

Design Features of Purillex® PFA and FEP Bottles

APPLICATION NOTE

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ABSTRACT



The Savillex Purillex® range of fluoropolymer (PFA and FEP) bottles are manufactured by a unique stretch blow molding process that provides several key benefits - enhancing both the functionality and the finish of the bottles. Compared with the traditional extrusion blow molding process used to manufacture all other PFA and FEP bottles, stretch blow molding gives a much smoother surface, resulting in more effective cleaning and reduced risk of carryover of trace metals.

Stretch blow molding also enables much more accurate and precise molding of the bottle neck and thread - this gives a much more secure seal and eliminates leaks. In addition, a smooth inner neck shape and the absence of molding

imperfections inside the bottle neck allow controllable, drip-free pouring. Manufactured inside a clean room from only the highest purity grade PFA and FEP resins, Purillex bottles are the cleanest, most advanced fluoropolymer bottles ever produced.

SHAPE AND DESIGN

Available in 50 mL, 100 mL, 250 mL, 500 mL, 1 L, and 2 L sizes, in both PFA and FEP, Purillex bottles feature a wide mouthed 45 mm diameter neck with a GL45 threaded closure (33 mm diameter closure on 50 mL bottle). The large, GL45 closure is very easy to grip and widely used in the pharmaceutical industry. Except for the 50 mL size, all Purillex bottles are produced in reagent bottle (also known as media bottle) shape - shorter and wider than traditional fluoropolymer bottles. This makes them more stable and harder to knock over, which is a useful safety feature.

Both PFA and FEP versions are highly transparent which makes them convenient to use. Only the highest purity grades (lowest trace metals content) of virgin PFA and FEP resin are used. The closure is molded from the same resin as the bottle, so only PFA (or FEP) comes into contact with the contents. For pharmaceutical and other compliant environments, Purillex bottles can be shipped with certificate of manufacture, stating date of manufacture, and resin lot number.

STRETCH BLOW VS. EXTRUSION BLOW MOLDING

In recent years, stretch blow molding has overtaken extrusion blow molding to become the predominantly used method for producing plastic bottles – almost every soda bottle is now made in this way. The benefit of stretch blow molding for bottle production is that it allows the neck and threads to be molded very accurately. This is because stretch blow molding is a two-step process. First, a “preform” is injection molded. A preform looks like a miniature version of the final product, comprising of the finished size neck and threads and a small, thick walled bottle part, which will be blown into the final shape. Because the preform is injection molded, the neck and threads are produced very accurately, enabling an excellent seal with the cap, also known as the closure (all closures are injection molded). No insert (liner) is needed inside the closure to produce a leakproof seal.

In contrast, extrusion blow molding is a one step process. A molten tube of plastic is extruded into the molding press. The heated mold (tool) is closed over the molten tube and pressurized air is injected into the interior of the tube forcing the molten plastic to conform to the shape of the tool. The neck and threads are molded at the same time, and excess polymer is trimmed off the top and bottom (producing excess waste). Because the neck and thread are molded during the blow molding step, the accuracy and finish is much poorer than when injection molded and secondary machining must be performed to improve the quality of the opening. There are also limitations on the number of threads and the neck depth and shape that can be achieved with extrusion blow molding.

There is no commercially available stretch blow molding machinery that can handle the demands of fluoropolymer molding, so Savillex designed and built its own stretch blow molding machinery in house. Among all fluoropolymer bottles on the market, only Purillex bottles are produced using stretch blow molding and feature the benefits of this manufacturing technique.

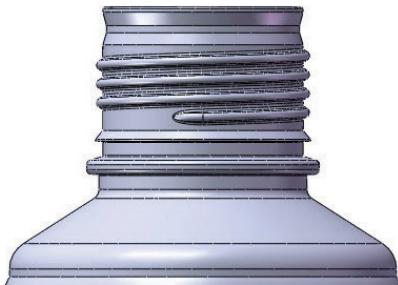


F500 mL PFA bottle preform; neck & threads already formed prior to blow molding step

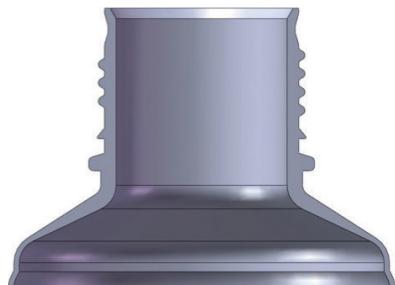
NECK AND THREAD

Purillex bottles feature a unique 3.5 turn thread design (other fluoropolymer bottles have only 1.5 thread turns). More thread turns means a greater thread engagement: this gives Purillex bottles a much more secure closure. As a result, a much better seal is achieved, capable of holding higher pressure without leaking. In addition, seal integrity is maintained over long storage periods because closure “relaxation” is eliminated. The CAD drawing of a Purillex bottle neck at the top of the next page clearly shows the 3.5 thread turns.

