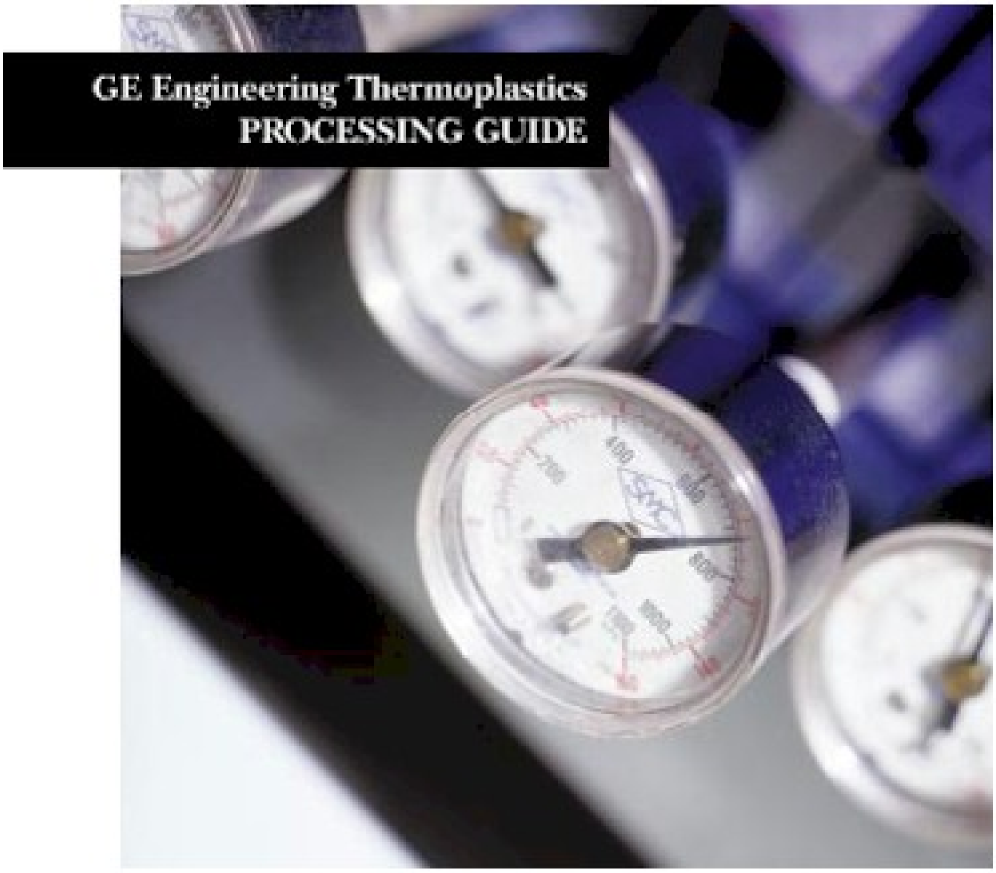
GE Plastics

CYCOLOY* PC/ABS Processing Guide



CYCOLOY resins are high impact amorphous polycarbonate and acrylonitrile- butadiene- styrene terpolymer blends. By varying the ratio of PC and ABS, CYCOLOY resin can be tailored to meet specific property requirement to achieve the optimal balance of performance, cost and processability for automotive body panels and instrument panels, computer housings, and cellular phones. This alloy features low-temperature ductility, excellent impact resistance, heat resistance and outstanding aesthetics.

Contents

Materials

CYCOLOY resins are high impact amorphous polycarbonate (PC) and acrylonitrile-butadine-styrene teropolymer (ABS) blends, which combine the properties of both materials resulting in an optimum balance of performance, processability and cost. By varying the ratio of PC and ABS, CYCOLOY resins can be tailored to address specific property requirements of a wide range of high performance applications from automotive body panels and computer housings, to instrument panels and cellular phones.

CYCOLOY resins offer the processability of ABS together with the mechanical properties, impact and heat resistance of polycarbonate. These thermoplastic alloys are formulated for exceptional flow for filling thin wall sections and complex parts. Impact resistance is maintained below -20°F (-29°C), while heat resistance can be in the range of 176 to 280°F (80 to 137°C) by manipulating the ratio of the two components.

Properties	Characteristic	Typical Designations
High Flow	A series of super high flow, UV stable blends with excellent impact.	C10000HF, C1110HF C1200HF, MC9000.
Low Temperature Impact	High impact grades, even at low temperature targeted at Automotive Component.	MC8002, IP1000
Low Gloss	Low gloss grades, even at unpainted applications in Automotive Component.	LG8002, LG9000
Electroplating	Designed for improved performance in plated applications.	MC1300
Mineral Filled	A grade designed for applications where dimensional stability and heat performance (up to 260°F) are critical, like in Automotive Exterior.	MC8800
Flame Retardant	Series of grades designed for the Business Equipment Market, that meet both UL and European environmental requirements.	C2800, C6200, C2950
Wear Resistant	PTFE filled grade designed for Business Equipment applications medium heat, flame retardant	C2801

The following pages contain additional information on mold design and/or processing specific to CYCOLOY 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

CYCOLOY resins can be molded in most standard injection molding machines with reciprocating screw. When determining the size of equipment to be used for molding a particular CYCOLOY 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 eq
30 to 80% of the machine capacity. Very small shots in a large barrel machine may create unnecessarily lon

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 pressure) has been determined, 3 to 5 tons of clamp force should be provided for each square inch of projected area to reduce flashing of the part. Wall thickness, flow length and molding conditions will determine the actual tonnage required (Figure 4-1.)

