INJECTION MOLDING OF PULSE™ ENGINEERING RESINS (unfilled & filled grades)

TRINSEO™

TECHNICAL INFORMATION

Drying

PC/ABS (polycarbonate/acrylonitrile butadiene styrene) resins are hygroscopic – they absorb water from direct immersion and from humid air. The amount of water absorbed normally depends on the exposure time, the air temperature and the relative humidity. At the temperatures used to mold PC/ABS, moisture levels that cause no visual flaws and voids can still cause severe degradation within the molded part. The greater the amount of water in the resin during processing, the greater the loss of properties. Therefore, it is recommended that resin moisture content be limited to 0.03 percent when processing PULSE™ Engineering Resins.

Unfilled Grades

Trinseo recommends four hours at 100°C as minimum drying conditions for PC/ABS resins dried in dehumidifying dryers (for unfilled PC/ABS only) Closed, hot-air systems are not recommended for use.

Filled Grades

In case of a mineral filled PULSE™ grade granules should be dried at 120°C for at least 5.5 hrs. in order to reach a residual moisture levels less than 0.03 percent.

It is recommended to check granule dryness using the Karl Fischer method after the drying- and before the injection molding step (residual level less than 0.03 wt%) – recommended air dew point: -40°C. Because dried granules of PC/ABS resin can quickly pick up moisture from the air, it is good practice to limit the residence time between dryer and feeding into the molding machine screw.

Drying Equipment and Conditions

Hopper dryers that incorporate dehumidifying units are recommended for drying PC/ABS. Tray dryers are less efficient than other systems because air cannot flow easily through the bed of granules, the rate of resin heat-up is very slow.

Machine Selection

Clamp Tonnage

The recommended clamp tonnage for PULSE™ resins is 0.44 to 0.88 tonnes per square centimeter of projected part area.

Machine Capacity

The size of the machine to be used is determined by the volume of plastic required to fill the mold cavity. It is good practice to keep the shot size of the machine between 20 and 75 percent of the total capacity. An optimum shot size is between 40 and 60 percent of the machine capacity.

vvScrew Selection

There are three general guidelines for selection of the screw for an injection molding machine to be used with PULSE™:

- A minimum of 15:1 length-to-diameter ratio.
- A compression ratio between 1.5:1 and 3.0:1.
- Use of a slip-ring type, non-return valve with clearances of at least 3.2 mm and a ring movement of at least 4.8 mm.

Vented Barrels

The use of vented barrels on injection molding machines for processing PC/ABS resins is not generally recommended.

Melt Temperature

The molding machine should be set up to deliver a melt temperature between 260 and 280°C, with an aim point of 270°C. The optimum temperature profile depends on many variables, such as the ratio of machine capacity to shot size, screw design, mold and part design and cycle time. Generally, barrel temperature controllers should be PID type, and set so the material melts gradually, with cooler rear zone and hotter front zone temperatures. Reverse temperature profiles are used occasionally to compensate for improper screw design, to reduce machine amperage or torque requirements and to compensate for machines with short let down (L/D) ratios.

Because machine set points and actual melt temperature often vary by as much as ±25°C, actual measurement of the melt temperature is recommended to verify that it falls within the recommended range. Keeping a uniform melt temperature within recommended range is essential to ensure part performance and color matching of mating component parts.

Melt temperatures in the upper end of the recommended range may be necessary when processing thin-wall parts, difficult-to-fill parts, parts with very small gates and parts with long flow lengths. Excessive melt temperatures may result in thermal degradation and a loss of performance properties and aesthetics. Lower processing temperatures reduce the risk of thermal degradation and shorten the necessary cooling time. However, excessively low melt temperatures may result in high residual molded-in stress.

Mold Temperature

The mold temperature range recommended for PULSE™ Engineering Resins is 60 to 80°C. Cooling time is important for part performance and cycle time optimization. To obtain the best part properties and consistent dimensional tolerances, uniform heat removal is critical. Using a mold temperature controller will minimize temperature variations. Cooling lines should be properly placed and spaced around the part for effective heat removal. The cooling lines should be adequately sized, without restrictions in the connectors or associated piping. The flow rate of the cooling medium should be sufficient to provide turbulent flow through the cooling lines. Cleanliness of the cooling medium should also

be maintained to prevent blockage of the cooling lines. Higher mold temperatures in the upper recommended range generally provides better surface finish and less molded-in stress because of slower cooling and easier filling of thin-wall parts and parts with long flow-lengths. Lower mold temperatures allow the molten polymer to cool faster thereby reducing the overall cycle time.

PULSE™ resins with different melt flow rates have different processing windows. In general, resins having higher melt flow rates allow the use of lower mold and melt temperatures. The higher melt flow rates are easier to process, and their lower molding temperatures allow for shorter cycle times.

