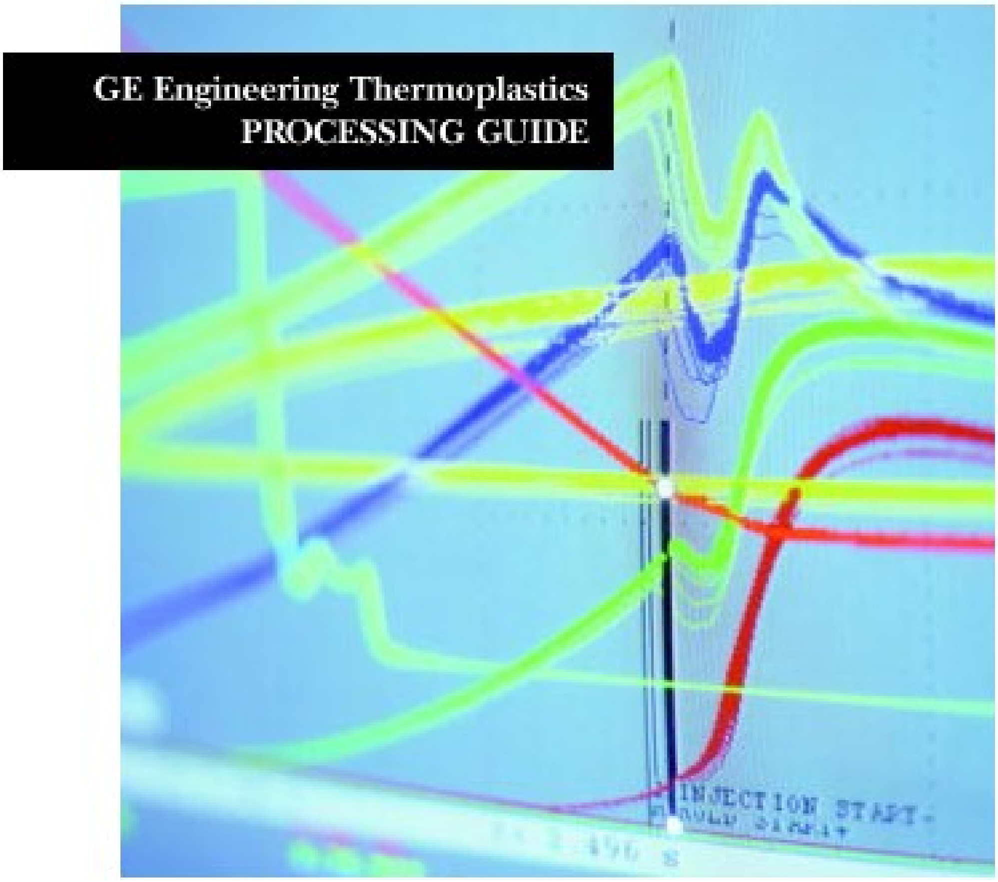
GE Plastics

XENOY* PC/PBT Processing Guide



XENOY resin is a versatile thermoplastic alloy blend of polybutylene terephthalate (PBT) and polycarbonate (PC). This product family offers good chemical resistance, great impact resistance even at low temperatures, heat resistance, outstanding aesthetics and flow characteristics. Certain resins offer very good UV resistance and color retention. The result? Cost-efficiency, improved productivity and higher yields in applications ranging from thin-wall automotive bumpers and body panels to housings for business equipment, lawn mower decks and cellular phones.

Contents

Materials

XENOY resin is a thermoplastic alloy blend of polycarbonate (PC) and polybutylene terephalate (PBT). The amorphous polycarbonate provides impact resistance and toughness while the PBT polymer provides enhanced chemical resistance and thermal stability. XENOY resins are characterized by their ductility, chemical resistance, high temperature dimensional stability and mechanical strength. Resins in this family also offer very good aesthetics, lubricity, UV resistance and color retention.

Originally developed for the automotive industry, XENOY resins are designed to provide resistance to both gasoline and oils, as well as a high level of impact strength at temperatures down to -40°F (-40°C). Impact modification completes the balanced performance profile of the XENOY resin family by providing both low and high temperature durability.

Whether it's the combination of impact strength and chemical resistance with dimensional stability; lubricity and high temperature resistance or toughness, XENOY resins offer a balance of performance characteristics unique among engineering thermoplastics.

Property	Characteristics	Typical Designations
Chemical and Impact Resistance	Resin grades offering resistance to gasoline and oils, automotive fluids. Good physical property retention.	1000 series
Chemical and Heat Resistance	Good chemical resistance with very good heat resistance and impact strength.	2000 series
Chemical/ Impact Resistance	Better chemical resistance with good impact strength	5000 series
Chemical/ Impact Resistance	Very good chemical resistance and good impact strength and electrical properties, with glass reinforced grades available.	6000 series

The following pages contain additional information on mold design and/or processing specific to XENOY resin. Additional information on these subjects is included in Chapter 1 (Mold Design) and Chapter 2 (Processing) of the GE Plastics Processing Guide.

Shrinkage

XENOY resins are alloys of amorphous and crystalline materials and thus can exhibit mold shrinkages typical of both. Mold shrinkages for each resin series can vary greatly. In addition, unreinforced grades tend to shrink isotropically, whereas shrinkage becomes anisotropic in reinforced grades. Part design, gate location and processing conditions can all influence shrinkage.

- A decrease in mold temperature can be expected to produce a corresponding decrease in mold shrinkage. It should be noted that if a part is molded at low mold temperatures [i.e., 100°F (38°C)] and later exposed to hi[...] than ambient temperatures [i.e., 150°F (66°C)] some additional post-mold shrinkage may occur.

- An increase in injection pressure can be expected to produce a decrease in mold shrinkage. A part that is not completely packed will typically experience excessively high mold shrinkage.
- Lowering the melt temperatures will generally produce a slight decrease in mold shrinkage.

Typical mold shrinkages for the various XENOY resins are listed in Table 13-1.

MOLD SHRINKAGE:

NOMINAL SHRINKAGES, IN./IN. E-3 @ 0.125" (3.2mm) WALL THICKNESS

XENOY Resin Grades	Parallel to Flow	Perpendicular to Flow
XENOY 2230 resin, unreinforced	6-9	6-9
XENOY 2735 resin, unreinforced	5-8	—
XENOY 5220 resin, unreinforced	8-10	8-10
XENOY 5720 resin, unreinforced	6-9	—
XENOY 6123 resin, unreinforced	12-15	—
XENOY 6240 resin, 10% GR	7-9	—
XENOY 6370 resin, 30% GR	4-5	7-9

Table 13-1. Mold Shrinkage.

Mold Shrinkage as a Function of Wall Thickness

Shrinkage may also increase for a given wall thickness when molding large parts and the flow length exceeds 12 inches from the gate. This can be caused by underpacking in long flow areas.

Figures 13-1 through 13-3 represent a profile of mean shrinkage values that may be expected when processing XENOY engineering thermoplastic resins at the conditions suggested in this guide. Varying processing conditions can affect shrinkage. Prototype test in part geometry will provide the most reliable data.