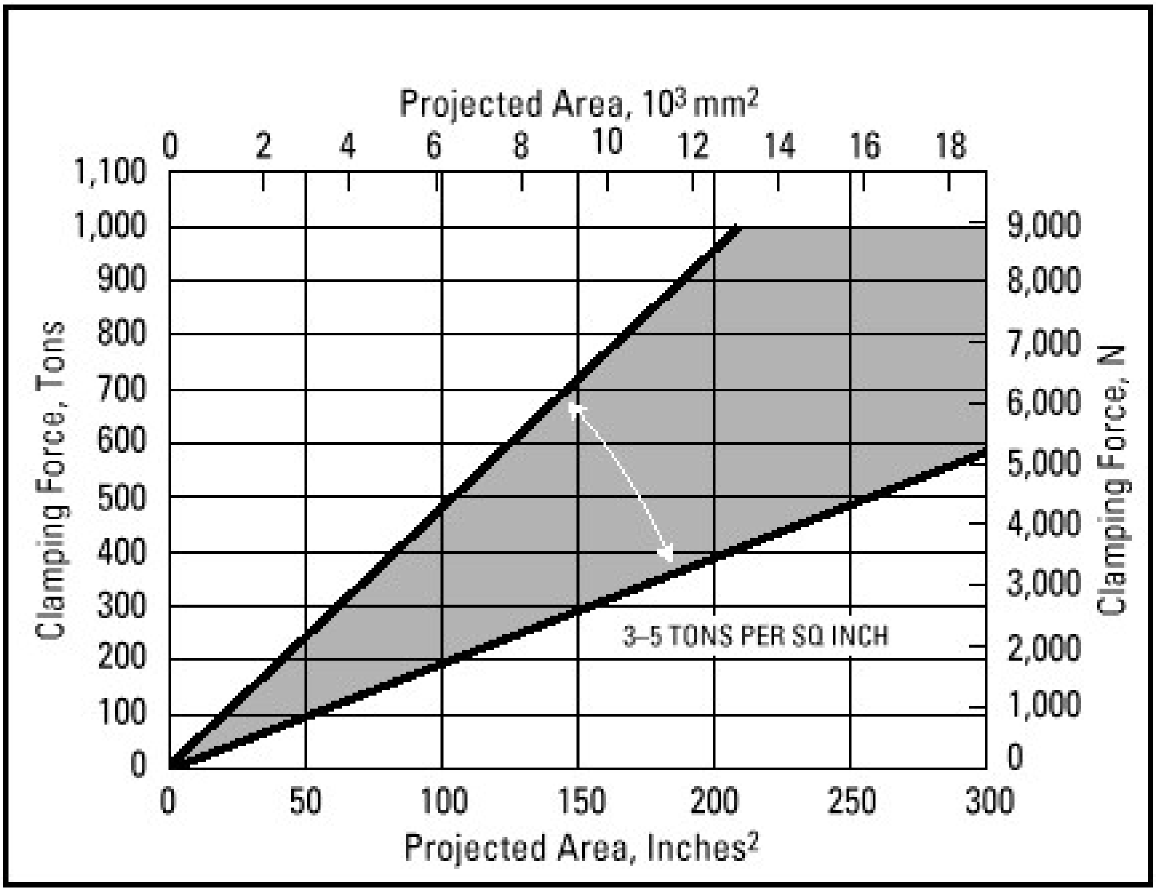


Figure 4-1. Clamping Force for CYCOLOY Resins.

Barrel Selection and Screw Design Considerations

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

Depending on screw diameter, a compression ratio of about 2.5:1 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 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. When a specific screw selection is not possible, general purpose screws with length to diameter ratios from 18:1 through 24:1 and compression ratios from 2.0:1 to 3.0:1 have been used successfully. Vented barrels are not suggested for processing CYCOLOY resins.

General Drying Parameters

CYCOLOY 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 and physical property performance. Consistent tight processing parameters should result in improved productivity by increasing part-to-part consistency and producing tougher parts. In order to reach the optimum performance of molded parts and to reduce the possibility of degradation, all grades of CYCOLOY resin must be dried before processing. The required moisture level can usually be reached by pre-drying CYCOLOY resin for 3 to 4 hours at the suggested temperature for each grade as shown in Table 4-1. Other drying parameters may apply to specialty resins.

Table 4-1. Suggested Drying Temperature Ranges for CYCOLOY Resins.

Grade	Temperature, °F (°C)
C2800, C2801, C2802	170-180°F (77-82°C)
C2950, C6200	180-190°F (82-88°C)
C100HF, MC1300	210-220°F (99-104°C)
C1110, C1110HF, C1200, IP1000, LG8002, LG9000, MC8002, MC9000	220-230°F (104-110°C)
MC8800	230-250°F (110-121°C)

Figure 4-2 shows the effect of drying time on moisture and on low-temperature impact of CYCOLOY C1110 resin, and Figure 4-3 shows representative drying curves for CYCOLOY resins.

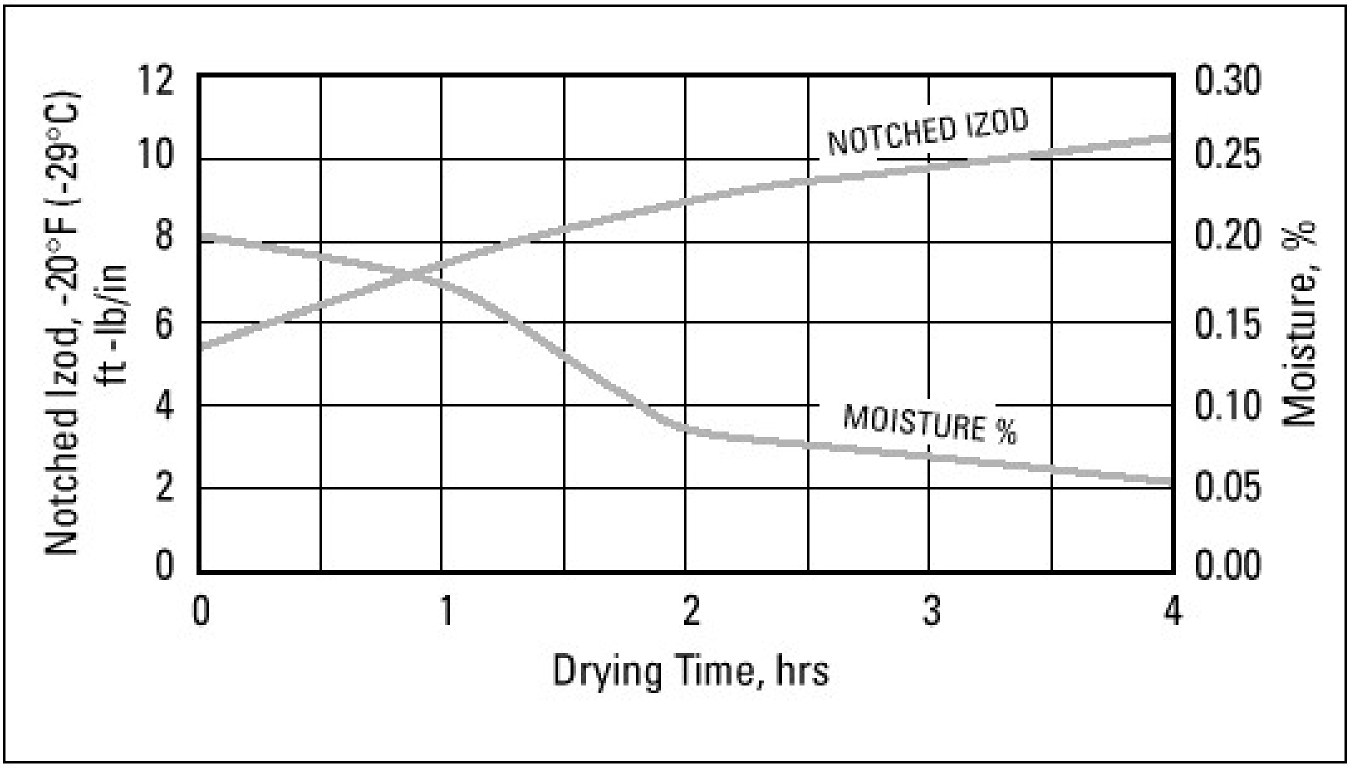


Figure 4-2. Izod Impact Vs. Drying Time for CYCOLOY C1110 Resin.

