GE Plastics

Geloy* ASA Processing Guide

GELOY resin offers exceptional durability in weather-related environments without painting. In outdoor applications, GELOY resins retain their color stability under long-term exposure to UV, moisture, heat, cold and impact. The material is blendable with PVC as a capstock co-extrusion for applications such as sliding and windows. It can be alloy solid extrusion profiles. GELOY sheet grade resins are formable for large structural parts such as spa and pool steps and recreational applications. Advanced grades of the GELOY resin family offer improved aesthetics, color, performance and improved processability.

Contents

Material Description

GELOY Resin Materials

GELOY® is an advanced amorphous terpolymer of acrylic-styrene-acrylonitrile (ASA). As an injection moldable resin, it offers exceptional durability in weather related environments without painting. In outdoor applications GELOY resins can retain their color stability under long-term exposure to UV, moisture, heat, cold and impact. Advanced grades of the GELOY resin family offer improved aesthetics, color options, good chemical resistance, high heat performance and improved processability.

Property	Characteristic	Typical Designations
Weatherability	Used for automotive exterior trim applications. Suitable for unpainted applications. Good chemical resistance.	XP4025 (Available in black only)
Heat Resistance	Similar to XP4025. Suitable for use in unpainted automotive exterior trim applications where heat resistance is required.	XP4304 (Available in black or gray only)
Moisture, Heat, Cold, Impact	General purpose injection molding resin offering exceptional durability in weather related environments without painting where durability is a factor.	XP1001, XP2003

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

Machine Selection

GELOY resins can be molded in most standard injection molding machines. Reciprocating screw machines are suggested.

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

Optimum results are typically obtained when the total shot weight (all cavities plus runners and sprues) is equal to 60 to 80% of the machine capacity. Very small shots in a large barrel machine may create unnecessarily long residence times which may lead to resin degradation.

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 pressur been determined, 3 to 5 tons of clamp force should be provided for each square inch of projected area to hel avoid flashing of the part. Wall thickness, flow length and molding conditions will determine the actual tonnage required (Figure 6-1).

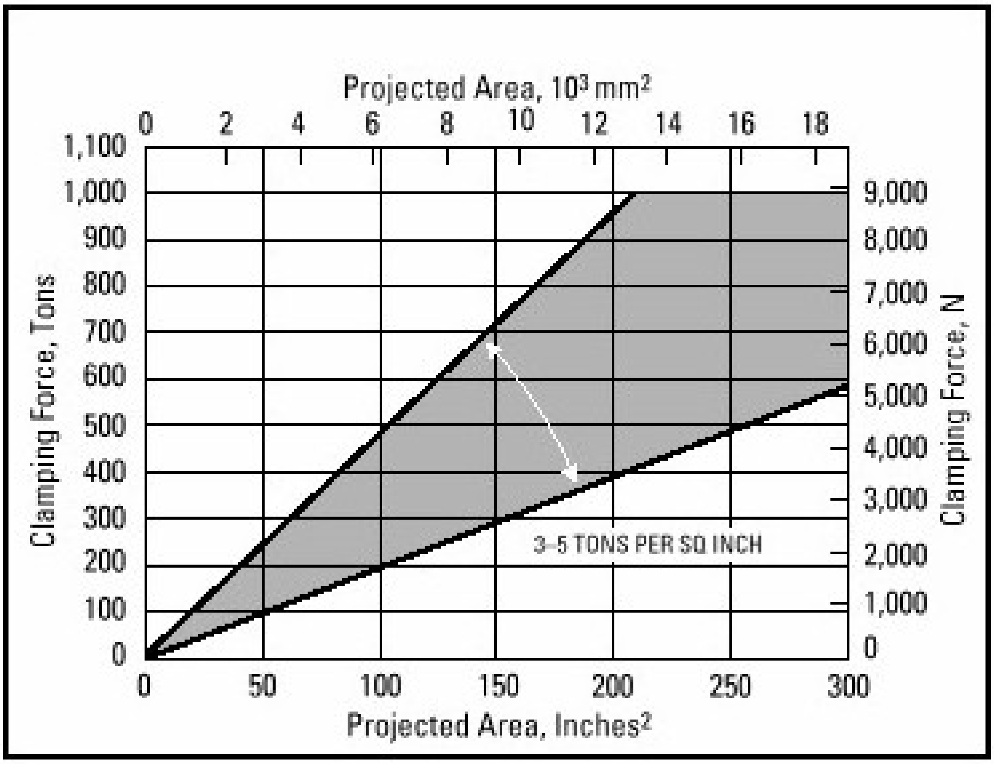

Figure 6-1. Clamping Force for GELOY Resins.

Barrel Selection and Screw Design Considerations

Conventional materials of construction for compatible screws and barrels are usually acceptable for processing GELOY resins. The use of bimetallic barrels is suggested.

Depending on screw diameter, a compression ratio of about 2.1:1 to 2.3:1 with a length to diameter ratio of 20:1 is preferred. A short feed zone (5 flights) and a long compression zone (11 flights) with a gradual and constant taper leading to a short metering zone (4 flights) is also suggested. The compression should be accomplished over a gradual and constant taper since sharp transitions can result in excessive shear and material degradation.

The non-return valve should be of the sliding check ring type (Figure 6-2). Flow-through clearances of at least 80% of the cross-section of the flow area in the metering zone of the screw are generally necessary. The check ring travel should be at least 3/16 inch (4.76 mm) for small diameter screws (2 1/2 inch (63.5 mm) diameter or less). Larger screws may require longer travel to provide necessary flow-through area.

Ball check type screw tips are not suggested because they can cause degradation of the GELOY resin, due to excessive shear and dead spots.