As thermoplastic alloys, different grades of XENOY resin exhibit varying shrink rates. For specific mold shrinkage information, consult the processing datasheets available for each grade.

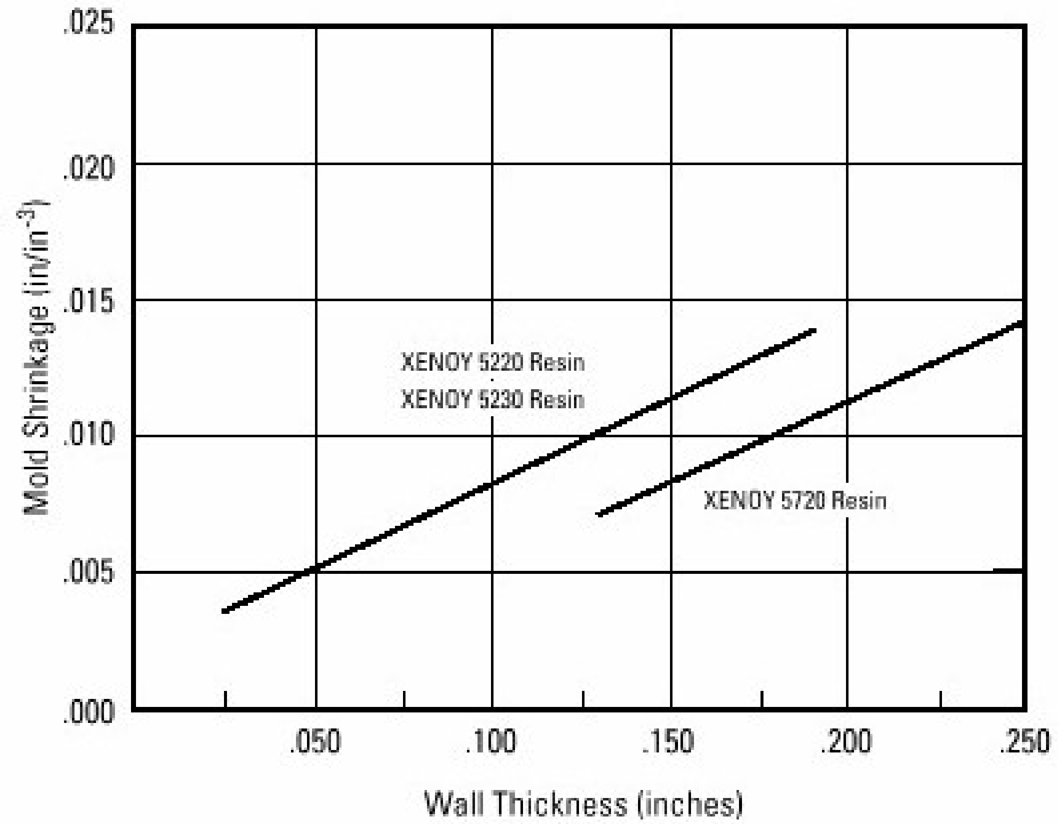


Figure 13-1. Profile: XENOY Resin 5000 Series - Mold Shrinkage vs. Wall Thickness.

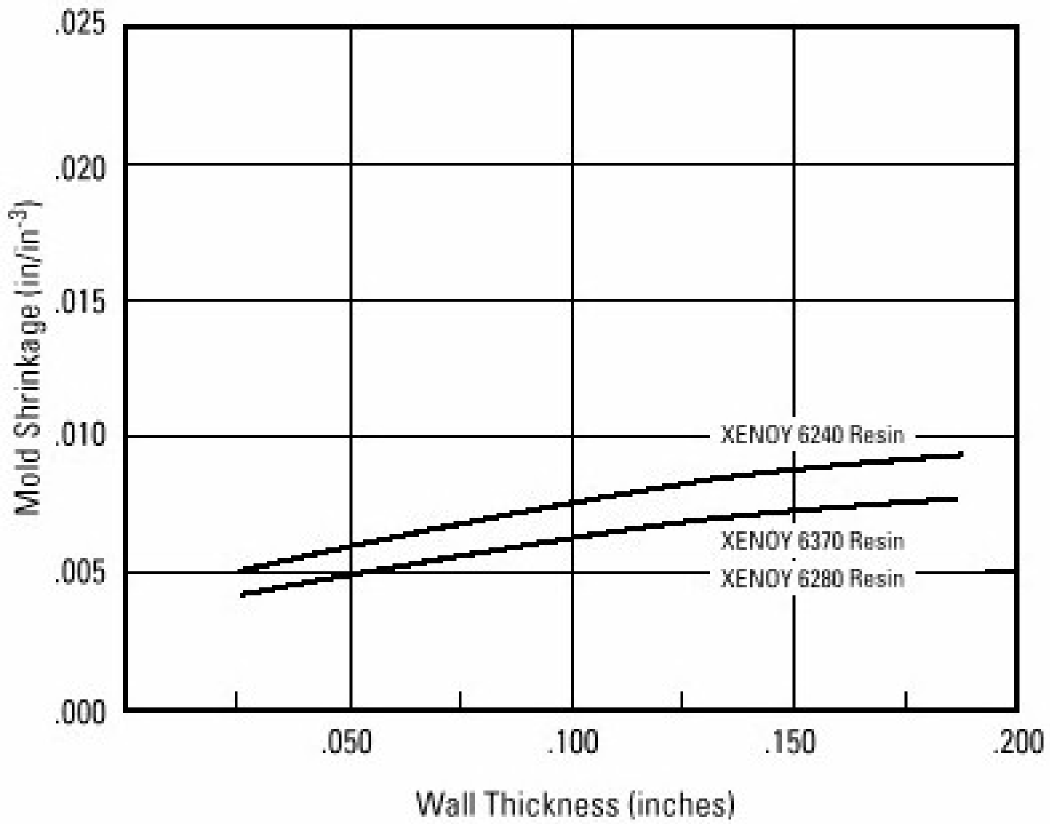


Figure 13-2. Profile: XENOY Resin 6000 Series Reinforced- Mold Shrinkage vs. Wall Thickness.