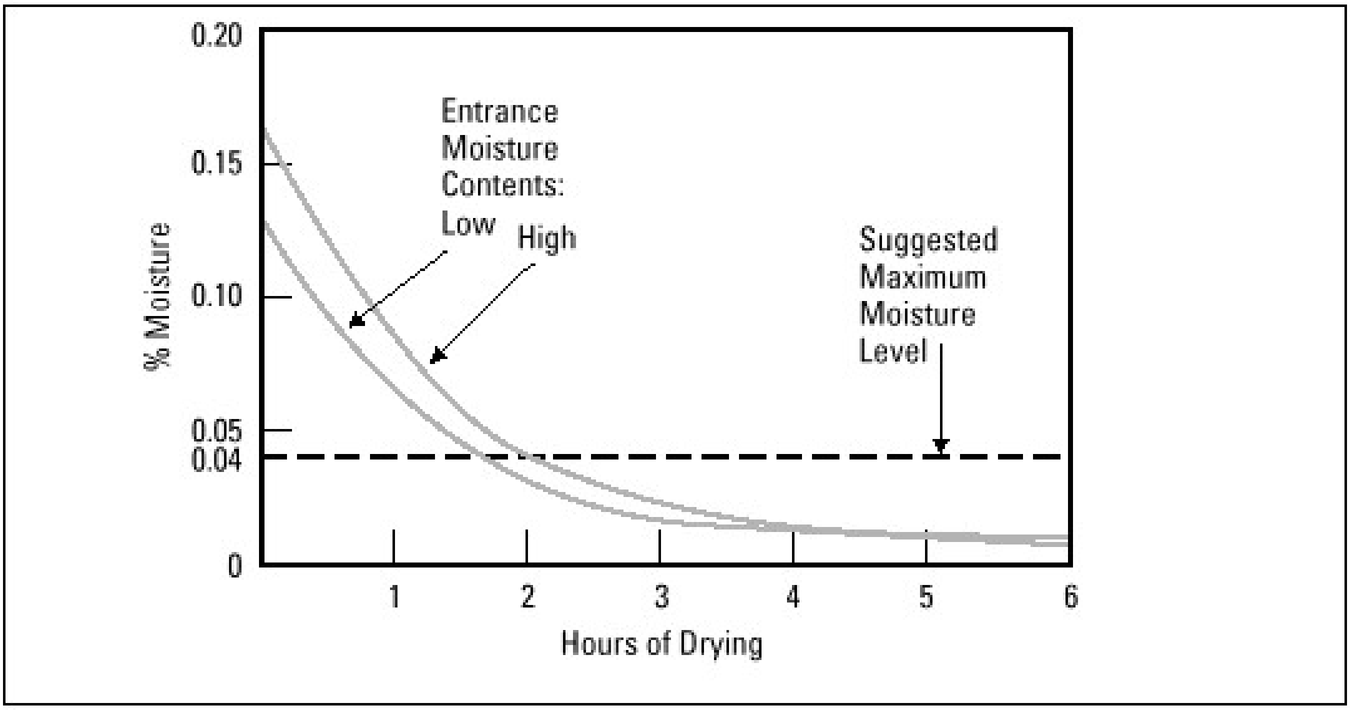


Figure 4-3. Representative Drying Curves for CYCOLOY Resins.

When using oven dryers, the resin should be spread in trays to a depth of approximately one inch. For large pellet size (regrind) or glass filled materials, the residence time should be increased to 4 to 6 hours. 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 protect the dried pellets from room atmosphere. If a hopper dryer is not available, only a sufficient quantity of dried, heated CYCOLOY pellets 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, use a hopper of sufficient volume to maintain the resin for a 3 to 4 hour minimum at recommended dry condition. The hopper dryer should be pre-heated 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.

Drying Specialty Resins

Other drying parameters may apply to more recently developed CYCOLOY resin grades, either in their virgin state or as regrind.

Prior to running CYCOLOY resins, refer to datasheets or contact a GE representative to confirm that suggested processing procedures are known. Call (413) 448-5800 or click onto GEP Live to request technical information.

Molding Conditions

As a general guideline, the standard grades of CYCOLOY resin are molded at different temperatures – the lower temperatures for the low viscosity resins and the higher temperatures for the high viscosity grades.

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

Mold temperature control is important in determining final part finish and molded-in stress levels. Cold molds more difficult to fill, necessitating high injection pressure and melt temperature. Heated molds generally prod part with a better finish and lower molded-in stress. Because of the high heat distortion, 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 speeds are 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. For typical processing parameters see Table 4-2.

Molding Conditions

		C2800 C2801 C2802		C2950 C6200		C1000HF MC1300		C1110 C1110HF C1200 C1200HF 1P1000 LG8002 LG9000 MC8002 MC9000		MC8800	
Processing Parameters	**Units**	**(min.)**	**(max.)**	**(min.)**	**(max.)**	**(min.)**	**(max.)**	**(min.)**	**(max.)**	**(min.)**	**(max.)**
Drying Temperature	°F(°C)	170(77)	180(82)	180(82)	190(88)	210(99)	220(104)	220(104)	230(110)	230(110)	250(121)
Drying Time (Normal)	h	3	4	3	4	3	4	3	4	3	4
Drying Time (Max.)	h	–	8	–	8	–	8	–	8	–	8
Maximum Moisture	%	–	0.04	–	0.04	–	0.04	–	0.04	–	0.04
Melt Temperature	°F(°C)	450(232)	525(274)	470(243)	530(277)	500(260)	550(288)	525(274)	575(302)	560(293)	610(321)
Nozzle	°F(°C)	450(232)	525(274)	470(243)	530(277)	500(260)	550(288)	525(274)	575(302)	560(293)	610(321)
Front Zone	°F(°C)	440(227)	525(274)	470(243)	530(277)	490(254)	550(288)	500(260)	575(302)	560(293)	610(321)
Middle Zone	°F(°C)	420(216)	500(260)	430(221)	510(266)	490(254)	550(288)	490(254)	560(293)	540(282)	600(316)
Rear Zone	°F(°C)	410(210)	490(254)	430(221)	490(254)	480(249)	540(282)	480(249)	550(287)	530(277)	590(310)
Mold Temperature	°F(°C)	120(49)	160(71)	140(60)	180(82)	170(77)	210(99)	170(77)	210(99)	160(71)	200(93)
Back Pressure	psi(MPa)	50(0.3)	100(0.7)	50(0.3)	100(0.7)	50(0.3)	100(0.7)	50(0.3)	100(0.7)	50(0.3)	100(0.7)
Screw Speed	rpm	40	70	40	70	40	70	40	70	40	700
Shot to Cylinder Size	%	30	80	30	80	30	80	30	80	30	80
Clamp Tonnage	tons/in^2	3	5	3	5	3	5	3	5	3	5
Vent Depth	in	.0015	.0030	.0015	.0030	.0015	.0030	.0015	.0030	.0015	.0030

Table 4-2. Typical Injection Molding Processing Parameters for CYCOLOY Resin.

