University of Jordan
Department of Chemical Engineering
Polymers and Plastics Engineering (0905553)

6. Compression Molding

Compression moulding is one of the most common methods used to produce articles from thermosetting plastics. The process can also be used for thermoplastics but this is less common - the most familiar example is the production of LP records. The moulding operation as used for thermosets is illustrated in Fig. 4. A pre-weighed charge of partially polymerized thermoset is placed in the lower half of a heated mould and the upper half is then forced down. This causes the material to be squeezed out to take the shape of the mould. The application of the heat and pressure accelerates the polymerization of the thermoset and once the cross linking ('curing') is completed the article is solid and may be ejected while still very hot. Mould temperatures are usually in the range of 130-200^{o}C. Cycle times may be long (possibly several minutes) so it is desirable to have multi-cavity moulds to increase production rates. As a result, moulds usually have a large projected area so the closing force needed could be in the region of 100-500 tonnes to give the 7-25 MN/m^2 cavity pressure needed.

During compression moulding, the charge of material may be put into the mould either as a powder or a preformed 'cake'. In both cases the material is preheated to reduce the temperature difference between it and the mould. Typical products include electrical insulators, pot handles, and some automotive parts.

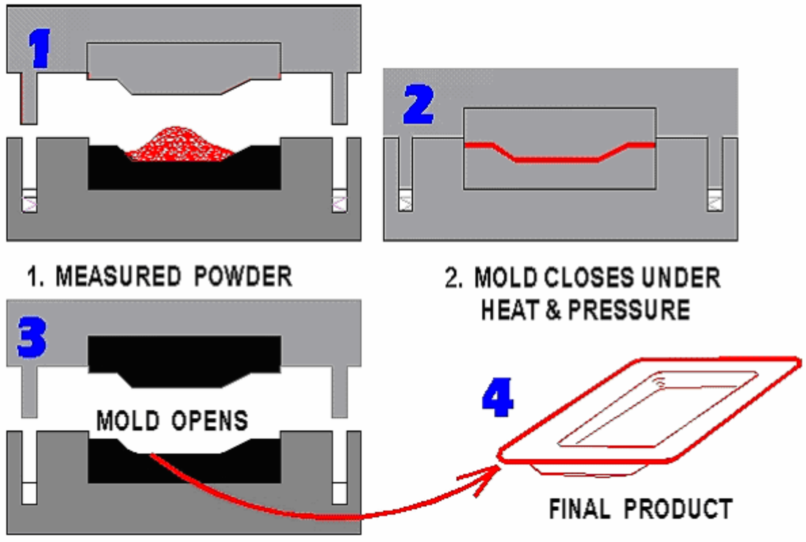

Fig. 4 Principle of compression moulding

The compaction force, F, required to produce a compression moulded disc is given by:

$$F = \frac{3\eta V^2}{8\pi t H^4}$$

Where H is the platen separation at time, t.

Example:

A circular plate with a diameter of 0.3 m is to be compression moulded from phenol formaldehyde. If the preform is cylindrical with a diameter of 50 mm and a depth of 36 mm estimate the platen force needed to produce the plate in 10 seconds. The viscosity of the phenol may he taken as 10^3 Ns/m^2.

7. Transfer Moulding

Transfer moulding is similar to compression moulding except that instead of the moulding material being pressurized in the cavity, it is pressurized in a separate chamber and then forced through an opening and into a closed mould. Transfer moulds usually have multi-cavities as shown in Fig. 5. The advantages of transfer moulding are that the preheating of the material and injection through a narrow orifice improves the temperature distribution in the material and accelerates the cross linking reaction. As a result the cycle times are reduced and there is less distortion of the mouldings. The improved flow of the material also means that more intricate shapes can he produced.

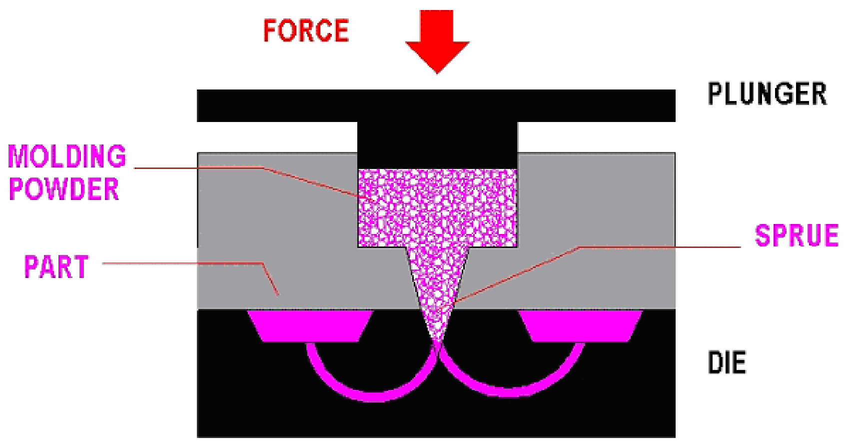

Fig. 5 Transfer moulding

8. Laminating

High pressure laminating is used to convert thermosetting materials into laminated sheets. This process incorporates high heat and pressure to "set" the polymer and bond it to reinforcing materials such as cloth, paper, wood, or fibers. While the process can be used on a variety of shapes, it is particularly common for laminated sheet production. The first step involves impregnating the reinforcing material with plastic resins which are stacked between two highly polished steel plates. Next heat and pressure (usually by a hydraulic press) is applied which causes the plastic to cure and presses the plies of materials into a single sheet. Products produced by laminating include kitchen counter tops and reinforced insulating tubes.

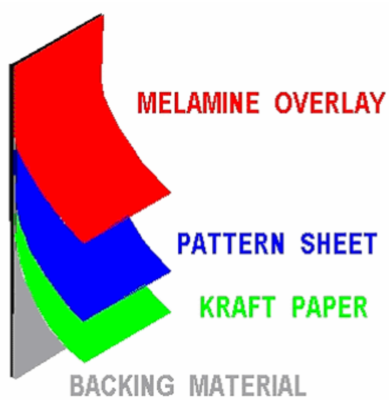

Fig. 6 Laminataing

9. Fiber Drawing

This process is a modification of extrusion and is used to produce synthetic fibers such as rayon, nylon, and polyester. The extrusion die has a small slit or is multiorificed (called a spinnerette). Small fibers are extruded through the die and then post die conditioned. These conditioning processes may be chemical treatments to harden the fiber, dye or coloring the material, or mechanical treatments for crystallization. Since molten polymers are amorphous. However it is desirable to crystallize the structure or reorient by elongation. When the polymers are about the glass temperature, they are strained or the structure oriented into linear strains. When the material is cooled below the glass temperature, the molecules will not rekink into an amorphous polymer. Thus the oriented and crystallized plastic is strong in the longitudinal direction. This does weaken the material in the lateral direction. However, since the process is for producing fibers, this is desirable if the product is made into fabric.

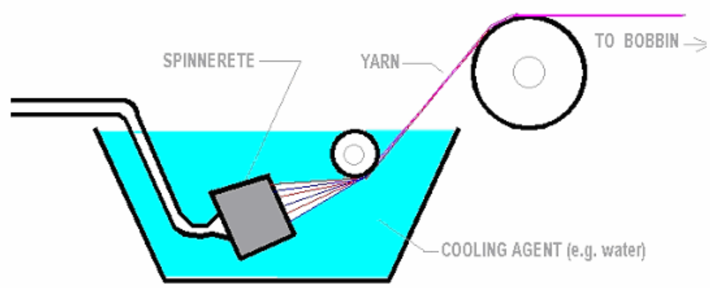

Fig. 7 Fiber drawing