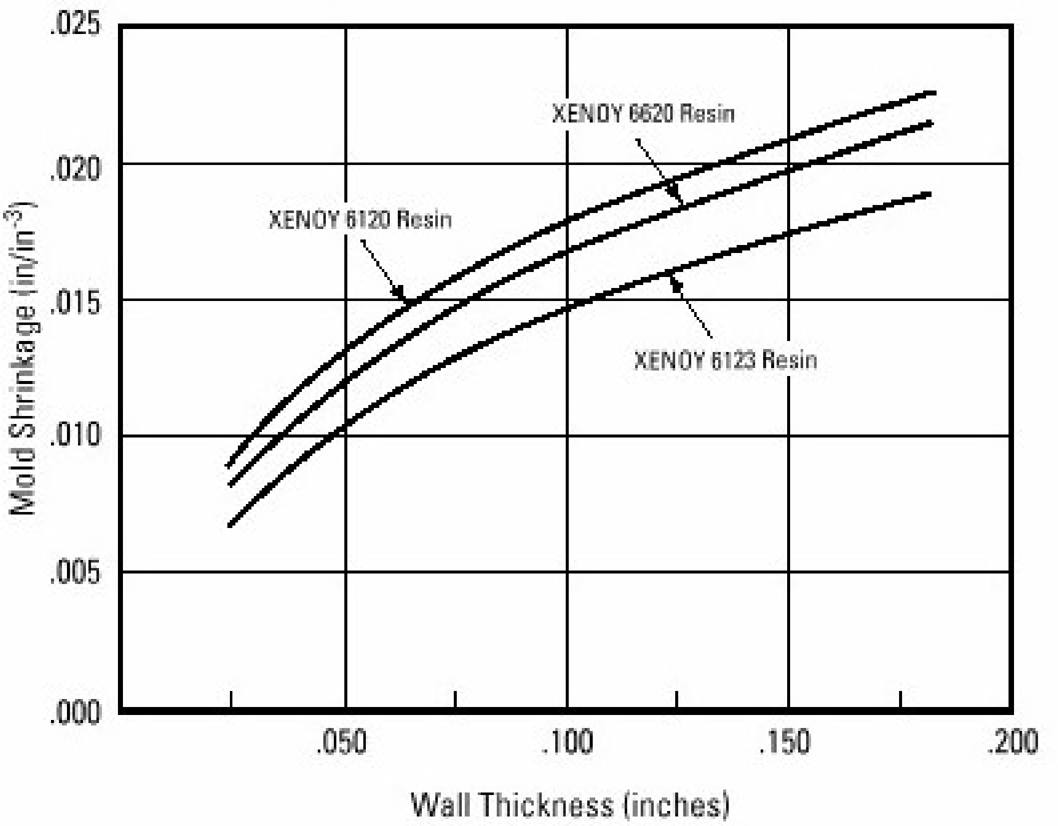


Figure 13-3. Profile: XENOY Resin 6000 Series Reinforced - Mold Shrinkage vs. Wall Thickness.

Machine Selection

When determining the size of equipment to be used for molding a particular XENOY resin part, total shot weight and total projected area are the two basic factors to be considered.

Optimum results are generally obtained when the total shot weight (all cavities plus runners and sprues) is equal to 30 to 80% of the machine capacity. Very small shots in a large barrel machine may create unnecessarily long resin residence times.

If it is necessary to mold at the high end of the temperature range, reduced residence time is usually required to reduce the possibility of material heat degradation. Therefore, for higher temperature molding requirements, it is suggested that the minimum shot size be greater than 60% of the machine capacity.

Once the total projected area of the complete shot (all cavity and runner areas subjected to injection pressure) has been determined, 3 to 6 tons of clamp force should be provided for each square inch of projected area to reduce flashing of the part. Glass reinforced resins may require slightly higher clamp force (estimate one ton per square inch more). Wall thickness, flow length and molding conditions will determine the actual tonnage required (Figure 13-4).

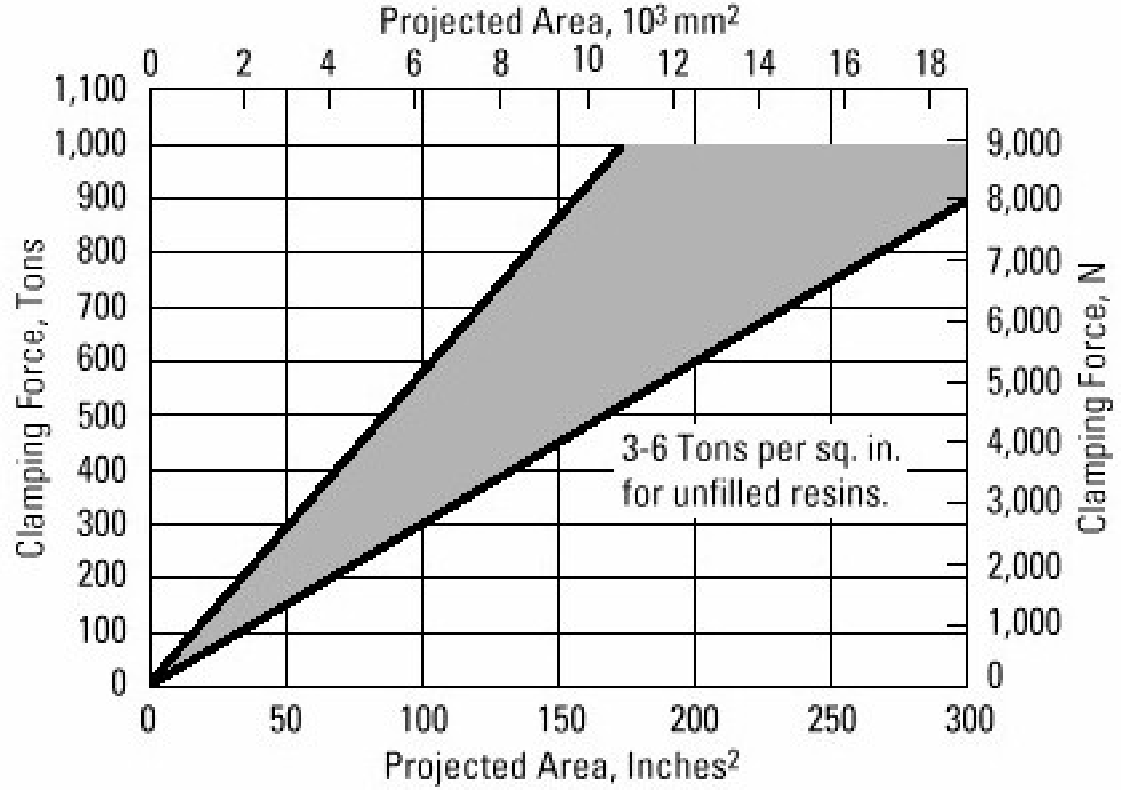


Figure 13-4. Clamping Force for XENOY Resins.

Drying Parameters

XENOY resin will absorb a small amount of water from the atmosphere after compounding and prior to processing. The amount absorbed will depend on environmental conditions, and may vary from 0.10 to 0.18%, depending on the temperature and humidity of the storage area.

Properly dried XENOY resin is more stable during molding and typically produces tougher parts.

In order to enhance performance of molded parts and to reduce the possibility of degradation, all grades of XENOY resin must be dried before processing. Resins should be dried until the moisture level is less than 0.02%, typically 4 to 6 hours at 230°F (110°C). Figure 13-5 shows a typical drying curve for XENOY resin compounds.

