Plastic as Packaging Material

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Plastic

- Plastics may be defined as any group of substance, of natural or synthetic origins, consisting chiefly of polymers of high molecular weight that can be molded into a shape or form by heat and pressure.
- certain building block molecules, undergo a process known as polymerization, a plastic or long chain polymer is produced.
- Other material such as accelerators, initiators, solvents and catalyst can be added during polymerization to improve the characteristics.

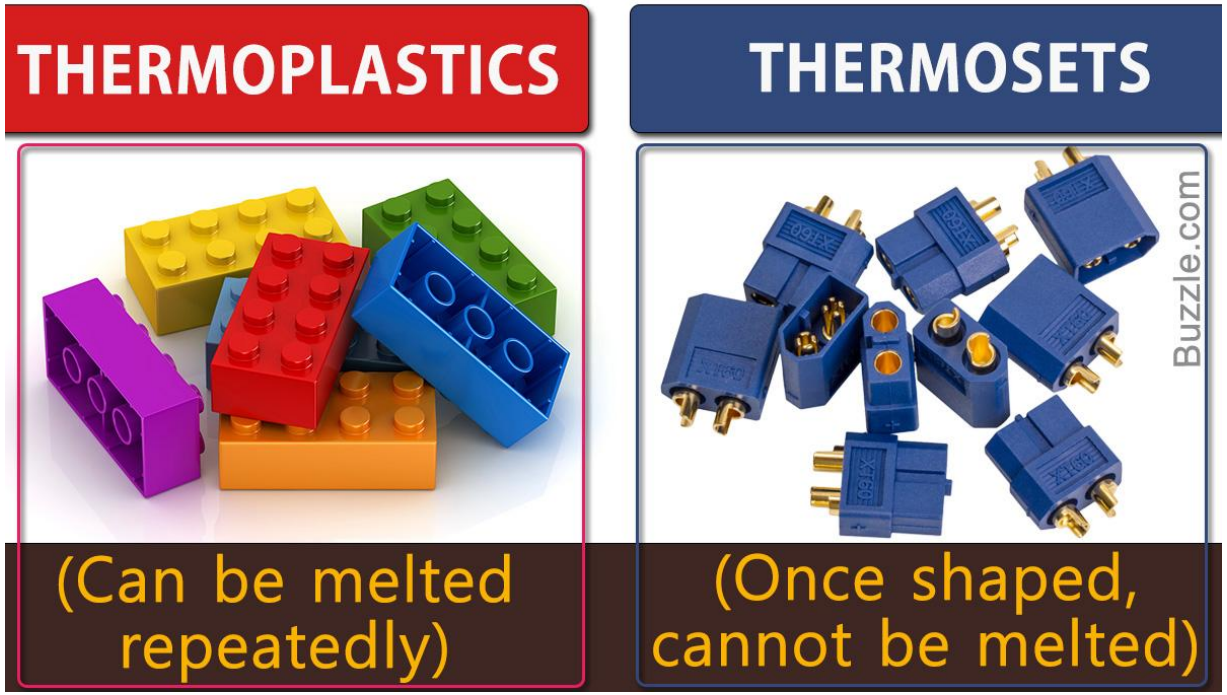
Types of Plastic

- **Thermoplastic Polymer**
- Melt when heated, harden when cooled

  E.g. Polyethylene, PVC, polystyrene, polypropylene, nylon, polyester

- **Thermosetting Polymer**
- Resin harden when heated, once it harden no longer to melt

  E.g. Phenolic, melamine, urea, alkyds, epoxides, certain polyesters



Plastics

- Advantages
- Light weight
- Reduced volume
- Good resistance (mold, bacteria)
- Inert
- Usually have good impact strength
- Wide design and decorative possibilities.

- Disadvantages
- Permeable to moisture and gas
- Permit some passage of light
- Difficult to clean
- Attacked by organic solvent
- Fully effective closing difficult

Polyolefin

- Polyolefin is a collective term for polyethylene and polypropylene
- Combined Properties
- flexibility, strength, lightness, stability, moisture and chemical resistance, and easy process ability, and suited for recycling and reuse

Polyolefin

- The simplest and most inexpensive plastic made by addition polymerization of ethylene is polyethylene.
- 2 types
  - 1. High density
  - 2. Low density

Polyolefin

- Polyethylene 2 types
- High density polyethylene
- Stiff, strong, tough, resistant to chemicals and moisture, permeable to gas, easy to process, and easy to form.
- Applications
- make bottles for milk, juice, and water; cereal box liners; margarine tubs; and grocery, trash, and retail bags.
- Low density polyethylene
- strong, tough, easy to seal, and resistant to moisture. relatively transparent, it is predominately used in film
- Applications
- Bread and frozen food bags, flexible lids, and squeezable food bottles.

