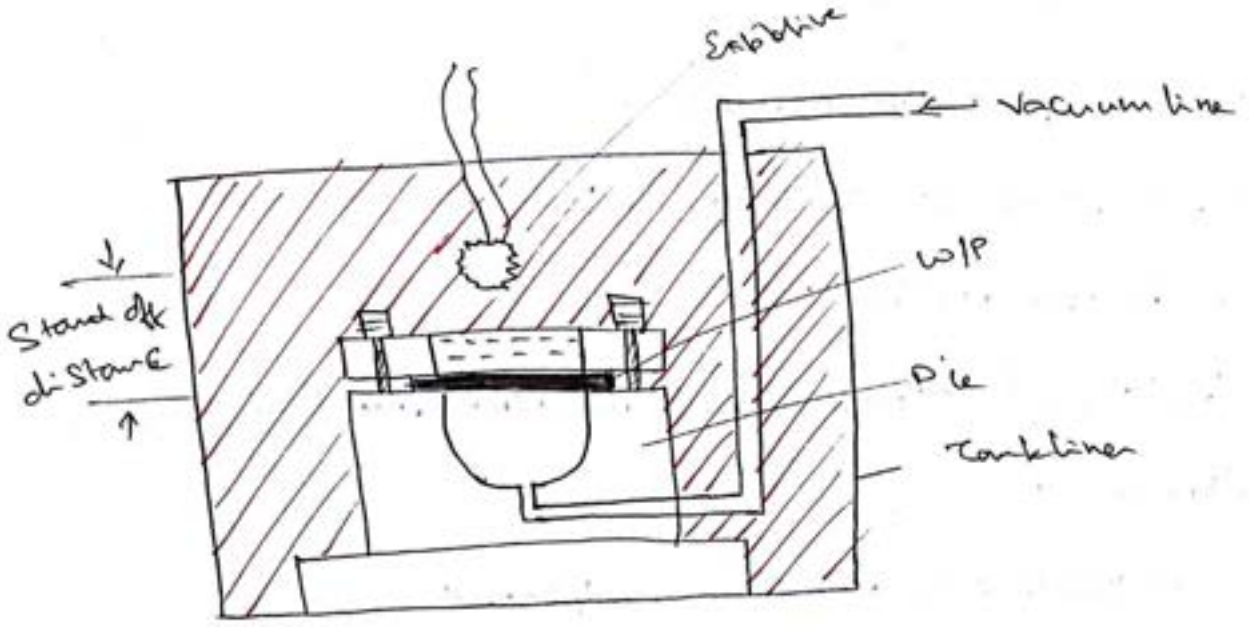
Production of ash trays, flower pots, lamp shades, missile & radar units, jet plane components tanks, air conditioning units & heating plants

Explosive forming

- used for blanking, cutting, expanding, coining, embossing, flanging, powder compacting, drawing & forging operations
- Explosives are used in various form such as rod, sheet granules, liquid, stick etc...

Types

1. Stand off operations
2. contact operation.



- Sheet metal is formed by generating pr. wave in a fluid
- the work tank contains water to receive vibrations in the form of pr. wave
- Explosives are also placed inside the tank which is perfectly insulated to avoid heat transfer from system to surrounding
- Explosive is ignited by detonator, hence a high pr. energy is released in the form of waves which is applied over the blank to obtain the reqd. shape.
- applied pr. varies from several hundred to thousands of kg/cm^2 with several hundred m/s displacement velocity.

$$P = P_m e^{-t/\theta}$$

P - Pr. as a function of time
P_m - Peak Pr. at that distance
θ - time constant

t - time after arrival of Pr. front at the blank surface

Advantages

1. Less capital investment
2. only one die is enough to form the sheet metal
3. Presses are not required
4. Large & complex shapes can also be handled