Melt Temperature

CYCOLOY resins have very good thermal stability within the suggested melt temperature range. Figure 4-4 illustrates the melt stability of CYCOLOY C2800 resin at 490°F (254°C) and CYCOLOY C1110 resin at 530°F (277°C). 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.

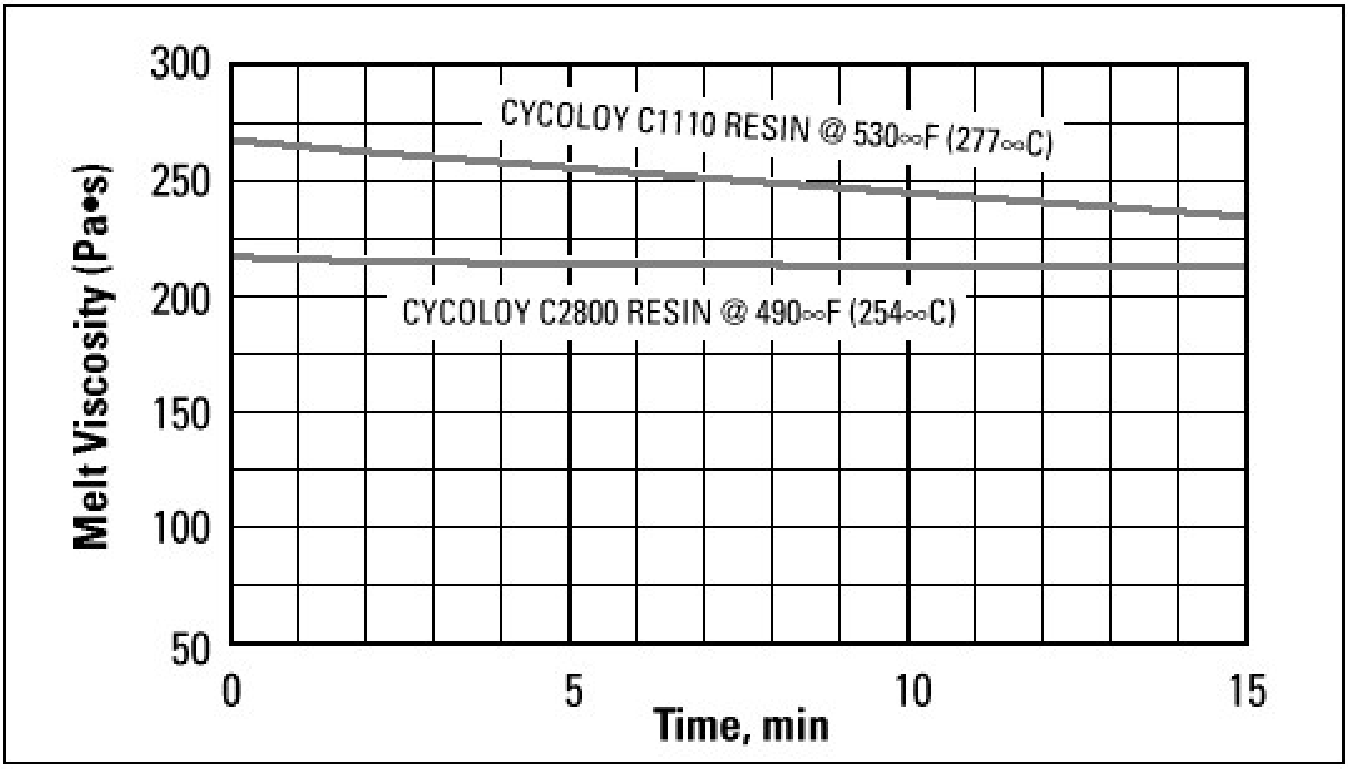


Figure 4-4. Thermal Stability at Sheer Rate 631 s-1.

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 may result.

CYCOLOY resin, like other engineered thermoplastics should not be left at elevated temperatures for prolonged periods of time without 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. The suggested shot size is 30 to 80% of the machine capacity for CYCOLOY resins. see Table 4-2.

Screw Speed

Screw speeds (RPM) should be adjusted to permit screw rotation during the entire cooling cycle without delaying the overall cycle (see Figure 4-5).

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.

