Lecture 06: Plastics Processes

1.1.Plastics Processes

1. Extrusion

- Raw materials are thermoplastic pellets, granules, or powder
- Placed in hopper and fed into extruder barrel
- Screw blends pellets and pushes them down the barrel –through the feed, transition/melt, and pumping sections
- Barrel is heated from outside, and by friction
- Plastic is liquefied and forced through a die under pressure
- Pellets for other plastics processes are made by extruding small-diameter rod and chopping into short segments
- Equipment costs on the order of $300,000
- Rated by barrel diameter (D, 1-8 inch) and L/D ratio (5 to 30)

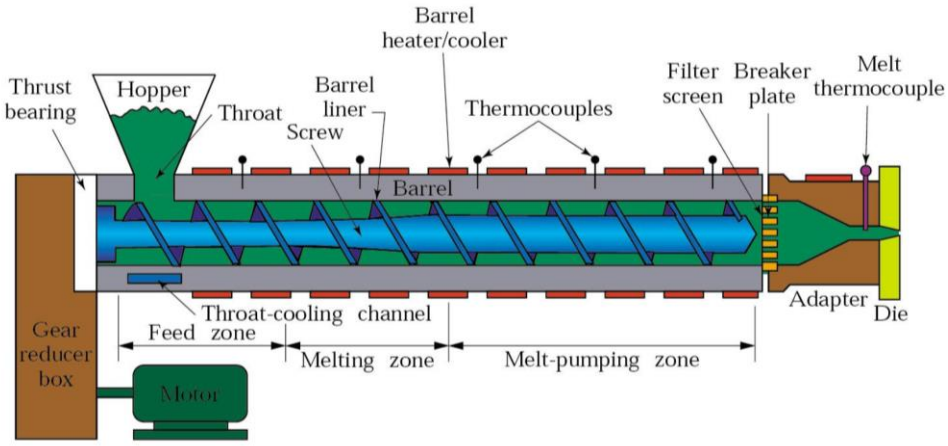

Fig. 1 extrusion process for plastic

Fig. 2 Several samples plastic extrusion products

2. Injection Molding

- Similar to hot chamber die casting of metals
- Pellets, granules, or powder are fed into heated cylinder, then forced into die chamber by hydraulic plunger or rotating screw system
- Pressures from 70-200 MPa (10-30 Kpsi)
- Cool molds for thermoplastics. Heated molds for thermosets
- Complex shapes and good dimensional accuracy
- Using metallic inserts, multiple materials/colors, and printed films can eliminate post processing or assembly operations
- Injection Molding Capabilities
  - High production rates
  - Good dimensional control
  - Machines are usually horizontal with clamping forces (100-250 tons)

