

## 5.5 Processing of Thermoplastic Plastics

- There are so many forms of raw materials for processing of plastics into final product.
- The commonly used forms are pellets, sheet, powder, rod, tubing, etc.
- Generally liquid plastics are used in the fabrication of reinforced-plastic parts.
- Thermoplastics can be processed to their final size and shape with the help of following processes:
  1. Injection moulding (plunger and screw type)
  2. Blow moulding
  3. Thermoforming
  4. Extrusion
  5. Rotational moulding

### 5.5.1. Injection Moulding

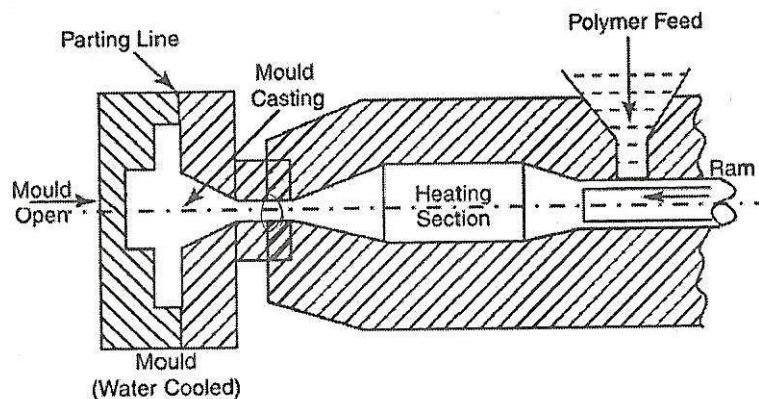
#### Working principle

The injection moulding is used to achieve high speed moulding of thermoplastics. The working principle of this process is that the molten thermoplastic is injected into a mould under high pressure. For achieving high pressure, the plunger system is used.

#### Operation

The moulding material is loaded into a hopper from which it is transferred to a heating section by a feeding device where the temperature is raised to from 150°C to 370°C. The material melts and is forced by an injection ram or by plunger through a nozzle and sprue in a closed mould which forms the part. There are two types of injection moulding and it is given below.

#### 5.5.1.1 Ram or plunger type injection moulding



**Figure 5.4 Ram or plunger type injection moulding machine**

The ram and plunger type injection moulding has two units.

1. Injection unit, and
2. Clamping unit.

So, it may be split in order to eject the finished component.

Initially, the polymer is filled in a hopper. Then, it goes to the heating section where the polymer is melted and the pressure is increased. The heated material is injected by the ram

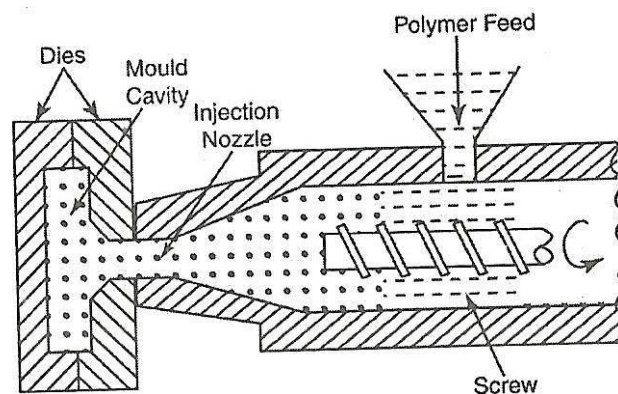
under pressure. So, the heated material is forced to fill in the mould cavity through the nozzle to get the required shape of the plastics. Here, the mould is water-cooled type.

### 5.5.1.2 Screw Type Injection Moulding

In this type also, there are two units to split and eject the finished component such as

1. Injection unit, and
2. Clamping unit.

The injection unit has hopper, screw, and heating section. In clamping section, it has mould. In a screw type moulding machine, the pellets are initially fed into the hopper. The resins are pushed along with the heated reciprocating screw. The screw is moved forward to force the plastic material into the mould. The screw itself is moving backwards and allowing the accumulation of enough material to fill the mould. The rotation of the screw provides the plasticizing action by shearing the frictional effects. The axial motion of the screw provides the filling action. The jet moulding process is used to find the problems occurred in injection moulding process. The reaction moulding is the recent development in injection moulding. In reaction moulding, the low viscosity monomers are used in the mould. A chemical reaction takes place between resins at low temperature and a polymer is created.



**Figure 5.5 Screw Type Injection Moulding machine**

In jet moulding, the plastic is preheated about 93°C in the cylinder surrounding the nozzle. The reaction moulding is suitable for the production of polyurethane moulding. The injection capacity of injection moulding machines ranges from 12,000mm<sup>3</sup> to 2.2 x 10<sup>6</sup>mm<sup>3</sup>.

#### Advantages of injection moulding

1. High production capacity and less material losses are possible.
2. The cost is low and it needs less finishing operation.
3. It is used for making complex threads and thin walled parts.
4. Accuracy becomes  $\pm 0.025$ mm.
5. Wide range of shapes can be moulded.

## Applications

1. It is used in making parts of complex threads.
2. Intricate shapes such as thin walled parts can be produced.
3. Typical parts such as cups, containers, tool handles, toys, handles, toys, knobs and plumbing fittings can be produced.
4. Electrical and communication components such as telephone receivers can be produced.

## Limitation

1. Equipment of cylinder and die should be non-corrosive.
2. The reliable temperature controls are essential.

### 5.5.2 Blow Moulding

It is a moulding process in which air pressure is used to inflate soft plastic into a mould cavity. It is used to make hollow, seamless parts with thin walls like bottles, containers, etc. from thermoplastic polymers. Blow moulding is performed in two steps:

- i. Fabrication of a starting tube of molten plastic which is called as parison.
- ii. Inflation of the tube to the required final shape.

