INJECTION MOLDING OF

MAGNUM™ ABS RESINS

TRINSEO™

TECHNICAL INFORMATION

Drying

Acrylonitrile butadiene styrene (ABS) Resins, along with other commercial polymers such as nylon, polycarbonate, acrylics, and thermoplastic urethanes, are hygroscopic, absorbing moisture and requiring drying before processing. However, unlike other resins that suffer the loss of physical properties, if water is not removed prior to processing, parts injection molded with ABS resins only suffer from poor surface aesthetics due to splay from the failure to adequately dry the resin. Splay results from the formation of tiny voids in the surface of the part created by water vapour and appearing as silver streaks on the part surface. ABS resin moisture should be less than 0.1 percent prior to injection molding to prevent surface defects.

Hot air desiccant bed dehumidifying hopper dryers are typically used. These dryers remove moisture from the process air to deliver hot, dry air with dew points as low as -40°C. Dew point readings of the air entering the hopper should be taken periodically to ensure that the desiccant is still effective and delivering air with a dew point less than -30°C. If measured dew point levels are greater than this, the desiccant should be regenerated or replaced.

Typical required air flow rates through the hopper dryer are one cubic foot per minute per pound of resin. Small lab scale samples are often adequately dried on flat trays in temperature controlled ovens prior to molding. The typical recommended drying conditions for ABS resins are a minimum of two hours at 80-90°C. However, pellet geometry and size and composition of the resin do affect the length of time to dry the resin to the recommended moisture level of 0.1 percent.

Melt Temperature

The ABS melt temperature should be between 220 and 275°C with an aim point of 230°C. The optimum temperature profile depends on many variables, such as machine capacity to shot size ratio, 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. For vented barrel machines, a relatively flat temperature profile is recommended to ensure the polymer is melted by the time it reaches the vent zone. 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.

Optimum melt temperature will depend on the particular ABS resin chosen as well as the part size, complexity, and desired surface appearance. 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. The suggested method for checking the melt temperature is to use a pyrometer with the probe heated to 15°C above the expected melt temperature. Insert the probe into the purge patty for 30 seconds, and record the melt temperature. Keeping a uniform melt temperature within the recommended range is essential to ensure good color matching of mating component parts.

A higher melt temperature reduces the viscosity of the material and allows the material to flow more easily. 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. Higher melt temperatures generally also produce parts with higher gloss. Excessive melt temperatures may result in thermal degradation and a loss of performance properties and aesthetics.

A lower melt temperature generally produces parts with lower gloss. Lower processing temperatures also 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

Generally, cooling time is the rate determining factor for overall cycle time. To obtain the best part properties and consistent dimensional tolerances, uniform heat removal is critical. Using a mold temperature controller will minimise temperature variations. Recommended mold temperatures range from 25 to 60°C, depending on the ABS chosen.

For plating or painting applications, higher mold temperatures (above the recommended range) may be required to reduce the surface stresses and provide for better plate or paint adhesion. 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 for 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 provide better surface finish, 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 resin to set-up faster to reduce the overall cycle time. Lower mold temperatures will produce lower gloss levels, while higher mold temperatures will produce higher gloss levels.

Plasticising Conditions

Screw Speed

For optimum homogeneity of the polymer melt, slow screw speeds are generally recommended for ABS. Screw rotation should occur throughout the cooling cycle. This can best be accomplished by establishing a proper balance between screw speed and back pressure, that is, a ratio of speed and pressure that will allow plasticisation to continue throughout the entire cooling cycle. Screw speed should be adjusted with a minimal pause (less than 2 seconds) before mold opening.

Back Pressure

Recommended screw back pressures range from 10-35 Bar, assuming a nominal hydraulic intensifying ratio of 10:1. Back pressure is necessary to ensure uniformity of the polymer melt for maximum part performance. It is particularly important to use sufficient back pressure when coloring in-house with color concentrates. Operating at the upper end of the recommended range may be necessary to achieve good distributive mixing and uniform part color.

