WORKSHOP TECHNOLOGY-1

Chapter 1- Welding

Syllabus

- Welding Process

Principle of welding, Classification of welding processes, Advantages and limitations of welding, Industrial applications of welding, Welding positions and techniques, symbols.

- Gas Welding

Principle of operation, Types of gas welding flames and their applications, Gas welding equipment - Gas welding torch, Oxy acetylene cutting torch, Blow pipe, Pressure regulators, Filler rods and fluxes

- Arc Welding

Principle of operation, Arc welding machines and equipment, A.C. and
D.C. arc welding, Effect of polarity, current regulation and voltage regulation

- Other Welding Processes

Resistance welding, introduction to spot and seam welding
Modern welding methods – TIG, MIG, ultrasonic welding, laser beam welding, robotic welding

- Welding Defects

Types of welding defects, methods of controlling welding defects, inspection of welding defects

1.1 Welding

technique used for joining metallic parts usually through the application of heat. This technique was discovered during efforts to manipulate iron into useful shapes. Welded blades were developed in the 1st millennium CE, the most famous being those produced by Arab armourers at Damascus, Syria. The process of carburization of iron to produce hard steel was known at this time, but the resultant steel was very brittle. The welding technique—which involved interlayering relatively soft and tough iron with high-carbon material, followed by hammer forging—produced a strong, tough blade.

In modern times the improvement in iron-making techniques, especially the introduction of cast iron, restricted welding to the blacksmith and the jeweler. Other joining techniques, such as fastening by bolts or rivets, were widely applied to new products, from bridges and railway engines to kitchen utensils.
Modern fusion welding processes are an outgrowth of the need to obtain a continuous joint on large steel plates. Rivetting had been shown to have disadvantages, especially for an enclosed container such as a boiler. Gas welding, arc welding, and resistance welding all appeared at the end of the 19th century. The first real attempt to adopt welding processes on a wide scale was made during World War I. By 1916 the oxyacetylene process was well developed, and the welding techniques employed then are still used. The main improvements since then have been in equipment and safety. Arc welding, using a consumable electrode, was also introduced in this period, but the bare wires initially used produced brittle welds. A solution was found by wrapping the bare wire with asbestos and an entwined aluminum wire. The modern electrode,

introduced in 1907, consists of a bare wire with a complex coating of minerals and metals. Arc welding was not universally used until World War II, when the urgent need for rapid means of construction for shipping, power plants, transportation, and structures spurred the necessary development work.

Resistance welding, invented in 1877 by Elihu Thomson, was accepted long before arc welding for spot and seam joining of sheet. Butt welding for chain making and joining bars and rods was developed during the 1920s. In the 1940s the tungsten-inert gas process, using a nonconsumable tungsten electrode to perform fusion welds, was introduced. In 1948 a new gas-shielded process utilized a wire electrode that was consumed in the weld. More recently, electron-beam welding, laser welding, and several solid-phase processes such as diffusionbonding, friction welding, and ultrasonic joining have been developed.

1.2 Basic Principles Of Welding

A weld can be defined as a coalescence of metals produced by heating to a suitable temperature with or without the application of pressure, and with or without the use of a filler material.

In fusion welding a heat source generates sufficient heat to create and maintain a molten pool of metal of the required size. The heat may be supplied by electricity or by a gas flame. Electric resistance welding can be considered fusion welding because some molten metal is formed.

Solid-phase processes produce welds without melting the base material and without the addition of a filler metal. Pressure is always employed, and generally some heat is provided. Frictional heat is developed in ultrasonic and friction joining, and furnace heating is usually employed in diffusion bonding.

The electric arc used in welding is a high-current, low-voltage discharge generally in the range 10–2,000 amperes at 10–50 volts. An arc column is complex but, broadly speaking, consists of a cathode that emits electrons, a gas plasma for current conduction, and an anode region that becomes comparatively hotter than the cathode due to electron bombardment. A direct current (DC) arc is usually used, but alternating current (AC) arcs can be employed.

Total energy input in all welding processes exceeds that which is required to produce a joint, because not all the heat generated can be effectively utilized. Efficiencies vary from 60 to 90 percent, depending on the process; some special processes deviate widely from this figure. Heat is lost by conduction through the base metal and by radiation to the surroundings.

Most metals, when heated, react with the atmosphere or other nearby metals. These reactions can be extremely detrimental to the properties of a welded joint. Most metals, for example, rapidly oxidize when molten. A layer of oxide can prevent proper bonding of the metal. Molten-metal droplets coated with oxide become entrapped in the weld and make the joint brittle. Some valuable materials added for specific properties react so quickly on exposure to the air that the metal deposited does not have the same composition as it had initially. These problems have led to the use of fluxes and inert atmospheres.

In fusion welding the flux has a protective role in facilitating a controlled reaction of the metal and then preventing oxidation by forming a blanket over the molten material. Fluxes can be active and help in the process or inactive and simply protect the surfaces during joining.

Inert atmospheres play a protective role similar to that of fluxes. In gas-shielded metal-arc and gas-shielded tungsten-arc welding an inert gas—usually argon—flows from an annulus surrounding the torch in a continuous stream, displacing the air from around the arc. The gas does not chemically react with the metal but simply protects it from contact with the oxygen in the air.

The metallurgy of metal joining is important to the functional capabilities of the joint. The arc weld illustrates all the basic features of a joint. Three zones result from the passage of a welding arc: (1) the weld metal, or fusion zone, (2) the heat-affected zone, and (3) the unaffected zone. The weld metal is that portion of the joint that has been melted during welding. The heat-affected zone is a region adjacent to the weld metal that has not been welded but has undergone a change in microstructure or mechanical properties due to the heat of welding. The unaffected material is that which was not heated sufficiently to alter its properties.

Weld-metal composition and the conditions under which it freezes (solidifies) significantly affect the ability of the joint to meet service requirements. In arc welding, the weld metal comprises filler material plus the base metal that has melted. After the arc passes, rapid cooling of the weld metal occurs. A one-pass weld has a cast structure with columnar grains extending from the edge of the molten pool to the centre of the weld. In a multipass weld, this cast structure may be modified, depending on the particular metal that is being welded.

The base metal adjacent to the weld, or the heat-affected zone, is subjected to a range of temperature cycles, and its change in structure is directly related to the peak temperature at any given point, the time of exposure, and the cooling rates. The types of base metal are too numerous to discuss here, but they can be grouped in three classes: (1) materials unaffected by welding heat, (2) materials hardened by structural change, (3) materials hardened by precipitation processes.

Welding produces stresses in materials. These forces are induced by contraction of the weld metal and by expansion and then contraction of the heat-affected zone. The unheated metal imposes a restraint on the above, and as contraction predominates, the weld metal cannot contract freely, and a stress is built up in the joint. This is generally known as residual stress, and for some critical applications must be removed by heat treatment of the whole fabrication. Residual stress is unavoidable in all welded structures, and if it is not controlled bowing or distortion of the weldment will take place. Control is exercised by welding technique, jigs and fixtures, fabrication procedures, and final heat treatment.

There are a wide variety of welding processes. Several of the most important are discussed below.

Forge Welding

This original fusion technique dates from the earliest uses of iron. The process was first employed to make small pieces of iron into larger useful pieces by joining them. The parts to be joined were first shaped, then heated to welding temperature in a forge and finally hammered or pressed together. The Damascus sword, for example, consisted of wrought-iron bars hammered until thin, doubled back on themselves, and then rehammered to produce a forged weld. The larger the number of times this process was repeated, the tougher the sword that was obtained. In the Middle Ages cannons were made by welding together several iron bands, and bolts tipped with steel fired from crossbows were fabricated by forge welding. Forge welding has mainly survived as a blacksmith's craft and is still used to some extent in chain making.

Arc Welding

Shielded metal-arc welding accounts for the largest total volume of welding today. In this process an electric arc is struck between the metallic electrode and the workpiece. Tiny globules of molten metal are transferred from the metal electrode to the weld joint. Since arc welding can be done with either alternating or direct current, some welding units accommodate both for wider application. A holder or clamping device with an insulated handle is used to conduct the welding current to the electrode. A return circuit to the power source is made by means of a clamp to the workpiece.

