PLASTICS

Plastics, mostly being synthetic materials (Synthetic materials are made from chemicals and are usually based on polymers.), are available in market a variety of forms to suit varied requirements. It is finding newer and newer usages in building construction and is quickly replacing many conventional materials like glass, ceramics and other building materials due to:

- Low temperature range in which they can be brought to the plastic state and the consequent ease of forming and fabrication.
- Their low cost and
- Easy availability.

It is being used for making fittings and fixtures to meet aesthetic requirements and structural components to withstand wear and tear.

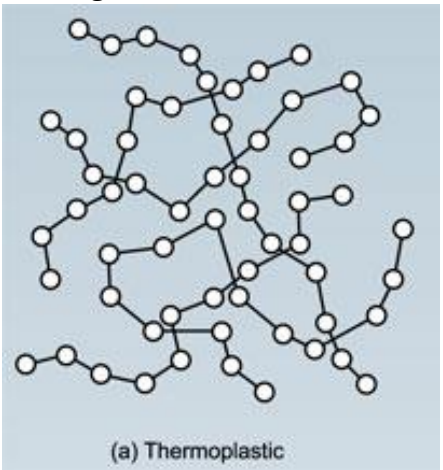
CLASSIFICATION

There are a very large number of plastics with varying constituent materials and varying properties and hence it is difficult to classify them on the basis of properties of their chemical constituents. By varying the proportions of the constituent materials the properties are affected very much. The field of plastics is expanding very fast and it is difficult to think of perfect classification on some basis. Conventionally, one important behavior of plastics in relation to heat is considered as the basis for broadly classifying the plastics. Accordingly, plastics are classified as:

a. Thermoplastics
b. Thermosets

a. Thermoplastics:

The thermoplastic variety softens on heating and hardens on cooling, i.e., their hardness is a temporary property subjected to change with rise or fall of temperature and can be brought again to plastic stage on heating. These are formed by addition polymerization and have long chain molecular structure. At low temperature these plastics are generally brittle in their natural state and hence plasticizers are generally combined in varying proportions to improve the quality during their manufacturing stage. The plasticizers (A Substance added to resin to improve flexibility and plasticity) may be


(a) Thermoplastic

granular or fibrous materials. Thermoplastics comprised of

Acrylic, Poly vinyl chloride (PVC), Poly ethylene, Poly vinyl acetate, Cellulose acetate, Poly propylene etc.

Other examples of thermoplastics are:

Polyethylene:

- Packaging
- Electrical insulation
- Milk and water bottles
- Packaging film
- House wrap
- Agricultural film

Polypropylene:

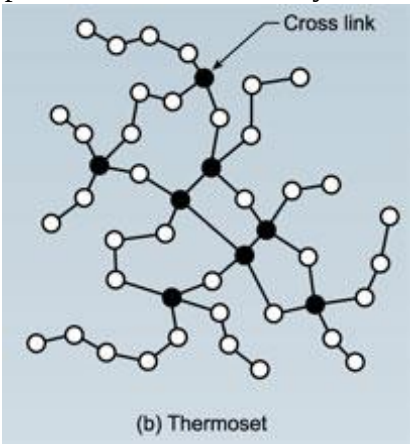
- Carpet fibers
- Automotive bumpers
- Microwave containers

Polyvinyl Chloride (PVC):

- Sheathing for electrical cables
- Floor and wall coverings
- Siding
- Automobile instrument panels

b. Thermosetting:

Thermosetting plastic cannot be reused. They require great pressure and momentary heat during molding and finally get hardened on cooling. The chemical reaction in this process cannot be reversed. Once solidified they cannot be softened. The thermosetting plastics acquire cross-linked structure with predominantly strong covalent bonds during polymerization retaining strength even on heating; under prolonged heating they fail by charring. Compared to thermoplastics, they are hard, strong and more brittle



Thermoplastics comprised of

Polyester, Vulcanized rubber, Polyimides, Epoxy resin, Melamine resin, Bakelite etc.