Polyesters

- Polyethylene terephthalate (PET or PETE), polycarbonate, and polyethylene naphthalate (PEN) are polyester
- Most commonly used polyester in food packaging is PETE.
- PETE
- good resistance to heat, mineral oils, solvents, and acids, but not to bases.
- Application: beverages and mineral waters.

Polyesters

- PET(E)
- 3 major packaging applications of PETE are
  - 1. Containers (bottles, jars, and tubs),
  - 2. Semi rigid sheets for thermoforming (trays and blisters), and
  - 3. Thin-oriented films (bags and snack food wrappers).

Polyesters

- PET(E)
- Amorphous (transparent) and a semi-crystalline (opaque and white) thermoplastic material.
- Good strength, ductility, stiffness, and hardness

Polyesters

- Polycarbonate
- Polycarbonate is formed by polymerization of a sodium salt of bisphenol acid (BPA) with carbonyl dichloride (phosgene).
- Clear, heat resistant, and durable
- Application
- Returnable/Refillable water bottles and
- Sterilizable baby bottles

Polyesters

- Polyethylene naphthalate.
- PEN is a condensation polymer of dimethyl naphthalene dicarboxylate and ethylene glycol.
- Barrier properties for carbon dioxide, oxygen, and water vapor.
- PEN provides better performance at high temperatures, allowing hot refills, rewashing, and reuse.
- PEN provides protection against transfer of flavors and odors
- Application: bottles for beverages such as beer.

Polypropylene (PP)

- PP has good chemical and grease resistance. Barrier properties of PP are similar to those of HDPE;
- It is a good water vapor barrier but a poor gas barrier.
- One of the main uses of PP in food packaging is in closures (caps) particularly for threaded caps.

Polyvinyl chloride (PVC)

- PVC is heavy, stiff, ductile, and a medium strong, amorphous, transparent material.
- It has excellent resistance to chemicals (acids and bases), grease, and oil; good flow characteristics; and stable electrical properties.
- Addition of plasticizers such as phthalates, adipates, citrates, and phosphates
- **Applications**: cosmetics, toys, and medical devices
- Problem: Toxic, carcinogen

Polyvinylidene chloride (PVdC)

- Polyvinylidene chloride (PVdC) is an addition polymer of vinylidene chloride.
- It is heat sealable and serves as an excellent barrier to water vapor, gases, and fatty and oily products.
- Application: packaging of poultry, cured meats, cheese, snack foods, tea, coffee, and confectionary

Polystyrene

- **Polystyrene (PS), an addition polymer of styrene, is**
- **clear, hard, and brittle with a relatively low melting point.**
- **Application**
- protective packaging such as egg cartons, containers, disposable plastic silverware, lids, cups, plates, bottles, and food trays

Polyamide

- Commonly known as nylon
- polyamides were originally used in textiles
- Nylon also offers good chemical resistance, toughness, and low gas permeability.

Ethylene vinyl alcohol (EVOH)

- Ethylene vinyl alcohol (EVOH) is a copolymer of ethylene and vinyl alcohol.
- It is an excellent barrier to oil, fat, and oxygen.

Laminates and Co-extrusions

- Plastic materials can be manufactured either as a single film or as a combination of more than 1 plastic

1. Lamination: involves bonding together 2 or more plastics or bonding plastic to another material such as paper or aluminum.
2. Co-extrusion: 2 or more layers of molten plastics are combined during the film manufacture

Manufacturing of Plastic container

- 1. Injection molding
- 2. Blow molding
  - Extrusion blow molding (EBM)
  - Injection blow molding (IBM)
  - Stretch blow molding (SBM)

Manufacturing of Plastic container

- 1. **Injection molding**
- The injection molding process consists essentially of softening thermoplastic material in a heated cylinder and injecting it under high pressure into a relatively cool mold where solidification takes place.
- After the plastic has solidified, the mold is opened and a part in the shape of the mold cavity is removed.
- Eg. tubs and jars

Manufacturing of Plastic

- Blow molding
- In blow molding, a molten tube of thermoplastic (known as a parison) is surrounded by a cooled mold having the desired shape.
- A gas (usually air but occasionally N_2) is introduced into the tube causing the molten mass to expand against the walls of the mold where it solidifies on cooling.
- The mold is then opened and the bottle or jar ejected.