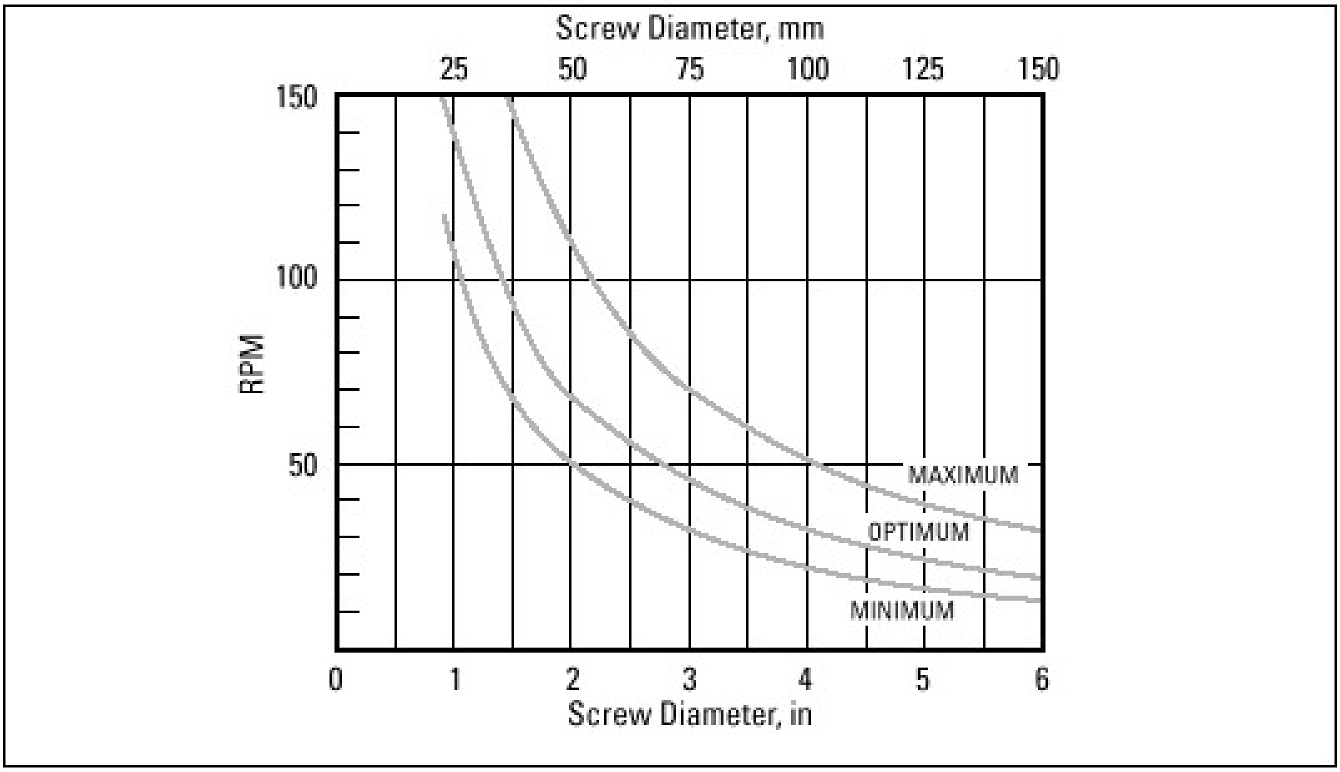


Figure 4-5. Screw Speed Suggestions for CYCOLOY Resins.

Back Pressure

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

Shot Size

The suggested shot size is 30 to 80% of the machine capacity for CYCOLOY resins.

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 faster fill speeds typically provide longer flow, fills thinner wall sections, and creates better surface finish. In thick parts, slow fill helps reduce voids. Thin-wall sections below 0.06 inch (1.52 mm) virtually always require fast ram speeds in order to fill the cavity and help produce high knitline strength. The fill rate of thick sections may be reduced to aid packing when filling through restricted gates.

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.

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

Cushion

The use of a small cushion (1/8 inch [3.18 mm] suggested) will compensate for machine variations and aids shot consistency.

Cycle Time

When adjusting cycle times, it is typically best to use a fast injection speed and a minimum holding time to achieve gate freeze-off and a short cooling time.

The fastest possible ram travel time is preferred for most parts. The thickest wall section of the part normally sets the cycle time. Figure 4-6 illustrates the overall cycle time prediction as a function of wall thickness. A runner/sprue section could exceed the part wall thickness and extend cycle times shown in Figure 4-6. This should be a consideration before the tool is built, as well as during actual molding.

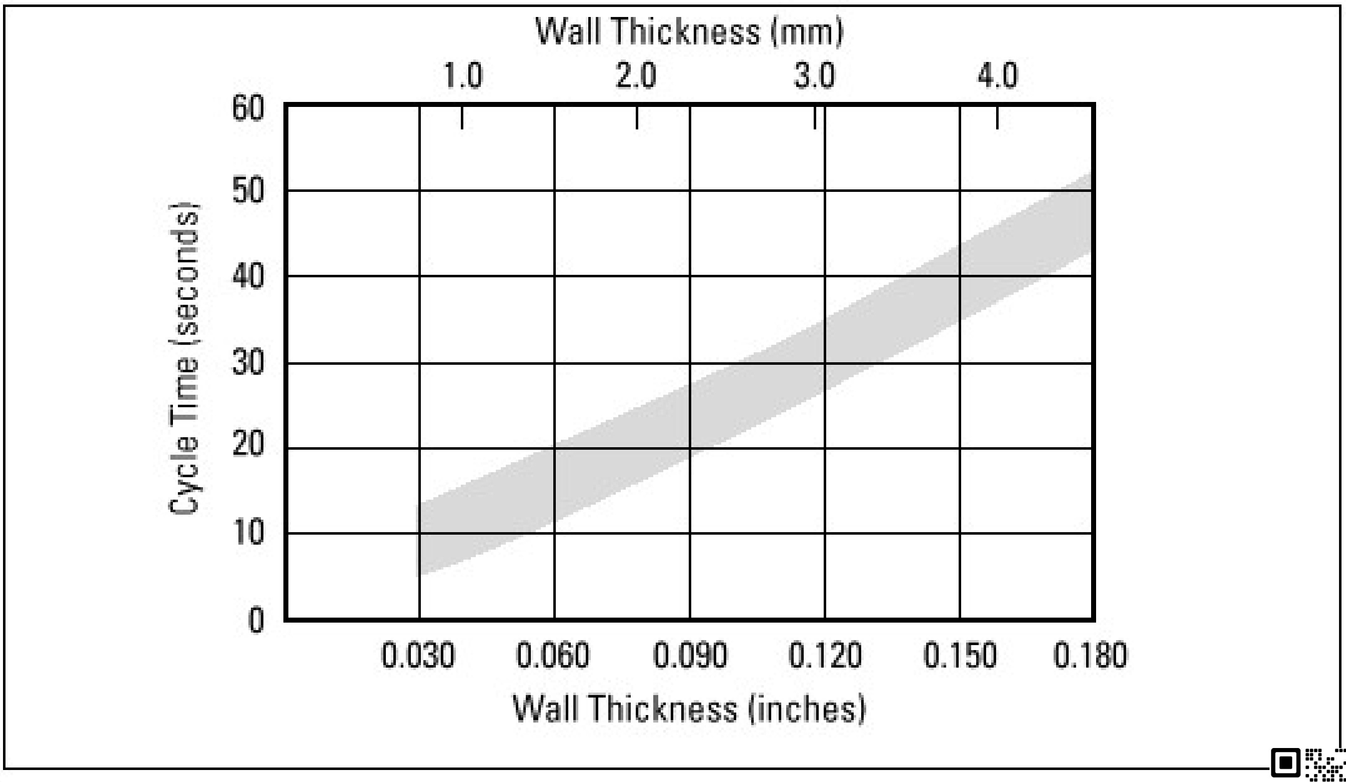


Figure 4-6. Typical Cycle Time vs. Wall Thickness for CYCOLOY Resins.

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 given below in Figure 4-7.