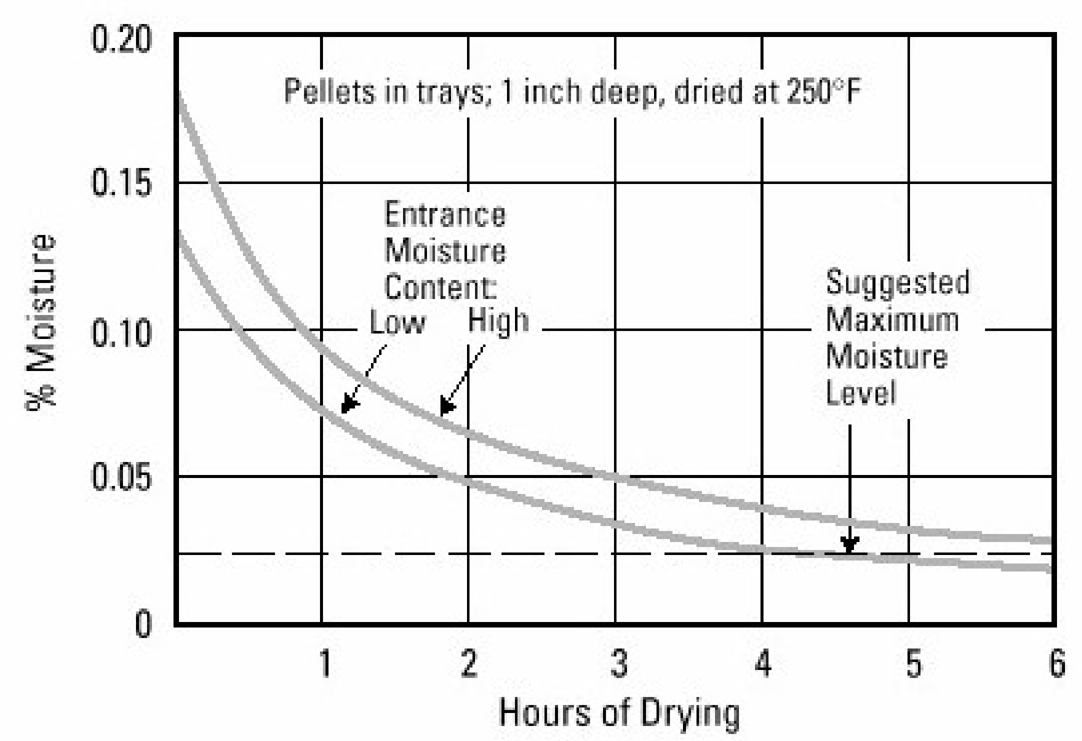


Figure 13-5. Representative Drying Curves fro XENOY Resins.

The suggested moisture level can usually be reached by predrying XENOY resin at temperatures suggested in Table 13-2.

XENOY Resin Series	Drying Temp. [°F (°C)]	Drying Time* (Hrs.)
2000	230 (110)	4-6
5000, 6620	230 (110)	4-6
6000	230 (110)	4-6

* Times suggested are "mean times" and may be longer for some colors and grades. Moisture content should be 0.02% or less.

Table 13-2. XENOY Resins Drying Suggestions.

The hopper capacity should be sized to provide a residence time of 3 to 4 hours. For example, a molding machine with a through-put of 100 pounds per hour would have a 400-pound hopper capacity to meet the drying time requirements.

The required drying temperature should be monitored at the input of the hopper. The dewpoint of the air at the input of the hopper should be -20°F (-29°C) to -40°F (-40°C) or lower.

Air flow volume should be one cubic foot of air per minute per pound of material processed per hour (1 cfm/pound of material/hour), the minimum air flow would be 100 cfm.

If dryer systems with permanently installed desiccant beds have not been used recently, it is suggested that the system be dry cycled at approximately 150°F (66°C) for sufficient time to allow the reactivation of all desiccant beds.

Check temperature with a calibrated pyrometer or thermometer at the input of the hopper with dryer operation at the rated air flow. Inlet air should be at 230°F (110°C); if not, adjust control to achieve 230°F. The correct placement of the thermocouple should be at the input to the hopper.

Molding Conditions

Control over processing conditions is critical to the economical production of quality parts. Fast cycles and low reject rates are both important in successful processing. For typical processing parameters of XENOY resin compounds, see Table 13-3.

Molding Conditions

		1102 1200 1731 1732 5220U	5720U 6123 6123M 6127 6620	1760E 2230U 2730U 2735 5770 6240 6370	
Processing Parameters	**Units**	**(min.)**	**(max.)**	**(min.)**	**(max.)**
Drying Temperature	°F(°C)	–	230(110)	–	230(110)
Drying Time (Normal)	h	4	6	4	6
Drying Time (Max.)	h	–	8	–	8
Maximum Moisture	%	–	0.02	–	0.02
Melt Temperature	°F(°C)	500(260)	530(277)	500(260)	540(282)
Nozzle	°F(°C)	490(254)	520(271)	490(254)	530(277)
Front Zone	°F(°C)	490(254)	530(277)	500(260)	540(282)
Middle Zone	°F(°C)	480(249)	520(271)	490(254)	530(277)
Rear Zone	°F(°C)	470(243)	510(266)	480(249)	520(271)
Mold Temperature	°F(°C)	150(66)	190(88)	150(66)	200(93)
Back Pressure	psig(MPa)	50(0.3)	100(0.7)	50(0.3)	80(0.5)
Screw Speed	rpm	50	80	50	80
Shot to Cylinder Size	%	50	80	50	80
Clamp Tonnage	tons/in²	3	6	3	6
Vent Depth	in	0.0005	0.0008	0.0005	0.0008

Table 13-3. Typical Injection Molding Processing Parameters for XENOY Resins.

Melt Temperature

Suggested melt temperatures for XENOY resin are listed in Table 13-3. Like the majority of thermoplastic molding materials, XENOY resin is sensitive to prolonged exposure to heat. Long residence times and excessive mel temperatures should be avoided. A relatively small increase in screw speed (RPM) can result in a dramatic increase in melt temperature with no change in controller set point. It is suggested that melt temperatures be measured using hand-held pyrometers. These measures should be taken on the thermoplastic melts after the machine is on cycle.

Mold Temperature

XENOY resin's rapid crystallization rate and other crystalline characteristics allow a wide range of mold temperatures without significant effects on physical properties.

XENOY resin can be processed in molds with temperatures between 130 and 220°F (54 and 104°C). The usual range for unreinforced materials is from 150 to 200°F (66 to 93°C), which generally gives the surface a very smooth, glossy appearance.

The aesthetic appeal of surfaces molded in reinforced XENOY resin can be enhanced by the use of fast fill rates, higher injection pressures, and mold temperatures in the 150 to 225°F (66 to 107°C) range.

Operating molds in this temperature range can also be used to improve flow, knitline strength and surface finish in reinforced resin.

When using reinforced XENOY resin, mold temperatures higher than 150°F (66°C) and the maximum permissible ram speed are suggested to help achieve a high-gloss surface.

All component parts of an assembly should be molded at the same mold temperature to promote color consistency when molding temperatures over 150°F (66°C).

Screw Speed

Screw speeds should be adjusted to permit screw rotation during the entire cooling cycle without delaying the overall cycle (Figure 13-6). Low screw speeds will help reduce glass fiber damage during plastication when molding reinforced grades.