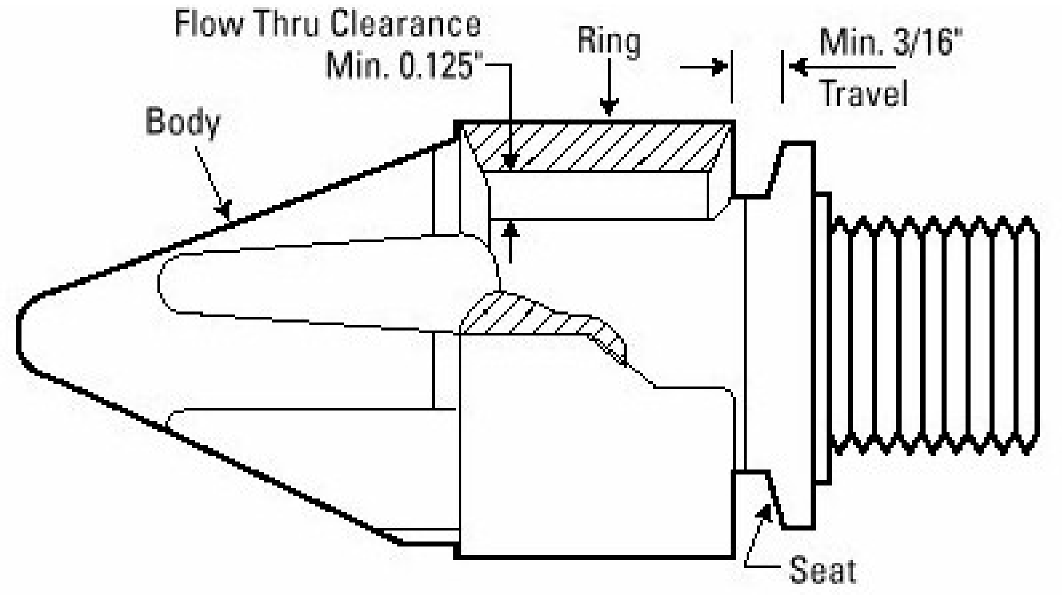

Figure 6-2. Non-Return Valve.

Nozzle Design

The nozzle opening should typically be minimum 3/16 inch (4.76 mm) with 1/4 inch (6.4 mm) and 5/16 inch (7.9 mm) preferred. For parts 12 lbs. and up, a nozzle orifice of 3/8 inch (9.5 mm) (or greater) is suggested.

Generally land lengths should be no longer than 3/16 inch 4.76 mm). The nozzle bore should be 0.5 inch (12.7 mm) minimum.

The nozzle opening should generally be kept 1/32 inch (0.8 mm) smaller than the "O" or orifice dimension on the sprue bushing.

Accurate heat control and full heater band coverage is necessary to help maintain part appearance. If extended nozzles are required, complete coverage with heater bands is essential to help maintain good temperature control. A separate control is suggested for the heater band at the tip of the nozzle. This is to help maintain proper temperature without overheating the main body of the nozzle. Heater bands that are hooked up to the same power source must be of the same wattage. If different watt values are used, separate voltage controls and temperature monitors should be used.

Specialty nozzles such as static mixers, shut-off nozzles and screen pack filters are not suggested, as they typically have sharp corners and areas of high pressure drop that can cause a variety of molding problems. The configuration of a general purpose nozzle is shown in Figure 6-3.

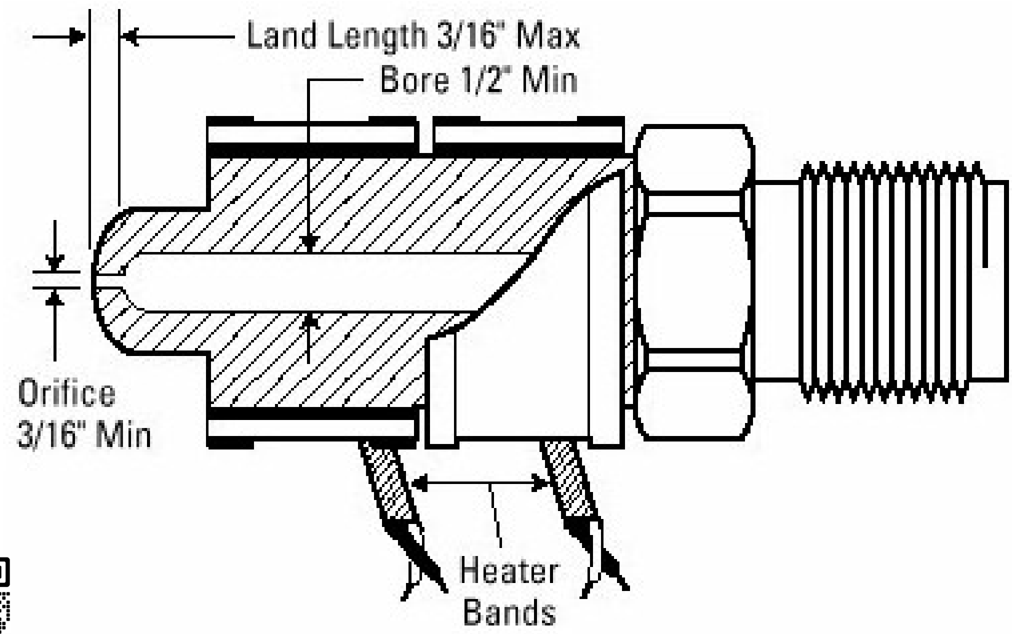

Figure 6-3. Nozzle.

General Drying Parameters

GELOY 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. Consistent drying of the resin to 0.04% increases the ability to stabilize processing parameters. Consistent tight processing parameters can help improve productivity by increasing part-to-part consistency and producing tougher parts. In order to improve performance of molded parts and to minimize the possibility of degradation, all grades of GELOY resin must be dried before processing. A closed loop dehumidifying, recirculating dryer is suggested. The required moisture level can usually be reached by pre-drying GELOY XP4034 resin for 3 to 4 hours at 200-220°F (93- 104°C). GELOY XP4025 resin should be pre-dried for 3 to 4 hours at 190-210°F (88-99°C).