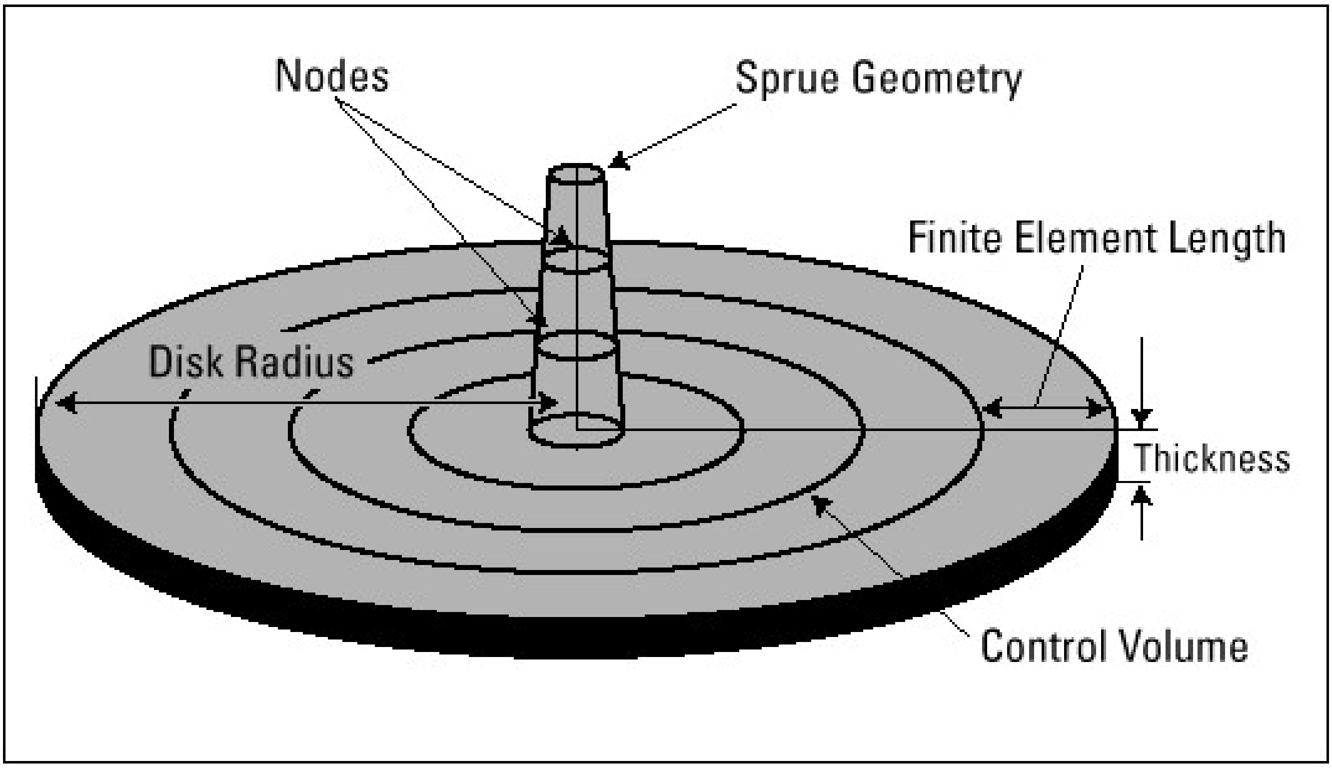
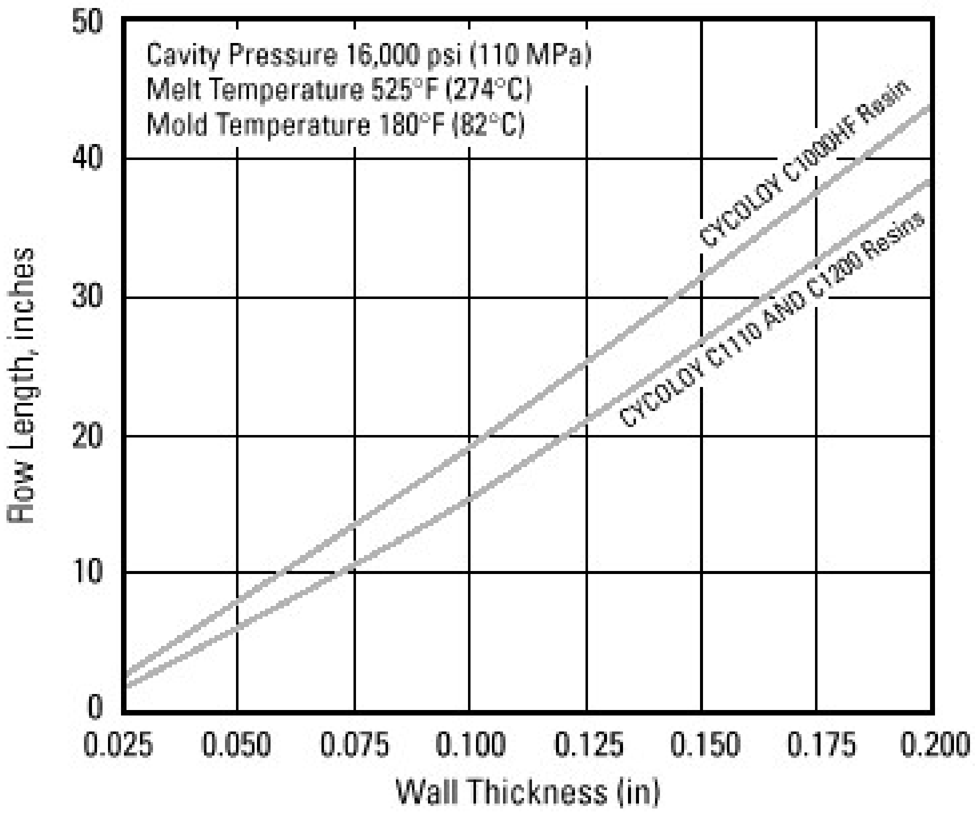


Figure 4-7. Diskflow Model.

Shown is the relationship of flow length versus wall thickness at a given capacity pressure (pressure at sprue) and melt temperature (see Figures 4-8 and 4-9). Diskflow radial flow results are normally conservative and may underpredict the flow lengths of many applications where flow is not entirely radial.



Results Obtained from Mold Filling Computer Simulation

Figure 4-8. Diskflow - Flow Length vs. Wall Thickness CYCOLOY Resin General Purpose Grades.