Gas-shielded arc welding, in which the arc is shielded from the air by an inert gas such as argon or helium, has become increasingly important because it can deposit more material at a higher efficiency and can be readily automated. The tungsten electrode version finds its major applications in highly alloyed sheet materials. Either direct or alternating current is used, and filler metal is added either hot or cold into the arc. Consumable electrode gas-metal arc welding with a carbon dioxideshielding gas is widely used for steel welding. Two processes known as spray arc and short-circuiting arc are utilized. Metal transfer is rapid, and the gas protection ensures a tough weld deposit.

Submerged arc welding is similar to the above except that the gas shield is replaced with a granulated mineral material as a flux, which is mounded around the electrode so that no arc is visible.

Plasma welding is an arc process in which a hot plasma is the source of heat. It has some similarity to gas-shielded tungsten-arc welding, the main advantages being greater energy concentration, improved arc stability, and easier operator control. Better arc stability means less sensitivity to joint alignment and arc length variation. In most plasma welding equipment, a secondary arc must first be struck to create an ionized gas stream and permit the main arc to be started. This secondary arc may utilize either a high-frequency or a direct contact start. Water cooling is used because of the high energies forced through a small orifice. The process is amenable to mechanization, and rapid production rates are possible.

Thermochemical Processes

One such process is gas welding. It once ranked as equal in importance to the metal-arc welding processes but is now confined to a specialized area of sheet fabrication and is probably used as much by artists as in industry. Gas welding is a fusion process with heat supplied by burning acetylene in oxygen to provide an intense, closely controlled flame. Metal is added to the joint in the form of a cold filler wire. A neutral or reducing flame is generally desirable to prevent base-metal oxidation. By deft craftsmanship very good welds can be produced, but welding speeds are very low. Fluxes aid in preventing oxide contamination of the joint.

Another thermochemical process is aluminothermic (thermite) joining. It has been successfully used for both ferrous and nonferrous metals but is more frequently used for the former. A mixture of finely divided aluminum and iron oxide is ignited to produce a superheated liquid metal at about 2,800 °C (5,000 °F). The reaction is completed in 30 seconds to 2 minutes regardless of the size of the charge. The process is suited to joining sections with large, compact cross sections, such as rectangles and rounds. A mold is used to contain the liquid metal.

Resistance Welding

Spot, seam, and projection welding are resistance welding processes in which the required heat for joining is generated at the interface by the electrical resistance of the joint. Welds are made in a relatively short time (typically 0.2 seconds) using a low-voltage, high-current power source with force applied to the joint through two electrodes, one on each side. Spot welds are made at regular intervals on sheet metal that has an overlap. Joint strength depends on the number and size of the welds. Seam welding is a continuous process wherein the electric current is successively pulsed into the joint to form a series of overlapping spots or a continuous seam. This process is used to weld containers or structures where spot welding is insufficient. A projection weld is formed when one of the parts to be welded in the resistance machine has been dimpled or pressed to form a protuberance that is melted down during the weld cycle. The process allows a number of predetermined spots to be welded at one time. All of these processes are capable of very high rates of production with continuous quality control. The most modern equipment in resistance welding includes complete feedback control systems to self-correct any weld that does not meet the desired specifications.

Flash welding is a resistance welding process where parts to be joined are clamped, the ends brought together slowly and then drawn apart to cause an arc or flash. Flashing or arcing is continued until the entire area of the joint is heated; the parts are then forced together and pressure maintained until the joint is formed and cooled.

Low- and high-frequency resistance welding is used for the manufacture of tubing. The longitudinal joint in a tube is formed from metal squeezed into shape with edges abutted. Welding heat is governed by the current passing through the work and the speed at which the tube goes through the rolls. Welding speeds of 60 metres (200 feet) per minute are possible in this process.

Electron-Beam Welding

In electron-beam welding, the workpiece is bombarded with a dense stream of high-velocity electrons. The energy of these electrons is converted to heat upon impact. A beam-focusing device is included, and the workpiece is usually placed in an evacuated chamber to allow uninterrupted electron travel. Heating is so intense that the beam almost instantaneously vaporizes a hole through the joint. Extremely narrow deep-penetration welds can be produced using very high voltages—up to 150 kilovolts. Workpieces are positioned accurately by an automatic traverse device; for example, a weld in material 13 mm (0.5 inch) thick would only be 1 mm (0.04 inch) wide. Typical welding speeds are 125 to 250 cm (50 to 100 inches) per minute.

Cold Welding

Cold welding, the joining of materials without the use of heat, can be accomplished simply by pressing them together. Surfaces have to be well prepared, and pressure sufficient to produce 35 to 90 percent deformation at the joint is necessary, depending on the material. Lapped joints in sheets and cold-butt welding of wires constitute the major applications of this technique. Pressure can be applied by punch presses, rolling stands, or pneumatic tooling. Pressures of 1,400,000 to 2,800,000 kilopascals (200,000 to 400,000 pounds per square inch) are needed to produce a joint in aluminum; almost all other metals need higher pressures.

Friction Welding

In friction welding two workpieces are brought together under load with one part rapidly revolving. Frictional heat is developed at the interface until the material becomes plastic, at which time the rotation is stopped and the load is increased to consolidate the joint. A strong joint results with the plastic deformation, and in this sense the process may be considered a variation of pressure welding. The process is self-regulating, for, as the temperature at the joint rises, the friction coefficient is reduced and overheating cannot occur. The machines are almost like lathes in appearance. Speed, force, and time are the main variables. The process has been automated for the production of axle casings in the automotive industry.

Laser Welding

Laser welding is accomplished when the light energy emitted from a laser source is focused upon a workpiece to fuse materials together. The limited availability of lasers of sufficient power for most welding purposes has so far restricted its use in this area. Another difficulty is that the speed and the thickness that can be welded are controlled not so much by power but by the thermal conductivity of the metals and by the avoidance of metal vaporization at the surface. Particular applications of the process with very thin materials up to 0.5 mm (0.02 inch) have, however, been very successful. The process is useful in the joining of miniaturized electrical circuitry.

Diffusion Bonding

This type of bonding relies on the effect of applied pressure at an elevated temperature for an appreciable period of time. Generally, the pressure applied must be less than that necessary to cause 5 percent deformation so that the process can be applied to finished machine parts. The process has been used most extensively in the aerospace industries for joining materials and shapes that otherwise could not be made—for example, multiple-finned channels and honeycomb construction. Steel can be diffusion bonded at above 1,000 °C (1,800

°F) in a few minutes.

Ultrasonic Welding

Ultrasonic joining is achieved by clamping the two pieces to be welded between an anvil and a vibrating probe or sonotrode. The vibration raises the temperature at the interface and produces the weld. The main variables are the clamping force, power input, and welding time. A weld can be made in 0.005 second on thin wires and up to 1 second with material 1.3 mm (0.05 inch) thick. Spot welds and continuous seam welds are made with good reliability. Applications include extensive use on lead bonding to integrated circuitry, transistor canning, and aluminum can bodies.

Explosive Welding

Explosive welding takes place when two plates are impacted together under an explosive force at high velocity. The lower plate is laid on a firm surface, such as a heavier steel plate. The upper plate is placed carefully at an angle of approximately 5° to the lower plate with a sheet of explosive material on top. The charge is detonated from the hinge of the two plates, and a weld takes place in microseconds by very rapid plastic deformation of the material at the interface. A completed weld has the appearance of waves at the joint caused by a jetting action of metalbetween the plates.

1.3 Weldability Of Metals

Carbon and low-alloy steels are by far the most widely used materials in welded construction. Carbon content largely determines the weldability of plain carbon steels; at above 0.3 percent carbon some precautions have to be taken to ensure a sound joint. Low-alloy steels are generally regarded as those having a total alloying content of less than 6 percent. There are many grades of steel available, and their relative weldability varies. Aluminum and its alloys are also generally weldable. A very tenaciousoxide film on aluminum tends to prevent good metal flow, however, and suitable fluxes are used for gas welding. Fusion welding is more effective with alternating current when using the gas-tungsten arc process to enable the oxide to be removed by the arc action.

Copper and its alloys are weldable, but the high thermal conductivity of copper makes welding difficult. Refractory metals such as zirconium, niobium, molybdenum, tantalum, and tungsten are usually welded by the gas-tungsten arc process. Nickel is the most compatible material for joining, is weldable to itself, and is extensively used in dissimilar metal welding of steels, stainlesses, and copper alloys.