Manufacturing of Plastic

- **Blow molding**
- ***Extrusion blow molding (EBM)***
- A mold is mounted under an annular die, the parison extruded between the open halves of the mold.
- Parison reaches the proper length, the extruder is stopped, the mold is closed around the parison, bottom of the parison is pinched together by the mold.
- A blow pin mounted inside the die head allows air to enter and blow the parison, which expands to fill the mold.
- Shape of the bottle or jar is defined

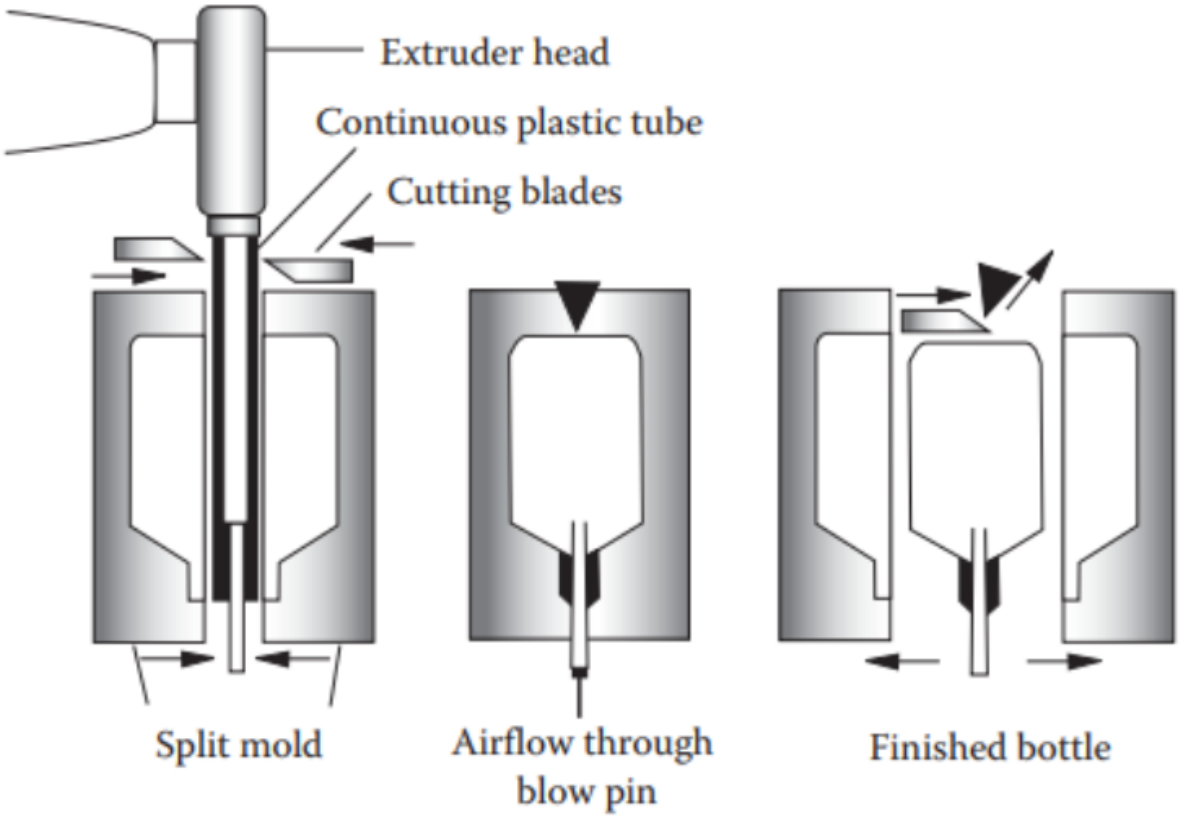


Fig. 1 Extrusion Blow Molding of plastic bottles

Manufacturing of Plastic

- Blow molding
- **Injection blow molding (IBM)**
- The parison is formed in one mold and then, while still molten, is transferred to a second mold where blowing with compressed air forms the final shape.
- After cooling, the mold is opened and the bottle ejected.

