LyondellBasell Technical Tip

# tech.topic

## Sharkskin

At one time or another, you may have found bottles coming off your blow molding machine with a "sharkskin" inner surface — wide, alternating bands of thick and thin wall sections.

- **What causes sharkskin and how can it be prevented?**

**The answers are fairly straightforward.**

If you are running a continuous-extrusion blow molder, sharkskin results from extruding the resin too fast. Simply slow the extruder RPM and the problem disappears.

If you are running a reciprocating-screw blow molder — and most dairy operations use this type of machine — you are not extruding the resin fast enough. Increasing the shot-pressure should get rid of the sharkskin defect in the bottles.

While these may seem like conflicting solutions to the same problem, the reasons are understandable if we look at the complex behavior of a high density polyethylene (HDPE) melt as it is pushed through a die. In general, as extrusion pressure is increased, the extrusion rate increases (or drop time decreases).

A plot of extrusion rate versus pressure under these circumstances resembles Figure 1.

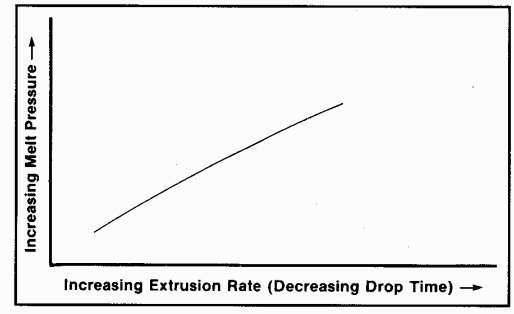


**Fig. 1: Melt Flow as Expected**

However, with HDPE, this plot is not entirely accurate. When the actual extrusion rate of HDPE is plotted against extrusion pressure, the curve formed looks like that shown in Figure 2. Starting at some low value, as pressure gradually increases, a correspondingly smooth increase in extrusion rate occurs for a time. Through the lower region of the curve, melt flow is steady and bottle surfaces are smooth. This region of the curve corresponds to the normal operation of a continuous-extrusion, blow molding machine, i.e., relatively slow extrusion of the parison or a long drop time.

As melt pressure continues to increase, suddenly sharkskin occurs. On the flow curve in Figure 2, this region is described as the "pressure plateau."

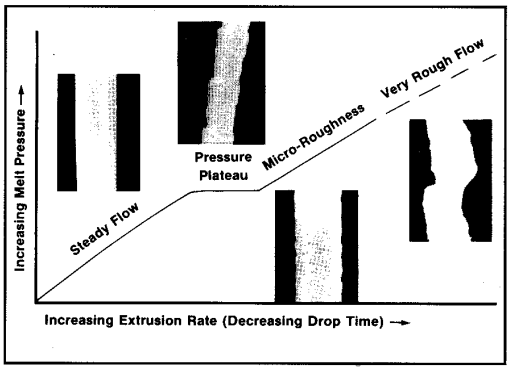


**Fig. 2: HDPE Melt Flow in Real Life**

However, if extrusion pressure is raised still further, the sharkskin disappears. Actually, neither the parison nor the bottle is quite as smooth as one produced in the steady-flow region. A very close examination of the inner bottle surface discloses a micro-fine roughness that does not detract from either the appearance or the performance of the bottle.

This region of micro-roughness continues over a wide range of increasing extrusion pressures and encompasses the operational range of most reciprocating-screw, blow molding

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## Sharkskin *(Continued)*

machines. If the extrusion rate continues to increase to very high levels, melt fracture occurs and the parisons are very rough and unmanageable and the resulting bottles are unacceptable.

The inset photographs in Figure 2 are enlargements of the extrudate from a capillary rheometer, an instrument enabling fine control of extrusion rates. The photos show the condition of the parison when extruded in different regions of the flow curve, i.e., at various rates of extrusion.

In continuous-extrusion, blow-molding machines, the extrusion of the parison takes place in the region of steady flow. The rapid extrusion of the parison in a reciprocating-screw, blow molding machine takes place at rates above the pressure plateau. These facts explain the seemingly contradictory solutions stated earlier to the sharkskin problem.

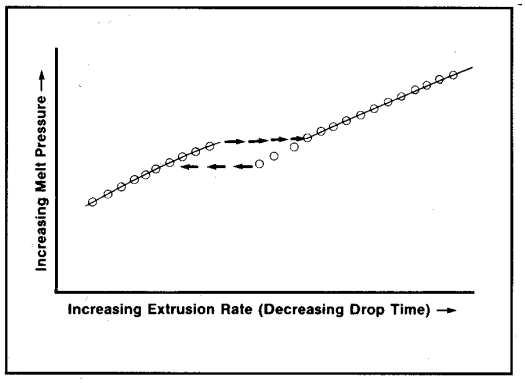


**Fig. 3: Pressure and Extrusion Rate Oscillations in the Pressure Plateau Regions Produce Sharksin**

Figure 3 takes a closer look at what happens in the pressure plateau. Within the plateau, very small increases in extrusion pressure cause the extrusion rate to nearly double. Conversely, a small pressure drop causes the extrusion rate to fall dramatically.

After such a drop, pressure starts to build again and the cycle repeats. Each of these rapidly occurring cycles produces a thin and thick section in the parison, which translates into sharkskin in the bottle.

All HDPE resins used for blow molding exhibit the phenomenon described above. HDPE resins from Equistar are designed to minimize the width of the plateau and to enable the operator to control sharkskin while maintaining high extrusion rates.

For more information about polyethylene for high-speed blow molding, contact your LyondellBasell sales or technical service representative.

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