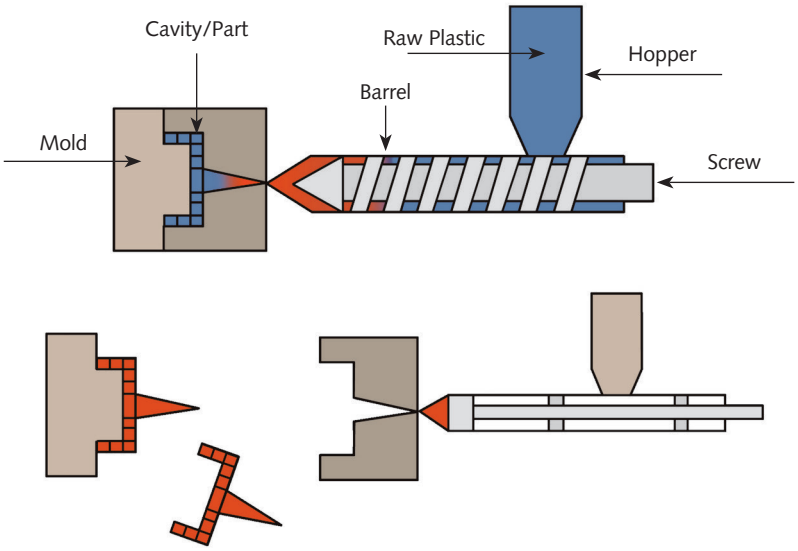
Forming processes on plastic

Polymers are widely used in engineering for the rapidity and flexibility of the shaping operations they can be subjected to. The main forming processes on plastics are: **injection moulding**, **extrusion moulding** and **blow moulding**. All processes include the same steps: a) heating the polymer into the molten state; b) pumping the melt into the forming unit; c) forming the melt into the required shape; d) cooling and solidification.

Injection moulding

It can be applied to both thermoplastic and thermosetting polymers. It entails forcing molten plastic into a cold **mould** and shaping it. For this purpose, a **hopper** must be filled with raw plastic pellets which are then conveyed into a heated **barrel** for melting. The barrel contains a reciprocating extruder **screw** that first rotates to soften, homogenise and pressurise the polymer to melt it, then stops rotating and acts as a piston, moving forward to inject the melted plastic into the mould. The plastic in the mould is then gently cooled (thermoplastics) or reheated to cure (thermosettings) and then finally the mould is opened and the plastic part is ejected out of it, in the configuration of the mould cavity.

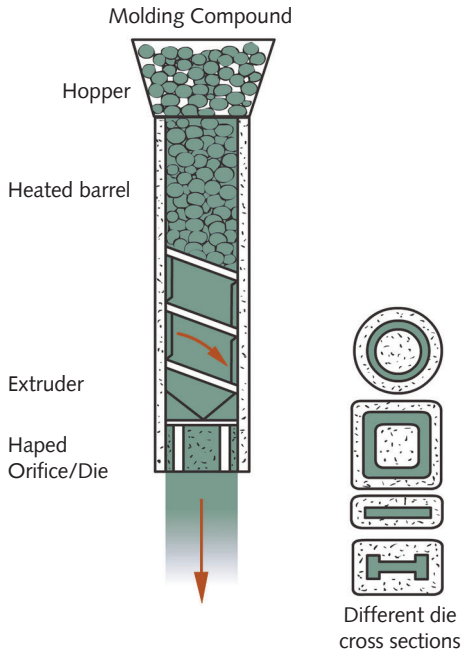


This forming process has relatively low operational costs, no finishing problems, great flexibility, repeatability and high precision. To raise the margin profit of injection moulding, **time** and **consistency** must be taken into consideration. The processing cycle must be relatively fast and produce the highest possible output and, therefore, multiple cavity moulds are employed to produce more than one part each time the moulding cycle is carried out. As regards consistency, it requires the careful analysis of four main interdependent variables: temperature and pressure of plastic in the mould, its filling rate in the mould and, finally, the cooling conditions.

barrel: *serbatoio*
bathtub: *vasca da bagno*
blow moulding: *stampaggio per soffiatura*
to carry out: *eseguire*
to conform: *conformarsi*
consistency: *coerenza nell'esecuzione*
to convey: *trasmettere, convogliare*
to cure: *vulcanizzare*
to drop: *cadere, lasciare cadere*
to employ: *impiegare*
extruder screw: *estrusore a vite*
finishing: *rifinitura*
hollow: *vuoto, cavo*
hopper: *contenitore*
hull: *scafo*
inflation: *gonfiaggio*
laundry detergent: *detersivo*
mould: *stampo*
parison: *stampo formatore*
pellet: *pallina*
rimming: *bordatura*
sheet: *foglio*
shower stall: *cabina doccia*
trimming: *guarnizione*
vacuum: *sottovuoto*

Extrusion moulding

It is used for shaping products with a constant cross-section such as tubes, optical fibres or insulated wires for electrical use. It is applied to thermoplastics in the form of pellets or granules which are first held in a hopper and then delivered to the heated barrel for melting. A rotating helical extender inside the barrel forces the melt through a die placed at the end of the machine. It is usually a steel die whose cross section has the shape of the required part. As the molten plastic flows out of the die, the material is cooled and cut as required. Extrusion has low initial manufacturing costs but it does not have a particularly high production speed, precision or a wide usage because it is limited to parts with a uniform cross section.



