

Plastic Processing:

i) Modifying polymers:

Polymers are initially produced as powders, granules or laces (like straws). However they are seldom used in their pure form but are changed by adding other materials to give them their special properties. For example, they may need to be resistant to sunlight, or very flexible or cheap. By using different types of additive the properties of the base polymer may be modified in very many different ways so that the range of use of the base polymer is extended. Some of the possible additives are:

Blowing agents.

Many plastics products are cellular in structure. If you look at them closely they look like a chocolate Aero bar. These expanded or foamed products can be made from base polymers by the addition of what are known as 'blowing agents'. This is done in the moulding process by adding a filler, which foams throughout the hot polymer filling it with bubbles. A good example of this is expanded polystyrene.

Colourants.

Plastics can be coloured by using either dyes or pigments. Dyes give transparent colours and pigments give opaque ones. A very wide range of colours can be obtained from clear to opaque black with a naturally clear material such as acrylic.

Fillers.

The term 'filler' is a name given to a range of materials that are added to polymers in order to modify their properties. They may also be added to a base polymer to lower the manufacturing cost of a product made from it. A good example of this is one of the first examples of the use of fillers, adding wood flour to phenol formaldehyde.

Protective agents.

Many plastics are degraded by heat and light, especially from the ultra violet light in sunlight. You may have seen evidence of this by plastics being 'bleached' by the sun. Adding protective agents will stop this. A special form of polyvinyl chloride is called UPVC, which is used in the manufacture of drainpipes so that the pipes do not degrade in the sunshine.

Impact modifiers.

Some plastics are designed to have great impact strength; the ABS used in the manufacture of car bumpers for example. Impact modifiers are polymers that when added to other polymers improve the impact resistance of a product.

Impact modifiers, based on acrylic polymers, are used in conjunction with PVC in order to get clear rigid bottles with good impact strength.

Lubricants.

These additives are widely used to help plastics flow in moulds. They are usually waxy materials that act by reducing the stickiness of the plastic on the mould surface.

Plasticisers.

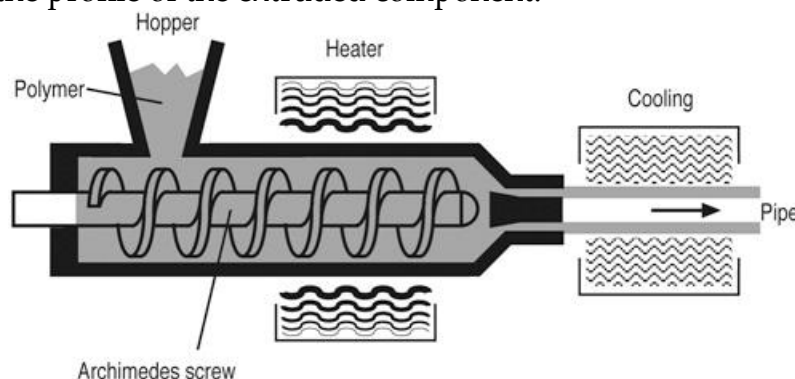
Plasticisers, such as dioctylphthalate are added to polymers in order to make the resulting materials more flexible. They make plastics more plastic. Plasticisers can change unplasticised polyvinyl chloride (UPVC) from a hard, rigid material suitable for drainpipes into a soft, flexible material suitable for upholstery.

ii) Plastic Processing:

Because of the properties of polymers it is possible to mould them and change their shape using a number of different repetitious manufacturing processes. The most important of these are extrusion, injection moulding, blow moulding, vacuum forming, extrusion blow moulding, rotational moulding, calendaring, foaming and compression moulding.

Extrusion.

Extrusion is a process that can be compared to squeezing toothpaste out of a tube. Thermoplastic granules are forced through a heated barrel and the fused polymer is then squeezed through a die that is the profile of the extruded component.