Some examples of thermoset plastics and their product applications are:

Polyurethanes:

• Mattresses

• Cushions

• Insulation

Unsaturated Polyesters:

• Boat hulls

• Bath tubs and shower stalls

• Furniture

Epoxies:

• Adhesive glues

• Coating for electrical devices

• Helicopter and jet engine blades

Phenol Formaldehyde:

• Oriented strand board

• Plywood

• Electrical appliances

• Electrical circuit boards and switches

COMMON PLASTICS AND USES

- Polyester (PES) – Fibers, textiles
- Polyethylene terephthalate (PET) – Carbonated drinks bottles, peanut butter jars, plastic film, microwavable packaging
- Polyethylene (PE) – Wide range of inexpensive uses including supermarket bags, plastic bottles
- High-density polyethylene (HDPE) – Detergent bottles, milk jugs, and molded plastic cases
- Polyvinyl chloride (PVC) – Plumbing pipes and guttering, shower curtains, window frames, flooring
- Poly vinylidene chloride (PVDC) – Food packaging, such as Saran

- Low-density polyethylene (LDPE) – Outdoor furniture, siding, floor tiles, shower curtains, clamshell packaging
- Polypropylene (PP) – Bottle caps, drinking straws, yogurt containers, appliances, car fenders (bumpers), plastic pressure pipe systems
- Polystyrene (PS) – Foam peanuts, food containers, plastic tableware, disposable cups, plates, cutlery, compact-disc (CD) and cassette boxes
- High impact polystyrene (HIPS) – Refrigerator liners, food packaging, vending cups
- Polyamides (PA) (Nylons) – Fibers, toothbrush bristles, tubing, fishing line, low-strength machine parts such as engine parts or gun frames

PROPERTIES OF PLASTICS

i. Plastics are very light in weight.
ii. Plastics have a low thermal conductivity.
iii. Plastics have generally low electrical conductivity.
iv. Plastics have great resistance to moisture and provide impermeable films for moisture barriers.
v. These are easy to work upon.
vi. Plastics are available in a wide range of colors and shades.
vii. Plastics can be transparent, translucent or opaque.
viii. Plastics offer good resistance to attack by organic acids, bases, salts and living organisms.
ix. Plastics are slow burning, self-extinguishing or even non-inflammable.
x. Plastics are available in a very wide range of properties to suit the needs of different applications.
xi. Plastics can be formed or molded into any shape.
xii. Plastics can be cast, molded, extruded, sawn, machined, riveted, welded or glue.
xiii. Plastics are rust proof.
xiv. Plastics can be reused after reprocessing.
xv. They have dimensional stability.
xvi. Plastics are cheap due to their light weight, adaptability, low maintenance and have aesthetic value.
xvii. These have good sound and heat absorption properties.
xviii. These are easy to install.

CONSTITUENTS OF PLASTICS

The constituents of plastics are resin, plasticizer, filler, pigment and dye, lubricant and catalyst.

1. **Resin** acts as binder for holding different constituents together.

2. **Plasticizer** modifies plastic to impart desirable combination of strength, flexibility and toughness. Plasticizers, which are mostly liquids, are usually organic compounds or resins. Their addition is particularly necessary when the softening temperature of a resin is too high. Some of the examples of plasticizers are vegetable oils, camphor, esters of stearic and oleic acids, tri butyl phosphate, tetra butyl phosphate and tri phenyl phosphate.
3. **Filler** is added up to 50 per cent of the molding mixture to increase the hardness, tensile strength, bond, opacity, finish and workability besides reducing the cost, shrinkage on setting, and brittleness of the final product. Some of the fillers are wood flour, asbestos fibers, mica, saw dust, ground cork, paper pulp, corn husk, carbon black, cotton fiber etc.
4. **Pigment** is added to achieve desired color of the plastic and should be resistant to the action of sunlight.
5. **Lubricant** is used to make the molding of plastic easier to prevent sticking of materials to the mould for a flawless finish e.g. soaps.
6. **Catalyst** is added only in the case of thermosetting plastics to accelerate the polymerization of fusible resin during molding operation into cross-linked infusible form.

