Common Plastic Production Processing
MAE 250L
Common Plastic Production Processing

- Extrusion
- Injection Moulding
- Blow Moulding
- Vacuum Forming
- Compression Moulding
- Rotational Moulding
Extrusion
**Extrusion**

Continuous process used to produce both solid and hollow products that have a constant cross-section. E.g. window frames, hose pipe, curtain track, garden trellis.

Thermoplastic granules are fed from a hopper by a rotating screw (auger) through a heated cylinder.

The tapered screw compacts the plastic as it becomes heated and elasticised. The die which is fitted to the end of the extruder barrel determines the cross-section of the extrusion.

Thicker cross-sections are extruded more slowly as more time is required for the initial heating and subsequent cooling of the larger quantities of material which are involved. As the extrusion leaves the die it is cooled by passing through a cooling trough (below) containing cold water.
Extrusion

- Produces tubes, rods and other shaped continuous form lengths.
- Heated polymer is fed into shaped die by a screw.
Materials used in Extrusion

This extrusion is part of a window seal made from thermoplastic elastomer (TPE).

Typical extruded plastic parts.
Common extruded products

pipe/tubing, weatherstripping, fencing, deck railings, window frames, plastic films and sheeting, thermoplastic coatings, and wire insulation…
Common Extruded Plastic Materials

Polyethylene (PE), Polypropylene, Acetal (Delrin), Acrylic (plexiglass), Nylon (polyamides), Polystyrene, PolyVinyl Chloride (PVC), Acrylonitrile Butadiene Styrene (ABS), Polycarbonate
Injection Moulding Video

Injection Moulding

Powder or granules from a hopper feed into a steel barrel with a rotating screw. The barrel is surrounded by heaters. The screw is forced back as plastic collects at the end of the barrel.

Once a sufficient charge of melted plastic has accumulated a hydraulic ram forces the screw forward injecting the thermoplastic through a sprue into the mould cavity.
Thermoplastic resin pellets for injection moulding.
Injection Moulding

Pressure is kept on the mould until the plastic has cooled sufficiently for the mould to be opened and the component ejected.

Materials used

Normally thermoplastics are used in this process although a few thermosetting plastics can also be injection moulded.

Toy made from high impact polystyrene (HIPS).
Standard two plates tooling – core and cavity are inserts in a mould base.
Feed screw filled
Polymer Injection
Component Ejected

- mould
- hopper
- heater
- hydraulic system
- motor
Injection Moulding

- A measured amount of molten thermoplastic is driven by a ram past a heating system into the mould.
- The mould is split to allow finished object to be removed after cooling.
Parts of Injection Moulding Machine

• A – split mould
• B – heater
• C – hopper
• D – hydraulic ram
• E – torpedo (spreader)

The function of the torpedo is to heat and melt molding material evenly using an inner heater and create back pressure for better mixing.
Simplified Diagram of the Process at the Mould

- nozzle
- charge
- sprue
- runner
- gates
- ejector pins
- parts
Injection Moulded Parts

- Sprue, runner and gates in actual injection moulding product
Materials for Injection Moulding

- Both thermoplastic and thermosetting polymers are used

Common polymers
- Epoxy
- Phenolic
- Nylon
- Polyethylene
- Polystyrene
Injection Moulding

• Injection moulding produces accurate and complex products with high quality finish.
• Production is fast with little waste.
• Wide range of products including bowls, buckets, containers, toys, electrical parts and car parts.
• Injection moulded parts can be recognised by the distinctive circular marks (5-10mm) caused by pins used to remove object from it’s mould.
1. A hollow length of plastic, called a parison, is extruded down between the two halves of the mould.

2. The mould closes.
3. Compressed air is blown into the inside of the parison which inflates it, pushing the soft plastic hard against the cold surfaces of the mould.