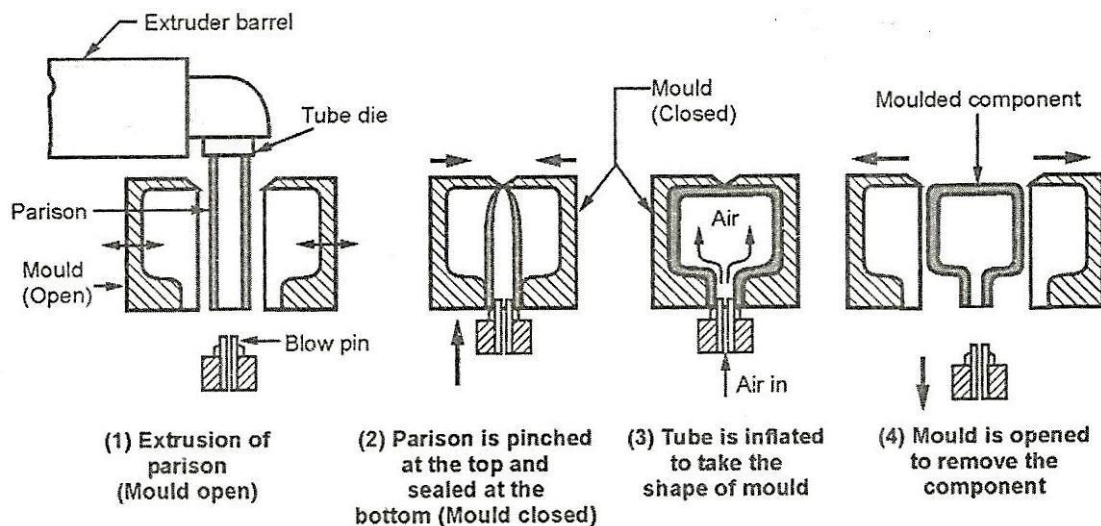
The forming of parison is carried out either by extrusion or by injection moulding. According to the forming of parison the blow moulding process can be classified as follows:

a) Extrusion blow moulding

b) Injection blow moulding

#### 5.5.2.1 Extrusion blow moulding

- Blow moulding consists of extrusion of the heated tubular plastic piece called as Parison which is transferred to the two piece mould, Refer Figure 5.6.



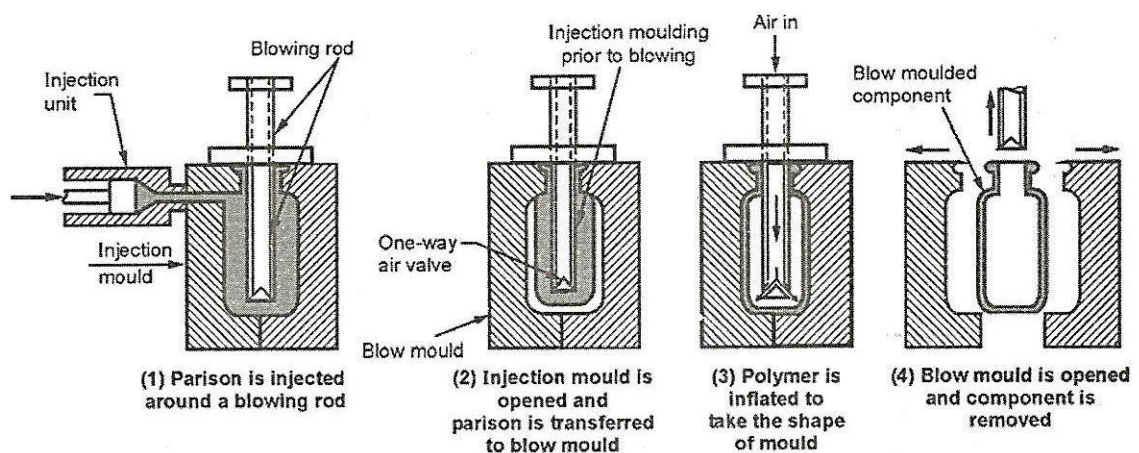
**Figure 5.6. Extrusion blow moulding**

- The parison is gripped between two-piece mould and its bottom end is sealed.
- Then, air is injected into the parison to force the plastic against the walls of the water-cooled mould.

- The pressure air is about 400 to 800 kPa.
- As the formed components cools, the mould is opened and the part is removed.
- This operation is similar to that used for forming bottles in glass industry.
- Polyethylene, polypropylene and cellulose acetate are some of the plastics that can be formed by blow moulding.

### 5.5.2.2 Injection blow moulding

- The working principle of injection blow moulding is similar to extrusion blow moulding.
- The only difference is that, in the injection blow moulding the starting parison is injection moulded rather than extruded. Refer Figure 5.7.



**Figure 5.7 Injection Blow Moulding**

- The main limitation of the injection blow moulding is that, the rate of production is low as compared to extrusion blow moulding.
- Due to this limitation, this method of blow moulding is rarely used.

### Advantages of blow moulding

- Initial cost of mould is low.
- Tool flexibility i.e. moulds can accommodate interchangeable neck finishes and body sections.
- Production flexibility i.e. neck inner diameters can be easily controlled to varying requirements. Bottle weights are adjustable.
- There is no restriction of container shape i.e. bottles can be long and flat or have handles.

### Applications of blow moulding

- Blow moulding process is mainly used for making cosmetic packaging, food and water bottles, pipes, floats, toys, doll bodies and many other articles.