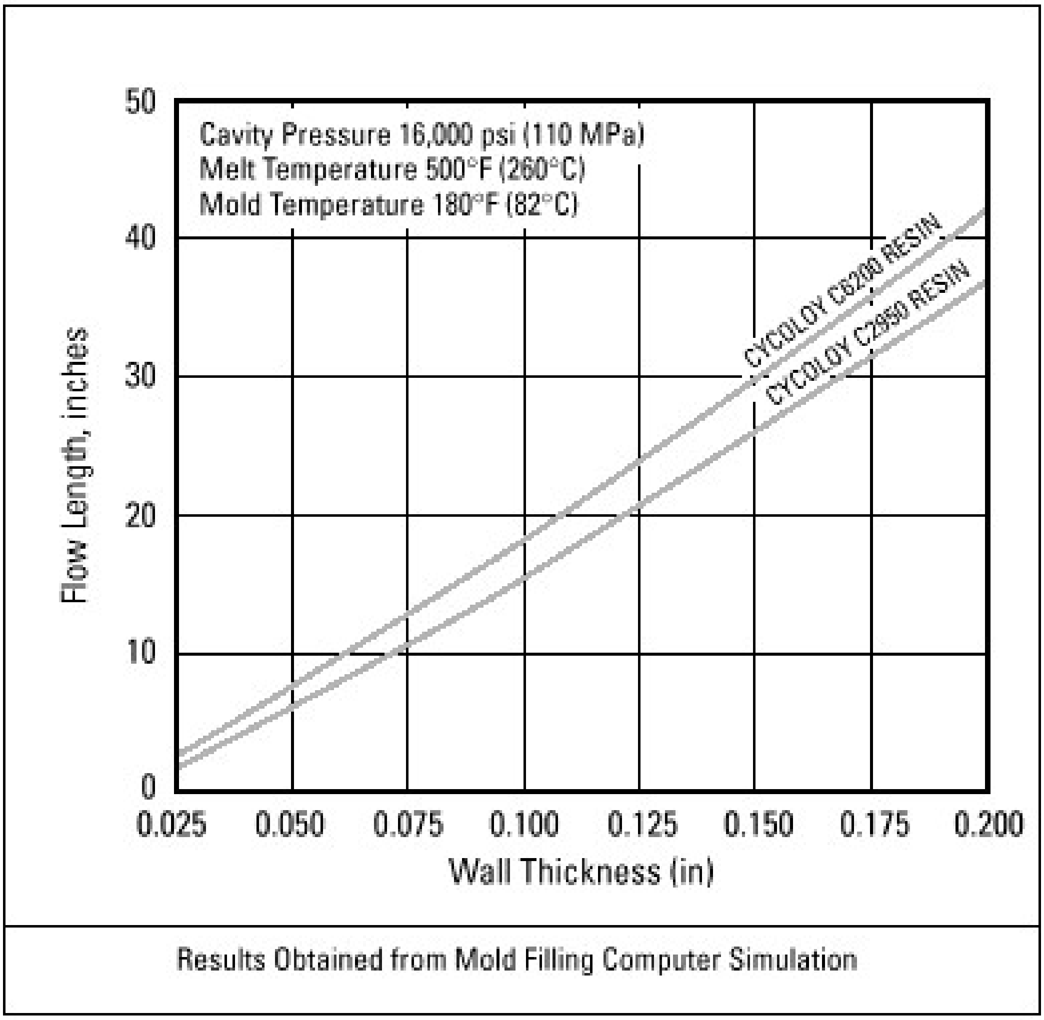


Figure 4-9. Diskflow - Flow Length vs. Wall Thickness CYCOLOY Resin Flame Resistant Grades.

Downtime

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

Short Term - CYCOLOY resins 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 on cycle 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 polystyrene, and ground cast acrylic are the best purging agents for CYCOLOY resins. 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, fines may 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.

Figures 4-10 through 4-13 illustrate the regrind stability of CYCOLOY C2950 resin molded at 545°F (285°C)

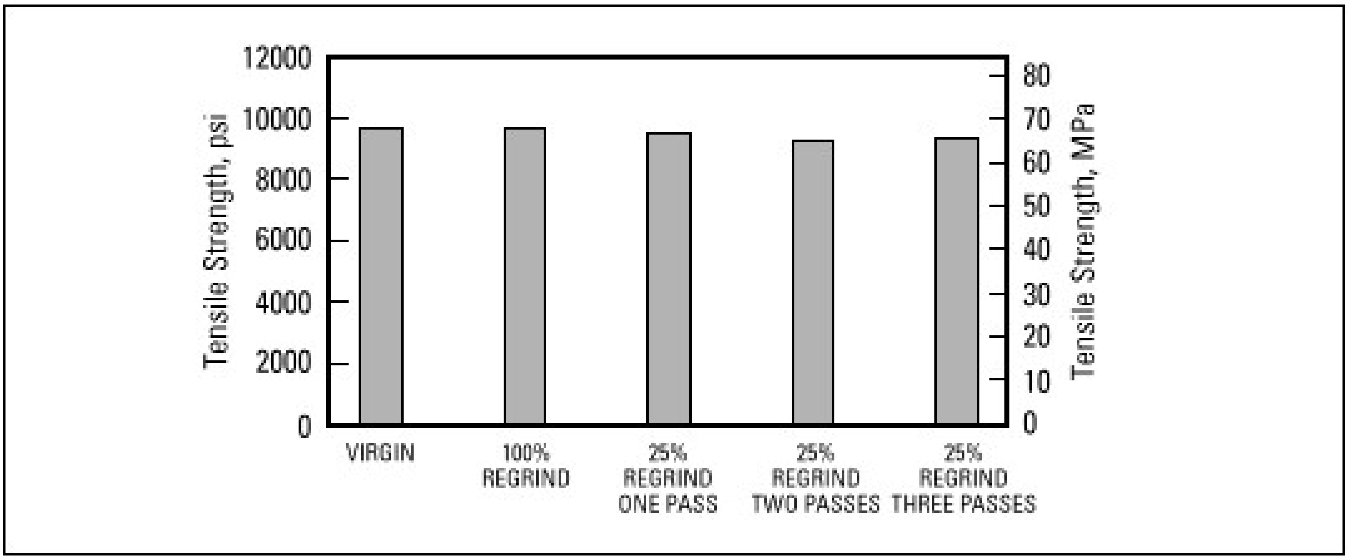


Figure 4-10. Regrind Stability - CYCOLOY C2950 Resin Effect of Regrind on Tensile Strength.