Applications

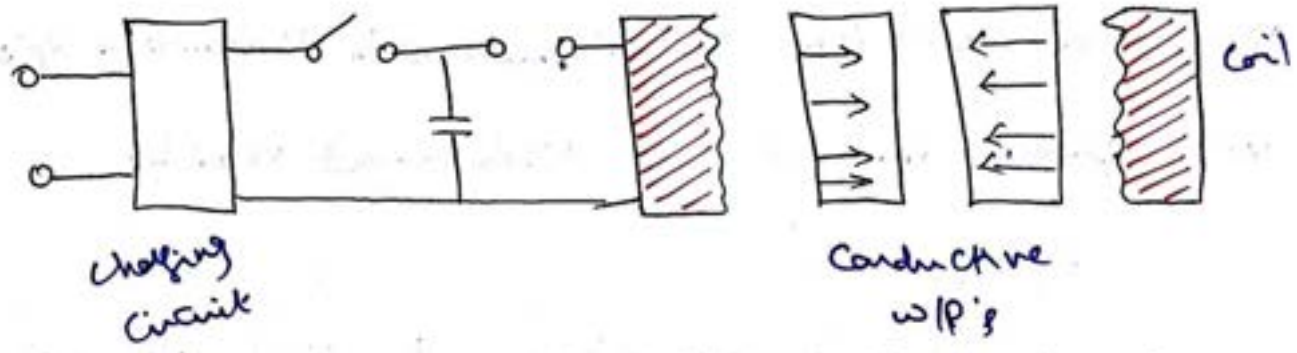
- Producing aerospace components

Limitations

- Noisy operation
- Highly trained operators are needed

Magnetic Pulse forming:

- reqd. shape is obtained by specially designed magnetic coil
- main Principle is that, discharging of a capacitor through a coil over a period of microseconds, on the blank to obtain required shape.



Advantages

- Surface finish is excellent
- time of opn is less as compared with some conventional process
- this process is carried out with uniform rate of forming

Applications

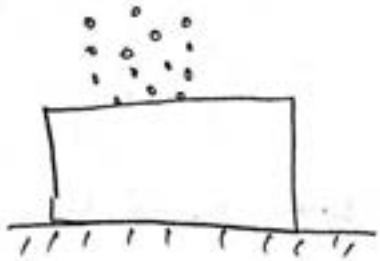
- Both compression & Expansion of circular bar is done
- Bulging of tube, Shrinkage of tube, attaching tubes @ end fitting w/o leaking is possible
- Forming of tubular joints, forging of structural joints b/w tubes & fitting are easily formed
- used for instrument gear assembly, embossing & lifting of cups.

Limitations

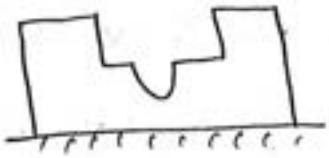
- Non conducting mtls. cannot be formed
- limited to form sheet metals. Bulk mtls. cannot be formed

Peen forming Process

- Surface cleaning process
  - Stream of metal shots are blasted against the surface of blank to be made into reqd. Shape
  - also known as free forming technique



Before Peen forming



After Peen forming

- Process is used to form irregular contour surfaces of M. Sheet and plates.

Advantages

- complex contours can be produced easily
- used as a salvage operations for correcting bent parts
- doesnot require any die or punch.

Limitations

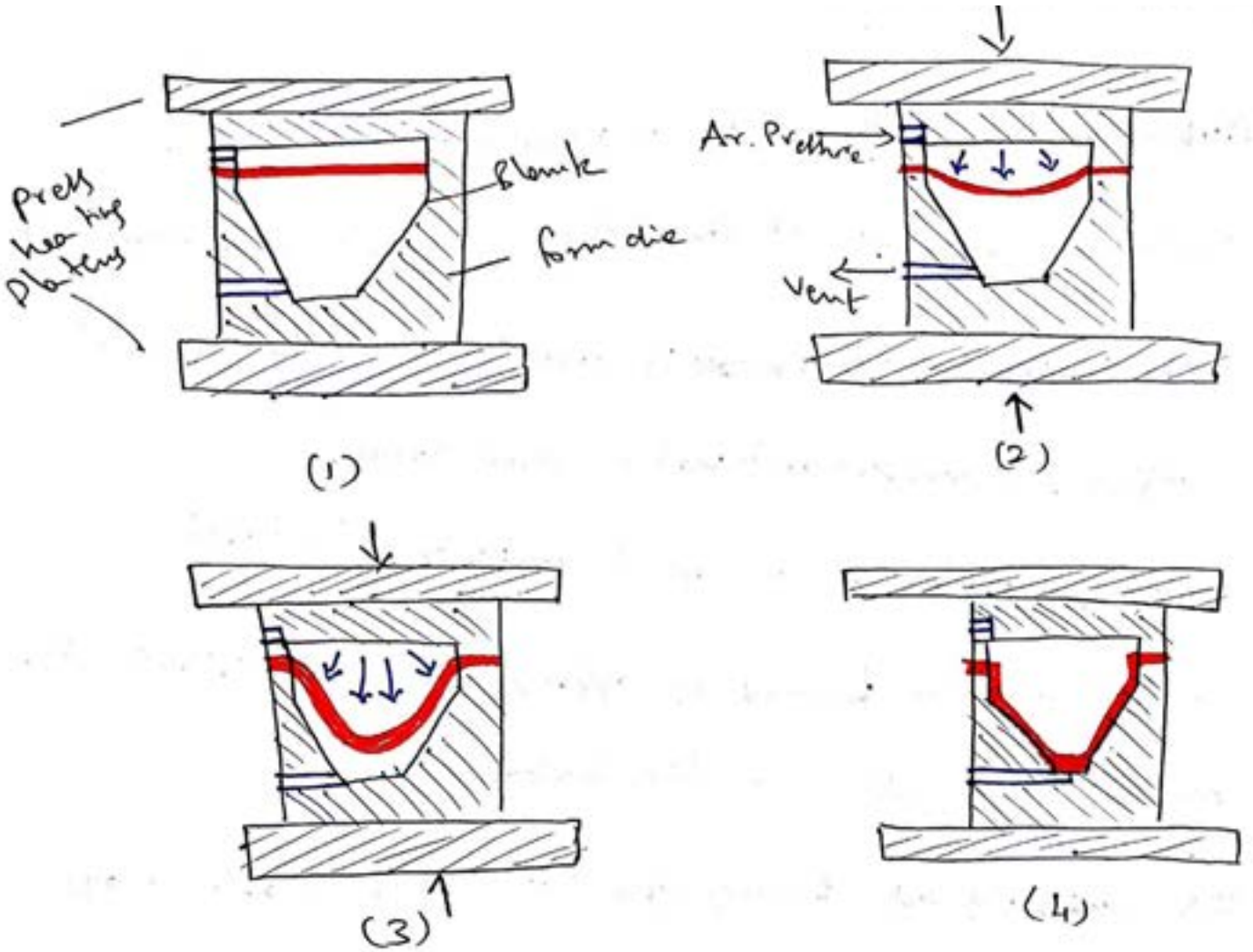
- Requires longer time for forming the required shape
- requires additional device for forcing out metal shots