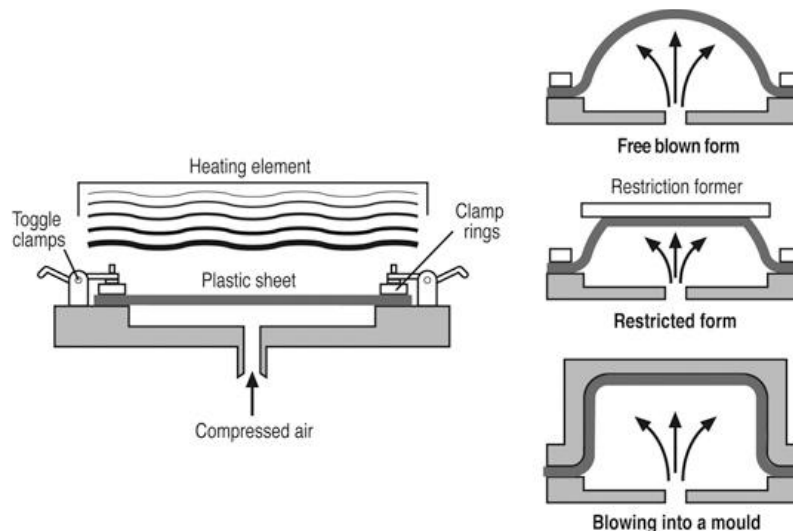
Extruding a pipe

The extrusion is cooled by water or air as it leaves the die and is finally cut to the required length. The shape of the die can be varied from a simple hole with a centrally supported core to produce tubes such as pipes, to very complex sections for curtain tracks or hollow window frames.

Blow moulding.

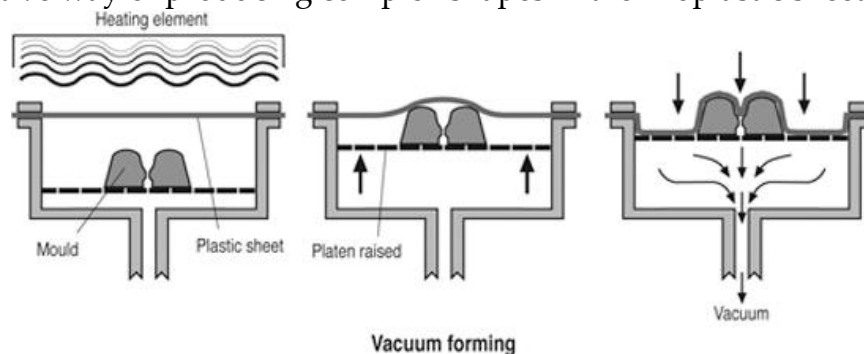
Blow moulding is a simple process where compressed air is introduced underneath a warmed sheet of thermoplastic material forcing the material into a mould cavity, or allowing it to expand freely into the shape of a hemisphere.

It is a good way of forming large domes, which when made out of clear acrylic sheet are often used in shop displays.



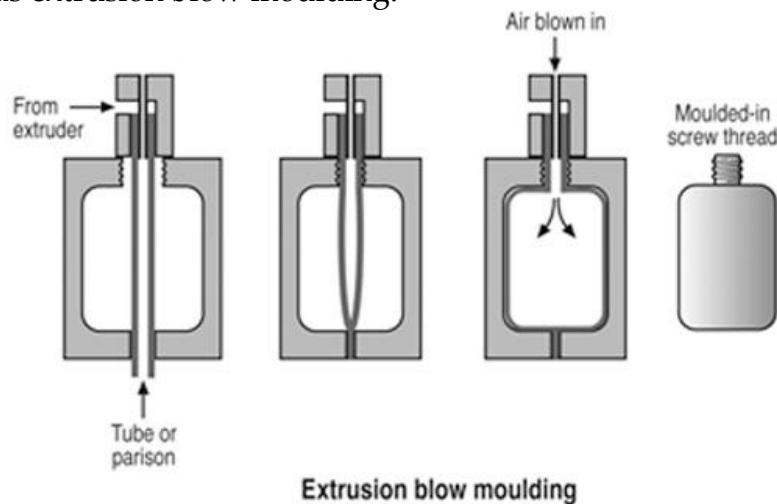
Vacuum forming.