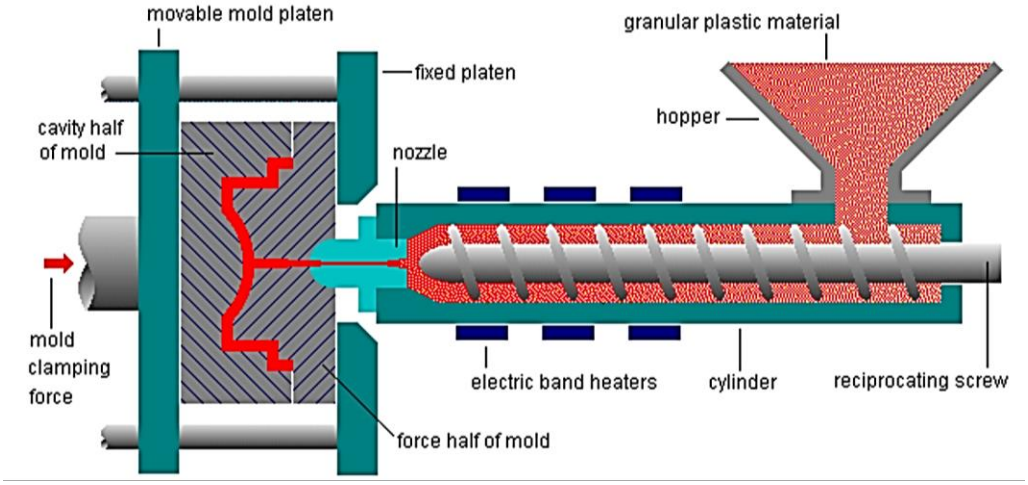

Fig. 3 Plastic Injection molding process

Fig. 4 Samples of Plastic Injection molding products

3. Structural Foam Molding

- A variation of the injection molding process developed for applications where stiffness is a primary concern, and particularly for large structural parts.
- Parts consist of a rigid, closed-cellular core surrounded by a continuous, solid skin.
- The polymer melt contains a dissolved inert gas; most commonly nitrogen, introduced in the extrusion screw.
- A predetermined shot size is injected into the mold cavity, the extruder valve is closed, and the foam material generates internal pressure and expands to fill mold cavity.
- A much lower pressure operation than the conventional injection molding system, which allows much larger parts to be molded

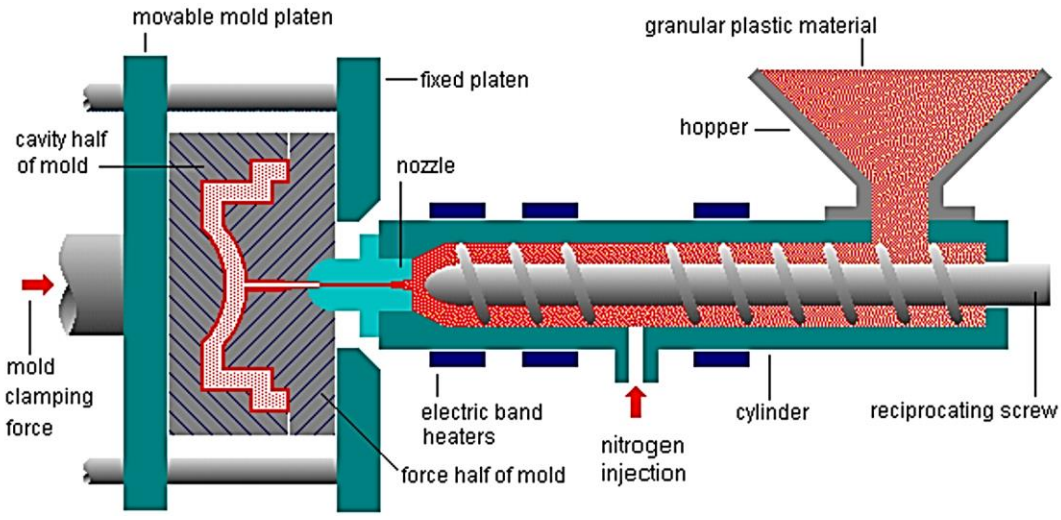

Fig. 5 Plastic Structural Foam Molding process

Fig. 6 Samples of Plastic Structural Foam Molding products

4. Blow Molding

- Modified extrusion and injection molding processes
- Extrusion Blow Molding
  - Small tube is first extruded, usually vertically, then clamped and air blown inside to expand it to fit a much larger diameter mold
  - Air pressures 350-700 kPa (50-100 psi)
- Injection blow molding
  - Short tubular piece (parison) injection molded, transferred to a blow-molding die
  - Plastic beverage bottles and hollow containers
- Multilayer blow molding
  - Plastic packaging for food and beverages, cosmetics and pharmaceutical industries