Application

- used in producing specific portions as crank shafts, connecting rods & gears
- used for producing honeycomb panels like aircraft wings & large tubular shapes.

Super Plastic forming Process

- Superplasticity is the ability of certain mtls. to undergo extreme elongation at the proper temperature & strain rate.
- Superplastic forming Process is used in manufacturing of complex lightweight automotive structures.
- valuable tool in aircraft & automobile industries
- Components are formed by applying high gas pressure flow one or more sheets & a die surface
- It consists of hot forming upto 1000°c superplastic alloys by blowing an inert gas pr. upto 50 bars.
- Some mtls. which are developed for superplastic forming are
  1. Bismuth - tin (200 % Elongation)
  2. Zinc - Aluminium
  3. Titanium (Ti-6Al-V)
  4. Aluminium (2004, 2419, 7475)
  5. Aluminium - Lithium alloys (2090, 2091, 8090)
- Once the temp. is reached, it is accurately controlled, while the gas pr. slowly inflates the blank.
- the mtl. at the super-plastic temperature can allow upto 500 % elongation



Advantages

- one step process used for higher mtl. elongations
- Elimination of unnecessary joints & rivets
- Reduction of subsequent machining
- minimizes the amount of scrap produced

Applications

- automotive body panels
- forming of aircraft flaps & skins
- Diaphragm forming of plastics
- Complex shape parts - window flaps, seat structures

Micro forming

- forming of sheet metals less than 0.3 mm
- generally used to make parts of
  - cellular telephones
  - IC Lead frames
  - health care
  - Miniature fasteners
  - Hard disc drives
  - Automobiles
  - Sensors
  - National Security & Defence

Process characteristics

1. Elongation
2. Yield Point Elongation
3. Anisotropy
4. Grain Size
5. Residual Stresses
6. Spring Back
7. Wrinkling
8. Surface conditioning.
9. Quality of sheared edges

Applications

- vehicle components
- aircraft
- Electronic products
- frames of TV, Computer screen, monitor, displays etc...
- medical implants
- Packaging of consuming foods,
- cans for food & drinks

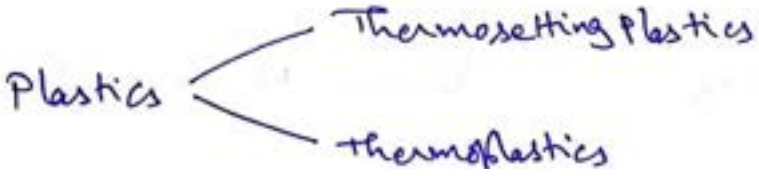
UNIT - 5

Manufacture of Plastic Components

Characteristics of Plastics

(i) Elongation
(ii) heat resistance
(iii) high rigidity
(iv) Surface hardness
(v) high viscosity
(vi) Maximum usage temperature
(vii) Density
(viii) Ignition temperature
(ix) Humidity absorption
(x) Chemical resistance

Types of Plastics



Thermosetting Plastics

- Plastics which are hardened by heat effecting a non-reversible chemical change are called 'Thermo-setting'.
- donot soften on reheating & cannot be reworked
- formed by condensation Polymerization
- - 2 or more unlike monomers are linked
- molecules of such type have 3D network & have very strong binding force b/w molecules.

