

figure 14-19. plastic state forming of glass chart



figure 14-20. expensive glass bottle

### Plastic State Forming

The *blowing process* is used to make hollow, thin walled glass items, such as bottles and flasks, and is similar to blow molding of thermoplastics. The steps involved in the production of an ordinary glass bottle by the blowing process are: blown air expands a hollow gob of heated glass against the walls of the mold. These molds are usually coated with a parting agent such as oil or emulsion to prevent the part from sticking to the mold. The surface finish of products made by the blowing process is acceptable for most applications. Although it is difficult to control the wall thickness of the products, the process is used for high rates of production. Light bulbs are made in automatic blowing machines at a rate of more than 1,000 bulbs per minute.

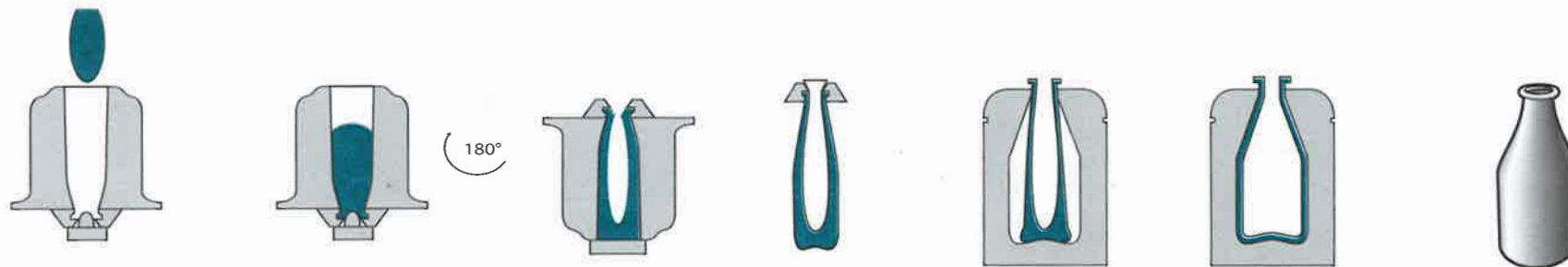


figure 14-21. stages in manufacturing a glass bottle

*Pressing* is good dimensional molten glass cannot be which the

*Centrifugal* products industrial missile no casting for molten gla

*Sagging* is such as dis shallow m and takes 1 with little

figure 14-22.



**Pressing** is used to form fairly simple open shapes with good dimensional accuracy. A plunger forces a gob of molten glass into a one piece or split mold. The process cannot be used on thin-walled parts or closed shapes from which the plunger cannot be retracted.

**Centrifugal casting** or **spinning** is used to make symmetrical products such as television picture tubes as well as large, industrial and aerospace high performance parts such as missile nose cones. The process is similar to centrifugal casting for metals, in which the centrifugal force pushes the molten glass against the mold wall.

**Sagging** is a process that shapes lightly embossed glass parts such as dishes, lighting diffusers, and sunglass lenses in a shallow mold. Heated glass sheet sags by its own weight and takes the shape of the mold as it cools. Shallow shapes with little detail are formed by this inexpensive process.



figure 14-23. centrifugal casting of glass

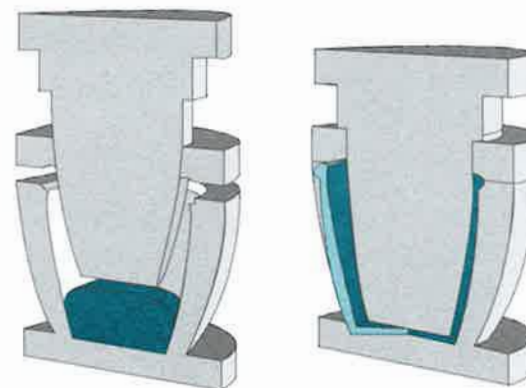


figure 14-22b. pressing glass in split mold

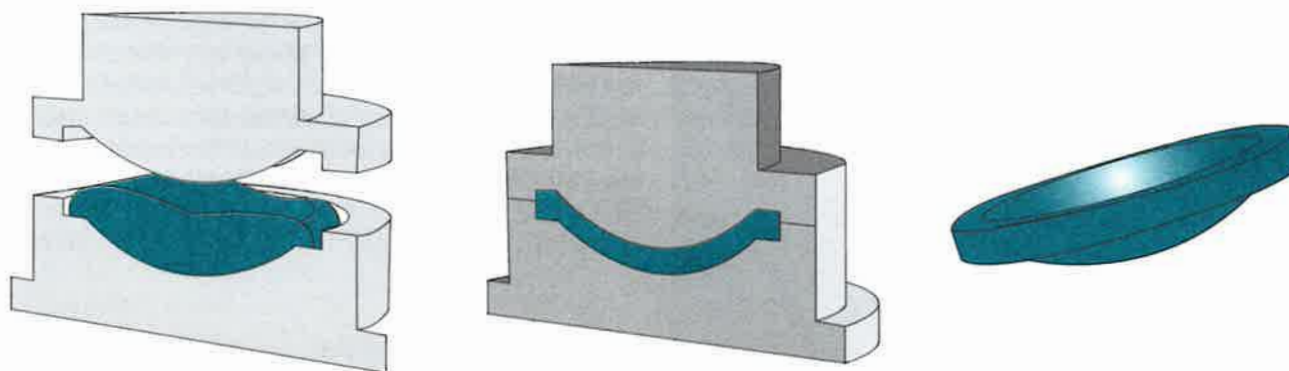


figure 14-22a. manufacturing glass item by pressing it in mold

**Treating Glass**

- **Thermal tempering** is a process that chills surfaces, causing tensile stresses to develop on its surfaces. As the rest of the glass sheet cools, it contracts, developing residual compressive surface stresses and interior tensile stresses. The process improves the strength of glass sheet, and the energy stored from the residual stresses causes tempered glass to shatter into many small pieces when broken.
  - **Chemical tempering** is a longer process that uses a bath of molten chemicals. Atoms are exchanged, resulting in residual compressive stresses that develop on the surface.
  - **Laminating** is another way to strengthen glass, and is commonly used for automotive windows. A tough plastic is sandwiched between two pieces of flat glass. The plastic holds the pieces if the glass is broken.
- Other processes:
- In **annealing**, glass is heated and then cooled gradually, usually at room temperature.
  - Glass sheet has a surface tension. It is usually "cut" by scoring the surface and then snapping it, causing the sheet to break along the score or "notch." This is called **notch sensitivity**.
  - Glass can be **cut**, **drilled**, and **ground** with special tools and **polished** with appropriate abrasives. Sharp edges and corners can be smoothed by **sanding**, grinding, or **fire polishing**.