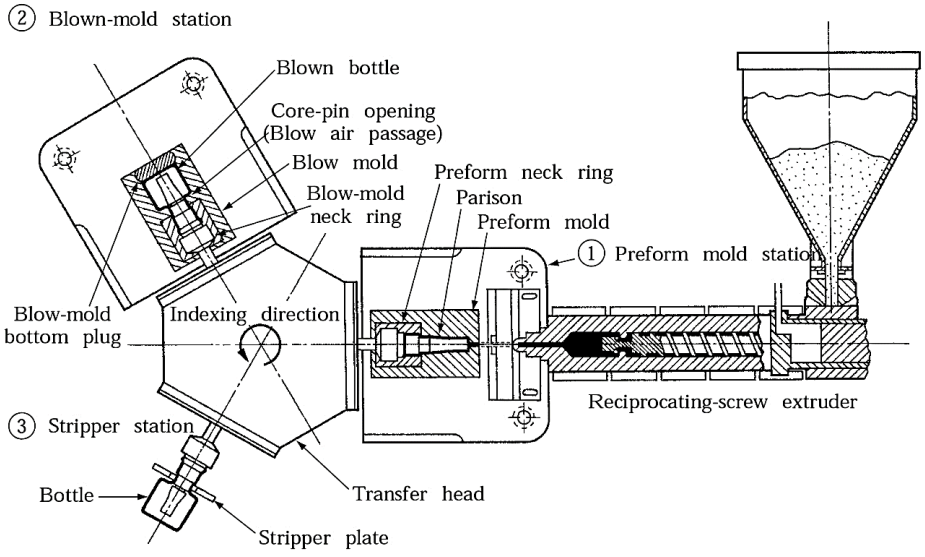

Fig. 7 A three station injection blow-molding machine

Fig. 8 Samples of Plastic blow-molding products

5. Reaction Injection Molding

- Chemical reaction between two polymer materials – thermoset
- Large parts
- Low tooling costs
- Car bumpers are good examples for this process

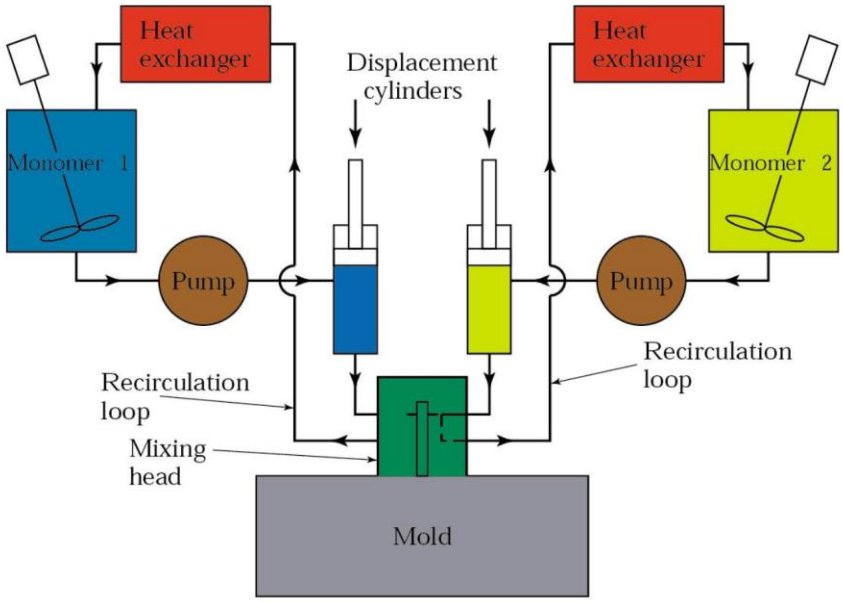

Fig. 9 Plastic Reaction Injection Molding process

Fig. 10 Samples of Plastic Reaction Injection Molding products

6. Rotational Molding

- Premeasured quantity of powder placed inside warm mold
- Rotated on two axes inside a heated furnace
- Low equipment costs
- Longer process times
- Trash cans, boat hulls, buckets, toys, footballs
- 0.4 mm wall thickness possible

