

Injection Blow Molding

Whereas extrusion blow molding is a continuous process from melting the resin to forming the parison to blowing the part in the mold, **injection blow mold** separates the operation of forming the parison from the operation of blowing the final part. Figure 13.6 shows the steps for both operations in making soft-drink bottles; and Photo 13.3 shows preforms and bottles for two different soft-drink bottles.

The first operation in injection blow molding is the formation of the parison or, as it is more commonly called in injection blow molding, the **preform**. The preform is made using a standard injection molding machine or in a machine that links the injection step to the blowing step in sequence. Because the preform must be hollow, the injection molding is done around a core pin. The thickness of the preform is determined by the thickness desired in the walls of the final product after full blowing has been completed. The length of the preform is usually somewhat less than the final bottle size because injection blow molding usually involves stretching the part in the longitudinal direction. Many injection blow molded products have threads for caps, as do soft-drink bottles, so these threads are also created during the injection molding step.

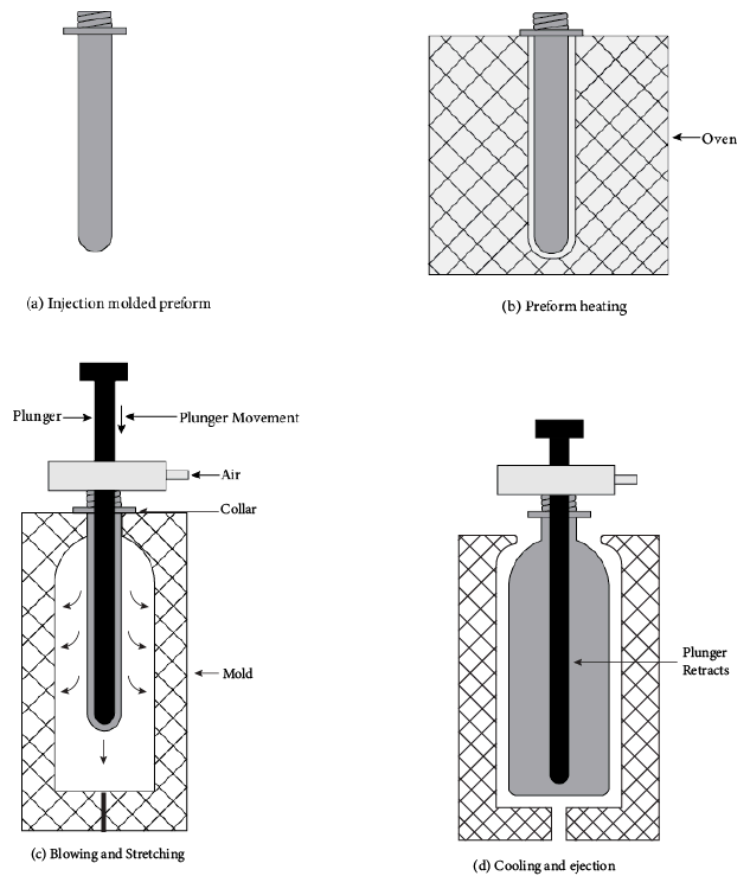


Figure 13.6 Injection blow molding process.

The blowing step is done by inserting the preform into an oven, usually so that the threads are not heated. To assist in insulating the threads from the oven and to hold the preform so that it easily rests on the top of the oven, a small collar is often molded just below the threads. This shape of the preform and the oven heating step are shown in Figure 13.6a and b.

After the preform has been heated to the proper temperature, it is removed from the oven and placed into a traditional blow molding mold. Air is introduced to blow the preform outward, against the walls of the mold, as in other blow molding processes. However, because some blow molded products need to be strengthened through longitudinal orientation, the part is stretched by the action of a plunger that pushes the bottom of the preform downward at the same time the air is blowing the part in the radial direction. This simultaneous stretching and blowing is shown in Figure 13.6c. The part is then cooled inside the mold and ejected, as in traditional blow molding.



Photo 13.3 Blow-molded bottle and various sizes of preforms for other bottles. (Courtesy of BYU)

The injecting and blowing cycles of injection blow molding need not be done at the same time or even at the same location. The preforms can be made by injection and then either stored until the finished blow molded parts are needed or shipped to a satellite location where they can be blown. When the blowing is not done immediately after the injection, the preform must be reheated. The flexibility of separating the two cycles has proven to be valuable in the manufacture of soft-drink bottles. The preforms are made in a central location on large, multicavity injection molding machines, which gives economy of scale and close engineering control over the injection molding step, the more critical of the two steps. The preforms are then moved to the blow molding machines (which can be at separate sites), reheated, and blown into the familiar soft-drink bottles. The blow molder does not need to have an expensive injection molding machine and injection mold but needs only an oven and a blowing station.

Injection blow molding allows the formation of a preform that can have a non-constant cross section. This flexibility in shape provides a method for blowing bottles with better wall thickness uniformity than can be made with extrusion blow molding. The blowing process naturally causes thin sections where the parison/preform has to be blown farther, such as in corners. Careful design of the shape of the core pin and mold cavity in injection blow molding allows the preform to be thicker in just the correct areas to compensate for this greater stretching. Injection blow molding offers another innovation in blow molding technology, called **stretch blow molding**, a technique that uses mechanical assistance to stretch the part in the longitudinal direction at the same time the blowing of the part stretches it in the hoop or radial direction. This biaxial stretching occurs when the parison or preform is blown into the desired shape in the blow mold. The longitudinal stretching of the parison is accomplished by using a telescoping mandrel or plunger that extends to push on the bottom of the preform at the same time that the air is being injected to push against the walls to stretch the material radially. For this process to have its maximum benefit, the temperature of the preform is carefully adjusted to the correct temperature for orientation. This process is shown in Figures 13.6 and 13.7.

