Processing Tips for Molding Polypropylene Resins

Polypropylene Injection Molding Start Points

Nominal Melt Flow Rate	g./10min	**2 - 10**			**10 - 20**			**35 -50**		
Section Thickness	in.	0.063	0.125	0.25	0.063	0.125	0.25	0.063	0.125	0.25
	mm	1.6	3.2	6.4	1.6	3.2	6.4	1.6	3.2	6.4
Melt Temperature	°F	460	440	420	440	420	400	420	400	380
	°C	238	227	216	227	216	204	216	204	193
Temperature Settings										
Rear Zone	°F	420	400	380	400	380	380	380	380	360
	°C	216	204	193	204	193	193	193	193	
Middle Zone	°F	440	420	400	420	400	400	400	400	380
	°C	227	216	204	216	204	204	204	204	
Front Zone	°F	460	440	420	440	420	400	420	400	380
	°C	238	227	216	227	216	204	216	204	
Nozzle	°F	440	420	400	420	400	400	400	400	380
	°C	227	216	204	216	204	204	204	204	
Mold	°F	50 – 100			50 – 100			50 – 100		
	°C	10 – 38			10 – 38			10 – 38		
Injection Pressure	psi	600 – 1500			600 – 1500			600 – 1500		
	MPa	4 – 10			4 – 10			4 - 10		

Polypropylene is an easy to process semi-crystalline polymer. This guide is intended to highlight injection molding process conditions and set up.

Molding Machine Considerations

Polypropylene can and has been successfully molded with plunger and reciprocating screw injection molding machines, including single and two-stage machines. A reciprocating screw machine is generally preferred for applications requiring melt homogeneity.

Injection machine requirements include 20,000 psi. injection high pressure and separate injection speed control. Injection and hold pressure profiling can also be of benefit. Using the lowest pressure that fills the mold can extend mold life. This will also reduce flashing, extending mold life.

Clamping forces between 1½ and 5 Tons/square inch have been used. Low viscosity (high melt flow rate) resins generally require lower tonnages than high viscosity resins. While a general-purpose screw can be used, many applications benefit from screw engineering to promote rapid melting and improved dispersion. Shot size should be 50 to 75% of barrel capacity.

Auxiliary Machines

Central and press-side auxiliary machines can be used for drying, mold temperature control and sprue & runner grinding. Selection will rely on individual plant engineering.

Drying

Polypropylene resins typically do not require drying before processing. Touch up drying may be required to reduce and eliminate splay from condensed moisture, as when resin is brought into a warm, moist building from cold transport or storage.

Mold Temperature Control

Heaters and or chillers will achieve mold temperature control. Low mold temperatures can give faster cycles, with the concern for molded in stresses. Higher mold temperatures will give more complete replication of mold surface features. Water or water/glycol mixtures are sufficient for most polypropylene molding requirements.

Grinders
Most conventional grinders are suitable for regrinding sprues, runners, and rejected parts. Screen diameters should be ~¼". Each application should be evaluated to determine the maximum acceptable level of regrind. The regrind should be kept clean, uncontaminated, and be well blended with virgin resin before molding.

Mold Design Highlights Mold Materials
Molds for polypropylene have been successfully made from many materials. Production molds are typically made from hardened steel, using pre-hardened bases and either stainless or higher hardness tool steel for the cavity and core inserts. Specialty inserts have been made from high conductivity materials such as copper alloys and/or self-venting porous materials. Prototype molds have been made from diverse materials such as aluminum, nickel coated epoxy, and cast zinc alloys.
Mold Design The **nozzle and sprue bushing** create the transition from injection molding machine to the mold. The nozzle and sprue need to be matched for both spherical radius (nozzle locating) and nozzle exit to sprue entrance diameter, for both cold sprue and hot sprue bushing applications. For cold sprue and runners, the nozzle will have an exit orifice typically ¼" diameter and the entrance of the sprue bushing will be 1/32" diameter larger. These dimensions will vary with specific parts and are intended to allow for the inevitable mis-match. The sprue and bushing diameters will probably be larger for hot sprue & runner applications. Matching these elements will aid part ejection and color transitions. Whether hot or cold runner systems are used, the runner should be as short and direct as possible. Runner and cavities should be balanced for multi-cavity molds. **Gate location** should be selected to minimize sinks, voids and weld lines. General practice is to gate the part into its thickest section. Many **gate designs** have been successfully used, among them - pinpoint, tunnel, cashew, rectangular, diaphragm or flash, and full round. Whatever gate design is selected, a smooth, tapered transition from runner to gate and short land length (~0.020") is preferred. Gate diameters range from 50% to 75% of the part thickness at the gate. **Cavity and runner venting** are essential for smooth, rapid filling and easy molding. Vents can be located on the parting line, along ejector pins, or with inserts made of porous mold materials as needed. Vent sizes can start at 0.0005" thick x 0.020" land x width to suit. In general, vents will increase in depth away from the cavity edge.

Part Design Highlights Shrink rates for polypropylene resins can range from 0.010 in./in. to 0.030 in./in., depending on selected resin, molding conditions, and part thickness. Prototyping critical applications will be needed to determine which shrink rate to use. The shrink rate with the flow will typically be greater then the shrink rate across the flow. Polypropylene materials will shrink at a greater rate in thick sections, compared to thin sections. Typical **draft** will be 1 degree per side. Less draft can make part ejection difficult. Polypropylene parts have been molded with as little as ½ degree per side draft. Textures will probably require more draft.

Molding Pointers Back Pressure can range from 50 to 250 psi. with machine capability. Increased back pressure will lengthen screw recovery time and increase mixing of additives such as colorants. Fast **Injection Speeds** will generally give better results than slow speeds. This can vary from one application to the next. Increased packing will generally give stronger and stiffer parts than under-packed. Caution is needed, as over-packed parts can be brittle. **Injection Pressures and Fill Rate** should be as high as possible. Transfer to hold should be set at 95 to 97% cavity fill. **Hold Pressure** should be 50 to 75% of Injection Pressure. Set **Hold Time to finish at Gate Freeze** to ensure packed parts.

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