Thermoplastics

- has separate long and large size molecules arranged side by side.
- doesnot have any cross-linking
- Some are amorphous in nature & some are crystalline in nature
- formed by addition ~~Polymerization~~
  - Similar monomers of large ~~molecules~~ numbers are chemically added one by one
- hardens on cooling & softens on heating
- could be easily Extruded & remoulded to any shape
- dont have definite melting temperature

Thermoplastics	Thermo setting plastics
1. Softened by heating	Cannot be softened
2. Structure is made of linear chain molecules	Structure is made of cross-linked molecules
3. Produced by addition Polymerization process	produced by condensation Polymerization process
4. Can be reproduced by heating & cooling	Cannot be reproduced
5. Temp. increases with increase in plasticity	Plasticity is stable @ high temp.
6. Softer & less strong	harder & Strong
7. Scrap can be reused	Scrap cannot be reused

Moulding of Thermoplastics

1. Injection moulding
   - Ram/plunger type injection moulding
   - Screw type injection moulding
2. Blow moulding
3. Rotational moulding
4. Film Blowing
5. Extrusion of profiles
6. Vacuum forming (Thermoforming)

Injection moulding

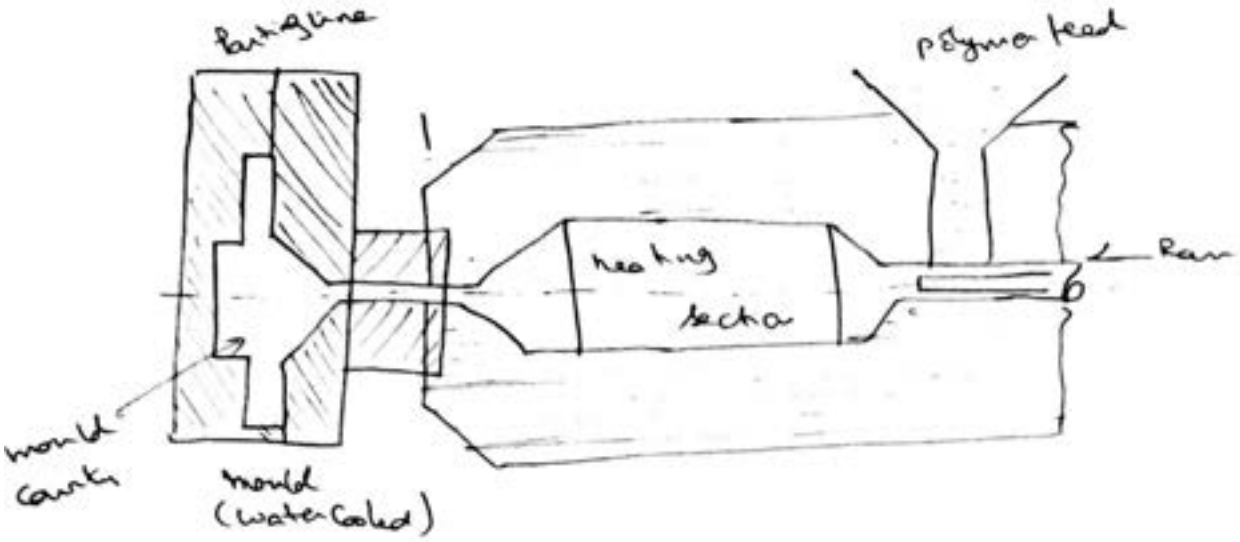
Principle - used to achieve high speed moulding of thermoplastics.
- here the molten thermoplastic is injected into a mould under high pressure.

Operation

- The moulding mtl. is loaded into a hopper from which it is transferred to a heating section by a feeding device. maintained @ 150°C to 370°C.
- The mtl. melts & is forced by an injection ram/plunger through a nozzle & sprue in a closed mold which forms the part.