Chapter 2- Pattern Making

Syllabus

- Types of pattern, Pattern material, Pattern allowances, Pattern codes as per B.I.S., Introduction to cores, core boxes and core materials, Core making procedure, Core prints, positioning of cores

Pattern:

A pattern may be defined as a model of desired casting which when moulded in sand forms an impression called mould. The mould when filled with the molten metal forms casting after solidification of the poured metal. The quality and accuracy of casting depends upon the pattern making. The pattern may be made of wood, metal(cast iron, brass, aluminium and alloy steel.), plaster, plastics and wax.

Pattern Allowances:

A pattern is always made larger than the required size of the casting considering the various allowances. These are the allowances which are usually provided in a pattern.

1: shrinkage or contraction allowance:

The various metals used for casting contract after solidification in the mould. Since the contraction is different for different materials, therefore it will also differ with the form or type of metal.

2: Draft allowance

It is a taper which is given to all the vertical walls of the pattern for easy and clean withdraw of the pattern from the sand without damaging the mould cavity. It may be expressed in millimeters on a side or in degrees. The amount of taper varies with the type of patterns. The wooden patterns require more taper than metal patterns because of the greater frictional resistance of the wooden surfaces.

3: Finish or machining allowance

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

4: Distortion or camber allowance

This allowance is provided on patterns used for casting of such design in which the contraction is not uniform throughout.

5: Rapping or shaking allowance

This allowance is provided in the pattern to compensate for the rapping of mould because the pattern is to be rapped before removing it from the mould.

<u>Types of Patterns:</u>

The common types of patterns are as follows:

1. solid or single piece patterns
2. split or two/multiple piece patterns
3. match plate pattern
4. cope and drag pattern
5. loose piece pattern
6. gated patterns
7. sweep pattern
8. skeleton pattern
9. shell pattern
10. segmental pattern
11. follow board pattern
12. lagged up pattern
13. left and right hand pattern

<u>Chapter 3- Moulding and Casting</u>

<u>Syllabus</u>

- Moulding Sand

Properties of moulding sand, their impact and control of properties. Various types of moulding sand.

- Mould Making

Types of moulds, molding boxes, hand tools used for mould making, molding processes, molding machines: squeeze machine, jolt squeeze machine and sand slinger.

- Casting Processes

Charging a furnace, melting and pouring both ferrous and non ferrous metals, cleaning of castings, Principle, working and applications of Die casting

- Gating and Risering System

Elements of gating system, Pouring basin, sprue, runner, gates, Types of risers, location of risers, Directional solidification

- Melting Furnaces

Construction and working of Pit furnace, Cupola furnace, Crucible furnace – tilting type, Electric furnace

- Casting Defects

Different types of casting defects, Testing of defects through magnetic particle inspection.

<u>Moulding sand properties and its classification:</u>

The moulding is a process of making a cavity or mould out of sand by means of a pattern. The molten metal is poured into the moulds to produce casting.
Properties of moulding sand
1: porosity or permeability
It is the property of sand which permits the steam and other gases to pass through the sand mould. The porosity of sand depends upon its grain size, grain shape, moisture and clay components are the moulding sand. If the sand is too fine, the porosity will be low.
2: Plasticity
It is that property of sand due to which it flows to all portions of the moulding box or flask. The sand must have sufficient plasticity to produce a good mould.
3: Adhesiveness
It is that properties of sand due to it adheres or cling to the sides of the moulding box.
4: Cohesiveness
It is the property of sand due to which the sand grains stick together during ramming. It is defined as the strength of the moulding sand.
5: Refractoriness
The property which enables it to resist high temperature of the molten metal without breaking down o r fusing.

<u>Classification of Moulding sand according to their use:</u>

1: Green sand

The sand in its natural or moist state is called green sand. It is also called tempered sand. It is a mixture of sand with 20 to 30 percent clay, having total amount of water from 6 to 10 percent. The mould prepared with this sand is called green sand mould, which is used for small size casting of ferrous and non-ferrous metals.

2: Dry Sand

The green sand moulds when baked or dried before pouring the molten metal are called dry sand moulds. The sand of this condition is called dry sand. The dry sand moulds have greater strength, rigidity and thermal stability. These moulds used for large and heavy casting.

3: Loam Sand

A mixture of 50 percent sand grains and 50 percent clay is called loam sand. It is used for loam moulds of large grey iron casting.

4: Facing Sand

A sand which is used before pouring the molten metal, on the surface is called facing sand. It is specially prepared sand from silica sand and clay.

5: Backing or Floor Sand

A sand used to back up the facing sand and not used next to the pattern is called backing sand. The sand which have been repeatedly used may be employed for this purpose. It is also known as black sand due to its colour.

6: System Sand

A sand employed in mechanical sand preparation and handling system is called system sand. This sand has high strength, permeability and refractoriness.

7: Parting Sand

A sand employed on the faces of the pattern before the moulding is called parting sand. The parting sand consists of dried silica sand, sea sand or burnt sand.

8: Core Sand

The cores are defined as sand bodies used to form the hollow portions or cavities of desired shape and size in the casting. Thus the sand used for making these cores is called core sand. It is sometimes called oil sand. It is the silica sand mixed with linseed oil or any other oil as binder.

Special Casting Processes

Special Casting Processes:

The sand moulds may be used for casting ferrous and non-ferrous metals, but these moulds can be used only once, because the mould is destroyed after the metal has solidified. This will increase the cost of production. The sand moulds also, can not maintain the tolerance and smooth surface finish. In order to meet these requirements, following casting method may be use:

1: Permanent Mould Casting

A casting made by pouring molten metal by gravity into a mould made of some metallic alloy or other material of permanence is known as permanent mould casting.

2: Slush Casting

The slush casting is a special application involving the used of permanent mould. It is used for casting low melting temperature alloys. This method is only adopted for ornaments and toys of non-ferrous alloys.

3: Die Casting

The die casting (also known as pressure die casting) may be defined as that casting which uses the permanent mould(called die) and the molten metal is introduced into it by means of pressure, following are two type of die casting machines commonly used for die casting:

(a) Hot chamber die casting machine

In a hot chamber die casting machine, the melting pot is an integral part of the machine. The molten metal is forced in the die cavity at pressure from 7 to 14 MPa. The pressure may be obtained by compressed air or by hydraulically operated plunger. The hot chamber die casting machine is use for casting zinc, tin, lead and other low casting melting alloys.

(b) Cold chamber die casting machine

In a cold chamber die casting machine , the melting pot is usually separate from the machine and the molten metal is not transferred to injection mechanism by ladle. The pressure on the casting metal may vary from 21 to 210 MPa and in same cases may reach 700 MPa. This process is used for casting aluminum, magnesium, copper, brass alloys and other high melting alloys.

4: Centrifugal Casting

A casting process in which the molten metal is poured and allowed to solidify while the mould is revolving, is called centrifugal process. The casting produced under this centrifugal force is called centrifugal casting. This process is especially designed for casting of symmetrical shape. The ferrous and the non-ferrous metals can be obtained by this process. The casting produced by this process have dense and fine grained structure.

5: Investment Casting

It is also known as lost wax process or precision casting. The casting produced by this method are within very close tolerance(±0.05mm).

6: Shell Moulding Process

The shell moulding process is also called croning process. The shell cast part can be produced with dimensional tolerance of ±02 mm.

Casting defects

Casting Defects:

The defects in a casting may be due to pattern and moulding box equipment, moulding sand, cores,gating system or molten metal. Some of the defects are:

<u>1: Mould shift</u>

It results in a mismatching of the top and the bottom parts of the casting , usually at the parting line.

<u>2: Swell</u>

It is an enlargement of the mould cavity by molten metal pressure resulting in localized or general enlargement of the casting.

<u>3: Fins and Flash</u>

These are thin projections of the metal not intended as a part of casting. These usually occurs at the parting line of the mould.

<u>4: Sand Wash</u>

It usually occurs near the in the gates as rough lumps on the surface of a casting.

<u>5: Shrinkage</u>

It is a crack or breakage in the casting on the surface of the work piece, which results from un equal contraction of the metal during solidification.

