ASHLAND

Cycletime Tips - General

Volume 15: How do you set first-stage pressure? -- Part 1

Editor’s note: If you don’t account for plastics’ viscosity change undershear, you won’t get good parts. In a two-part series, John Bozzelli addresses process control this moreth, and constant flow rate next month.

By John Bozzelli

Correct process control is imperative for making identical injection molded parts that meet tight tolerances and numerous complex quality standards. One essential, and often overlooked, variable is velocity control. Molding must have a wide operating window in which the machine adjusts on the fly for plastic viscosity changes.

This processing guide addresses plastic flow rate during first stage. It’s important to maintain context, however. This is only one of hundreds of issues involved in plastic processing.

First stage—also called boost—is defined here as the filling of the mold cavity. For this discussion, first stage is used to fill the cavity 99% by volume. The part is not packed out and may appear short or contain sink marks. The last area to fill does not see much pressure and the flow front may be Obvious if the press is stopped at the end of first stage. This may be different from the way you currently mold, but it is a critical point in developing a stable process. Know what the part looks like at the end of the first stage.

Understanding the polymer’s flow characteristics during filling a cavity is critical in developing a strategy for setting up first stage. Of the numerous aspects to polymer flow, we will concentrate on only one: most plastics exhibit a viscosity change as a function of flow rate. Water and oil do not change viscosity as a function of flow rate and they exhibit what is described as Newtonian flow.

It can be demonstrated through mold filling analysis, capillary rheology or using the injection molding machine as a rheometer that plastics change viscosity as injection rate changes.

Figure 1 shows how a typical plastic’s viscosity is affected by various flow and shear rates. Temperature effects are not shown. Most data of this type are usually—and more correctly— graphed on log scales. However, to make a point we have plotted the data on linear scales. Note that the horizontal scale is reversed, going from slow data fills on the left to fast fill times on the right. The scale covers fill time from 12 seconds to less than 0.50 second to fill this particular mold with ABS. Ninety-nine percent of all plastics exhibit this behavior.

This curve showing changing viscosity may be confusing. Most of us were trained with the industry standard for relating viscosity: the Melt Flow Rate (MFR) test. MFR is also known as Melt Index (MI). The details of the MFR test are set by ASTM D 1238- 90b and are reported as one number with the typical units of gram/10 minutes. Without describing the MFR test, the point to be realized is that it is a single number, and a single number cannot describe the viscosity behavior of plastics in processing. A single number can describe the viscosity of water or oil. Note the straight line in Figure 1. Water’s viscosity does not change whether you push it slow or fast. Also, MFR is a single number at a slow flow rate or low shear rate. Does grams/10 minutes relate to your normal injection speeds?

Once it is realized that plastic changes viscosity with respect to flow rate, the next step is to apply this information to molding.

John Bozelli is a General Polymers senior processing engineer in Warren, MI.