Ram/Plunger type injection moulding:

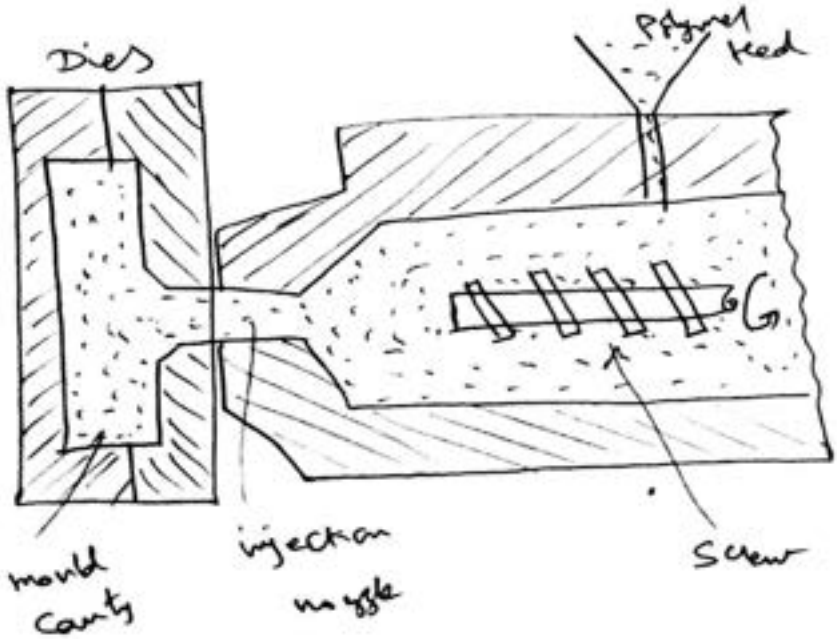
- Consists of 2 units
  1. Injection unit
  2. clamping unit



- Polymer is filled & fed into the heating section by means of a hopper.
- The heated mtl. is injected by means of a ram, which forces the mtl. to fill in the mould cavity through nozzle, to get reqd. shape of plastics.

Screw type injection moulding

- consists of 2 units
  1. Injection unit (hopper, screw & heating section)
  2. clamping unit (mould)



- Pellets are fed into hopper & forces are pushed along with the heated reciprocating screw.
- Screw is moved forward to force the plastic mtl. into mold.
- The rotation of screw provides the plasticizing action by shearing & frictional effects.
- injection capacity of moulding m/c (injection) ranges from 12 000 mm^3 to 2.2×10^6 mm^3.

Advantages

- high Production capacity
- low cost
- complex threads can be made
- Accuracy of ± 0.01 mm is achieved
- wide range of shape can be moulded

Applications

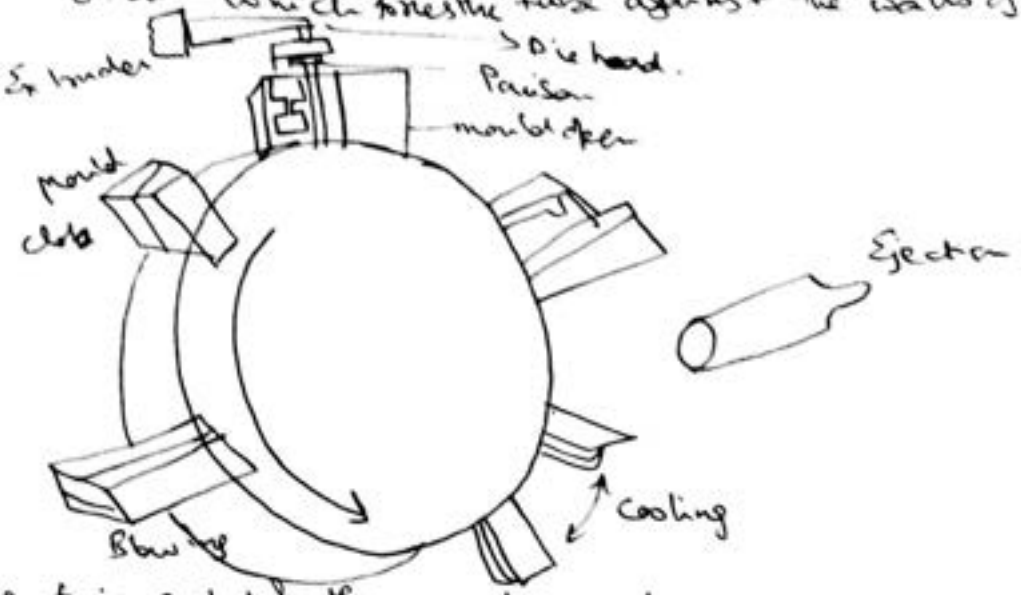
- used in making parts of complex threads
- Intricate shapes such as thin walled parts can be produced
- Typical shapes like toys, plumbing fittings, knobs are produced
- Electrical & communication components can be produced.

Limitation:

1. Equipments like cylinder & die must be non-corrosive
2. reliable temp control is essential

Blow moulding

- Hot Extruded tube of plastic called Parison is placed b/w 2 parts of open moulds
- Bottom end of parison is sealed
- Compressed air is used to blow the molten plastic into the mould about 0.7 to 10 kg/cm² which forces the tube against the walls of mold



- Component is cooled & the mould opens to release the component.
- Blow molding method ranges from simple manual ops to complicated automatic ones.