Because the neck is injection molded, the inside of the neck can be produced perfectly smooth and cylindrical. With extrusion blow molding, excess polymer forms ridges inside the base of the neck which allows pockets to be formed where liquid becomes trapped. With a Purillex bottle there are no such issues and the smooth inner neck contour allows very controllable pouring which is an important safety feature when dispensing concentrated acids.



Purillex bottle neck - detail

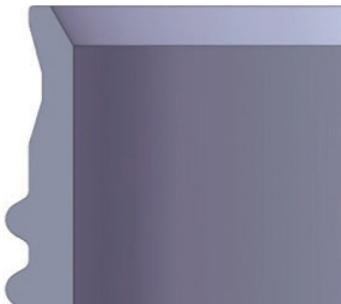


Purillex bottle neck - cross section

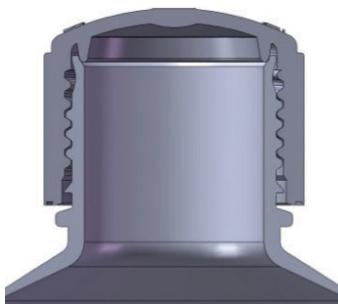
LIP AND CLOSURE

Another benefit of stretch blow molding is that, because it is injection molded, the shape of the lip of the neck is very accurately formed. The angled inner lip (shown below) is very smooth – no additional machining of the lip is required to improve the seal. The shape of the inner lip also completely eliminates drips when pouring which is an important safety benefit when dispensing concentrated acids – especially HF.

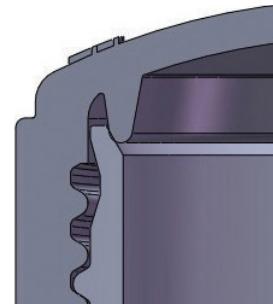
The Purillex GL45 closure (shown below) has an inner lip that aligns and seals with the lip of the bottle neck. Because both surfaces are injection molded, an excellent seal is achieved; and because no machining of the bottle lip is required, the surface is free from machining marks that can degrade seal quality. No cap liner is required, which helps to avoid the risk of contamination, (e.g. a liner is placed on the lab bench and then used to reseal bottle). Liners can also easily be lost or discarded, which then means the bottle is not sealed properly.



Purillex bottle neck - lip detail



Purillex bottle neck closure

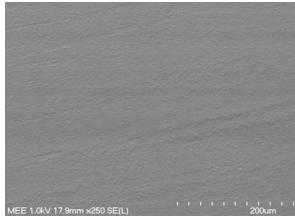


Purillex bottle closure - detail

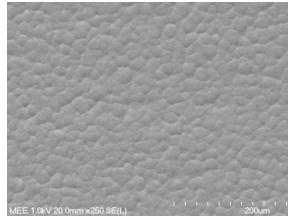
SURFACE FINISH

Another benefit of stretch blow molding is its much smoother surface finish: extrusion molding the preform gives it a very smooth surface, which is retained when the preform is blown into the final bottle. The SEM images below give a very graphic comparison of the difference in surface smoothness between a Purillex bottle

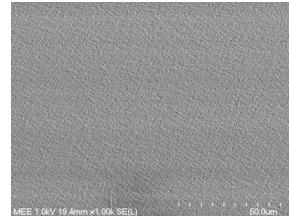
and a traditional extrusion blow molded bottle. The left two images below compare the inside walls and the right two images compare the inside base of the bottles.



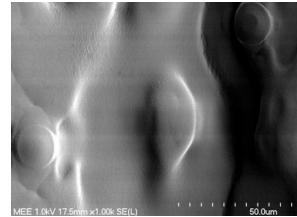
Purillex PFA bottle
inside wall (250x
SEM magnification)



Competitor PFA bottle
inside wall (250x
SEM magnification)



Purillex PFA bottle
inside base (1000x
SEM magnification)



Competitor PFA bottle
inside base (1000x
SEM magnification)

The much smoother surface finish of the Purillex bottles improves cleaning effectiveness and significantly reduces the likelihood of trace metals being trapped on the surface and causing residual contamination where bottles are used multiple times.

SUMMARY

By applying, for the first time, stretch blow molding technology to the production of fluoropolymer bottles, Savillex has raised the design and performance of PFA and FEP bottles to new levels. Purillex bottles have superior pouring and sealing characteristics, a smoother surface finish than any traditional PFA or FEP bottle, and are manufactured in the USA from our Eden Prairie, Minnesota facility.

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