Eastar™ copolyester

Processing guidelines for Eastar™ copolyester MN058

Introduction

Eastar copolyester MN058 provides the consumer with brilliantly clear parts as well as good impact strength, chemical resistance, dimensional stability, low shrinkage rates, and other enhanced physical property advantages. These processing guidelines are given to help optimize these physical properties.

Drying

- Use a desiccant-type drying system with dry air at a dew point of –30°C (–20°F) or less.
- Dry Eastar™ copolyester MN058 at 160°C (320°F) for 4–6 hours. The actual inlet air temperature at the dryer should be measured and used as the drying temperature which should be controlled within ± 3°C (± 5°F) throughout the drying cycle. Extended drying times, greater than 12 hours, will require reduced air temperature to prevent pellet degradation. Contact your Eastman representative for more information.
- The dryer should have sufficient airflow to ensure a uniform pellet temperature throughout the dryer. A minimum airflow of 0.062 M^3/h is suggested for each kilogram of polymer processed per hour (1.0 cfm per pound per hour of polymer processed).

Processing

Barrel and melt temperatures

- Processing at the lowest processing temperature and residence time in the machine will help maximize physical properties. For planning purposes, we suggest a maximum residence time of 5 minutes even though residence times of as much as 7 minutes have been used with resultant parts having excellent properties.
- Well-dried material is key to maximizing physical property retention. Copolyesters are hygroscopic; meaning they will absorb moisture into the pellets. If this moisture is still present when the resin is heated to processing temperatures, a chemical reaction (hydrolysis) occurs that changes the molecular structure of the resin and results in loss of physical properties—thus, drying is key to obtaining good molded parts with good physical properties.
- Normal processing temperatures range from 277° to 293°C (530° to 560°F) for a purge shot measured by a suitable pyrometer and sampling technique. If higher melt temperatures are required (for example to fill the mold), reduced residence time will be needed to help maintain part properties. Residence time can be reduced by faster cycles and/or using more of the barrel's shot capacity. On the other hand, long residence times caused by "low shot size to barrel capacity" ratios can be compensated by using a lower melt temperature. We suggest, when possible, selecting a machine in which 50%–70% of capacity is used for each molding cycle.
- Shear heating will typically cause the actual melt temperature to be higher than the barrel set point selected; thus, the actual temperature should be checked once equilibrium is established and rechecked if major changes are made.

The following formula is used:

$$\frac{\text{Barrel capacity (oz of PS)}}{\text{Sp. grav. polystyrene (1.06)}} \times \frac{\text{Sp. grav. copolyester (1.33)}}{\text{Molded shot wt (oz)}} \times \text{Molding cycle (s)} \times \frac{\text{1 min}}{\text{60 s}} = \frac{\text{Residence time}}{\text{Minutes}}$$

Melt temperature

- A typical temperature profile setting is normally used; i.e., a barrel with a four-zone system might have settings as follows:

Zone 1	271°C (520°F)
Zone 2	282°C (540°F)
Zone 3	288°C (550°F)
Zone 4	288°C (550°F)
Nozzle	282°C (540°F)

- Since each machine is different, the barrel temperatures might need to be set as much as 5°–11°C (10°–20°F) lower than the targeted melt temperature because of shear heating. It is good practice to determine the actual melt temperature using a pyrometer. Also, it is important that the casting around the feed throat of the injection molding machine barrel be cooled to at least 38°C (100°F) to provide optimum pickup of the material.

Mold temperature

- Mold temperatures ranging from 16° to 32°C (60° to 90°F) produce the best parts.
- These amorphous Eastar copolyesters require colder molds than some other plastics, so preparing cooling ahead of time pays dividends in cycle time and processability. High mold temperatures, even in small areas of the mold, can cause sticking or crystallization. Ample mold-cooling channels, good cooling of pins and thin-steel areas, and good cooling near hot spots such as sprues are all required to produce good moldings at optimum cycle times. Coolant passages should be properly spaced and located for good uniform cooling. Avoid needless restrictions such as shut-off-type quick disconnects or undersized baffled drops. Heat transfer is improved by higher coolant flow rates.

Nozzle configuration and temperature

- The nozzle can be a source of splay unless proper equipment and temperature are used. A nozzle having ample heater band coverage is needed to prevent hot or cold spots from occurring. Too few heater bands can result in hot and/or cold areas depending on thermocouple (TC) location. The TC should not be in direct contact with the heater band but should be midway between two of the heater bands. The heater bands should be of a moderate watt density (approximately 35 watts/in.^{2}) and be spaced to avoid large blank spots. Locate one band as close to the tip as possible. When splay is encountered, an adjustment or equipment check is suggested. Check to ensure all heater bands are functional and of the proper type and position as noted. Note also that a removable tip nozzle must be designed and installed so that the face of the tip's threaded base will bottom out in the nozzle extension. This is required to eliminate dead spots which will permit resin to hang up and degrade to the point of causing black specks.

Fill rate

- Typical fill rate for Eastar™ copolyester MN058 is fast. Gate blush can be minimized by proper gate design and/or adjusting the fill rate.

Screw speed (rpm)

- Adjust screw rpm to achieve a full-shot plastication 2 to 5 seconds prior to mold opening. This minimizes excessive shear heating of the melt and yields a melt having improved thermal homogeneity.

Pack and hold pressure

- Pack and hold pressures should be sufficient to obtain proper part sizing and appearance.

Cushion size

- Cushion size should be at the absolute minimum to ensure the screw does not hit bottom and the pack and hold pressures are getting into the part. The screw should not reach bottom before all stages of injection time out. With this condition satisfied, the cushion should typically be 2.5–5.0 mm (0.1–0.2 in.). Larger cushions can add to hold time in the barrel and aggravate degradation. If the screw continues to move forward at the end of the shot after adequate time is given to come to a stop, it is a sign of a leaking check valve, which may cause short shots and shot-to-shot variability.

Back pressure

- Back pressure is usually minimum at about 0.3 MPa or 3.5 bar (50 psi).[1] To improve melt uniformity (and mix concentrates), increase melt temperature, or to get rid of air entrapment (air splay), back pressure can be increased gradually to as much as 2.5 MPa or 25 bar (350 psi). High back pressures can aggravate drooling into the mold and typically require more decompression which can cause splay.

Decompression (suck back)

- In general, use very small or no decompression because it tends to pull air (possibly moist air) back into the nozzle causing splay in the next shot. Very small amounts of decompression can be used to reduce drool if needed.

Screw and barrel design

- General-purpose screws having compression ratios of 2.8 or 3.2 to 1 and an L/D of 18–20:1 are typically used. The transition zone should have a gradual transition (typically 4–6 diameters) so that high shear heating of rapid transition is avoided. It is suggested to use a free flow sliding check ring type nonreturn valve at the end of the screw instead of a ball check type valve. Vented barrels are not recommended. The unfilled resins are generally mild on screw wear. Corrosion of barrel and screw parts is not expected with copolyesters.

Purging

Purging other polymers to Eastar™ copolyester MN058:

- Purge with clear undried polycarbonate or clear polycarbonate regrind at the copolyester processing temperature of 260°–280°C (500°–540°F) to eliminate the previous polymer. After an adequate amount of purging, which will vary depending on the previous polymer molded, the polycarbonate that is in the barrel of the injection-molded machine can be followed directly with Eastar™ copolyester MN058 without further purging.

[1] *Note that this is actual hydraulic pressure, not molding machine gauge pressure.*

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