Applications:

1. Used in making plastic bottles & toys
2. Hollow containers are produced by this process
3. multilayer blow molding is used in cosmetics & pharmaceutical industries.

Rotational molding:

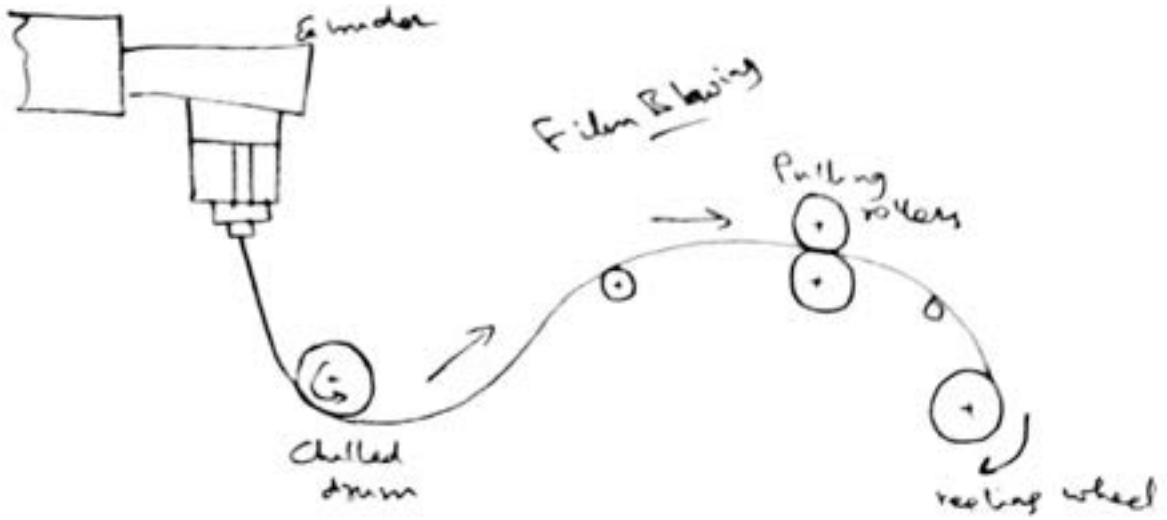
- Used to make thin walled hollow parts.
- The mold is closed & it is rotated about 2 mutually ⊥ axes as it is heated
- The rotation will cause the powder to fuse against the mold walls.
- After heating & sintering, the mould is cooled by using water or air.
- Then rotation is stopped when the moulded component is removed.
- A measured quantity of powdered plastic mtl. is placed inside the mould.
- Most of the thermoplastics & some thermosets can be formed into large hollow parts by Rotational moulding.
- In some parts chemical agents are added
- Large sized parts 1.8m × 1.8m × 3.6m can also be formed by this process.
- The temp, time relationship during the oven cycle is very important.

Applications:

1. Used to produce toys in P.V.C
2. Used to make large containers of Polyethylene
3. Used to make petrol tanks for motor cars from Polyethylene & nylon.
4. Used to produce tanks of various sizes, boat hulls & footballs.

Film Blowing

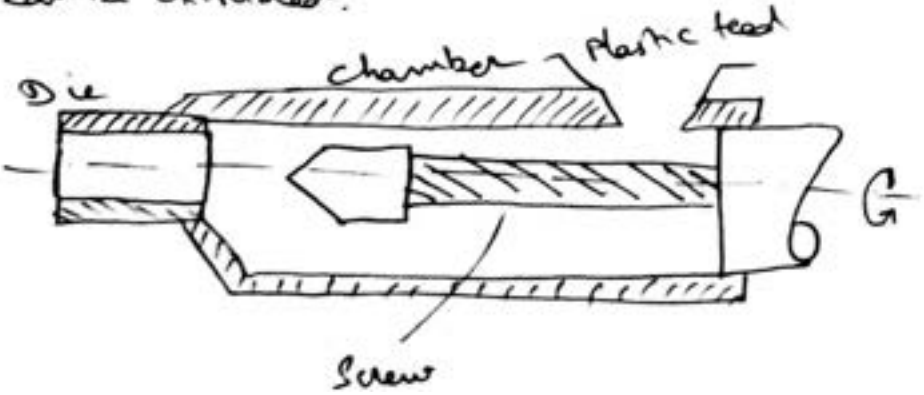
- Initially heated Plastic powder is extruded by extruder.
- Crystalline sharp melting polymers are suited for the film productions by melt casting techniques.