When using oven dryers, the resin should be spread in trays to a depth of approximately one inch. To avoid excessive heat history, it is suggested that the material be dried no longer than 48 hours.

The hopper and any open areas of the feed mechanism should be covered to help protect the dried pellets from room atmosphere. If a hopper dryer is not available, only a sufficient quantity of dried, heated GELOY resin should be removed from the oven and placed in the hopper at one time. The length of exposure to ambient atmosphere which the dried resin can withstand before a potentially harmful amount of moisture is absorbed can range from 15 minutes to several hours depending on relative humidity.

Where hopper dryers are available, a hopper of sufficient volume to maintain the resin for a 3 to 4 hour minimum at suggested dry condition should be used. The hopper dryer should be preheated to the suggested drying temperature before the pellets are loaded in. Air entering the hopper should be at recommended dry condition and have a flow of 1.0 cfm for every pound per hour of use. The dew point at the input of the hopper should be at -20 to -40°F (-29 to -40°C) or lower.

As a general guideline, the standard grades of GELOY resin are molded at different temperatures.

Increased melt temperatures typically reduce viscosity and increases resin flow, thus providing for longer flow for thin wall sections and producing lower residual stress.

Mold temperatures are important in determining final part finish and molded-in stress levels. Cold molds are more difficult to fill, necessitating high injection pressure and melt temperature. Heated molds generally produce a part with a better finish and lower molded-in stress. Because of the high heat distortion, relative to standard ASA resins, parts are ejected more easily at higher temperatures.

The faster fill speeds provide longer flow, fills thinner wall sections, and helps to create a better surface finish. Slower fill is suggested for sprue-gated and edge-gated parts to help prevent gate blush, splay and jetting. In thick wall parts (0.2 inches (5.06 mm) and up) slow fill can help reduce sinks and voids. Slow to medium fill speeds are suggested for GELOY XP4034 and XP4025 resins. For typical processing parameters see Table 6-1

Melt Temperature

GELOY resins have thermal stability within the suggested melt temperature range. As a general rule, residence time should be as short as possible when molding near the maximum suggested melt temperature.

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.

When processing near, or at, the upper limit of the melt range, the shot weight should generally approach 60 to 80% of the cylinder capacity of the machine. If the cylinder temperature exceeds the upper limit of the suggested melt range, thermal degradation of the resin and loss of physical properties and appearance may result.

GELOY resins, like other engineered thermoplastics should not be left at elevated temperatures for prolonged periods of time without occasional purging.

Mold Temperature

The midpoint of the suggested range can be expected to give good results with respect to part appearance and cycle time. Higher mold temperatures typically result in better flow, stronger knitlines and lower molded-in stresses. Using lower than the suggested mold temperatures can result in high molded-in stresses and compromise part integrity. (See Table 6-1).

Molding Conditions

		XP1001		XP2003		XP4025		XP4034	
Processing Parameters	**Units**	**(min.)**	**(max.)**	**(min.)**	**(max.)**	**(min.)**	**(max.)**	**(min.)**	**(max.)**
Drying Temperature	°F(°C)	170(77)	180(82)	150(66)	160(91)	190(88)	210(99)	200(104)	220(104)
Drying Time (Normal)	h	3	6	2	3	3	4	3	4
Drying Time (Max.)	h	–	8	–	3	–	8	–	8
Maximum Moisture	%	–	0.04	–	0.04	–	0.04	–	0.04
Melt Temperature	°F(°C)	440(227)	490(254)	380(193)	410(210)	490(254)	520(271)	500(260)	540(282)
Nozzle	°F(°C)	440(227)	470(243)	370(188)	400(204)	460(238)	490(254)	470(243)	510(266)
Front Zone	°F(°C)	430(221)	460(238)	360(182)	385(196)	460(238)	500(260)	480(249)	510(266)
Middle Zone	°F(°C)	420(216)	450(232)	340(171)	370(188)	460(238)	490(254)	470(243)	500(260)
Rear Zone	°F(°C)	400(204)	420(216)	330(166)	350(177)	450(254)	480(249)	460(238)	490(254)
Mold Temperature	°F(°C)	120(49)	150(66)	80(27)	140(60)	130(55)	160(71)	130(55)	160(71)
Back Pressure	psi(MPa)	50(0.3)	100(0.7)	50(0.3)	100(0.7)	50(0.3)	150(0.10)	50(0.3)	150(0.10)
Screw Speed	rpm	30	80	30	80	30	80	30	80
Shot to Cylinder Size	%	40	80	40	80	40	80	40	80
Clamp Tonnage	tons/in^2	3	5	3	5	3	5	3	5
Vent Depth	in	0.0015	0.0030	0.0015	0.0030	0.0015	0.0030	0.0015	0.0030

Table 6-1. Typical Injection Molding Processing Parameters for GELOY Resins.

Screw Speed

Screw speeds (RPM) should be adjusted to permit screw rotation during the entire cooling cycle without delaying the overall cycle. Suggested screw speed for GELOY XP4034 and GELOY XP4025 resin is 30-80 RPM.

Suggested screw speed is dependent on screw diameter. In general, the optimum linear velocity of screw O.D. is 8 inches (202.4 mm) per second. RPM = screw diameter x # divided into the optimum linear velocity of 8 inches (202.4 mm) per second x 60. For example, for a 3 inch (75.9 mm) diameter screw: 3 (screw dia.) x 3.1416 = 9.4248 divided into 8 inches (202.4 mm) per second (optimum linear velocity) x 60 = 51 RPM.

Back Pressure

A back pressure of 50 to 100 psi (0.35 to 0.7 MPa) is suggested to promote a homogeneous melt and help maintain consistent shot. Higher back pressures used to improve melt mixing result in higher melt temperatures.

Shot Size

The suggested shot size is 40 to 80% of the machine capacity for GELOY resins.