<u>6: Hot Tear</u>

It is an internal or external ragged discontinuously in the metal casting resulting just after the metal has solidified.

<u>7: Sand Blow or Blow Hole</u>

It is smooth depression on the outer surface of the casting work piece.

<u>8: Honeycombing or Slag holes</u>

These are smooth depression on the upper surface of the casting. They usually occur near the ingates.

<u>9: Scabs</u>

These are patches of sand on the upper surface of the casting component.

<u>10: Cold Shut and Misruns</u>

These happens when the mould cavity is not completely filled by the molten and insufficient material or metal.

<u>11: Run-outs and Bust-outs</u>

These permit drainage of the metal from the cavity and result in incomplete casting.

Shell Moulding

Shell Moulding

Shell moulding ;

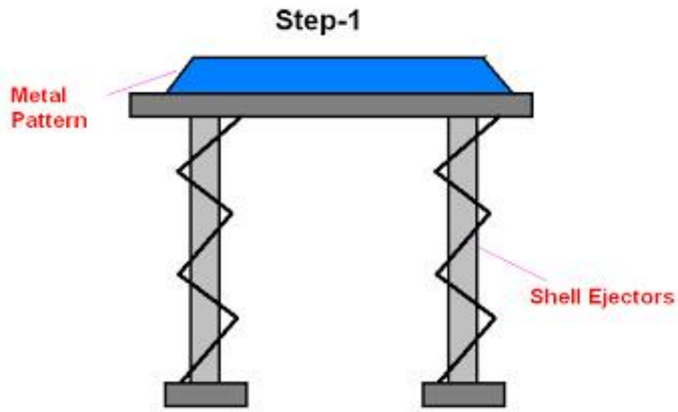
It is a process in which the sand is mixed with a thermo setting resin is allowed to come into contact a heated metallic pattern plate ‘so that a them and strong shell of mould is formed around the pattern’ then she is removed the pattern and the cope and drag are remove together and kept in a flask with the necessary back up material and the molten metal is pored into the mould.

Generally dry and fin sand which is completely free of the clay is used for preparing the shell mould in are the phenol formaldehyde rising combined with sand they hare very high strength and resistance through heat.

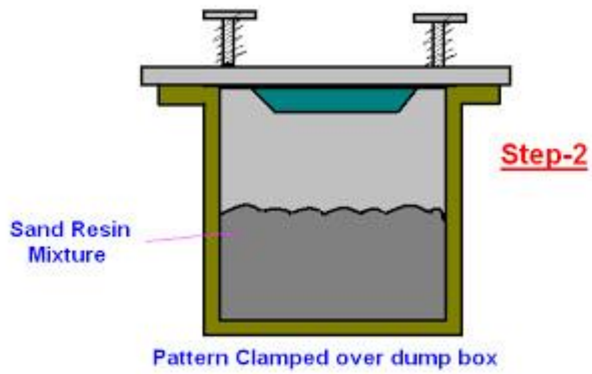
Steps Involve;

Step 1;

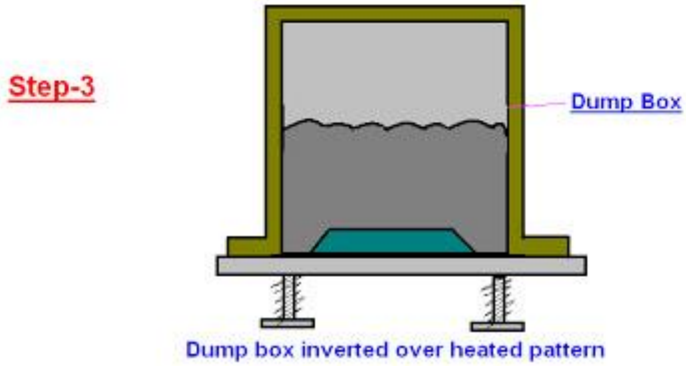
A metal pattern having the profile of the required casting is heated to 180°-260°c in an own maintained at 300°-400°c pattern after being heated is taken out of the own and sprayed with a solution of a lubricating agent containing silicon. It is necessary to prevent the shell from sticking to the metal pattern.



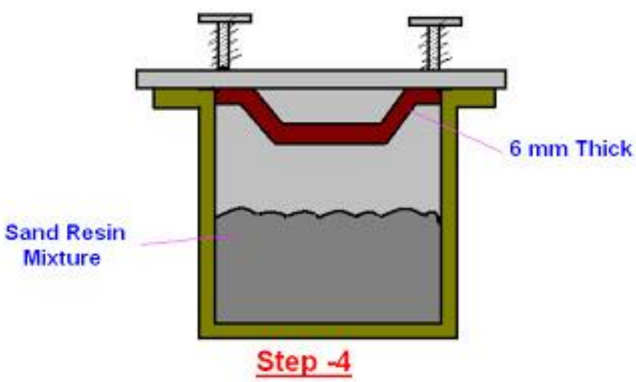
Step 2:
Metal pattern(made up of iron or steel)is then turned faced down and clamped over the open end of the dump box.



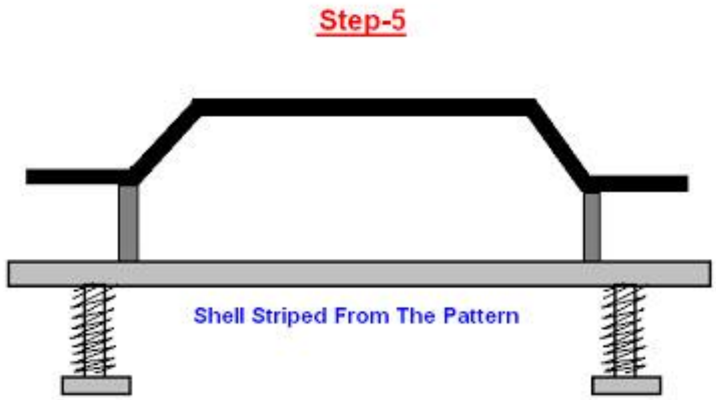
Step 3:
the dump box is inverted so that dry sand raisin mixture falls on the face of hot metal pattern . the raisin the raisin softens and fuses to form a soft and uniform sand mixture in contact with the pattern gets heat up .the rasinsoftens and fuses to form a soft and uniform shell of about 6mm thickness on the surface of pattern.



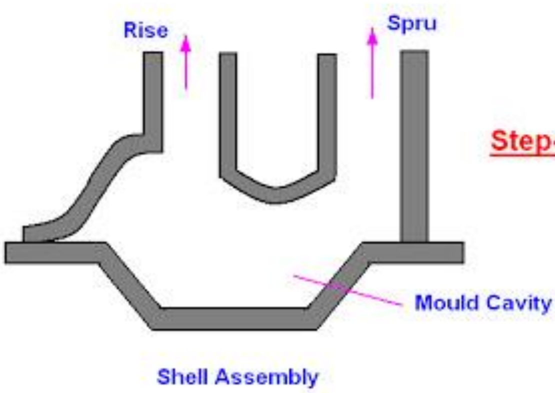
Step 4;
As the dump box is turned to its original position. Excess sand resin mixture falls beak into the dump box leaving a shell adhering closely to the pattern



Step 5;
The shell is then stripped from the pattern plate with the help of ejector pins which are an integral part of the metal pattern



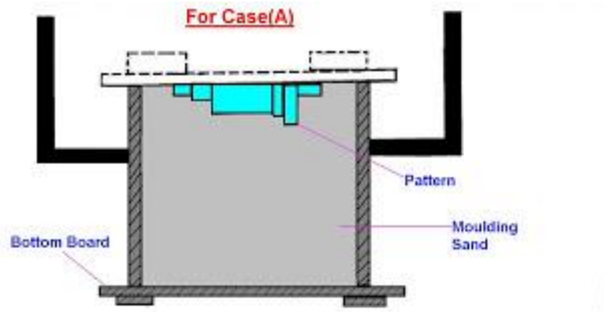
Step 6;
After the shells so obtained have cooled. Two meeting shell are securely fastened together to from a complete mould.



