CHAPTER 19

Forming and Shaping Plastics and Composite Materials
Examples of Injection Molding

Figure 19.9  Typical products made by injection molding, including examples of insert molding. 
Source: (a) Courtesy of Plainfield Molding, Inc. (b) Courtesy of Rayco Mold and Mfg. LLC.
Figure 19.14  A 2.2-MN (250-ton) injection molding machine. The tonnage is the force applied to keep the dies closed during the injection of molten plastic into the mold cavities and hold it there until the parts are cool and stiff enough to be removed from the die.  Source: Courtesy of Cincinnati Milacron, Plastics Machinery Division.
Injection Molding

Figure 19.7 Schematic illustration of injection molding with (a) plunger and (b) reciprocating rotating screw.
Figure 19.10 Illustration of mold features for injection molding. (a) Two-plate mold with important features identified. (b) Four parts showing details and the volume of material involved. Source: Courtesy of Tooling Molds West, Inc.
Rough estimate: \[ F = P \times A \]
Example 19.2

Given: Injection molding machine of 2MN, product of gear of diameter = 110mm, injection pressure=100MPa.

Find: Number of gears in a mold?

Solution:

\[ A = \frac{\pi \times 110^2}{4} = 9503 \, mm^2 \]

\[ F = P \times A \]

\[ = 100 \times 9503 \]

\[ = 950,300 \, N \]

Total clamping force of machine = 2,000,000 N

Number of gear in a mold = \( \frac{2,000,000}{950,300} \approx 2 \)
Tapes used in Making Reinforced Plastic Parts

Figure 19.24 (a) Manufacturing process for polymer-matrix composite tape. (b) Boron-epoxy prepreg tape. These tapes are then used in making reinforced plastic parts and components with high strength-to-weight ratios, particularly important for aircraft and aerospace applications and sports equipment. Source: (a) Courtesy of T. W. Chou, R. L. McCullough, and R. B. Pipes. (b) Courtesy of Avco Specialty Materials/Textron.
Figure 19.25  (a)  Single-ply layup of boron-epoxy tape for the horizontal stabilizer for an F-14 fighter aircraft.  (b)  A 10-axis computer-numerical-controlled tape-laying system.  This machine is capable of laying up 75- and 150-mm (3- and 6-in.) wide tapes on contours of up to +/- 30 degrees and at speeds of up to 0.5m/s (1.7 ft/s).  Source:  (a) Courtesy of Grumman Aircraft Corporation.  (b)  Courtesy of The Ingersoll Milling Machine Company.
Figure 19.29  (a) Schematic illustration of the filament-winding process; (b) fiberglass being wound over aluminum liners for slide-raft inflation vessels for the Boeing 767 aircraft. The products made by this process have high strength-to-weight ratio and also serve as lightweight pressure vessels.  Source: Courtesy of Brunswick Corporation.
Pultrusion

Cure chamber with pultrusion die

Cured pultrusion

Pre-shaper

Prepreg feed system

Microwave generator

To puller
Figure 19.30 (a) Schematic illustration of the pultrusion process. (b) Examples of parts made by pultrusion. The major components of fiberglass ladders (used especially by electricians) are made by this process. Unlike aluminum ladders, they are available in different colors but are heavier because of the presence of glass fibers. 

Source: Courtesy of Strongwell Corporation.
Ch 19
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