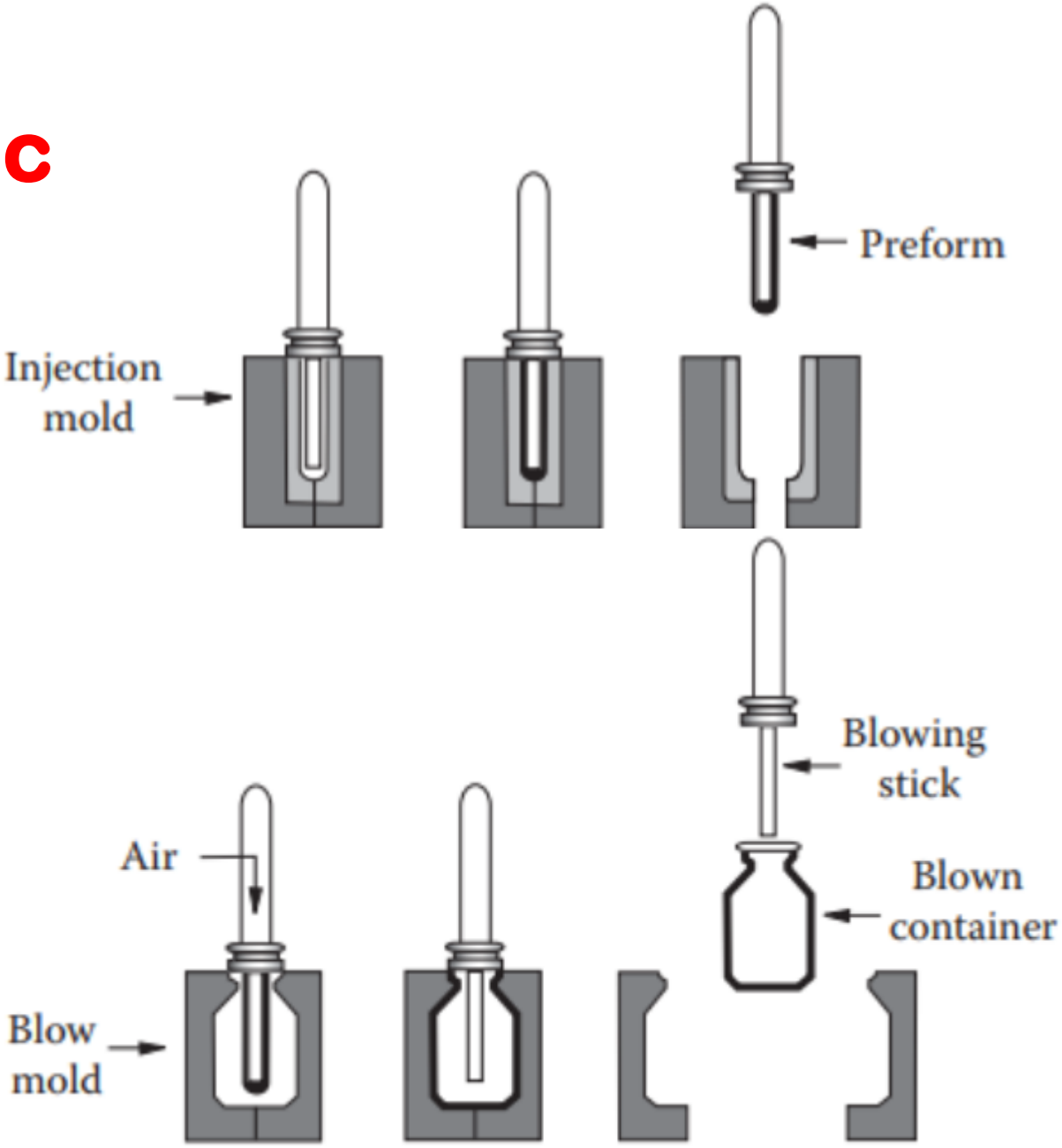


Fig 2. Injection Blow Molding of plastic bottles

Manufacturing of Plastic

- Blow molding
- **Stretch blow molding (SBM)**
- a preform or parison (produced either by injection molding or extrusion of a continuous tube or parison, which is then cut to the required length and closed at one end) is stretched longitudinally under heat and blown into a bottle with consequent transverse orientation.
- A metal stretch rod enters the bottle to assist in the stretching process