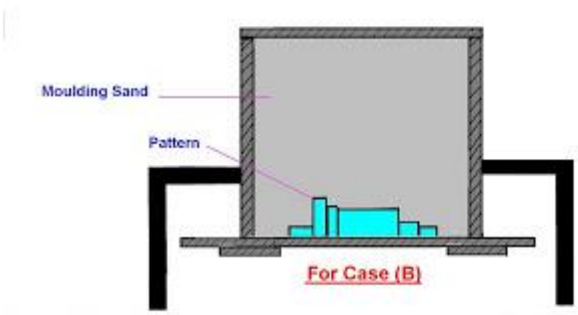
Sand Casting processes

Sand Casting Processes
Sand Casting Processes
For Case(A):
Bottom board is placed either boundary moulding from or on the floor making the surface even. The drag

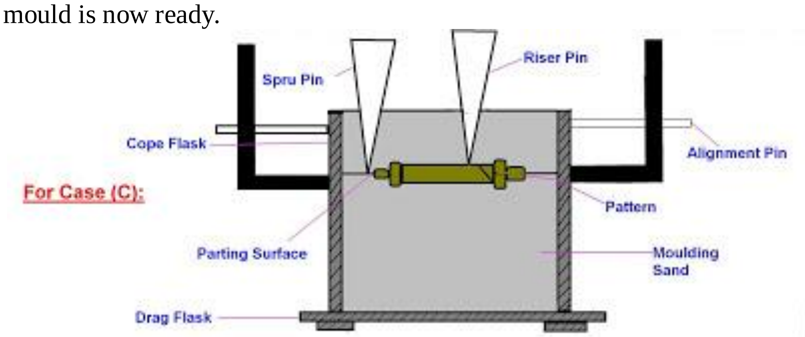
moulding flask is kept upside down on the bottom board. Dry facing sand is sprinkled over the board. Rest of the drag flask is completely filled with back up sand and uniform the rammed to compact the sand. The remaining of sand should be done properly. So as to compact it to hard , which makes the escape of gases difficult not to lose.
So that mould could not have enough strength . After the ramming is over , the excess of sand in the flask is completely scraped using a flat bar to the level of the flask edges. Now with a vent wire which is a wire of 1-2mm diameter with a pointed end, vent holes are made in the drag to he full depth flask as well as to the pattern to facilitate the removal of gases during casting solidification. This complete the preparation of the drag.



For case B:
We finished the drag flask is now rolled over to the bottom bolt exposing the pattern and cope of the pattern is placed over the dragged pattern.



For case C:
The cope flask on the top of the drag is rotated aligning again with the help of the pins. A screw pin for making the screw passage. The sand is thoroughly rammed and excess sand scrap and vent holes are made over all in the cope as in the drag. The screw pin and the riser pin are carefully with drawn from flask the mould is now ready.



Chapter 4- Metal Forming Processes

syllabus

- Press Working - Types of presses, type of dies, selection of press die, die material. Press Operations-Shearing, piercing, trimming, punching, notching, shaving, gearing, embossing, stamping
- Forging - Open die forging, closed die forging, Press forging, upset forging, swaging, up setters, roll forging, Cold and hot forging
- Rolling - Elementary theory of rolling, Types of rolling mills, Thread rolling, roll passes, Rolling defects and remedies
- Extrusion and Drawing - Type of extrusion- Hot and Cold, Direct and indirect. Pipe drawing, tube drawing, wire drawing

Manufactuing Processes:

Introduction:
Manufacturing involves turning raw material to finished products, to be used for various purposes. There are a large number of processes available. These processes can be broadly classified into four categories.
1: Casting processes
2: Forming processes
3: Fabrication processes
4: Material removal processes
Casting Processes
These processes only processes where the liquid metal is used. Casting is also the oldest known manufacturing process.
Basically it consists of inducing the molten metal into a cavity of mould of the required form and allowing the metal to solidify.The object after solidification removed from the mould. Casting processes are universally used to manufacture a wide variety of products. Casting is the most flexible and cheapest method and given high strength of rigidity to the parts which are difficult to produce by other manufacturing processes.
The principle process among these sand casting where sand is used as the raw material. The process is equally suitable for the production of a small batch as well as on a large scale.Some of the other classified casting processes for specialized need are

- Shell mould casting
- Precision mould casting
- Plaster mould casting
- Permanent mould casting
- Die casting
- Centrifugal casting

Forming Processes:
These are solid state manufacturing processes involve minimum amount of material wastage. In forming process metal may be heated to temperature which is slightly below. This solidify temperature and large force is applied such the material flows and act in desired shape. The desire shape is controlled by means of a set of tool ties and dies, which may be closed during manufacturing.
These processes are normally used for large scale production rates. These are generally economical and in many cases improve the mechanical properties. These are some of the metal forming processes.

- Rolling forging
- Drop forging
- Press forging
- Upset forging
- Extrusion forging
- Wire forging
- Sheet metal operation

Fabrication Processes
These are secondary manufacturing processes where the starting raw materials are produced by any one of the

previous manufacturing processes desired. Its assembly involve joining pieces either temporary or permanent. So that they would be perform the necessary function. The joining can be achieved by either or both of heat and pressure joining materials.
Many of the steel structure construction, we see are first rolled and then joined together by a fabrication process are

- Gas welding
- Electric arc welding
- Electrical resistance welding
- Thermo welding
- Brazing welding
- Soldering welding
- Cold welding

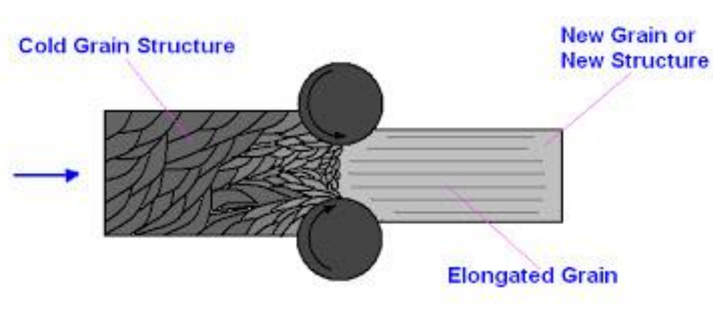
Material removal processes:
These are also a secondary removal manufacturing process, where the additional unwanted material is removed in the form of chips from the blank material by a hard tools so as to obtained the final desired shape. Material removal is normally a most expensive manufacturing process. Because more energy is consumed and also a lot of waste material is generated in this process. still this process is widely used because it deliver very good dimensional accuracy and good surface finished. Material removal process are also called machining processes. Various processes in this category are

- Turning
- Drilling
- Shaping and planning
- Milling
- Grinding
- Broaching
- Sawing
- Trimming

Hot and Cold working processes

<u>Hot and Cold Working Processes</u>

Hot and Cold working Processes:
The metal working processes are derived into hot working and cold working processes. The division is on the basis of the amount of heating applied to the metal before applying the mechanical force. Those processes working above the re-crystallization temperature are hot working processes where as the below or termed as cold working processes.



Hot and Cold Working Process

Under the action of heat and force when the atom reach a certain high energy level the new crystal start forming , which is termed as re- crystallization. Re-crystallization destroys the old grain structure deform by the mechanical working and entirely new crystal which are strain free and form.
Re-crystallization temperature is defined as the approximate minimum temperature at which complete re-crystallization of a cold work metal occurs with in a specified time.
Hot working processes.
Hot working of metals takes place above re-crystallization by hot working processes the metal are given desired shape by subjecting then two forces which cause then to undergo plastic deformation at the temperature above the re-crystallization range.
Different hot working processes are as follows:

1: Forging

Hammer or smith forging
Drop forging
Upset forging
Press forging
Roll forging
Swaging

2: pipe welding

Butt welding of heated strips
Butt welding of electrical resistance
Lap welding
Hammer welding

3: Rolling

4: Piercing

5: Spinning

6: Extruding

7: Drawing or Cupping

Cold working processes

<u>Cold Working process</u>

Cold working processes:
Below the recrystallization temperature if the mechanical work is done on the metals , there will no grain growth but it must be grain this integration elongation , the process is known is cold working processes. In cold working process greator pressure is required than that required in hot working. As the metal is in a more rigid state. It is not permanently deform until stress exceeds the elastic limit. Most of the cold processes are performed at room temperature , the different cold working processes are