FABRICATION OF COMMERCIAL ARTICLES FROM PLASTICS/MANFACTURING

Depending upon the shape, size and thickness of the finished product and the quality of resin used, one of the following methods may be used in fabricating commercial articles from plastic:

CASTING

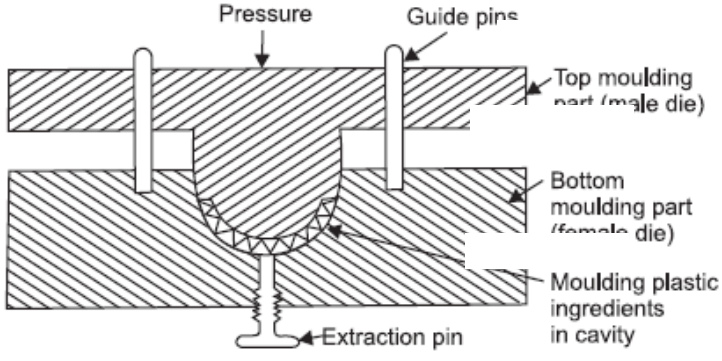
Molten raw material is cast into molds. Zinc, wooden, steel, or plaster of Paris molds are used for the purpose. Product obtained is smoothened by polishing.

MOULDING

Plastic can be molded into finished products by adopting any one of the following procedures.

- **COMPRESSION MOULDING**

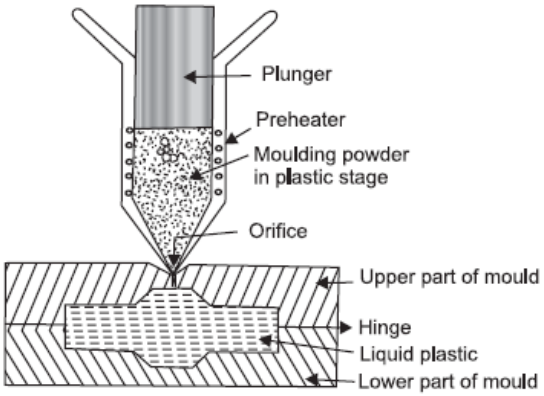
In this process the raw material is placed in the mould cavity and both parts of the mould are subjected to high pressure along with the simultaneous heating of the mould. Pin in upper part of the mould when inserted in corresponding hole in lower part of the mould help the two parts of the die to take the correct relative position.



The raw material on becoming soft due to heat forces into air areas of the cavity because of applied pressure. The temperature and the pressure are continued to be applied till the chemical changes have taken place. The two parts of the die ore then separated and the molded article is taken out for cooling.

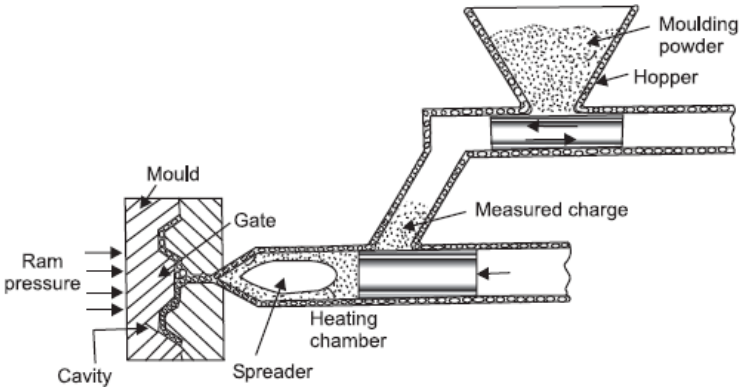
- **TRANSFER MOULDING.**

It consists in passing the molten material into the molds and then it is subjected to pressure so that it reaches all recesses in the mould. The pressure is continued till the chemical changes have taken place. The molded article is then taken out of the mould. Complex machine parts made, of thermosetting plastics are molded by this process.