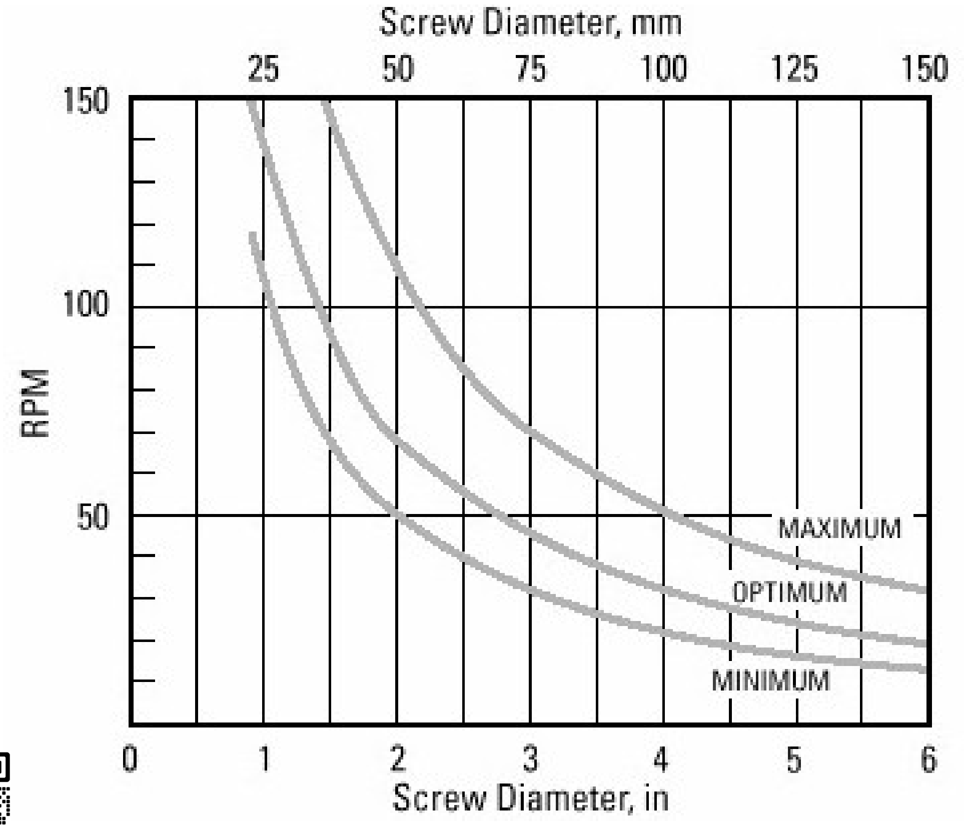


Figure 13-6. Screw Speed Suggestions for XENOY Resins.

Back Pressure

A back pressure of 50 to 80 psi (0.34 to 0.55 MPa) is suggested to promote a homogeneous melt and consistent shot size. Higher back pressures used to improve melt mixing result in higher melt temperatures.

When molding reinforced grades, low back pressure will help reduce glass fiber damage during plastication.

Shot Size

The suggested shot size is 30 to 80% of the machine capacity. For blended grades where color control is critical, it is suggested the shot size be as close to 80% of machine capacity as possible in order to minimize residence times.

Ram Speed

When selecting injection speed, careful consideration must be given to adequate mold venting, resin melt temperature and injection pressure, along with the potential for jetting.

The fastest fill speed possible generally provides longer flow, fills thinner wall sections, and creates better surface finish. Slower fill is suggested for sprue gated and edge-gated parts to prevent splay and jetting. In thick parts, slow fill can help reduce sinks and voids. XENOY 6000 resin series requires a fast fill to prevent premature freeze-off. Thin-walled sections below 0.06 inch (1.52 mm) virtually always require fast ram speeds in order to fill the cavity and produce high knitline strength. The fill rate of thick sections may be reduced to address air entrapment or to aid packing when filling through restricted gates. XENOY 5000 resin series require a moderate injection rate to reduce shear. Injection speeds of 0.5 to 2 inches/second are typical.

Programmed injection is suggested for parts with small gates (pin gates and subgates). A slow injection rate can be used at the start to reduce gate blush, jetting, and burning of the material.

Injection Pressure

The actual injection pressure will depend on variables such as melt temperature, mold temperature, part geometry, wall thickness, flow length, and other mold and equipment considerations. Generally, the lowest pressures which provide the desired properties, appearance and molding cycle are preferred.

XENOY resin flows relatively easily, however, medium to high injection pressure may be required to fill intricate part configurations or thin walls. Normal injection pressures are 8,000 to 14,000 psi (55 to 97 MPa).

Holding pressures from 60 to 80% of the injection pressure are usually adequate for normal requirements.

Due to the speed at which XENOY resin crystallizes, thin-walled parts with small gates may require only moderate holding pressure. However, thick sections with large gates will require typically high holding pressures and longer holding times.

Cushion

The use of a nominal cushion [1/8 inch (3.18 mm) suggested] reduces material residence time in the barrel and helps accommodate machine variations.

Cycle Time

Cycle time is primarily dependent on part thickness, therefore thin sections from 0.03 inch to 0.06 inch (.76 to 1.52 mm) usually give overall cycles of about 10 to 18 seconds, while thicker sections of up to 0.15 inch (3.81 mm) can usually be molded in about 40 seconds. Specific cycle time is dictated by part and mold design. Refer to Figure 13-7 depicting the general effect of wall thickness on cycle time.