- After extruding the thin film, it is stretched by the pulling rollers.
- The thin film is cooled in the chilled drum & rollers are used to pull the film from chilled drum.

Extrusion Process

- A rotating screw carries the powder fed through hopper into the heated chamber & forces it out through the heated orifice of the die.
- The mould is suitably cooled by water or air. Hot & carried away by a running belt.
- For the extrusion of plastics, a single screw machine has completely replaced the ram type machine.
- The screw imparts both axial & rotary motions. The restricting effect of the die will build up a pressure until it is in a plastic state & can be extruded.

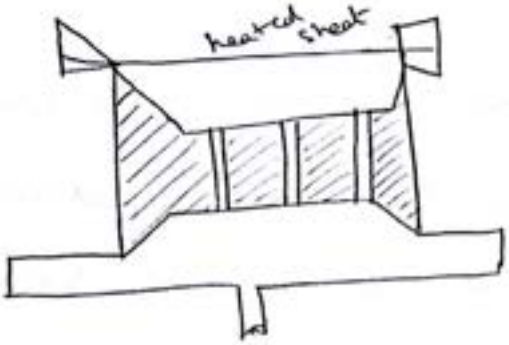


Applications:

- used to make tubes, sheets, films, pipes, pipes & other profiles.
- Complex shapes with constant cross section can be extruded with relatively inexpensive tooling.

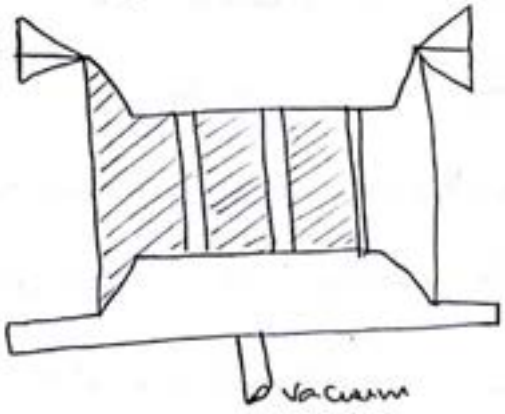
Thermoforming (vacuum forming process)

First Stage



Second Stage

- a process where plastic sheet is changed to a desired shape by causing it to flow against the mould surface.



Third Stage

- In the second stage, the heated sheet is placed on the die where the air blw sheet & mould is removed.
- In third stage, the increasing intensity draws the sheet against the surface of the mould where it cools & solidifies.

- Also called as thermoforming, which is low cost & quick process.
- Wide variety of plastic products are made by this thermoforming.

Application:

- Very much useful for making trays, drinking cups, refrigerator door liners.
- Used for making panels for shaver stalls and advertising signs.

Thermosetting Plastics

1. Compression moulding
2. Transfer moulding

Compression moulding

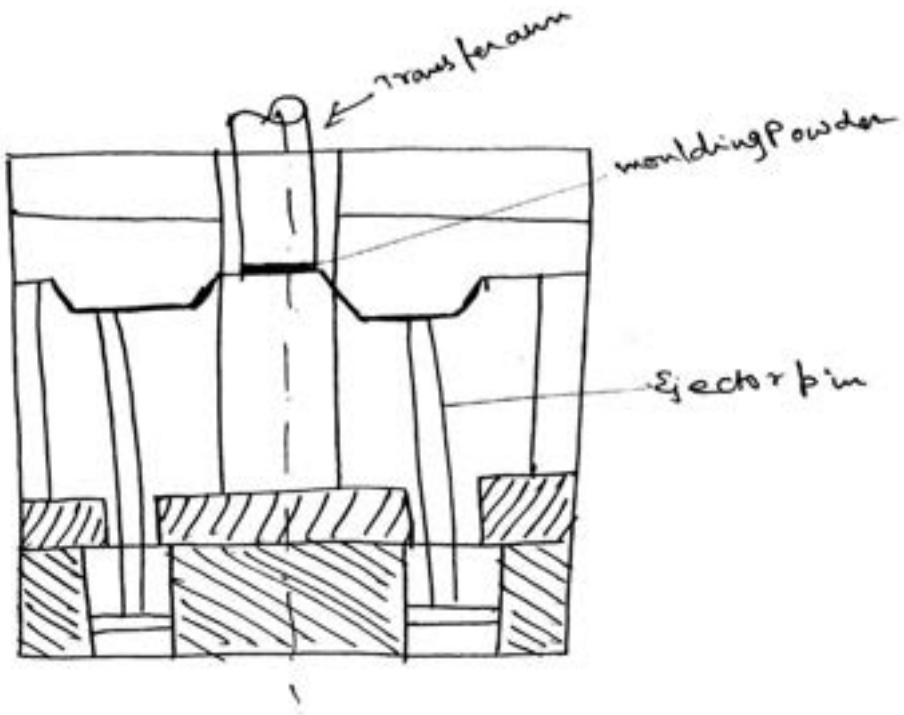
- involves the measured quantity of plastic in the form of particles
- Charge is placed in the heated mould cavity and mould is closed
- Desired compression is given by compression press thereby resulting an immediate contact of the polymer charge with all parts of the mould.
- Both pr. & heat ensure the flow of ~~resin~~ melting & finally the mould is opened & ejected from the cavity.
- The mould is cooled below the transition temperature before the mould is opened while making thermoplastics.
- Excess metal is placed in the mould & squeezed out b/w mating surfaces of the mould.
- moulding temp. ranges from 150°C to 180°C
- Some commonly used compression moulding types are