Melt Decompression

With GELOY XP4034 and XP4025 resins, excessive melt decompression should be avoided as it will cause splay on the molded part.

Effect of Wall Thickness on Flow Length

Variables affecting melt flow length include wall thickness, mold temperature, injection pressure, melt temperature, and material composition.

Diskflow (or radial flow) results can be obtained from mold filling computer simulation. An example of Diskflow is provided in Figure 6-4.

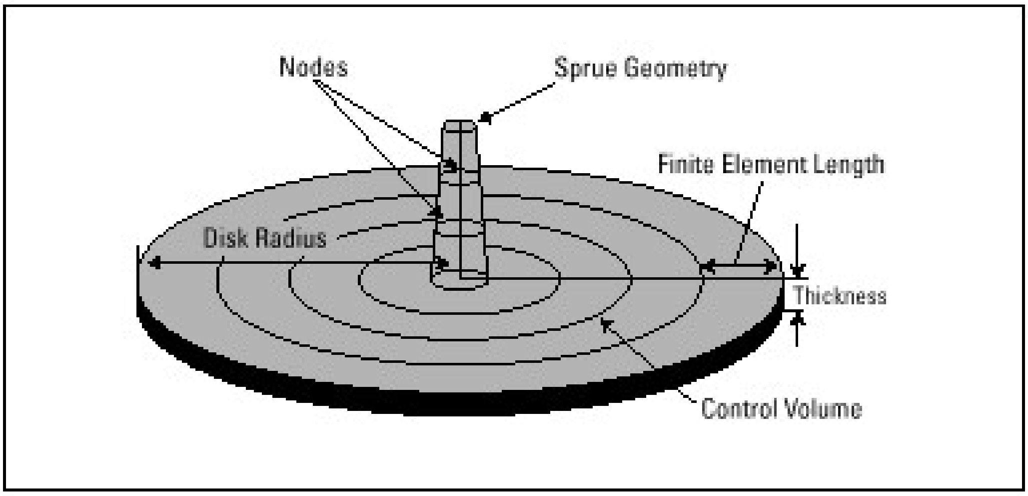

Figure 6-4. Diskflow Model

Shown is the relationship of flow length versus wall thickness at a given capacity pressure (pressure at sprue melt temperature (see Table 6-1 and Figure 6-5). Diskflow radial flow results are normally conservative and r underpredict the flow lengths of many applications where flow is not entirely radial.

	GELOY XP4025 Resin	GELOY XP4034 Resin
Melt Temp, °F	510	530
Mold Temp, °F	150	150
Injection Pressure, PSI	16000	16000

Table 6-2. Conditions Used to Predict GELOY Resin Flow Length.

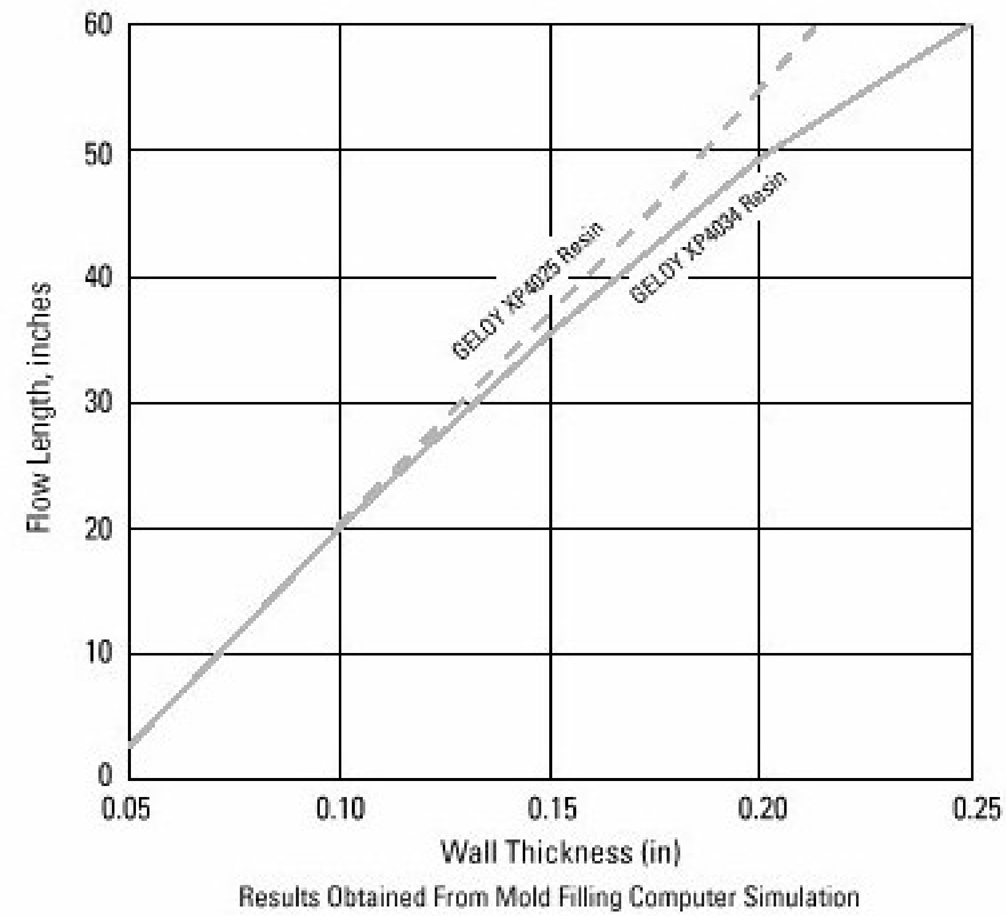

Figure 6-5. Diskflow-Flow Length vs Wall Thickness GELOY Resins.

Gloss and Color Vs. Mold Temperature

The color and gloss of parts molded with GELOY resin can be affected by molding conditions, especially mold temperature. Generally, the gloss of a highly polished surface increases with an increase in mold temperature. The increase in gloss is incremental (see Figure 6-6).