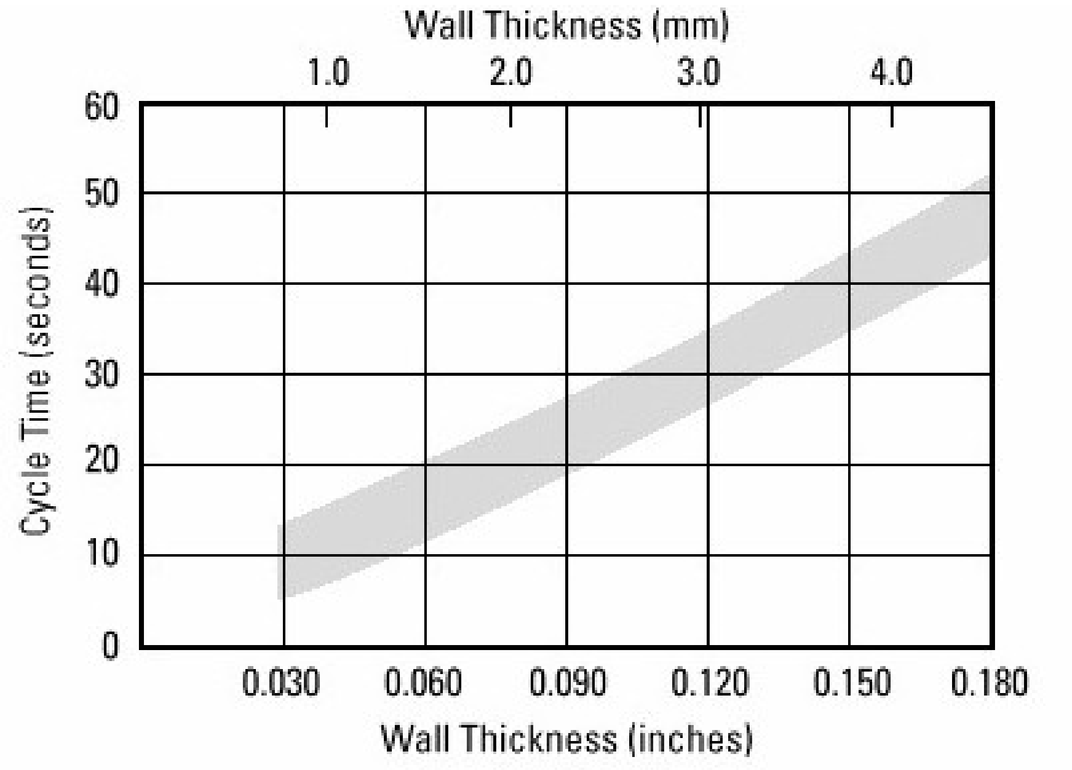


Figure 13-7. Typical Cycle Time vs. Wall Thickness for XENOY Resins.

Effect of Wall Thickness on Flow Length

An example of Diskflow is illustrated below in Figure 13-8. Diskflow (or radial flow), results are obtained from mold filling computer simulation. Shown is the relationship of flow length versus wall thickness at a given cavity pressure (pressure at sprue) and melt temperature. Diskflow radial flow results are normally conservative and may underpredict the flow lengths of many applications where flow is not entirely radial.

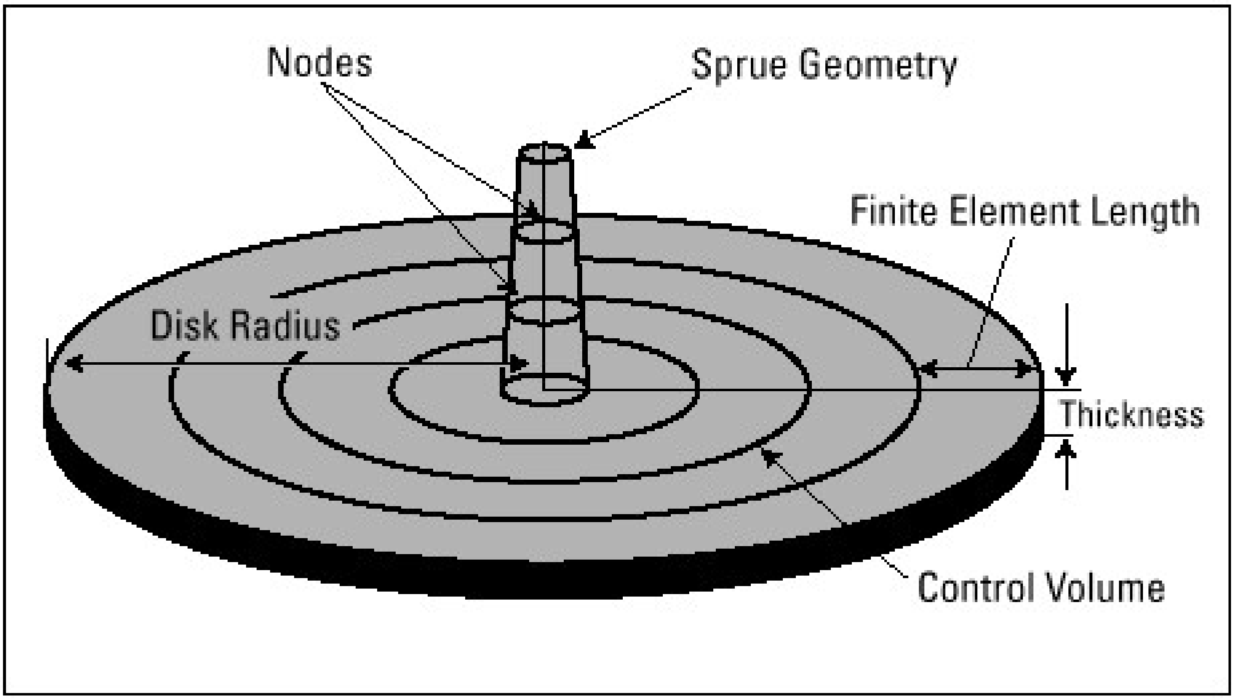


Figure 13-8. Diskflow Model.

Figures 13-9 through 13-12 show the effects of melt temperature and injection pressure on the flow length of XENOY resin at various wall thicknesses.