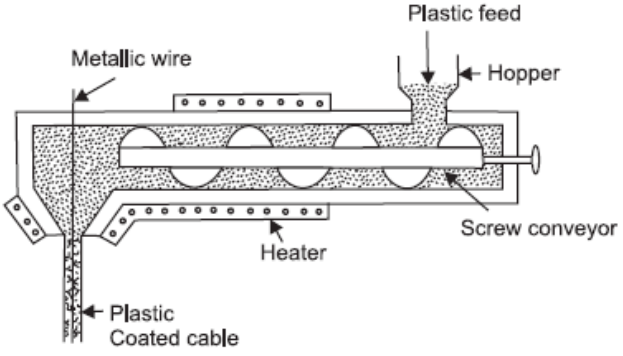
- **INJECTION MOULDING**

The raw material is fed into a tube which is heated by a heating element surrounding the tube when the plastic has liquefied then the same is pushed out of a nozzle by pushing the plunger with force. The liquefied raw material passes from the nozzle into the entire cavity provided for in the cold mould. The molded article is removed out of the mould and the process repeated. It is a quick method used for molding thermoplastics.



EXTRUSION

The raw material is fed into a hopper which is then propelled onwards by a rotating screw. The tube wherein the screw rotates is covered with a heating element because of the heat of which the raw material melts. The molten raw material is forced out of a notch having the shape of the finished product needed. Thermoplastic rods and



tubes are extruded through dies. If, however, something is to be provided with the plastic covering like insulation of electric wires and cables then the same is drawn through a die.

LAMINATION

In it thin sheets of paper, cloth, wood, glass fiber or asbestos are impregnated with thermosetting resin and passed through rollers, thereby subjecting them to heavy pressures. These sheets under the effect of pressure and temperature are bonded, together and form sheets of varying thicknesses. The laminates are extensively used for ornamental and decorative purposes.

BLOWING OF THERMOPLASTIC

The process is similar to blowing of molten glass and is used for fast and cheap production. This can be done manually or by automatic and semiautomatic machines.

MACHINING AND CEMENTING

Plastic sheets, rods and tubes can be machined with ordinary lathe machines to obtain the desired shape and size. These can also be cemented or riveted with suitable glues and riveting materials. Thermoplastics can also be welded by using certain solvents.

USES OF PLASTICS IN BUILDING CONSTRUCTION

Plastics have innumerable applications either to substitute or protect other building materials, or to improve the comfort conditions. However, because of relatively low stiffness they are not used as primary load bearing materials. Some of the uses of plastics are as follows.

i. Roofing

Corrugated sheets of phenolic resin bonded paper laminates manufactured in rather darker shades provide light, strong and corrosion resistant opaque roofing material. Corrugated plain or curved sheets in glass reinforced polyester resin, or of Acrylic resin are translucent and when used for roofing they provide ample day light. These sheets are resistant to weathering, are strong and light in weight.

ii. Wall Facing Tiles

Polystyrene tiles have excellent water proofing properties and are used for bathrooms, kitchens, lavatories, swimming pools and facing tiles.

iii. Flooring Tiles

Polyvinyl chloride synthetic resins used for floor tiles are nonabsorbent, resistant to abrasion, wear and tear.

iv. Flooring Sheets

Mastics, prepared from synthetic resins such as polyvinyl acetate with suitable plasticizers form decorative linoleum floor coverings.

v. Water Proofing Membranes

Polythene and polyvinyl resins with suitable fillers and plasticizers, oils and anti pyrene compounds are used to make films which have high elastic strength rupture value and acid resisting properties. These films are used for damp proofing courses, covering of concrete for curing, temporary protection from rain and wind.

vi. Pipes and Sanitary Appliances

Polythene, polypropylene and polyvinyl chloride are used for making pipes and sanitary wares and fittings.

vii. Walls

In walls the use of structural insulated panels made with expanded polystyrene can help homeowners to reduce heating and cooling costs.

viii. Windows

Poly carbonate a material used in eye glasses is used in windows. These light weight, shatter resistant plastic products have low thermal conductivity, and which can help to reduce heating and cooling cost.