The opposite is typically true for vapor-honed or textured surface. The gloss can decrease greatly with an increase in mold temperature (see Figure 6-7). The color of the molded part is dependent on the gloss. A higher gloss will generally result in a darker color.

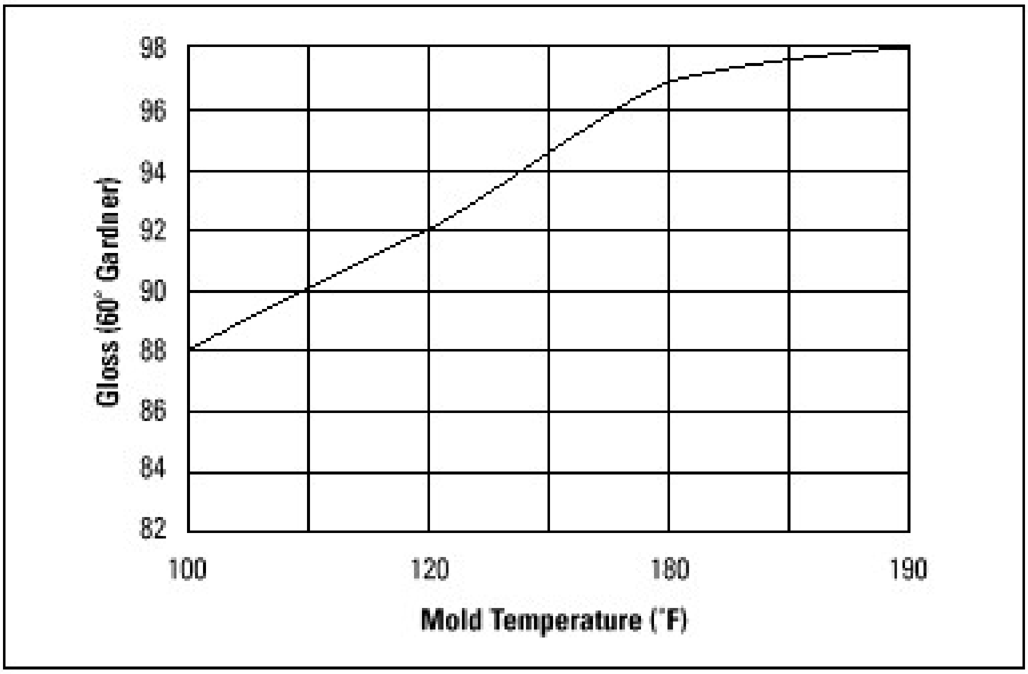

Figure 6-6. Effect of Mold Temp on a High Gloss Mirror Polished Surface.

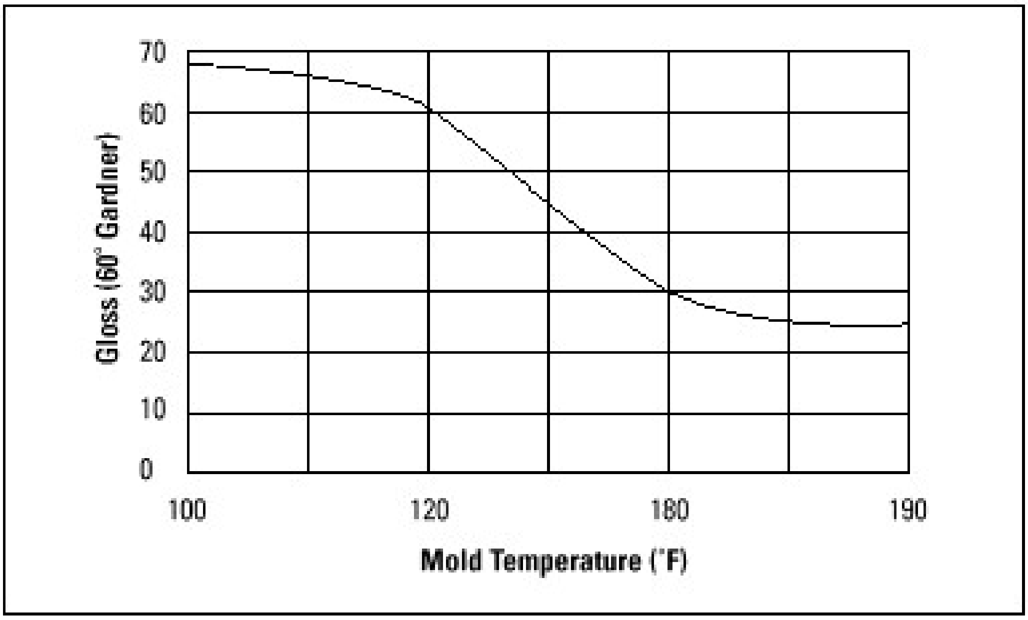

Figure 6-7. Effect of Mold Temp on a Low Gloss Vapor Honed Surface.

Gating

The basic considerations in gate location are part design, flow, and end-use requirements. As a general guideline, the following points should be kept in mind:

- Edge gate, modified fan gate and tab gate are the pre-ferred gate designs for GELOY resins to help reduce risk of gate blush.
- Land length of 0.02" (0.5 mm) and depth of 85% of wall thickness to be used for edge gates. 0.250" (6.35mm)diameter runners are common with GELOY resins.
- Tunnel gates may be used when located on a nonshow surface of the part that is at least 0.07" (1.8 mm) in diameter.
- Pin point gates generally should not be used with GELOY resins to help prevent delamination and gate blush.

Edge gates are commonly used gates in injection molding GELOY resins. For optimum resin flow, the height hickness of the gate should generally be 85 to 100% of the wall thickness up to 0.125 inch (3.2 mm). The ga width should be two times the depth. A radius should be located at the junction of the molded part to prevent surface splay and to minimize molded-in stresses (Figure 6-8). A land length of 0.020 to 0.040 inch (0.50 to 1.01 mm) is suggested.