4. The mould is then opened the moulding ejected and the waste (called flash) is trimmed off with a knife.
Materials used in blow moulding

High density polyethylene (HDPE) and low density polyethylene (LDPE) are both commonly used for blow moulding as are other types of thermoplastics. The thermoplastic used in blow moulding needs to be more viscous (flow less easily) than that used for injection moulding as the parison must retain its form before the mould closes around it.

Used extensively to make bottles and other lightweight, hollow parts
Blow Moulding

- Used to make bottles and hollow toys.
- Air is blown into a plastic tube, called a parison, to take the shape of the mould.
- PVC and polythene are often used.
Vacuum Forming

1. Mould is attached to a platen (support plate). The platen and mould are then lowered and a rigid thermoplastic sheet material is clamped onto an air tight gasket and usually heated from above.

2. Once the thermoplastic sheet is softened enough (reaches a plastic state) then air is blown in to raise the sheet in a slight bubble before the platen is raised bringing the mould into contact with the plastic.
3. trapped air remaining between the platen and the heated plastic sheet is then evacuated by a vacuum pump. Atmospheric pressure acting over the top surface completes the forming process by pressing the plastic sheet onto the mould.

4. Once the plastic sheet has cooled down to below its freeze point the air flow is reversed to lift the forming off the mould and the mould lowered.
Materials used in Vacuum forming

Many types of thermoplastics are suitable for vacuum forming. The most popular is High Impact Polystyrene (HIPS). It is relatively cheap, comes in a wide range of colours and is easy to form. This process is used to manufacture a variety of products in thermoplastic materials. These products range in size from garden pond liners to food trays used in supermarkets.
Vacuum Forming

- Plastic sheet is clamped and heated.
- Heat is removed and pattern raised.
- Vacuum forces the sheet onto the pattern.
- The sheet is removed and trimmed.
Vacuum Formed Products

- Case tops for limited production or low-cost item
1. The mould is charged with a measured amount of powder or granules ready to be compressed. Sometimes plastic charge is first compacted into a shape called a preform.

2. When the two halves of the mould are brought together the plastic material is forced under compression to flow rapidly around the cavity. Heat from the platens causes the plastic to cure resulting in a permanent change in shape.
Compression Moulding

The component is ejected from the mould and any excess material formed at edges (flash) is removed.

**Materials used.**

Typical thermosetting plastics used in compression moulding are urea formaldehyde and phenol formaldehyde.
Compression Moulding

THE PRINCIPLE OF COMPRESSION MOULDING

- Preheated Moulding Powder
- Heated Platen
- Guide Pins
- Punch
- Die
- Measured Quantity of Moulding Powder
- Heater
- Mould Closed
- Mould Open
- Moulded Item
• Thermoset plastics are shaped with heat and pressure causing cross-linking.
• The polymer can be in powder or slug (cube) form.
• Products such as electrical fittings, saucepan handles and bottle tops are often formed out of formaldehyde plastics.
• High quality finishes are achieved with only the removal of ‘flash’ (excess material usually at the mould split) for finished products.
Transfer Moulding

Thermoset polymers can be formed when a preset amount of material is placed in a separate cavity and heated. A plunger moves the material into the shaped mould with high pressure.
Rotational Moulding

1. A measured weight of thermoplastic is placed inside a cold mould. The mould is then closed and moved into an oven chamber.

2. Heated to a temperature of 230-400 C whilst being rotated around both vertical and horizontal axes. As it rotates the mass of powder at the bottom of the mould fuses and sticks to the mould surface.
Rotational Moulding

3. the mould moves into a cooling area or chamber where it is cooled by air or water jets.

4. The hollow moulding can be removed as soon as it is cool enough to hold its shape.
Materials used

90% of rotational mouldings are made from polyethylene (PE), used mainly to manufacture hollow shaped products such as footballs, road cones and storage tanks up to 3m³ capacity.
PROCESSING PLASTICS

- Calendering – produces sheets by rolling into shape.
- Lamination – layers of materials (e.g., paper, cloth) are bonded with a resin into a strong solid structure, often with heat and pressure.
- Foaming – expansion into sponge-like material by a foaming agent.