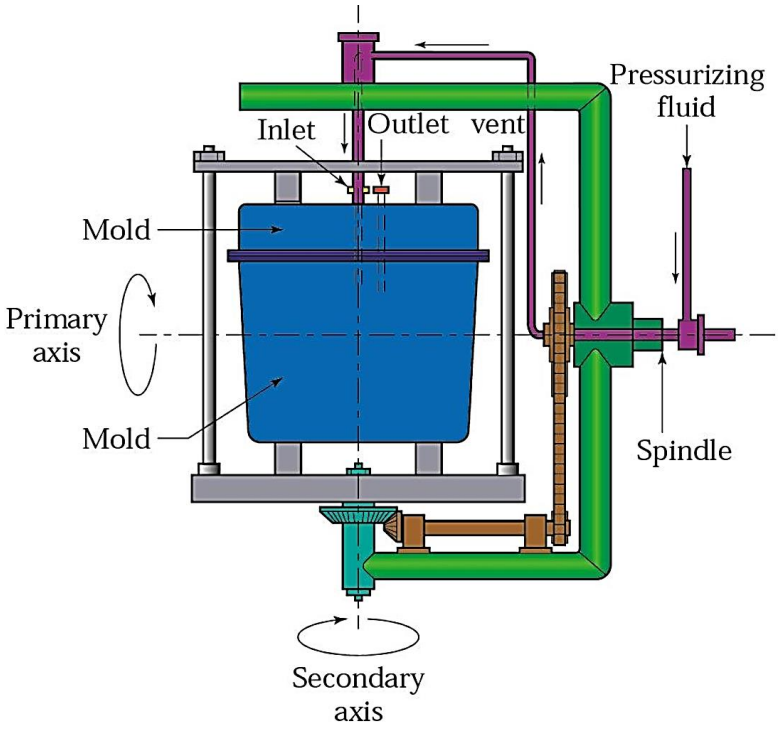

Fig. 11 Plastic Rotational Molding process

Fig. 12 Samples of Plastic Rotational Molding products

7. Thermoforming

- Plastic sheet is heated to a sag point (softened, but not melted)
- Heated sheet placed over a room-temperature mold and forced against it by vacuum pressure
- Stretch forming process – material thickness variations
- Advertising signs, refrigerator liners, appliance housings, shower stalls, packaging

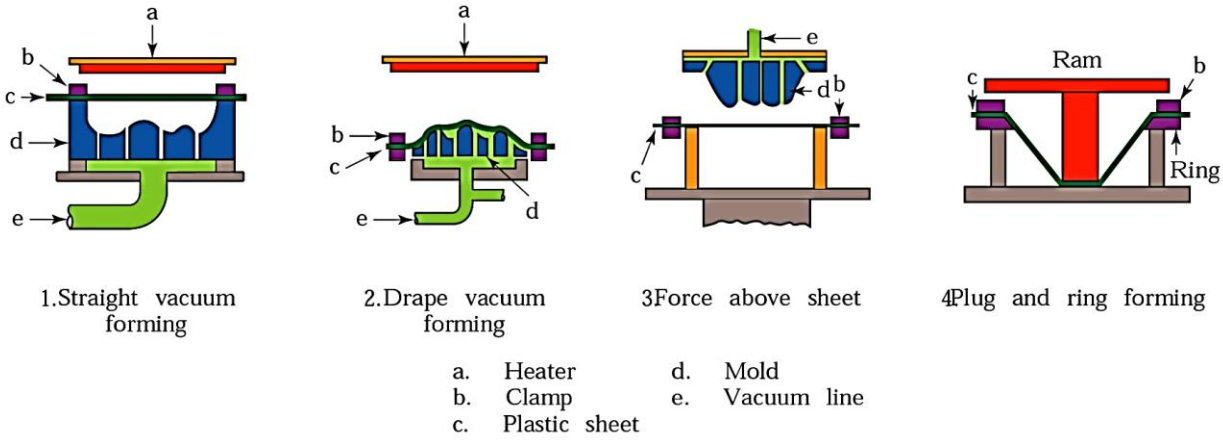

Fig. 13 Plastic Thermoforming process

Fig. 14 Samples of Plastic Thermoforming products

Plastics Processes (summary)

Extrusion	Long, uniform, solid or hollow complex cross-sections; high production rates; low tooling costs; wide tolerances.
Injection molding	Complex shapes of various sizes, eliminating assembly; high production rates; costly tooling; good dimensional accuracy.

Structural foam molding	Large parts with high stiffness-to-weight ratio; less expensive tooling than in injection molding; low production rates
Blow molding	Hollow thin-walled parts of various sizes; high production rates and low cost for making containers.
Rotational molding	Large hollow shapes of relatively simple shape; low tooling cost; low production rates
Thermoforming	Shallow or relatively deep cavities; low tooling costs; medium production rates.
Compression molding	Parts similar to impression-die forging; relatively inexpensive tooling; medium production rates
Transfer molding	More complex parts than compression molding and higher production rates; some scrap loss; medium tooling cost.
Casting	Simple or intricate shapes made with flexible molds; low production rates.
Processing of composite materials	Long cycle times; tolerances and tooling cost depend on process.

YouTube: https://youtu.be/-saKpxY4-no