Edge Gating

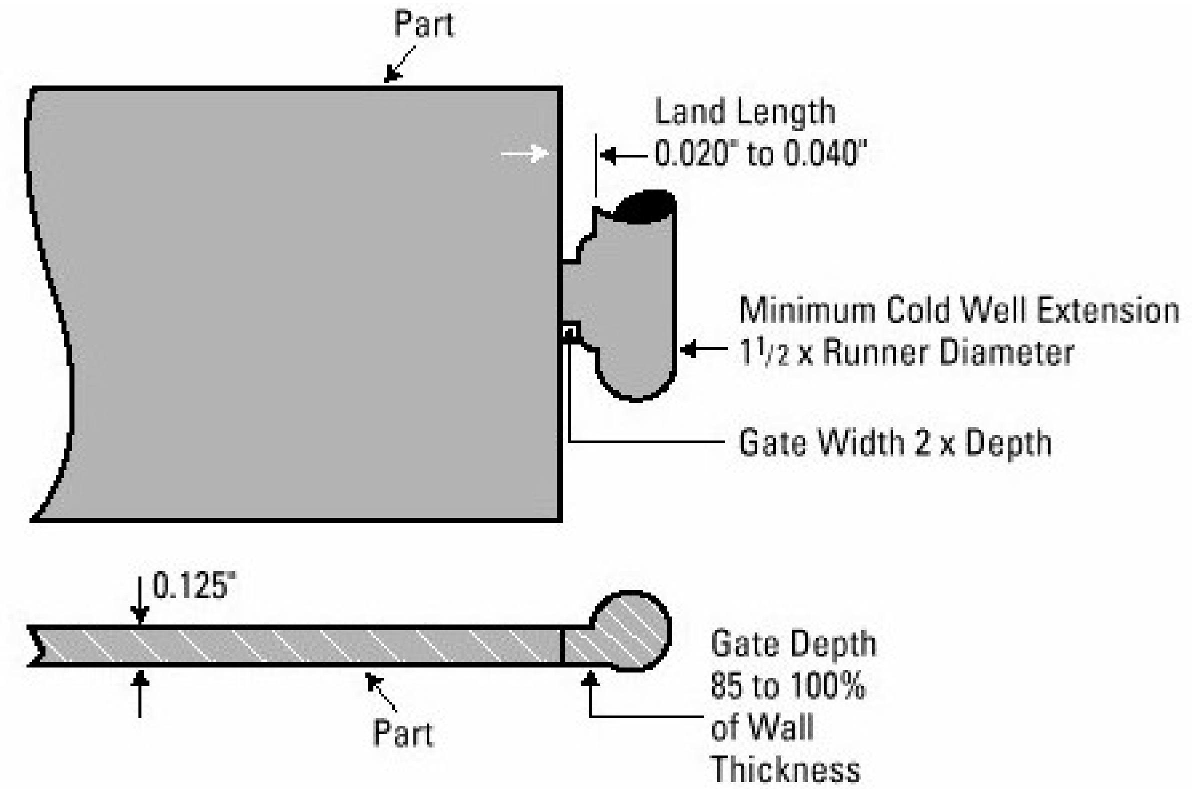

Figure 6-8. Edge Gating.

For flat, thin-walled sections, modified fan gating helps minimize jetting and splay while reducing high stresses caused by mold packing. The runner approach should be liberal and positioned 90° to the gate using as short a land length as possible (Figure 6-9). Smooth radii and transitions between runners and gates are suggested. Cold well extensions should typically be a minimum of 1-1/2 times the runner diameter. If gate blush or high stress persists, it is suggested that the cold well be extended. (2 to 3 times the runner diameter is usually sufficient.)

Modified Fan Gating

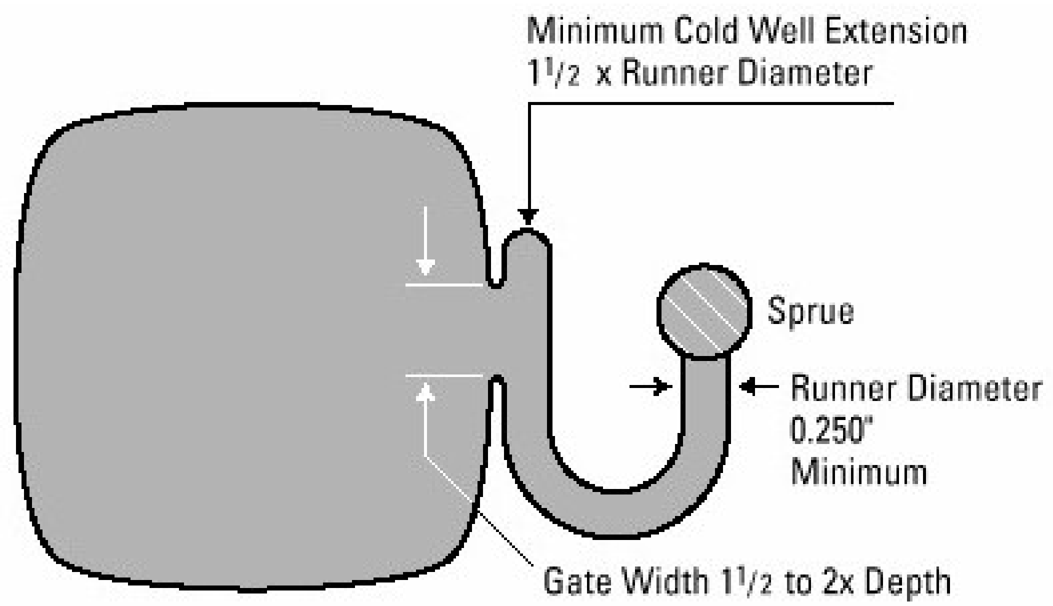

Figure 6-9. Modified Fan Gate.