1: Drawing
- Wire drawing
- Tube drawing
- Blanking
- Spinning

2: Sequeezing
- Coining
- Sizing
- Riveting

3: Bending
- Angle bending
- Plate bending
- Roll forming

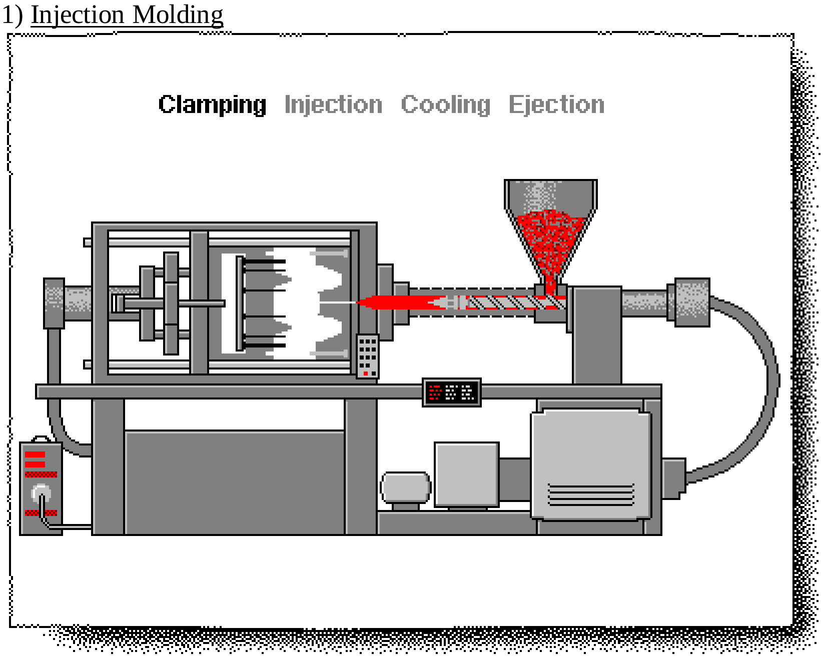
4: Shearing
>Punching >Blanking
> Trimming > Perforating
>Notching >Launcing
>Slittig
5:Extruding

Plastic Processing (05 hrs)

Industrial use of plastics, situation where used.
Injection moulding-principle, working of injection moulding machine.
Compression moulding-principle, and working of compression moudling machine.
Potential and limitations in the use of plastics

Plastics are mainly organic polymers of high molecular mass, but they sometimes contain other substances as well. Plastics are usually synthetic, most commonly derived from petrochemicals, but many are partially natural. Plastics are usually classified by their chemical structure of the polymer's backbone and side chains. Some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics. There are a variety of methods used to process plastic. Each method has its advantages and disadvantages and are better suited for specific applications. There are various plastic processing techniques featured with their relevant animations.

1) Injection Molding



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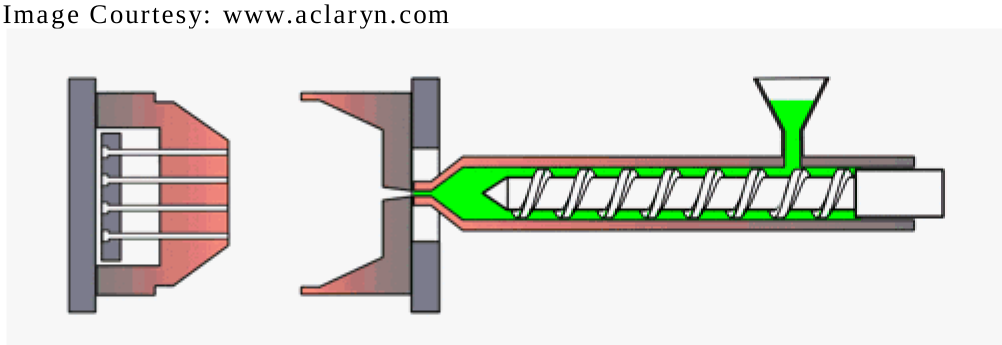

Image Courtesy: www.mitras-composites.de

Injection molding is a manufacturing process for producing parts by injecting material into a mold. The main method used for processing plastic is injection molding. With this process, the plastic is placed into a hopper. The hopper then feeds the plastic into a heated injection unit, where it is pushed through a long chamber with a reciprocating screw. Here, it is softened to a fluid state. A nozzle is located at the end of the chamber. The fluid plastic is forced through the nozzle into a cold, closed mold. The halves of the mold are held shut with a system of clamps. When the plastic is cooled and solidified, the halves open and the finished product is ejected from the press.

2) <u>Plastic Extrusion</u>

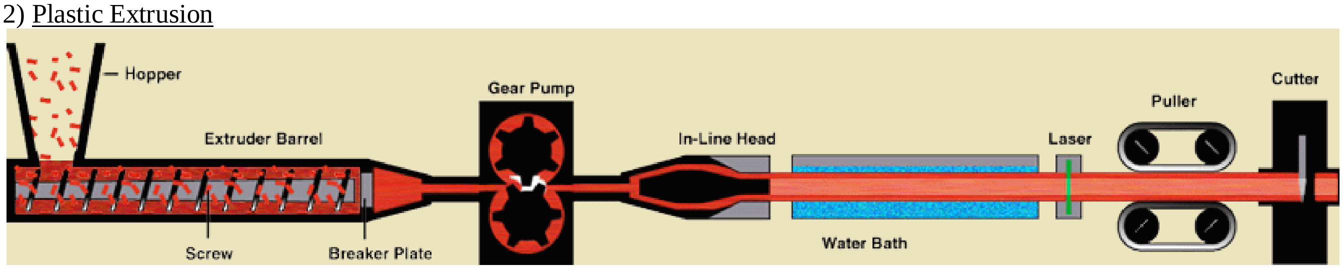

Image Courtesy: www.schenectady.k12.ny.us

Plastics extrusion is a high volume manufacturing process in which raw plastic material is melted and formed into a continuous profile. The process of extrusion is usually used to make products such as film, continuous sheeting, tubes, profile shapes, rods, coat wire, filaments, cords, and cables. As with injection molding, dry plastic material is placed into a hopper and fed into a long heating chamber. At the end of the chamber, however, the material is forced out of a small opening or a die in the shape of the desired finished product. As the plastic exits the die, it is placed on a conveyor belt where it is allowed to cool. Blowers are sometimes used to aid in this process, or the product may be immersed in water to help it cool.

3) <u>Blow Molding</u>

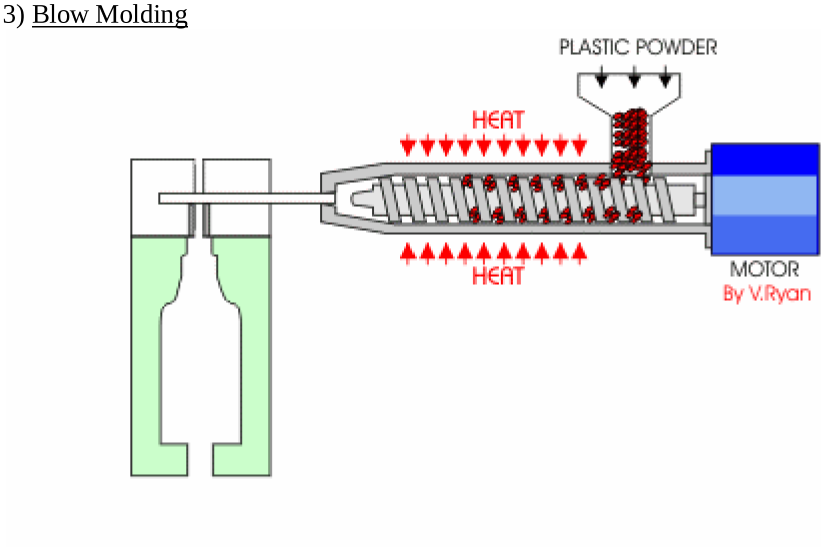

Image Courtesy: www.technologystudent.com

Image Courtesy: www.smg3d.co.uk

Stretch Blow Molding process is mainly used when the plastic product that needs to be created should be hollow. A molten tube is created with blow molding by using compressed air, which blows up the tube and forces it to conform to the chilled mold. Variations of blow molding include injection, injection-stretch, and extrusion blow molding.

