FOCUS ON

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# WATER BOTTLES

## Closing the Loop on Material Selection

The water cooler—the social epicenter of every office and in some countries the main water source in homes—now is showing up in other environments from restaurants to coffee shops, schools and hospitals.

Since the bottled water industry is experiencing growth, there is an increased demand for the number of bottles needed. The plastics industry works with bottlers to decide which resin to use to make bottles and what equipment should be purchased to mold the resins.

In order to determine the type of plastic resin to use in bottles, it is important to determine how the bottles are being used. Disparate systems in the United States and Mexico are compared below as an example. Other critical considerations include the manufacturing system and the environment in which the bottle is used.

### United States

The United States uses a closed-loop system. Bottles are filled and delivered by the bottle company to customers. When empty, the bottles then are picked up and returned to the bottler for washing and reuse. In this system, it usually is more cost-effective to use a stronger, more durable plastic for longer bottle life and to resist damage from everyday distribution and handling. In more than 95 percent of the U.S. market, polycarbonate (PC) is the material choice for large water bottles.

PC has a higher bottle cost, typically about $5 per bottle or about $0.05 per 100 trips, which is the average life of a PC bottle. So, over time, it can offer significant cost savings. PC bottles can offer exceptional clarity, impact resistance and scuff resistance. Also, some PC now can be used in injection stretch blow molding, in addition to extrusion blow molding.

However, there are some negatives to PC bottles including limited recycling sites in certain countries despite the material's recyclability. The bottles also can crack with high detergent levels in the wash cycle, so the amount of detergent used is critical in maintaining bottle integrity. However, this can be avoided as PC can be cleaned at higher temperatures requiring less detergent.

### Mexico

Mexico uses an open-loop system. While many of the large bottle companies in Mexico use PC bottles, the numerous small distributors often choose the lower cost bottles made from polyvinyl chloride (PVC), polyethylene terephthalate (PET) or glass. These bottles often are less expensive to manufacture and experience a much shorter life, which tends to work sufficiently in an open-loop system. Because many of these small distributors do not expect the bottle to be returned after use, they often choose the lowest priced bottle and aren't as concerned with total system costs. Also, many Mexican manufacturers are familiar with PET so they are more easily manufactured.

However, as Mexico goes to a closed-loop system, material selection will need to change. The PET bottles currently used in Mexico's open-loop system have a lower bottle cost of $2.70 per bottle. If PET bottles are used in a closed-loop system the cost is approximately $0.07 per trip, based on 35 trips, which is the average life of a PET bottle. Attributes such as bottle life, strength and durability need to be considered. Several large bottlers in Mexico now are looking to create more brand recognition, so bottle aesthetics, clarity and overall quality may become even more important. PET or PVC bottles generally are less durable and impact and scuff resistant than bottles made from PC. Lastly, they shrink with heat incurred during washing and shipping. PC would be a logical choice for a closed-loop system.

### GE Plastics in Mexico

GE Plastics is establishing a technical center in Tampico, Mexico, in the fall of 2001, to support infrastructure development of the five-gallon polycarbonate water bottle. GE Plastics will bring a system, best manufacturing practices, geographic access and bilingual capability to Mexico. The technical center will focus on value-added activities such as training, scrap reduction and first pass yield increase, cycle time reduction, life cycle improvements, cost/benefit measurement, design review and programs for increasing market share.

### Processing

In addition to logistics, equipment costs also need to be taken into account when selecting a material, since equipment can determine the type of plastic resin that can be used. Large water bottles usually are produced by two processes, extrusion and injection stretch blow molding. Another process of reheat and blow molding is used only for smaller containers.

Extrusion blow molding is a process where a hot tube of plastic is dropped from an extruder and captured in a water-cooled mold where the plastic is blown into the bottle shape. This process for large water bottles is limited to PC because of the required melt strength and the need for a slow crystallization rate for clarity. This is significant because a molder with extrusion blow molding equipment cannot go into the PET large bottle market due to clarity and melt strength challenges.

Extrusion blow molding process can be very productive for large continuous runs of a product. It also allows for the introduction of handles on the bottle. There have been complaints in the past about the quality in the neck of some bottles and the result is water leakage at installation, but enhancements of the extrusion blow molding process have greatly reduced the problem.

Injection stretch blow molding (ISBM), on the other hand, is used extensively for PET. However, recent breakthroughs show that it now can be used for PC as well. With this process, the plastic is first injected into a cavity where it encircles the blow stem. This stem is where the neck of the bottle is produced. The injected material is carried to the next station on the machine where it is stretched and blown into the finished bottle. Handles on the water bottles cannot be produced by ISBM. Nevertheless, the neck on the bottle often is quite good in this process and is the big advantage over extrusion blow molded advertised by PET manufacturers. Until recently, PC bottles could not be produced in this process. However, a PC material now has been developed that has the required melt flow index to be produced in ISBM equipment allowing PC to be used in both large bottle molding processes.* This is significant because the molder and original equipment manufacturer (OEM) will not be limited to PET because of their existing ISBM equipment. (See Table 1.)

### Environmental Conditions

A third way to determine the material to use in bottles is to research the conditions the bottles endure. The type of plastic in bottles determines many of its characteristics. For example, storage conditions and wash cycle temperatures affect stability of volume. Specifically, PET bottles lose volume capacity at high temperatures.

The U.S.'s closed loop system generally has a quick logistical turnaround so

bottles aren't left in harsh conditions for long. Bottles usually are stored indoors. Moreover, bottles made with PC resins, as most U.S. bottles are, can withstand harsh conditions. Also, they usually last longer than bottles made with PET, which can lower costs and increase profitability.

However, PET bottles, when left at 140° F for more than 10 days can lose 3 percent of their volume. Bottles in Mexico generally are stored outside in the sun or in closed trucks where these conditions easily can be replicated in the summer. But volume loss usually is not as important with single-use bottles.

Although there are benefits and costs to each type of plastic, moving to a closed-loop system likely will require stronger bottles that do not lose volume in higher heat. These bottles typically are made of PC, which initially can be more costly but can last longer, making them much more cost-effective. The right plastic can allow more efficient market growth for bottlers looking to institute a closed-loop system.

** PC material was developed by GE Plastics.*

**About the Author**
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## Table 1. Advantages/Disadvantages of Blow Molding Types

**Process Advantages**

**Extrusion Blow Molding**
- Die costs are lower
- Extruder compounds material well
- Able to mold in handles for bottle

**Injection Stretch Blow Molding**
- Can produce more accurate wall thickness
- No bottom weld to trim
- Both PET and PC can be used

**Process Disadvantages**

**Extrusion Blow Molding**
- Limits material for bottle
- Scrap from bottom weld
- High machine cost

**Injection Stretch Blow Molding**
- Unable to mold in handles for the bottle
- Very high tooling cost (two molds required)