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Cycletime Tips - General

Volume 12: Four Injection Molding Variables

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The successful plastic part is the combination of proper part design, material selection, tool design and optimized process. For this article we will discuss a portion of the process component.

Injection molding machines have from a relatively few to an overwhelming number of machine control options which affect the polymer as it moves from container to the mold cavity. These include barrel temperatures, hydraulic pressures, hydraulic flow rates, oil temperatures, function times, and clamp force. Thermoplastic variables can be reduced to plastic temperature, plastic flow rate, plastic pressure and plastic cooling rate/time. Plastic variable measurement is independent from machine variables and can be repeated on any injection molding machine.

Plastic temperature or melt condition is determined by a combination of barrel temperatures, screw design, screw check valve design, screw rotation speed, back pressure and residence time. Plastic temperature should be checked using a calibrated, pre-heated pyrometer placed into a purge puddle that was taken on cycle. Machine temperature controllers must be properly calibrated and tuned. Screw recovery time should be monitored for consistency.

Plastic flow rate is measured in seconds from the start of injection until transfer to pack/hold at 95-99% full mold. This fill time is not the same as first stage timer setting. Fill time in combination with a calculation of shot volume gives a volumetric flow rate which is a plastic variable measurement. Plastic flow rate determines plastic viscosity as it enters the mold cavity. As the plastic molecules flow, they untangle and become aligned, they take up less space and slide easily past one another thus reducing the viscosity of the polymer melt. Because of this unique and direct relationship of fill time to plastic viscosity, fill time must be maintained shot to shot and run to run.

Plastic pressure is defined as a measure of the amount of compression of the polymer in the mold cavity at the end of the molding cycle. It is necessary to control both the amount of polymer put into the mold and the amount of polymer maintained or held in the cavity until the gate has frozen. The key machine controls that determine plastic pressure are pack pressure, pack time, hold pressure and hold time. The best method of measuring plastic pressure in the molded part is to use cavity pressure transducers.

Plastic cooling rate and time will affect final part dimensions, part appearance and cycle time. The mold surface temperature affects part aesthetics and part performance by affecting the thickness of the oriented layer of plastic molecules. When the mold is filled with plastic, most of the heat content of the melt must be transferred to the mold cavity and ultimately away from the area. Some heat is lost by radiation but most is removed by forced convection through the cooling channels in the mold. Optimize heat transfer by having turbulent flow in all cooling channels, by keeping cooling channels free of scale that insulates, by directing coolant flow to the most needed areas and by keeping the plastic against the cavity surface as long as practical. Compare coolant temperature in versus coolant temperature out in each circuit to evaluate the heat removal performance. A difference of 4°F or larger is undesirable and indicates poor rate of heat removal.

Process optimization and troubleshooting are easier when you understand how machine variables affect the four injection molding variables. I hope this information helps in your next project.

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