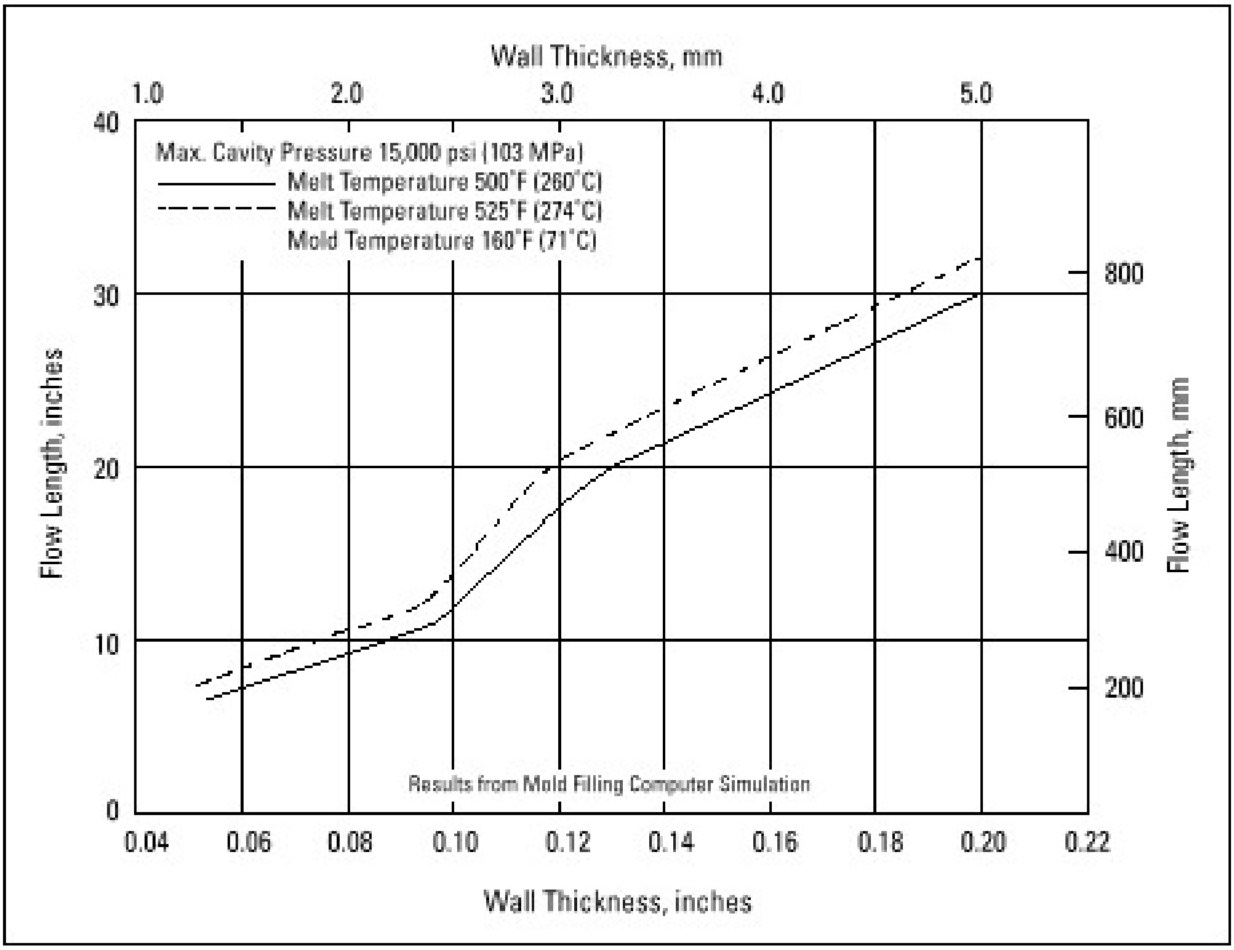


Figure 13-9. XENOY 1102 Resin Diskflow - Flow Length vs. Wall Thickness.

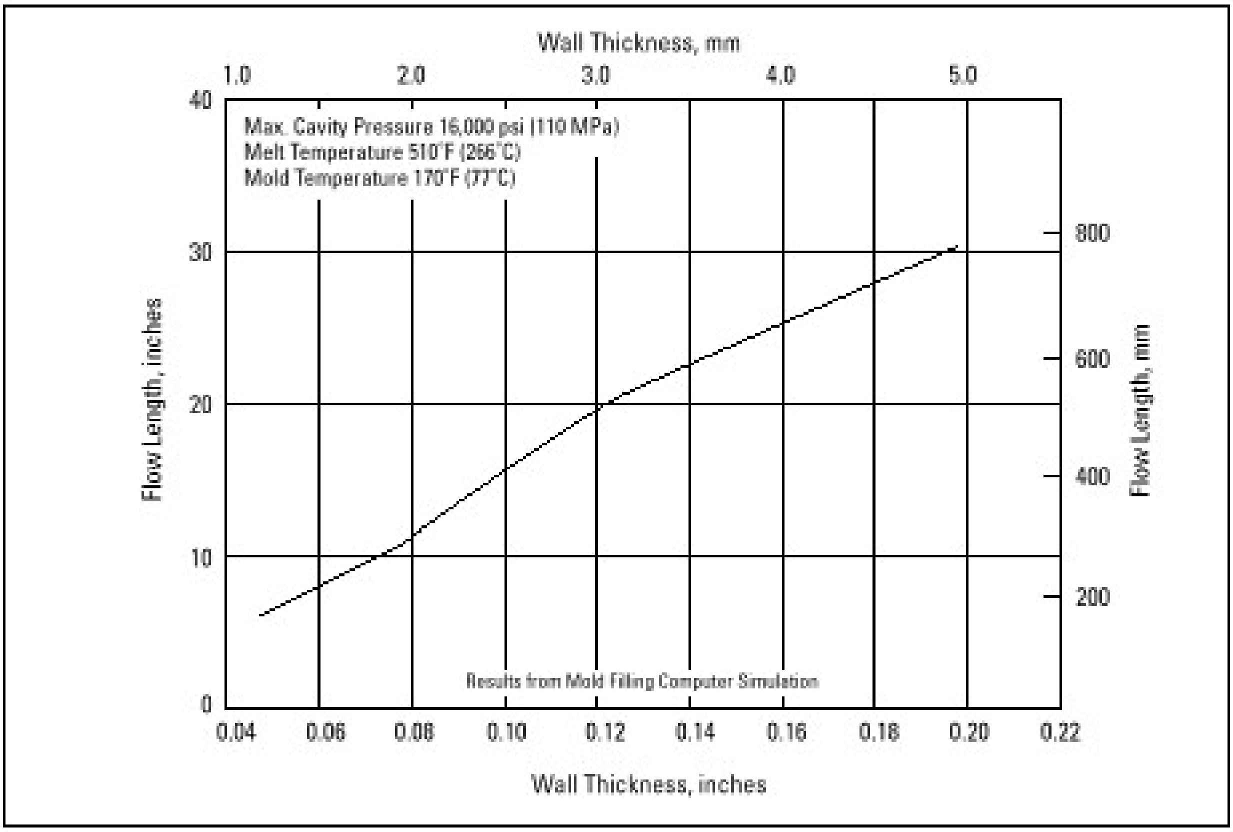


Figure 13-10. XENOY 2230 Resin Diskflow - Flow Length vs. Wall Thickness.