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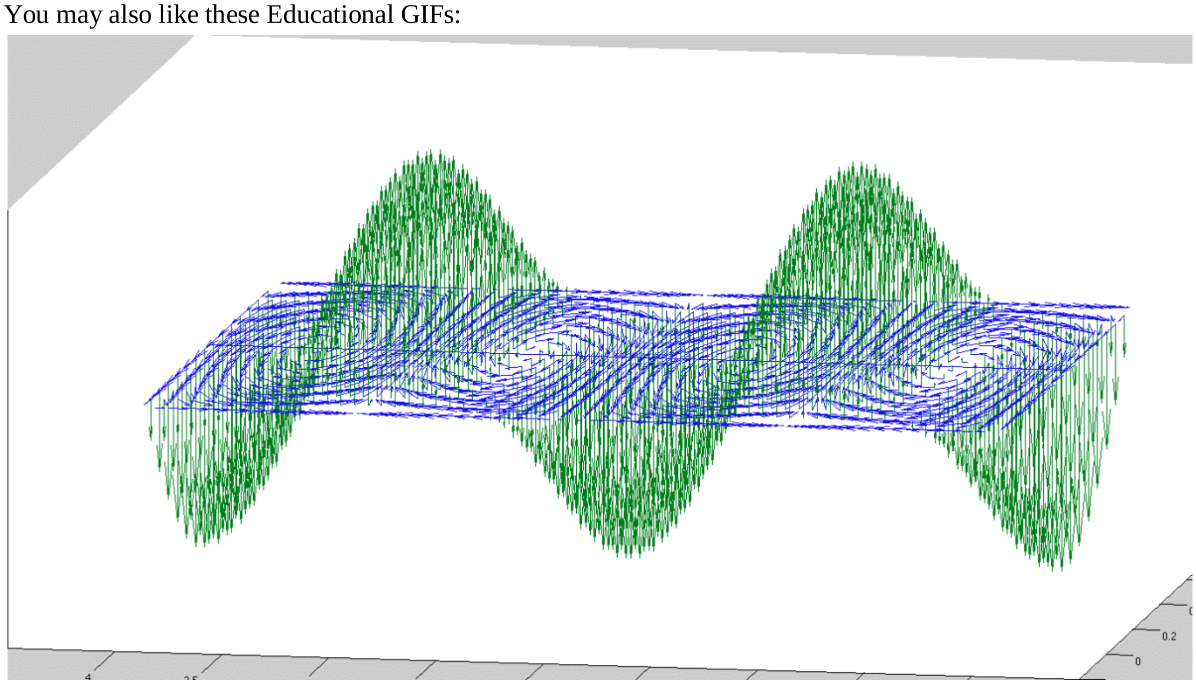


A visual representation of varying basic Electromagnetism phenomenon through GIFs

4) Thermoforming

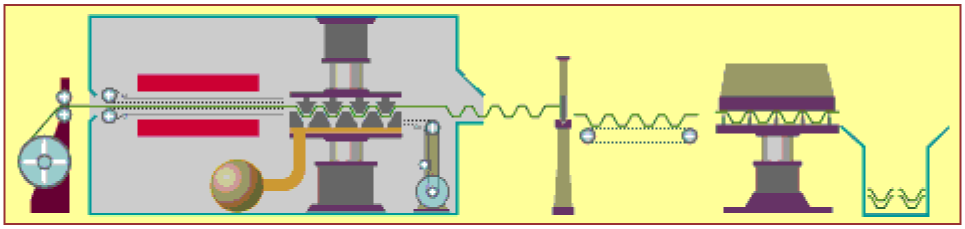


Image Courtesy: www.creativeformplastics.com

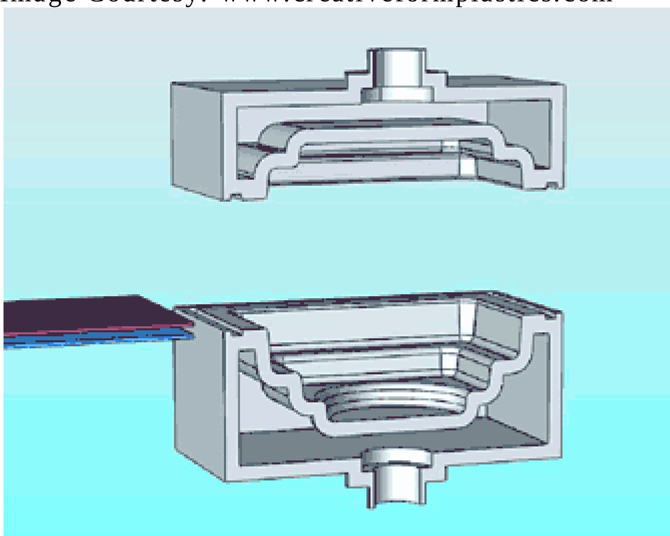
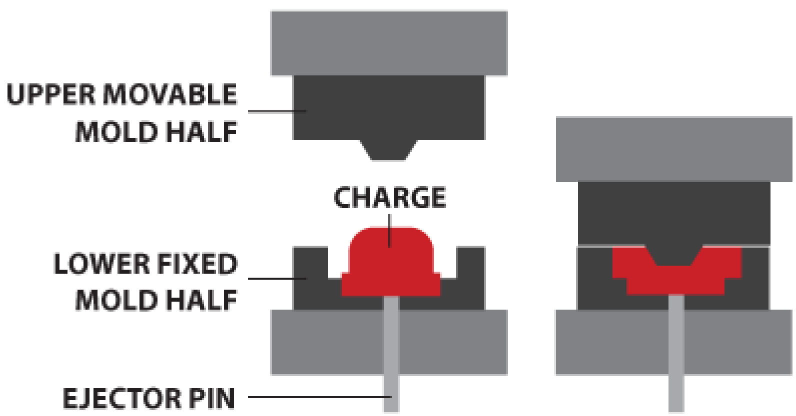


Image Courtesy: www.pmwproducts.com

Thermoforming is a manufacturing process where a plastic sheet is heated to a pliable forming temperature, formed to a specific part shape in a mold, and trimmed to create a usable product. The sheet, or film when referring to thinner gauges and certain material types, is heated in an oven to a high-enough temperature that it can be stretched into or onto a mold and cooled to a finished shape. The second animation shows the twin sheet thermoforming process whereby two individual components are fused together through the application of tremendous pressure which forces two molds together, thereby fusing the materials together.

5) Compression Molding



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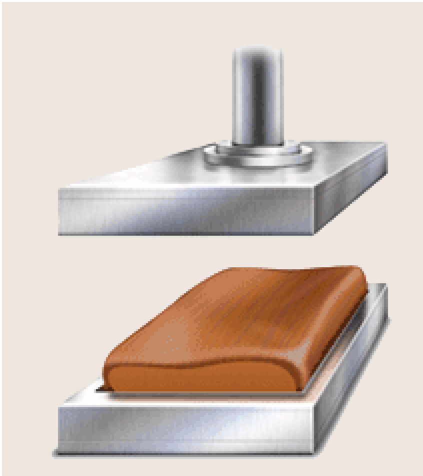

Image Courtesy: www.tamko.com

Compression molding is the most common process used with thermosetting materials and is usually not used for thermoplastics. With this process, the material is squeezed into its desired shape with the help of pressure and heat. Plastic molding powder and other materials are added to the mix in order to create special qualities or to strengthen the final product. When the mold is closed and heated, the material goes through a chemical change that causes it to harden into its desired shape. The amount temperature, amount of pressure, and length of time utilized during the process depends on the desired outcome.