If the indirect approach of a runner with a cold well cannot be used, the tab gate design can often be used to reduce the effect of residual stresses and gate blush in the gate area (Figure 6-10).

Tab Gating

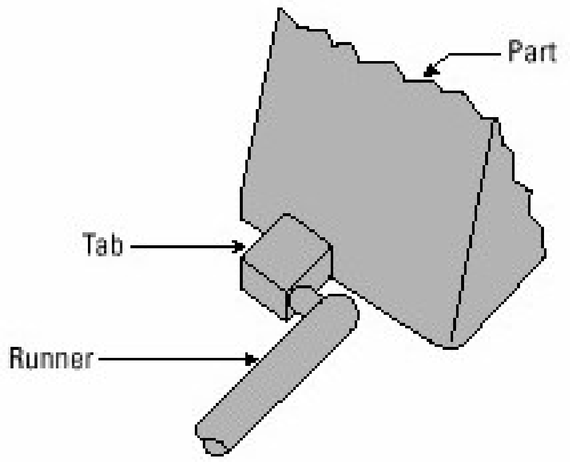

Figure 6-10. Tab Gate.

This gate design permits automatic degating of a part from the runner system during ejection. One possible gate approach is illustrated in Figure 6-11.

Tunnel Gating (Subgating)

Approach to the tunnel gate should be fairly thick to help prevent flow restriction, while the diameter of the orifice should measure no less than 0.050 inch (1.27 mm). A generous short approach off a full-round runner is suggested to reduce the chance of a loss of injection pressure.

Tunnel gating into an appearance surface is not suggested and should be avoided.

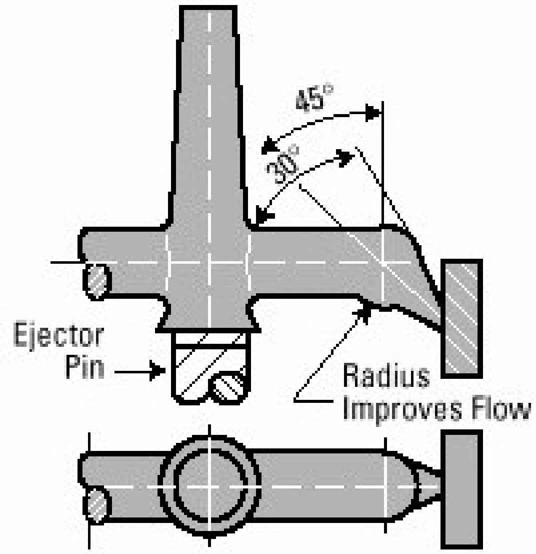

Figure 6-11. Tunnel Gate.

Cavity Venting

When molding GELOY resins it is extremely important for the cavity to be vented effectively to allow complete evacuation of gases to obtain good aesthetics of the molded part. Proper venting helps prevent "dieseling" (or super-heating of trapped air) and often results in burn marks at the end of the resin flow. Inadequate venting slows down the filling rate, resulting in incomplete mold fill. For GELOY resins mold vent depths of .0015 to .003 inches (.0381 to .0762 mm) are suggested.

Adequate venting at the knit line is key to good knit line aesthetics.

With GELOY resins it is suggested that vents be provided at parting lines, ejector pins and runners as shown in Figure 6-12. Vent locations where flow fronts converge and at the last point to fill.

Continuous venting as shown in Figure 6-13 is suggested if possible by cutting a 1/8" half-round groove around the cavity.

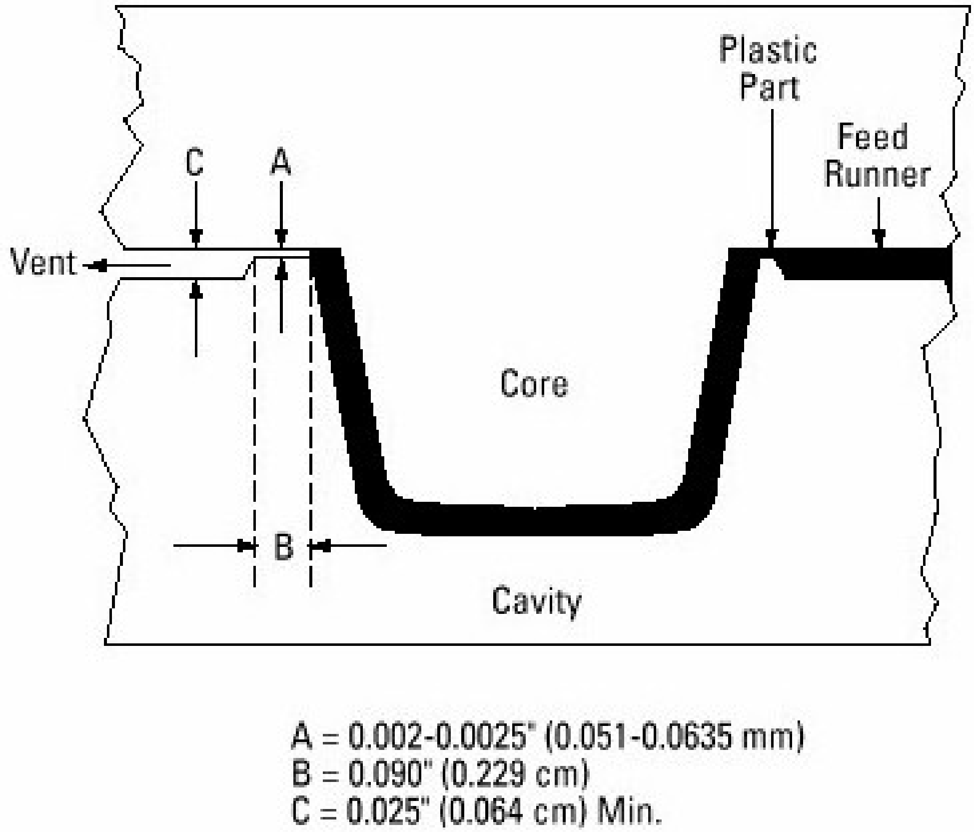

Figure 6-12. Conventional Parting Line Valve.