Injection Conditions

The injection molding process is generally divided into two stages. The first is injection or fill and the second is packing or hold. During the first stage, or filling stage, it is recommended that pressure is set near its maximum and the speed of the screw is controlled with velocity controls.

The machine will only use whatever pressure is necessary to move the ram at the set speed. This technique will help provide consistent parts because the cavity is filled at a uniform rate, despite differences in viscosity due to temperature fluctuations and other factors. It is very important to switch from first stage to second stage when the part is 95 to 98 percent full. Without a switch from first to second stage pressure before the cavity is full, the high pressure of the first stage pump will cause the part to flash and may cause damage to the mold.

It is recommended to switch from first stage to second stage based on the position of the ram or the cavity pressure. Switchover based on hydraulic pressure and time is recommended if ram position or cavity pressure controls are not available. While maintaining a cushion, second stage pressure should be set at the lowest level necessary to properly pack out the part to achieve the desired surface aesthetics. In general, packing pressure is lower than first stage pressure. Under-packing the part will result in excessive sink marks, poor dimensional tolerances and poor surface aesthetics. Over-packing will result in excessive molded-in stress, increased part weight and poor part performance.

Injection Speed

Injection speed depends on the particular part and machine. Since an erratic injection speed can cause a variety of part defects, a uniform injection speed is best. In general, moderate to fast injection speeds are recommended for high gloss ABS resins. High injection speeds will create high shear as the melt passes through the runners, gates and along the cavity surface. Because of the shear rate dependency of ABS, this will decrease the polymer viscosity, which allows the material to flow easier and helps fill thin-wall parts. However, excessive injection speed may result in flash, or thermal degradation due to shear heating. When using low gloss ABS resins, medium to slow injection speeds usually provide more uniform low gloss. Fast injection speeds may result in excessive gate blush and higher gloss levels.

Melt Cushion

The use of a “cushion,” or 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 gate freeze-off. A small melt cushion provides a ready source of additional melt to use during packing. If the screw is allowed to “bottom-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. This will minimise the residence time and heat history of the polymer, reducing the potential for polymer degradation.

Regrind

Trinseo’s mass solution polymerisation process results in ABS resins with excellent thermal and processing stability. To the converter this means that there are few limitations to using regrind from MAGNUM™ ABS Resins, as long as normal material handling conditions have been observed. Some of our customers produce parts from 100 percent regrind MAGNUM™ ABS Resins, although the risk of contamination limits this practice to selected applications.

SUGGESTED INJECTION MOLDING CONDITIONS FOR MAGNUM™ ABS RESINS

If you have a specific application requirement or would like more information about MAGNUM™ ABS Resins, contact your Trinseo Specialist or visit www.trinseo.com.

Parameter		Value	
Temperature (°C)			
	Temperature	**Low or normal gloss**	**High heat or high gloss**
	Nozzle	230	245–290
	Front	220	245–290
	Intermediate	210	220–250
	Rear (Hopper)	195–200	205–215
	Mold Temperature	30–70[1]	50–70
	Manifold Temperature	220–275	230–290
	Melt Temperature (Air Shot)	220–275	230–290
Pressure (Bar)			
	Back Pressure	10–35 (higher for self coloring)	
	Injection Pressure	Adjust to control part weight & dimensions	
	Hold/Pack Pressure	30–70	
	Clamp Force (Tonnes/cm^2 Projected Area)	0.3–0.8	
Drying			
	Time (Hours) Exludes Warm-up time)	2–4	
	Temperature (°C)	80–90	
	Maximum Moisture (%) (Equilibrium Level = 0.8%)	0.10	
Rate			
	Injection Speed	Adjust to control appearance	
Ratios			
	Screw Compression Ratio	2.0–3.0/1	
	Screw L/D Ratio	>20/1	
	Mold Shrinkage (%)	0.4–0.7	

(1) Higher mold temperature will improve gloss for the low gloss grades

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