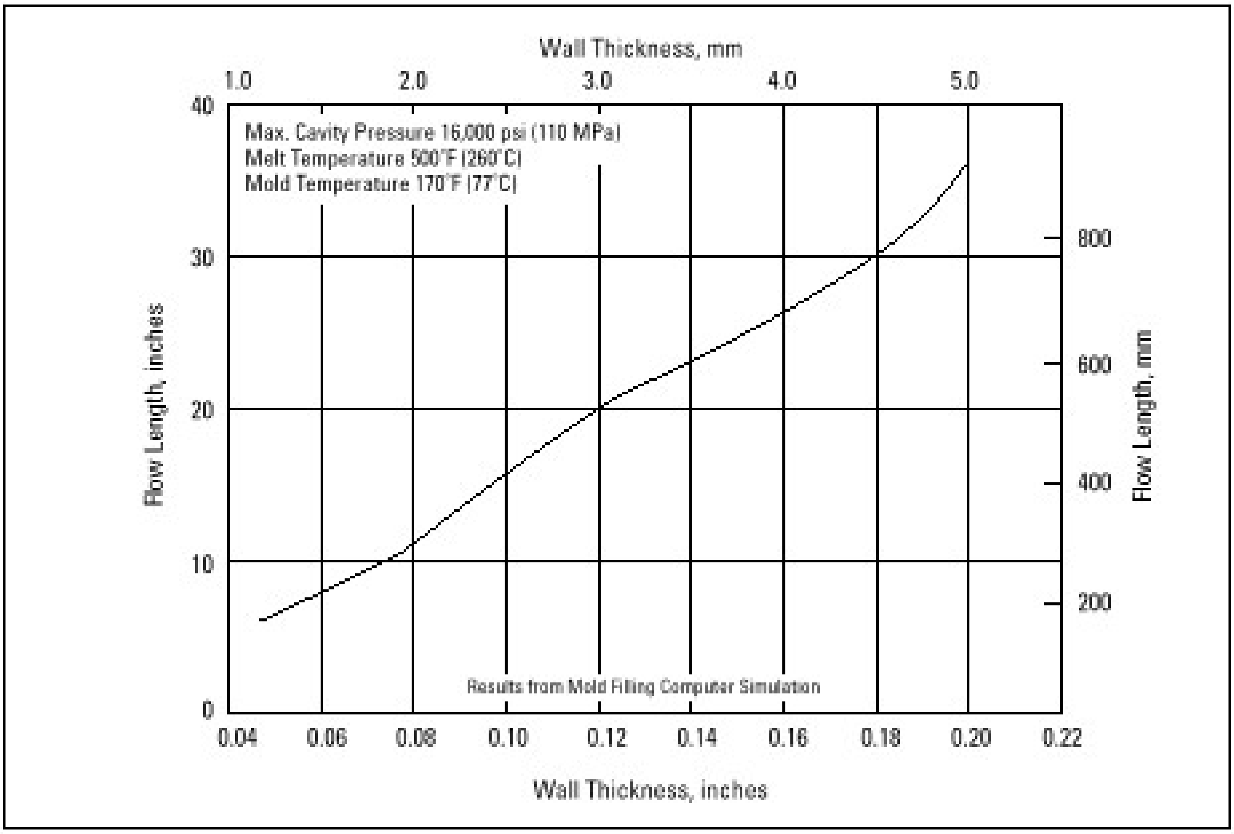


Figure 13-11. XENOY 5220 Resin Diskflow - Flow Length vs. Wall Thickness.

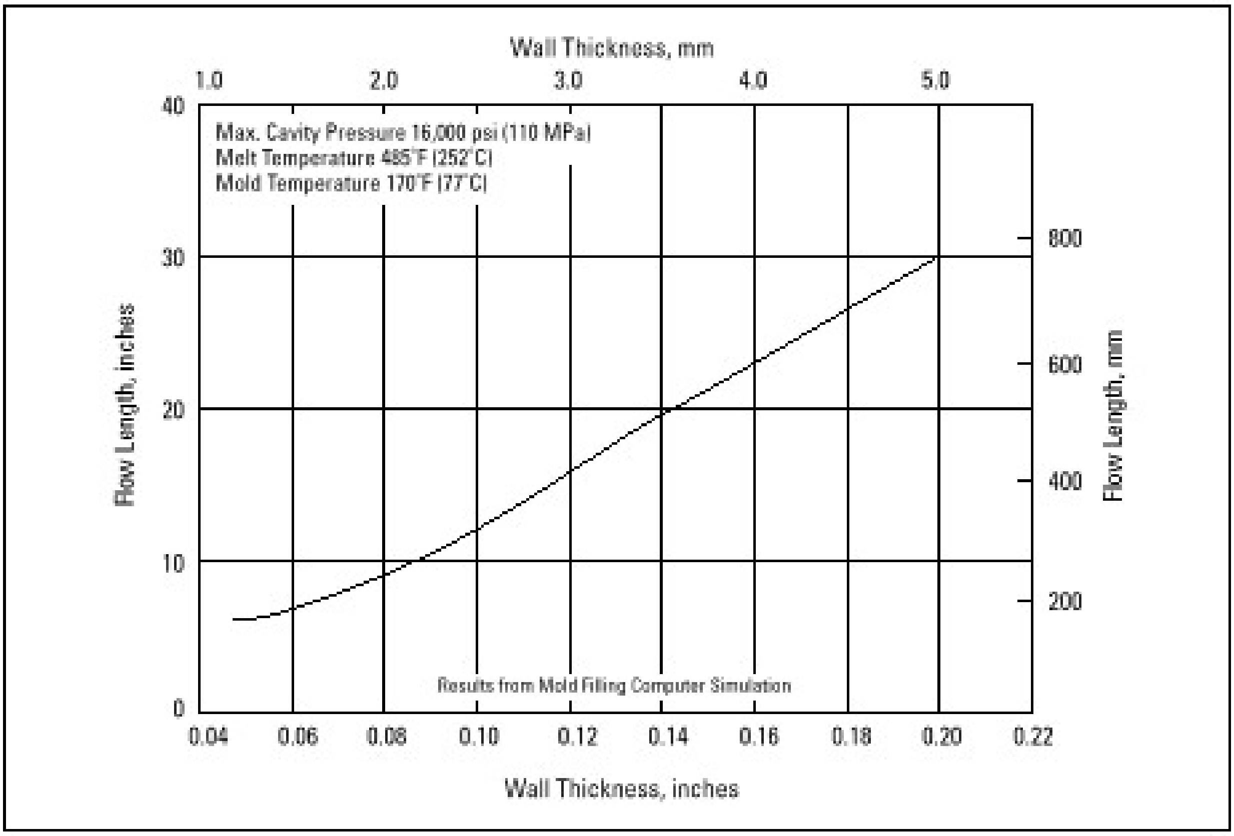


Figure 13-12. XENOY 6370 Resin Diskflow - Flow Length vs. Wall Thickness.

Mold Release

Smooth surface finish and good lubricity helps to make parts molded in XENOY resin generally easy to eject from mold cavities without the use of mold release agents.

The ability to reproduce intricate detail can sometimes interfere with mold release if the mold surface has imperfections such as tool marks, nicks, scratches, pool polish, or EDM finish. These conditions form undercuts that hinder part removal.

If the part design causes ejection difficulties, most standard mold release agents may be used at reasonable levels.

Downtime

When the molding cycle is interrupted, the following steps are suggested:

Short Term – When processing XENOY resins in the melt range of 460 to 525°F (238 to 274°C) on a machine of the suggested shot-to-barrel size with the screw in the forward position, the material may be held in the barrel for a short period (5 min.) without purging. As with other engineering resins, air shots should also be taken periodically (8 to 12 min.) to help prevent degradation and reduce problems in start-up.

Long Term – Purge the barrel free of the resin material, following standard shut-down procedures. Then:

1. Close the hopper feed slide, continuing to mold on cycle until the screw does not retract.
2. Purge the remaining material.
3. With the screw in the forward position, reduce cylinder and nozzle temperatures to 250°F (121°C).
4. Always purge the machine clear of material when long delays are encountered in molding flame retardant grades.

Purging

When changing over to XENOY resin from higher melt temperatures or heat sensitive materials, either polystyrene (GP) or high-density polyethylene may be used as an intermediate purging material.

For ease in subsequent start-ups, XENOY resin should be purged with the suggested purging materials prior to shutdown.

Regrind

Reground sprues, runners, and non-degraded parts may be added to the virgin pellets up to a level of 25%. Grinder screen sizes should be at least 5/16 to 3/8 inch (7.9 to 9.5 mm). If a smaller size is used, too many fines could be generated, creating molding problems such as streaking and burning. It is important to keep the ground parts clean and to avoid contamination from other materials. Drying time should be increased since regrind will not be the same size as virgin pellets, and therefore water diffusion may be different. Regrind utilization may produce some effect on color. Actual regrind usage should be determined for each individual application.