The major advantage of stretch blow molding is the improvement of mechanical properties. Polymers are stronger in the direction of orientation of the molecules. Therefore, by stretching in two directions, the parts can be made higher in both burst strength (dependent on hoop orientation) and impact strength (improved by longitudinal orientation). PET soft-drink bottles are a prime example of the use of this technique. If not stretched, the PET resin will remain amorphous and will not meet the drop-breakage test that is expected of a soft-drink bottle (dropped full from 6 feet without breakage). The crystallization forced by stretching also improves the resistance of the PET to gas permeation. These and other advantages are discussed in the case study at the conclusion of this chapter.

13.3.1. Comparison of Extrusion and Injection Blow Molding

The similarities and differences between extrusion blow molding and injection blow molding are important in choosing the method for forming the part. A brief review of the characteristics of each of the methods is therefore

given.

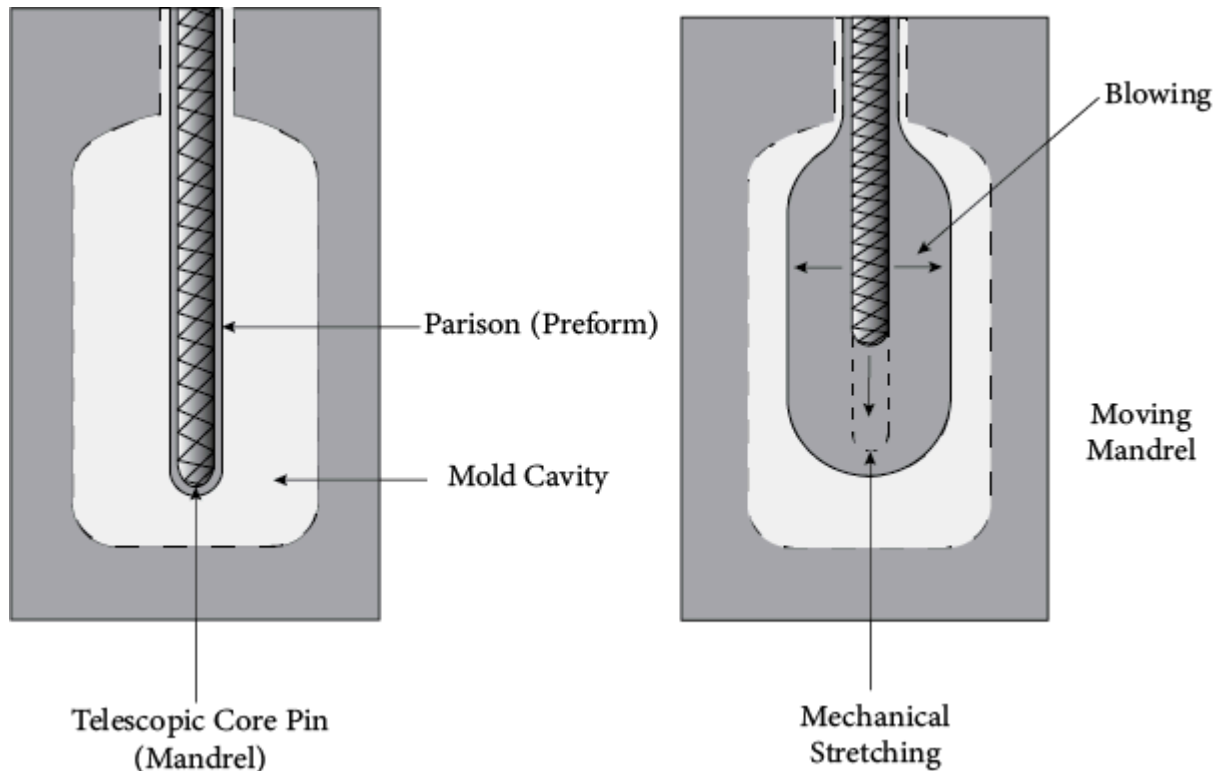


Figure 13.7 Stretch blow molding.

Extrusion blow molding

- It is best suited for bottles over 1/2 pound (200 g) in weight, shorter runs, and quick tool changeover.
- Machine costs are comparable to injection blow molding.
- Tooling costs are 50% to 75% less than injection blow molding.
- It requires sprue and head trimming, which generates 20 to 30% scrap.
- It requires additional equipment to grind scrap and reintroduce it into the molding machine.
- The total cycle is shorter than with injection blow molding, since parison formation and blowing can be done on the same machine with no need to transfer to another mold.
- Wider choice of resins is possible with extrusion under present technologies because resins that do not liquify sufficiently for injection molding can be extruded into a parison and blown.
- Final part design flexibility can be greater because asymmetrical openings can be made by extrusion blow molding, as can additional openings and blown handles. These design features are difficult with injection blow molding.

Injection blow molding

- Best suited for long runs and smaller bottles.
- No trim scrap.
- Higher accuracy in the final part, that is, the precisely formed parison (preform) is more likely to make consistent and accurate parts.
- Uniform wall thicknesses.
- No seam lines or pinch marks; more stable base designs are possible with injection blow molding.
- Better transparencies with injection blow molding because the crystallization can be better controlled and the blowing can be more stress-free.
- Can lead to improved mechanical properties from improved preform design and from the possibility of stretch blow molding.



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