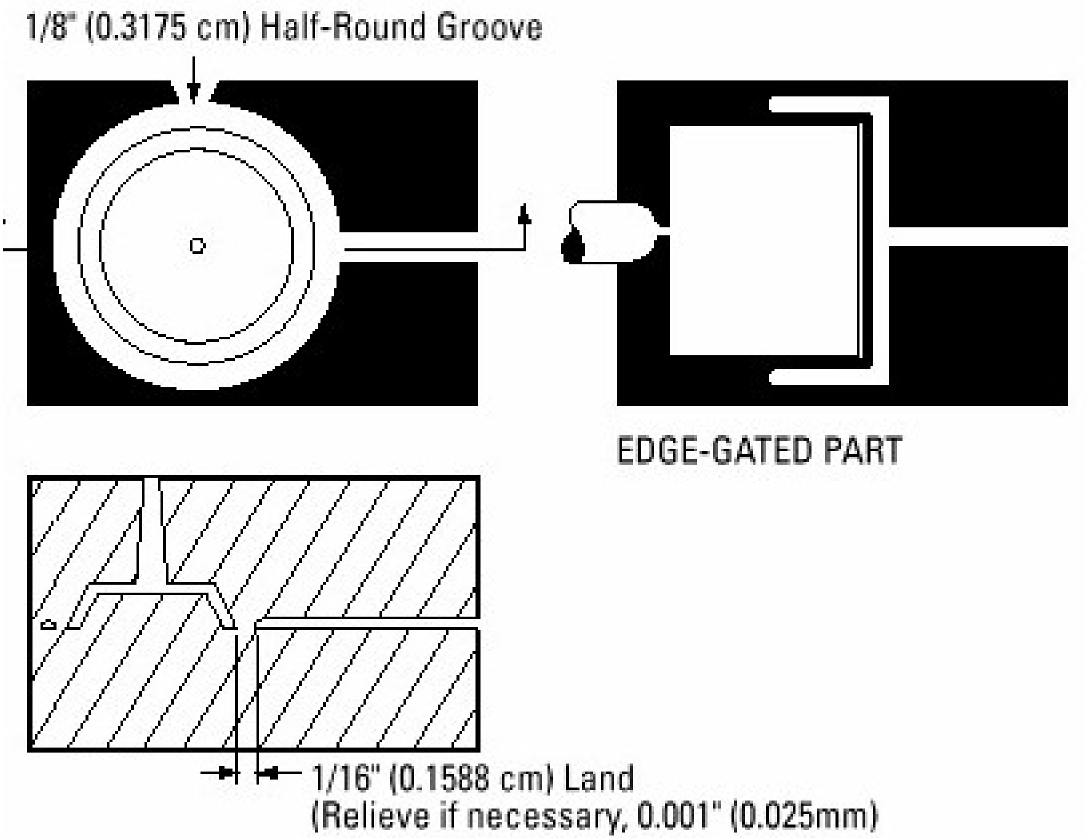

Figure 6-13. Continuous Venting Technique.

Downtime

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

Short Term - GELOY resin may be held in the barrel for a short period (10 to 15 minutes) without purging. As with other engineering resins, air shots should be taken periodically (15 to 20 minutes) 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 as follows:

1. Close the hopper feed slide, continuing the mold oncycle until the screw does not retract.
2. Eject the remaining material.
3. The screw should be left in the forward position with the barrel heaters off.

Start-Up

When starting up the machine, set the barrel heaters to normal processing temperatures, extrude until residual material is completely purged and begin molding. The initial shots should be checked for contaminants in the molded parts.

Purging

HDPE, general purpose ASA, and ground cast acrylic are all acceptable purging agents for GELOY resin. The cylinder may be purged at process temperatures and the temperature should be gradually lowered until it reaches 400°F (204°C). It is important to have proper ventilation during the purging procedures.

Regrind

If the application permits the use of 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 will be different. Regrind utilization may produce some effect on color. Actual regrind usage should be determined for each individual application.

Trouble Shooting Guidelines

Key:
- ↑ Increase to Improve.
- ↓ Decrease to Improve.
- ● Check item Indicated.

Suggested Action \ Molding Issue	Short Shots	Sink Marks	Voids in Part	Poor Weld Lines	Splay	Streaking/Color Shift	Part Warpage	Burn Spots	Part Brittleness	Jetting	Sticking in Mold	Poor Mold Surface Reproduction	Gate Blush
Adjust Feed	↑	↑	↑										
Injection Pressure	↑	↑	↑	↑			↓				↓	↑	↓
Melt Temperature	↑	↑↓	↓	↑	↑↓	↑↓	↓	↓	↓	↑		↑↓	↑
Mold Temperature	↑	↓	↑	↑	↑	↑	↓		↑	↑	↑↓	↑	
Injection Speed	↑	↑	↓	↑	↑↓	↓	↑↓	↓	↓	↓		↑	↓
Injection Mold Time		↑									↓		
Inspect Wear on Check Ring	●	●	●	●		●						●	
Improve Venting	●			●	●			●					
Nozzle/Sprue/Runner/Gate Size	↑	↑	↑		↑			↑		↑			↑
Check Pellet Drying					●				●				
Nozzle Temperature					↓			↓			↓		↑
Rear Zone Temperature					↓						↓		
Check for Contamination					●	●				●			
Screw RPM						↓		↓					
Screw Back Pressure					↑↓	↓	↓						
Check Heater Bands					●	●				●			
Cooling Cycle							↑						
Check Cooling Lines							●						
Avoid Sprue/Screw Decompress					●								
Improve Melt Quality					●								

Table 6-3. Trouble Shooting Guidelines for GELOY Resins.

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