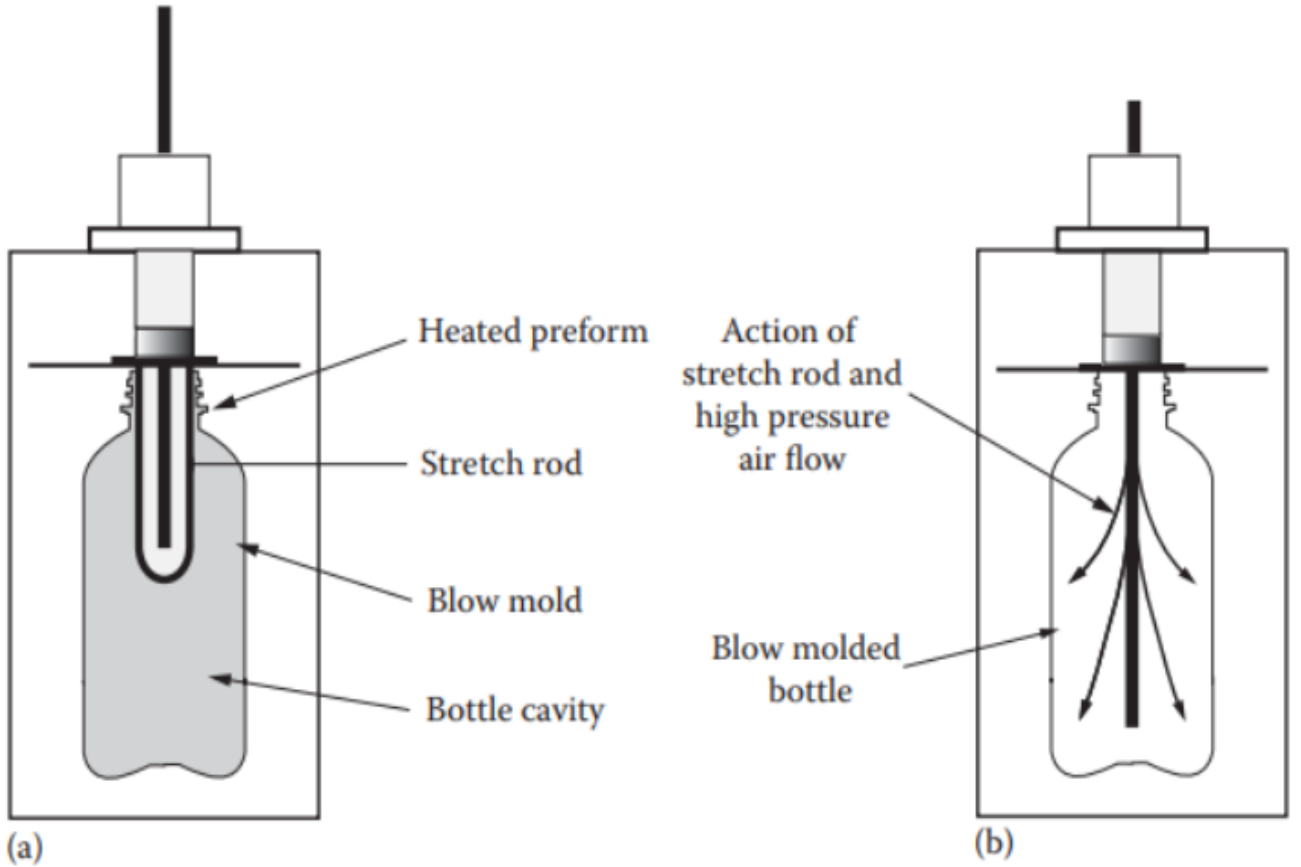


Fig. 3 Stretch blow molding process. (a) Mold closed on preform. (b) Stretching and blowing.

Typical Technologies of Converting

- **Coating**- Thin membrane that is coated liquid on the film sheet. Process of applying one or more layers of polymer latices or polymer melt to the surface of a substrate.
- **Laminating**-made multiple layers by adhesives and extrusion molten resin.
- **Printing** -to express conveyance of eye information and ornament.
- **Metallizing**- metals are vaporized and adhere to substrate.
- **Embossing**- of set of concave-convex design to substrate by embossing roll to make soft-feeling and mat surface.
- **Slitting** - film sheet is continuously slit constant position width of the product for secondary processing. **make a long, narrow cut in**
- **Winding**- is of set purpose to adjust edge of roll product and get rid rejective part.

Constituents in Plastic

- Plasticizer
- Fillers (ground calcium carbonate (GCC), precipitated calcium carbonate (PCC), kaolin, talc, and carbon black)
- Toughening agent/impact modifiers
- Lubricants
- UV absorber
- Slip additives
- Anti-slip additives
- Anti-blocking agent
- Antioxidants
- Colorants
- Extenders (plastic additives primarily used to bulk up the plastic, reduce cost and enhance properties)
- Internal release agent
- Inhibitors

Thank You