Blow moulding

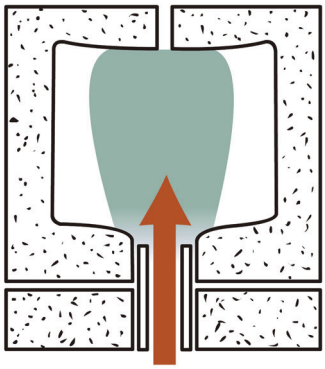
It is the technology applied for manufacturing hollow one-piece plastic objects, such as bottles, jars, or fuel oil tanks. It is used extensively in the automotive sector, electronics, furniture, medical equipment and sporting goods. Compressed air is used to expand hot plastic against the internal surface of a mould to make it adhere and take its shape. Two main types of blow moulding can be distinguished: extrusion blow moulding and injection blow moulding; both of them include four main phases: heating, moulding, inflation, and cooling.

- **Extrusion blow moulding** is the oldest and most commonly applied method. It has low initial costs, fast setup to start production and is quite simple to carry out. Its precision is limited and it is particularly suitable for large container shapes such as milk jugs, food containers or laundry detergent bottles. It also offers moderate flexibility (it is limited to hollow parts) and mediocre production speed.

1. First the plastic material is heated to about 400 degrees to reach its molten state and then extruded into a hollow tube called a **parison**.

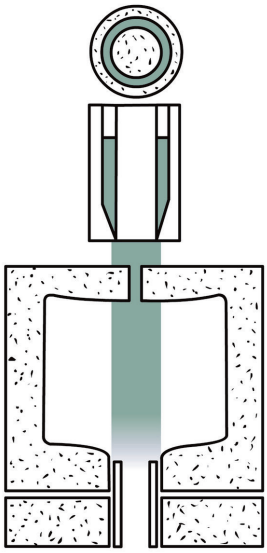
2. The warm extruded parison is dropped into a **mould** whose interior cavity will finally determine the shape of the required object. The mould is cooled with water.

3. At this point of the process, **inflation** starts: compressed air is blown into the mould filling the centre of the parison tube and forcing its sides to expand and conform to the inner shape of the mould. The parison is still warm and thus it can expand without breaking but when it meets the cold wall of the mould, it freezes and becomes rigid.



4. Finally, the parison is **cooled** inside the mould, solidifies definitively and can be removed from the mould. Rimming and trimming are carried out.

- **Injectison blow moulding** combines injection moulding and blow moulding. It offers higher precision and faster production speed than extrusion blow moulding but its initial setup costs are higher: two moulds are employed in each moulding cycle and it may take longer to start production. It is limited to hollow parts of small containers with simple shapes.



1 PAIR WORK Take turns to answer the following questions.

1. Why are polymers widely employed in engineering?
2. Which steps do shaping processes of plastics include?
3. What kind of polymers can injection moulding be applied to?
4. What is a hopper for?
5. What happens in the barrel?
6. Are there different final treatments for the polymers in the mould?
7. What are the advantages of injection moulding?
8. What are the most important factors for successful injection moulding processes?

2 Complete the sentences.

1. Blow moulding is used for .....
2. In blow moulding, hot plastic is formed by .....
3. This shaping method follows four main phases: .....
   .....
4. To carry out extrusion blow moulding, first you need ....., then ....., and finally .....

3 Decide if the statements are true or false and correct the false ones.

	T	F
1. Extrusion is outdated.	☐	☐
2. Extrusion is employed for producing a tube-like continuous work.	☐	☐
3. Plumbing pipes or optical fibres are produced through blow moulding.	☐	☐
4. Blow moulding is used in the production of hollow plastic objects.	☐	☐
5. Injection blow moulding relies on two moulds.	☐	☐

4 Refer back to the text and complete the table.

Forming processes	Applications	Advantages	Disadvantages
Extrusion			
Blow moulding		Extrusion blow moulding: Injection blow moulding:	Extrusion blow moulding: Injection blow moulding:

THERMOFORMING

Thermoforming involves operating with sheets of thermoplastic polymers to make them become very flexible. It allows the production of various objects, such as bathtubs, shower stalls and boat hulls but also smaller items like blister packs for pills. It has low initial setup and production costs but no high precision or flexibility. The sheets of polymers are heated differently according to their type and thickness and are moulded using various methods. In **vacuum thermoforming** the heated sheet is made to adhere to a concave mould shape with vacuum pressure. In **pressure thermoforming** a convex mould shape is employed and the sheet is pressed down on it while **mechanical thermoforming** uses a combination of the two moulds and presses the sheet between them (the product is moulded on both sides).