This is a very common manufacturing process used, for example, to make a range of plastics packaging. Think of the boxes sandwiches come in, or the inner in a chocolate box, or your acrylic bath. It is really the opposite of blow moulding. Instead of the warmed plastic sheet being forced into a mould by air pressure, in vacuum forming the air is drawn out from under the softened plastic sheet, so it is forced over or into a mould by atmospheric pressure. Vacuum forming is a very common and effective way of producing complex shapes in thermoplastic sheeting.



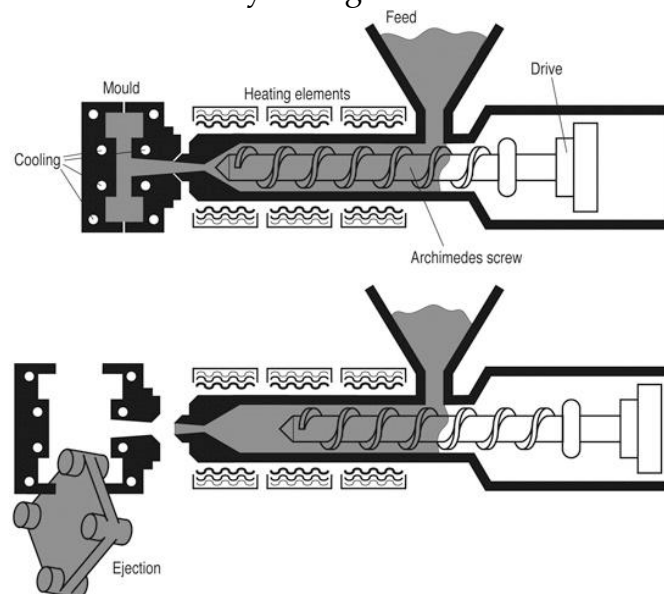
Extrusion blow moulding.

This is a combination of extrusion and blow moulding and is often used where the article to be made has a narrow neck, such as a bottle. The plastic material is first extruded as a tube shape into an open die. The die is then closed to seal the ends of the tube and air is blown in forcing the plastic tube to take up the shape of the die cavity. As the material is extruded first and then blow moulded, the process is known as extrusion blow moulding.



Injection Moulding.

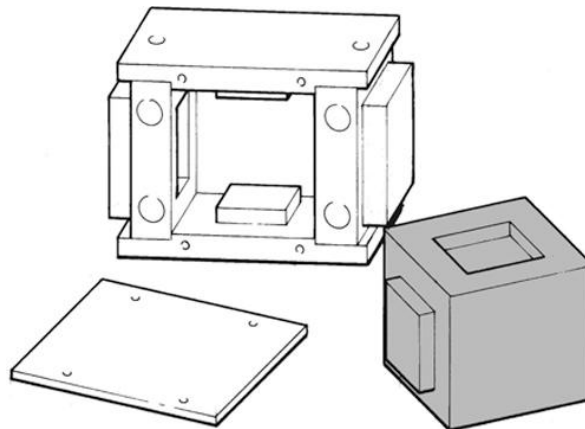
This process is one of the most common of all plastics manufacturing processes. The polymer, in granule form, is heated until fused and forced into a closed mould. Because of the viscous (thick, syrupy) nature of the fused polymer, very high pressures are needed to make it flow, which means that the machine and mould have to be very strong to withstand the forces involved.



A typical industrial injection moulding machine uses a screw to force the granules along a heated barrel, and when the granules become fused the screw is used as a plunger to force the polymer into the mould. The moulds are usually made from high-grade steel to withstand the forces involved and must also be highly polished to produce a very good finish on the product, as any scratches will show up in the moulded plastic surface. Because of the ability of the plastic to show even the smallest of marks very fine detail can be cut into the surface of the mould, for example in the form of trademarks, lettering or textures.

Rotational Moulding.

Rotational moulding is used to produce hollow thermoplastic products such as drums, storage tanks and litterbins. A carefully calculated amount of plastic is placed in a closed mould that is heated in an oven and rotated slowly around both a vertical and horizontal axes. The plastic material fuses and sticks to the hot mould surface, building up the required thickness. The mould is then gradually cooled by air or water while still rotating. The mould is opened, the finished product removed and the mould reloaded and closed for the next cycle. The time it takes to make one of the product is known as the product's cycle time.