6) Calendering

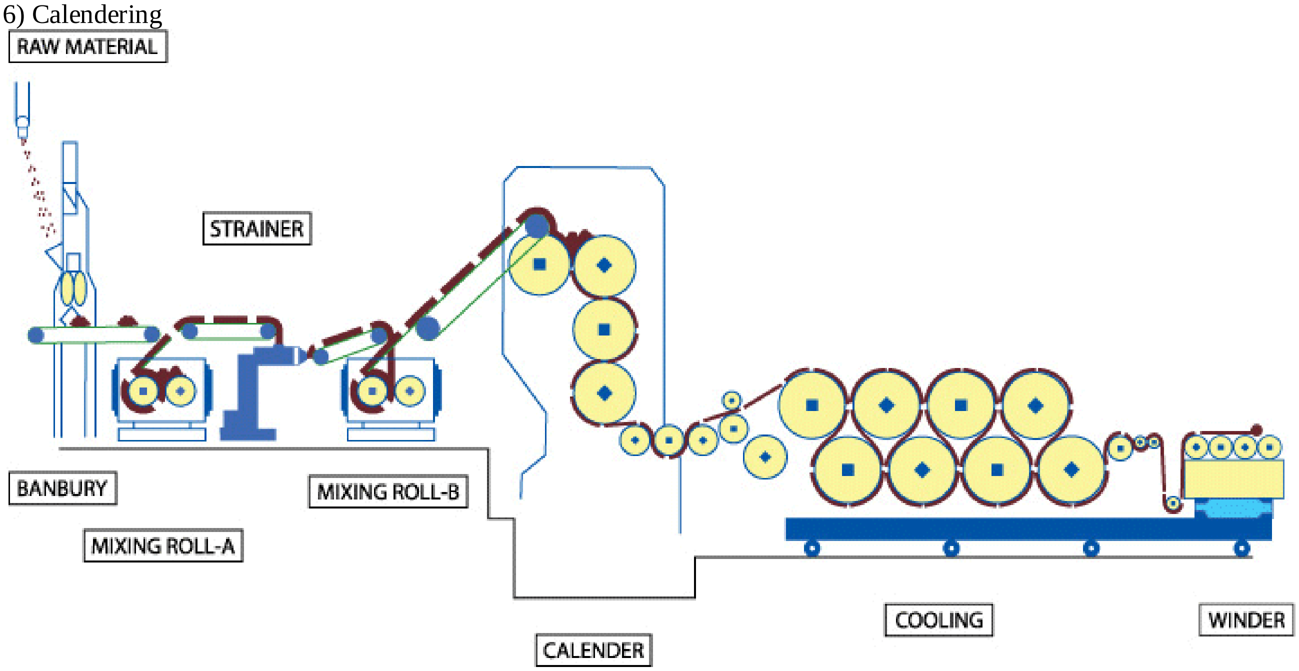

Image Courtesy: www.thainam.com

Calendering is a continuous process which works in much the same way as an old-fashioned clothes mangle. For plastics, there are usually four heated rollers of different sizes rotating at slightly different speeds. The material is fed into these rollers, heated and melted, then shaped into a sheet or film. This is then cooled and rolled up. The sheets can be mono-oriented during this process. The most commonly calendered material is PVC.

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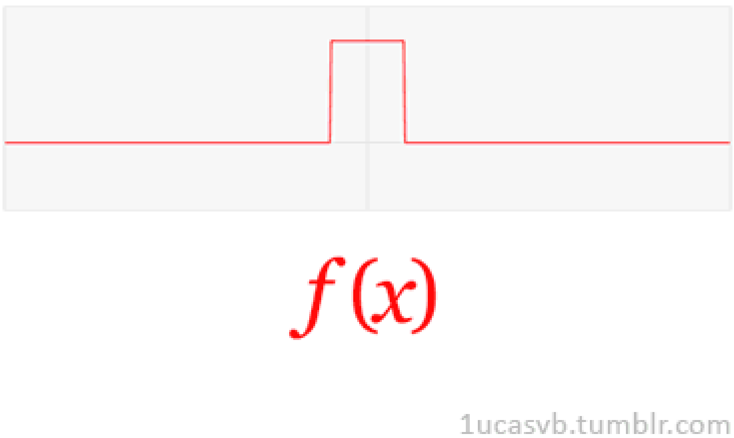
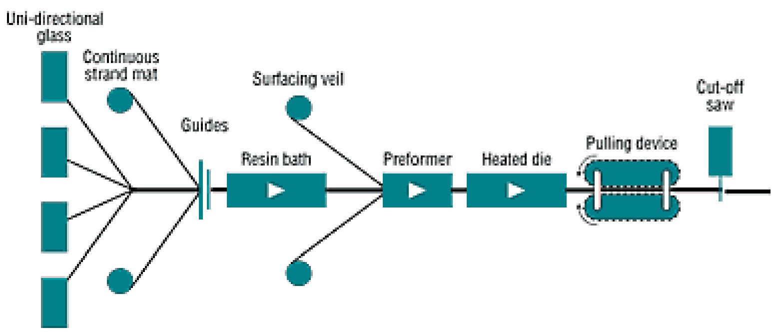


<u>Math Equations that changed the World presented with their related GIFs</u>

7) <u>Pultrusion</u>



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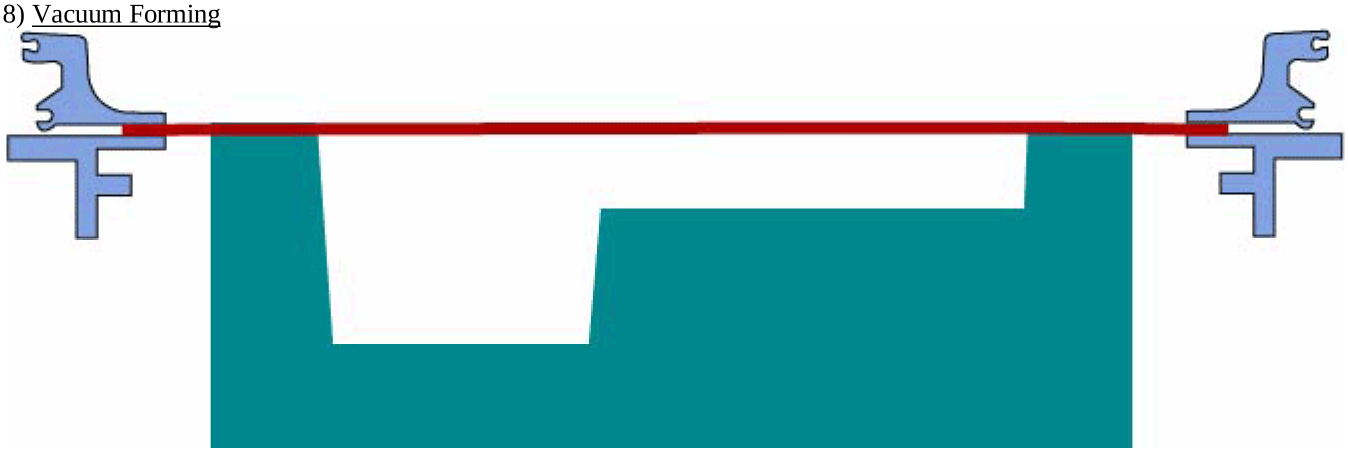
Pultrusion is similar to extrusion in that it produces continuous cross-sectional profiles. While extrusion relies on press to push unreinforced thermoplastic materials through a short die, pultrusion pulls a variety of reinforced fibers, wetted by thermosetting and/or some thermoplastic resins, through a heated die. Polymerization of the resin occurs as the wetted fibers pass through the die, forming a continuous, rigid profile corresponding to the orifice shape.

8) <u>Vacuum Forming</u>



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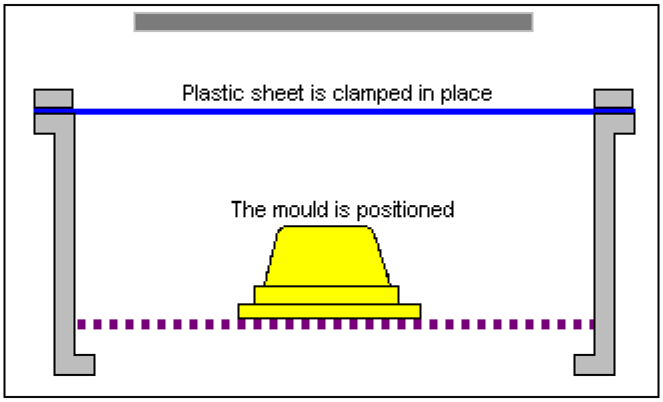

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Vacuum forming is a simplified version of thermoforming, whereby a sheet of plastic is heated to a forming temperature, stretched onto a convex, or into a concave, single-surface mold, and forced against the mold by a vacuum (suction of air).

9) <u>Rotational Molding</u>