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LyondellBasell Technical Tip

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Extrusion Blow Molding Polypropylene

Many blow molders are familiar with the blow molding of high density polyethylene. HDPE is by far the largest volume thermoplastic used for extrusion blow molding. Fewer blow molders are familiar with polypropylene. This Technical Topic discusses some of the typical parameters used in the extrusion blow molding of polypropylene and some of the differences from polyethylene blow molding.

Polypropylene has a number of attributes that make it an excellent choice for specific end use applications.

One of the primary advantages of polypropylene over polyethylene is better retention of properties at elevated temperature. Polypropylene items, if not subjected to excessive loads, can easily be steam sterilized and will survive exposure to boiling water. In many cases polypropylene bottles are chosen when the bottle must be filled while the product is still hot.

Polypropylene grades are not subject to environmental stress cracking, making them excellent for packaging soaps, detergents and other surfactants. Polypropylenes, particularly random copolymer grades, have excellent contact clarity and can be formulated for reasonable non-contact clarity.

When considering the extrusion blow molding of polypropylene, there are some differences from polyethylene blow molding that must be taken into account.

EXTRUSION EQUIPMENT

Polypropylenes are readily plasticated on extruders that use standard polyethylene screws. Poor melt homogeneity is one of the more frequent problems with polypropylene extrusion. Therefore, an extruder with a L/D ratio of at least 20:1 and a compression ratio of about 3.5:1 is preferred for good mixing.

Many continuous extrusion blow molding machines have parison cutting devices that slice through the hot parison just before the molds index away from under the extrusion heads. Cutting the parison is more difficult with polypropylene than with polyethylene. While cold knives are often used to cut polyethylene parisons, hot knives are strongly recommended for use with polypropylene. Keeping the knives sharp is also more critical with polypropylene.

PROCESSING TEMPERATURES

Extrusion blow molding grade polypropylenes generally operate best at temperatures somewhat higher than typical for general-purpose blow molding polyethylenes. Stock temperatures typically run in the 380 to 430°F. range. Homopolymer polypropylenes have a higher melting point than copolymer polypropylenes and may operate best at temperatures even a little higher. For the best cycle times it is recommended that the stock temperature be as low as possible, but high enough to avoid melt fracture and to produce good pinch-off welds.

In order to minimize melt fracture problems, longer die land lengths have been found useful when blow molding polypropylene. A die land to die gap ratio of 10:1 is considered by many to be optimal.

DIE SWELL AND MELT STRENGTH

Polypropylenes generally have higher die swell than HDPE resins. This is countered, however, by their relatively poor melt strength. So, while the high swell produces a larger diameter parison, the natural sag of the parison may negate the increased diameter swell.

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The comparatively low melt strength of polypropylenes has been a limiting factor to the size of the blow molded parts made from the resin. It is more difficult to maintain good wall thickness distribution with a sagging parison. A good parison programmer will increase the chance of producing a larger part from polypropylene.

SHRINKAGE

Polypropylenes shrink about 25% less than do polyethylenes. That means that, if specific dimensions are critical, a mold designed for polyethylene may not produce a suitable part out of polypropylene.

MOLD FINISH

As with other polyolefins, most molds for polypropylene are lightly grit blasted to reduce air entrapment. For applications demanding the best clarity possible, however, polished molds can be used, if the design is such that air entrapment is not a problem.

Venting of entrapped air between the parison and the mold as the parison is inflated is a subject often taken for granted. Trapped air keeps the hot polymer from contacting the cold mold surface, leaving hot spots on the molded item. Problems with wall thickness distribution and small "witness lines" can result from inadequate venting. Venting of difficult molds can be helped with the use of sintered plugs or small pinhole vents in the mold cavity. Hardened steel standoffs (0.002 to 0.003 inch) at the corners of the mold parting line can also be incorporated into the mold design, with corresponding attention to the pinch-offs. Radial wiping of polished molds may help move entrapped air out through the parting lines.

TRIMMING

Polypropylenes are more difficult to trim than polyethylenes. Polypropylene can be bent, stretched and oriented to give exceptional strength, such as in a living hinge. For this reason, it is better to have trim tooling that incorporates a shearing or cutting action. If the trim tooling bends the flash, the flash may hinge and refuse to separate. The trim tooling should have sharp edges and tooling alignment should be monitored closely. It generally takes more force to trim a polypropylene bottle than a polyethylene bottle.

DECORATING

Polypropylene, like the other olefin plastics, has a very low natural surface tension. Surface treatment similar to that used with HDPE is required for the application of inks and labels. Flame and electrostatic treaters used for HDPE are also suitable for polypropylene.

LyondellBasell Industries
P.O. Box 3646
Houston, TX 77252-3646
United States

www.LYB.com

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