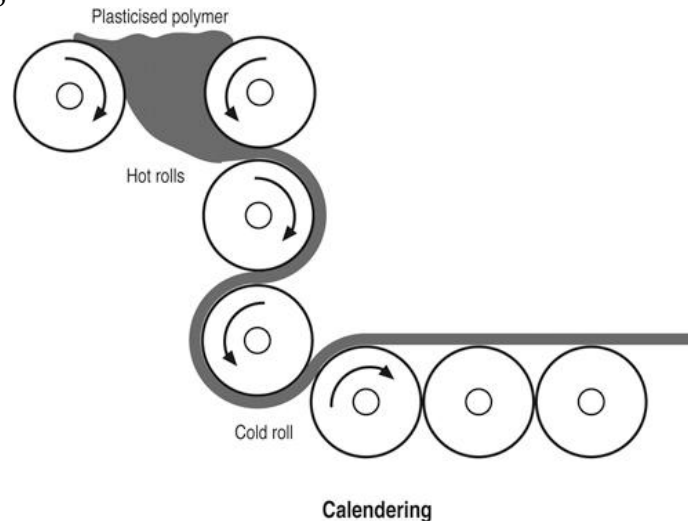
Foaming.

Plastic foams used in packaging and the upholstery industry can be produced by using blowing agents that are mixed with the base polymer. When heated these agents release gas which form bubbles in the plastic. Another method is to inject compressed nitrogen gas into molten plastics during the moulding process. A third method is to freeze a gas within the plastics granules which then expands due in the heat of the moulding process.

Calendering.

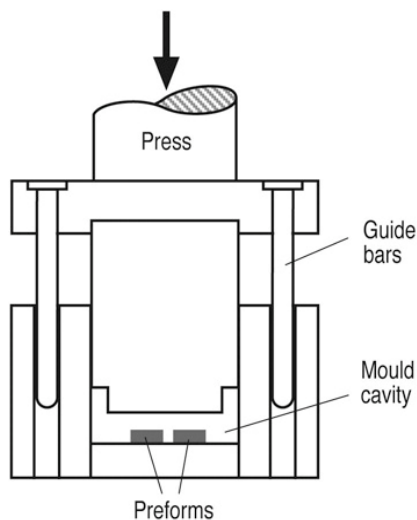
Calendering is used to produce plastic sheeting and products such as floor tiles, coated fabrics and coverings for car interiors. Fused thermoplastic is extruded on to heated rotating rollers that

squeeze the material into a continuous sheet or film. The film is cooled by jets of air or water, before being cut to suitable lengths or loaded onto rolls.



Compression moulding.

Compression moulding is one of the oldest manufacturing technologies associated with plastics and was used in 1854, for example, by Samuel Peck to make picture frames from shellac mixed with wood flour. The process is almost always used with thermosetting plastics. A carefully weighed amount of thermosetting polymer is placed into a preheated lower mould cavity. The mould is then closed by the placing of the upper half and subjected to further heat, and pressure provided by a press, often of several hundred tons capacity. The pressure and heat causes polymerisation and the flow of the plasticised material within the mould.



Raw thermoplastic materials containing fillers may be compressed whilst cold into small blocks of predetermined weight called preforms. Using preforms in compression moulds saves having to weigh out powdered material each time the mould is filled and decreases the cycle time, as the preforms may be preheated.

A development of compression moulding is transfer moulding. In this process the thermosetting polymer is first loaded into a heating chamber above the mould cavity and allowed to polymerise. It is then squeezed through channels into the mould cavity by the action of a powerful press. Transfer moulding is used when complex mouldings are required and the polymer needs to flow quickly around the mould cavity.

Many plastic articles have metal parts included within them during the moulding process. These metal parts are called inserts, and may, for example, be in the form of captive nuts used in conjunction with bolts to hold other parts of the final product assembly. The inserts are placed in recesses in the lower mould either by hand or by using loading jigs before the polymer is introduced into the mould. Compression and transfer moulding are manufacturing techniques that lend themselves to the inclusion of moulded inserts. When inserts are used the technique is often termed insert moulding.