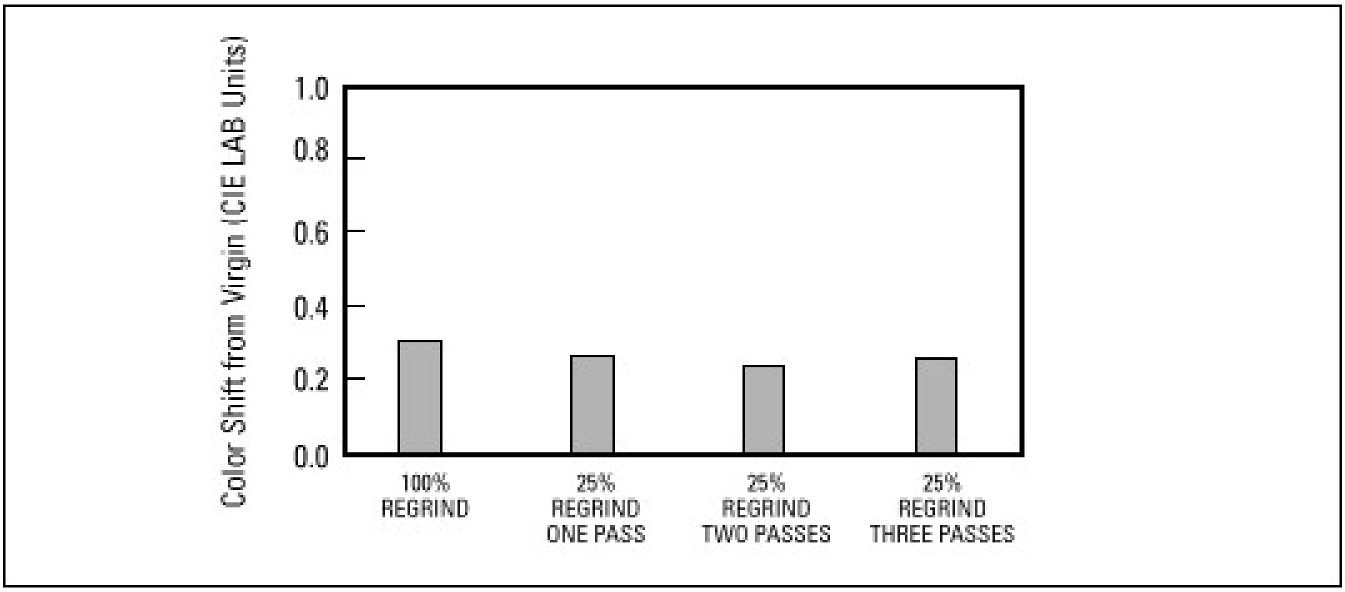


Figure 4-11. Regrind Stability - CYCOLOY C2950 Resin Effect of Regrind on Color.

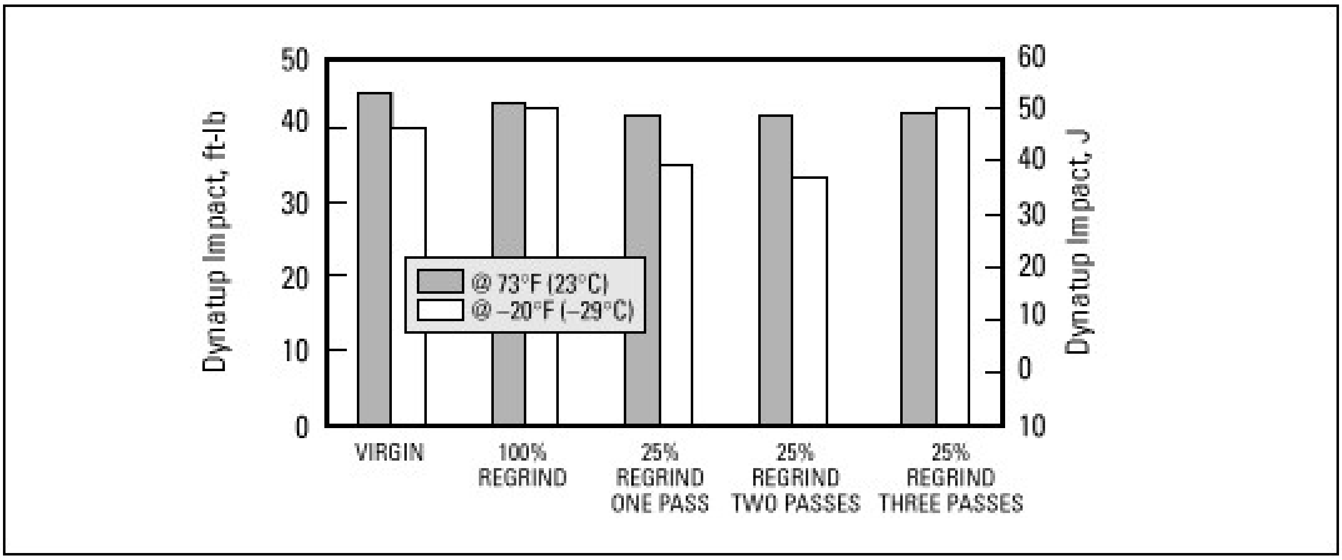


Figure 4-12. Regrind Stability - CYCOLOY C2950 Resin Effect of Regrind on Dynatup® Impact.

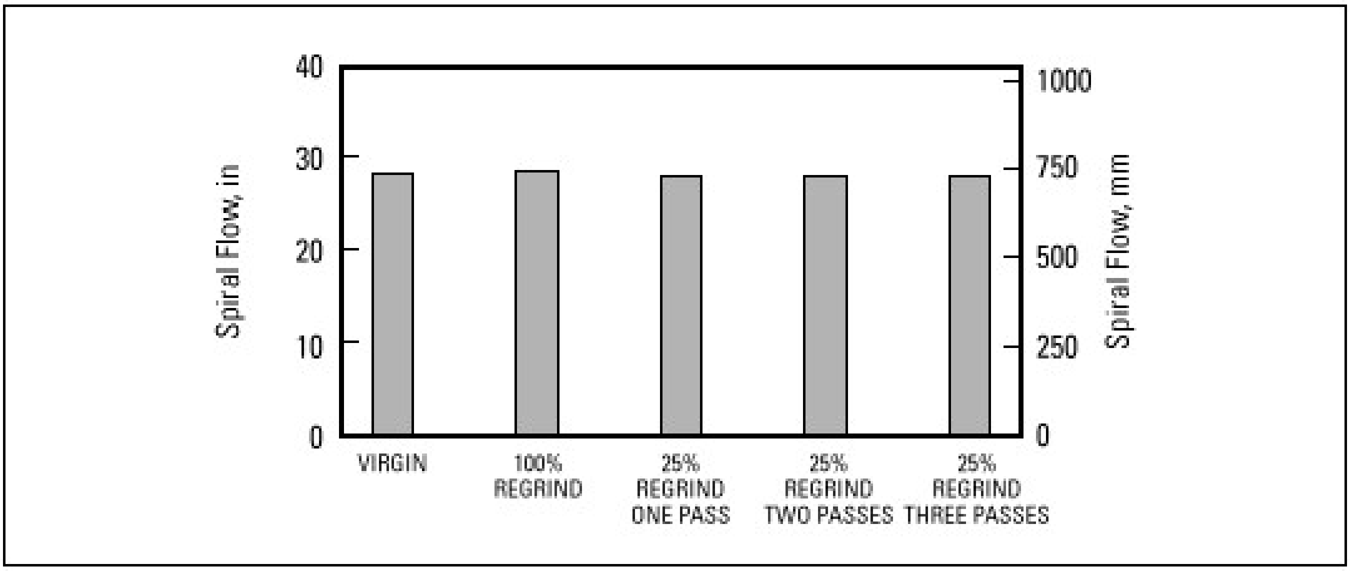


Figure 4-13. Regrind Stability - CYCOLOY C2950 Resin Effect of Regrind on Spiral Flow.

Dynatup® is a registered trademark of Instron Corporation.

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 4-1. Trouble Shooting Guidelines for Cycoloy Resins.