ASHLAND

# Cycletime Tips - General

**Volume 16: How do you set first-stage pressure? -- Part 2**

Editor's note: If you don't account for plastics' viscosity change under shear, you won't get good parts. In this second part of a two-part series, John Bozzelli addresses constant flow rate.

By John Bozzelli

**Constant flow rate**

Since viscosity changes with flow rate, if we want a stable process, we must keep flow rate (injection velocity or speed) constant. If flow rate changes, then viscosity changes; if viscosity changes, then parts will be different.

Therefore, our first strategy is to fill all cavities identically with each shot. To do this, we need to keep flow rate constant. We can measure injection velocity by the ram's velocity or by fill time.

Since not all injection machines have velocity measurement capability, we will use fill time. Bottom line: fill time to a 99% full cavity must be constant shot to shot and run to run. This velocity control is similar to cruise control on a car. Note we are not worried about specific machine settings. We have established a universal number that will work on any plastic machine's fill time.

The key strategy in maintaining constant velocity control is establishing a pressure differential (delta P) across the flow valve. Do you want to maintain constant machine conditions or constant plastic conditions?

The next question is how to keep fill time constant while running an injection molding machine.

Most hydraulic machines have some type of valve to control flow of oil to the hydraulic ram. This can be a manual valve, servo valve, proportional, cartridge or something else. These valves are adjusted manually or electrically, and they can be open loop or closed loop. Their purpose is to regulate the flow of oil to the ram. For these valves to function properly, they require one common variable to be set correctly: a pressure differential (delta P) across the valve.

That is, first-stage pressure must be set higher than the maximum pressure required to push the plastic to fill the cavity 99% full. If first-stage set pressure on the pump aide ever nears or equals the pressure in the hydraulic ram, the injection speed will slow down. If the ram slows down, then the viscosity of the plastic will change (get stiffer) and

you will see a stair-step effect. If the plastic gets harder to push, then the ram will slow down some more and so on, until you may have a short shot. Bottom line: For velocity control you must operate your machine with a delta P across the flow control device with abundant pressure on the pump side.

Caution must be exercised in setting this delta P. An adequate delta P is needed to control velocity. You also must protect the mold from the situation that arises if it's a multi-cavity mold, and one of the cavities blocks off due to metal contamination or unmelt. Then, for example, in a four-cavity mold, we would be driving four cavities worth of plastic into only three cavities. If there were slides in the mold, we might flash them and damage the tool.

Without delta P and process control on fill, parts will vary. At excess pressure, mold over-packing—and perhaps even damage—are possible. The ram must be taken off cruise control before the last area fills out; otherwise the mold will likely flash. It's like driving a car under cruise control into a bridge support—not a wise idea. A well-built mold should be able to withstand a certain amount of excess pressure. Overpressurizing the mold is likely to happen for a number of reasons throughout its life. The question is how much extra or abundant pressure is needed to gain velocity control yet not potentially damage the mold. The machine should not be set to full system pressure for all molds.

Methods to find the minimum delta P are available, but not practiced by many molders.

One way to find this pressure is to raise hydraulic pressure as you are making short shots until the fill time stops decreasing. Then you can measure how much you are using to drive the plastic for a 99% full part and note what the first-stage set pressure is at transfer. Delta P is the difference between what the hydraulic ram uses and what you have set for first-stage (it must be higher). First-stage set point is a relief pressure.

You now have to test the stiffest lot the resin supplier may provide you so that you can set the machine with enough first-stage pressure to control velocity. The ram will use whatever pressure it needs to achieve this. For easy-flow or hotter plastic, it will use less pressure. For stiffer-flowing or cooler material, it will use more pressure-keeping velocity, and therefore, viscosity constant shot to shot and run to run. Every shot should take a little different pressure for first stage.

Another method of finding the required delta P is to ask what the machine manufacturer recommends. They designed and built the press. They should understand this concept fully. What is their recommendation for setting first stage?

A word of caution: Many machinery manufacturers and trainers teach the use of constant hydraulic pressure. This strategy is like setting your car on a constant rpm to maintain 85 mph. There is a difference of opinion in our industry on this and you have to make a choice. It boils down to a strategy of constant machine conditions or constant plastic conditions.

Which strategy makes your life easier and provides higher profits? Try constant rpm on your next trip.

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