Plasticising Conditions

A moderate screw speed of 40-70 rpm is recommended for PULSE™ resins. Specific machine limits – due to machine and screw design differences – may require operation outside these recommendations.

Machine back pressure should be set as low as is practical. Due to the excellent rheological properties of PULSE™ resins, a low back pressure is sufficient to plasticize the resin and produce a uniform polymer melt.

Injection Conditions

The appropriate injection speed for PULSE™ Engineering Resins is determined largely by gate design. PULSE™ resins are susceptible to formation of surface defects around the gate. Therefore mind to avoid high-shear zones in the barrel tip, (hot-)runner and gates by:

- Use of a generous barrel & mold/hot-manifold orifice
- Using non-valve, non-torpedo, open hot-drops
- Locating gates in non-visible areas. When sequentially filling the part, position the 1st gate well away from a visible area.
- Use a wider tab gate with slightly more thickness in it's center and gradually getting thinner towards its extremes

For parts gated into a visible surface, it may be necessary to initially fill the part at as slow an injection speed as possible. If blush is not an issue, a faster injection speed may be used.

Filled Grades

For mineral filled PC/ABS materials it is recommended to start the injection cycle with slow injection speed, and ramp up injection speed once multiple gates are open (if applicable). Reduce injection speed near end of injection cycle in order to optimize degassing.
The use of a "cushion" of residual polymer melt in the barrel after injection will help ensure that the proper amount of material is injected into the cavity. During the packing phase, the material in the cavity is shrinking. To compensate for this shrinkage, additional material must be supplied to the cavity until gates freeze-off. A small melt cushion provides a ready source of additional melt to use during packing. If the screw is "bottoming-out," the packing pressure cannot be transferred through the polymer to pack out the cavity. This will result in poor part consistency due to short shots, poor dimensional stability, excessive sink marks or poor aesthetics.
It is generally recommended that a small cushion size be employed to minimize heat history on the polymer, reducing the potential for polymer degradation.

Regrind

Regrind can be used with PULSE™ Engineering Resins if care is taken to avoid contamination and moisture pick-up. Like virgin resin, regrind must be dried to a moisture content of 0.03 percent. Large particle sizes of regrind may require longer drying times. However, parts that were rejected because they were molded with wet resin cannot be reground and reused, as the polymer has already been degraded.

Purging

Where exposure time to a high temperature will be (or has been) excessive, it may be necessary to purge the barrel and nozzle. Purging will also be necessary for color or polymer changes. There are many purging compounds available on the market. You can also use PULSE™ resins to purge off-color material from the barrel. Purge at the low end of the melt processing range, being careful not to exceed the screw torque limit. Alternatively, a low melt flow rate general purpose polystyrene (GPPS) or polymethylmethacrylate (PMMA) resin may be used.

Colorants

PC/ABS resins are easily colored (using Trinseo color concentrates...) Color concentrates are available from a number of sources and can be custom-matched to customer specifications for color, processing technique, and end use. A color carrier system compatible with PULSE™ resins must be used, or part aesthetics and performance may be compromised. For example, a color system that works well in ABS may degrade the PC in PC/ABS blends.

Color systems designed for polycarbonate typically give good results. It is critical that colorants be properly dispersed. Lack of dispersion will cause aesthetic and performance problems in a part. The molding process typically will not increase dispersion. In the event of poor color distributive mixing, it may be necessary to increase the back pressure on the injection molding machine. A further alternative is to add a static or dynamic mixer to the machine or change to a mixing screw.

SUGGESTED INJECTION MOLDING CONDITIONS FOR PULSE™ ENGINEERING RESINS

If you have a specific application requirement or would like more information about PULSE™ Engineering Resins, contact your Trinseo Specialist.

Parameter		Value	
Temperature (°C)			
	Barrel Temperature		
	Rear (Hopper)	225–260	
	Intermediate	255–275	
	Front	255–280	
	Nozzle	255–275	
	Mold Temperature	60–80	
Pressure (Bar)			
	Back Pressure	3.0–15	
	Injection Pressure	Adjust to control part weight & dimensions	
	Hold/Pack Pressure	30–70	
	Cushion (mm)	3.0–6.0	
	Clamp Force (Tonnes/cm^2 Projected Area)	0.4–0.5	
Drying		**Unfilled Grades**	**Filled Grades**
	Time (Hours)	4	5.5
	Temperature (°C)	100	120
	Maximum Moisture (%) (Equilibrium Level = 0.6%)	0.03	0.03
Rate			
	Injection Speed	Adjust to control apprearance	
Ratios			
	Screw Compression Ratio	1.5–3.0/1	
	Screw L/D Ratio	>15/1	
	Mold Shrinkage (%)	3.0–6.0	

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