1. Flash type
2. Positive type
3. Landed positive type
4. Semi positive type

Applications:

- used to make dishes, handles, container types & fittings.
- Electrical & Electronic components, washing m/c agitator and housings are made by this process

Transfer moulding:



- a modification of compression moulding in which the mtl is first placed in a separate chamber called transfer pot.
- Pressure used is 50 to 100% higher than compression moulding.
- Transfer moulding cycle are shorter than compression moulding.
- mtl. to be moulded is often pre-heated by radio frequency methods.
- generally employed for thick sections and also useful for incorporating metal parts in the moulding.

Transfer moulding design:

1. Flow of mtls. should be easy
2. Ejecting of mould is easy
3. Heating of all parts should be uniform

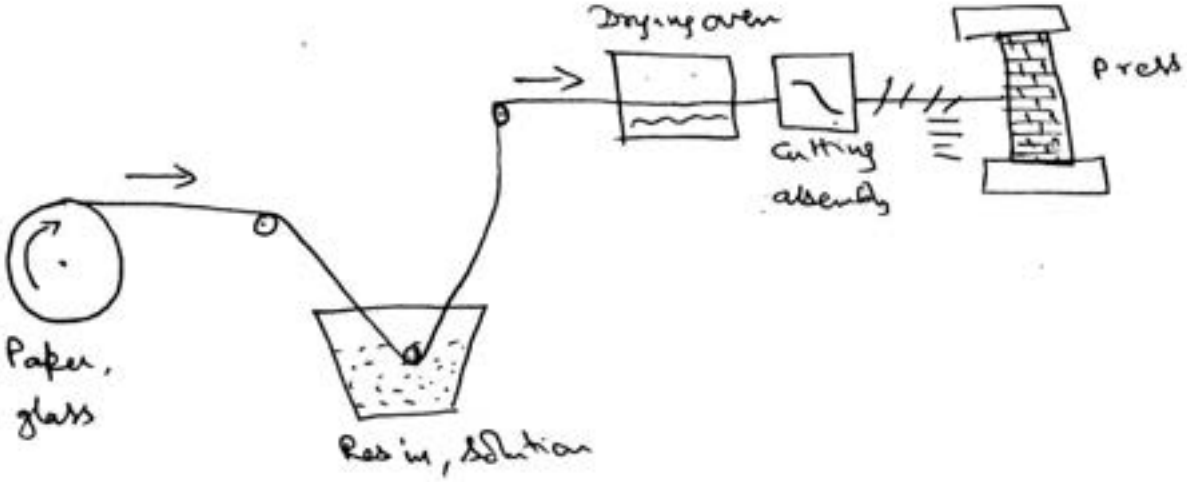
Application:

- used for Batch production
- Short runs of mould metal during moulding
- Shape of mould can be readjusted.

Advantages

- Cold Press can be used
- Viscosity of flow mtl. reduced

Bonding of Thermoplastics:



- done by the application of pressure & heat.
- consists of layers such as kraft cellulose, glass fibre etc...
- Thermoplastics are bonded by the process of lamination

1. High Pr. laminates – upto 7 MPa & temp – 150°C
2. low Pr. laminates

- mtls. are like asbestos, cotton, fibres are fabricated by this process.
- low Pressure laminates are called "Reinforced plastics".

- Paper & glass are impregnated in the resin solution using rollers & then resin mixed plastics are dried in the drying oven.
- dried plastics are cut in the cutting section.
- after cutting, it will be pressed by the press

1. Saturation of the base with the resin solution
2. wet drying
3. Size cutting
4. Pressing.

- laminated plastics are used in electrical & electronic equipments.
- In furniture industry, decorative laminations are used.

- reinforced plastics have the characteristics of

1. Elastic stability
2. less weight

- Reinforced plastics are used in

1. making thin sheets
2. Making aircraft panels
3. making ships
4. Making storage bins.