KYDEX® FST IM Resin - Suggested Processing Parameters

TB - 301

Introduction

FST resin offers many excellent advantages; however, to get the most out of this material, there are some processing quirks that are not understood by everyone involved. The following sections are some tips for the technical engineer.

Material Handling

Material must be kept free of airborne dust and dirt. Bags must be resealed. Gaylords must be covered at all times. The recommended method of covering opened gaylords is with a gaylord cover, which is typically made from a non-porous material, has a small opening to provide access for a material loader lance, and has a stretch fit feature on the edges to allow tight fit to the gaylord.

Dryers and hoppers should be fully self-contained and be capable of dew points to –40˚C (–40˚F). Dust filters should be checked, cleaned and/or replaced once per 8 hours. Dust from these systems can and will get into the process material and may cause splay. Generally speaking, the material should be dried to no more than 0.02%, and no less than 0.01% moisture by weight. Over drying the material can result in splay, color shift, and clumping. FST resins dry at 104˚C (220˚F). Over drying FST is among the most common errors in processing this material does not exceed cumulative drying times of 12 hours.

Processing

Do not exceed the recommended maximum melt temperature in the barrel or the actual temperature of the melt. Elevated temperatures not only degrade the resin but also decrease the allowable residence time of the material. Degradation may cause streaks, splay, or color shift as well as affect the final part properties. Be certain that the nozzle assembly has full and proper heater band coverage to avoid cooler areas on the nozzle. Nozzle tip length should be kept as short as possible.

Residence time is the amount of time it takes one pellet of material to get from the inlet of the barrel to the cavity. This is extremely critical when processing FST resins. Large barrels can accept very little over-residence time, due to the increased linear length of the screw. Acceptable residence time varies depending upon barrel size, process cycle, and shot size. The average acceptable residence time for FST is 5 minutes. To determine acceptable residence time, use either of the following formulae:

$$\frac{\text{Barrel Size}}{\text{Shot Size}} \times \frac{\text{Cycle Time}}{60}$$

In this formula, a 5 ounce barrel (141 grams) with a 22 gram shot (include runner) having a cycle time of 22 seconds would yield a residence time of 2.35 minutes. Another usable formula is:

$$\frac{(\text{Barrel Size}) \times (\text{Specific Gravity}) \times (\text{Cycle Time}/60)}{\text{Shot Weight}}$$

In this formula, using the same part and barrel weights with a specific gravity of 1.34, yields a residence time of 3.15 minutes. This formula is considered to be the most accurate. It is important to note that if using a hot runner manifold, the volume of material within the manifold must be included in the barrel size for either formula.

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Screw Design:
Screw design is critical for proper processing of FST resin, both for material integrity and for aesthetic control. "GP screws" are not recommended. A "GP" screw could be designated as a crystalline, or Olefin screw having 8 or more flights in the feed zone and 5 or less zones in the compression zone. High compression screws greater than 2.5:1 are NOT recommended. Screws with the following characteristics should be used:

- 20:1 L/D preferred, maximum allowable 24:1
- 2:1 compression ration preferred, 2.5:1 maximum allowable.
- 5 flights feed, 11 or more flights compression, 4 flights or less metering zones.

Ball check assemblies:
Ball check assemblies contain material dead spots and should not be used with any polycarbonate. These dead spots leave resin behind for many shots. This "dead resin" degrades and becomes black carbon residue which will bleed out as black specs or streaks. A free flow, sliding check ring assembly is recommended for FST processing. The check ring assembly must be well maintained to be certain that wear does not become excessive over time and that the check ring itself does not crack. Excessive wear between the check ring O.D. and barrel I.D. will allow material to wipe back and forth over the ring, creating high shear and streaks as well as splay and process inconsistencies. The generally accepted allowable clearance between the check ring and barrel is not to exceed 0.076mm (0.003") per side clearance.

Be certain that all components of the machine and mold (end cap, nozzle, nozzle tip, sprue bushing hot manifold, etc.) are in proper alignment and that seats are clean and free of nicks or chips.

Back Pressure:
In general, FST resin performs poorly using high backpressure; 100 psi should be the standard for running FST resin.

Velocity:
Generally speaking, FST resin should be injected as quickly as practical to extend the flow distance and to reduce molded in stress. As a guideline, a 1 pound part should be filled in 1st stage injection in approximately 1 second. Of course this will vary depending upon part design and gating, but fast injection rates nearly always produce parts with the best visual and physical characteristics. Having said this, FST is a highly viscous (stiff) material and runners, nozzle orifices and gates must be designed accordingly.

Tool Temperatures:
Tools should be run from 71-104˚C (160-220˚F) degrees at the steel surface. Hotter tools result in improved gloss and better surface appearance.

Hot Runner Systems:
Hot runner system work very well with most resins. However, as in all engineering grade materials, the system must be designed and built with the specific resin in mind. Internal manifold passages must be large, with a minimum diameter of 15.88mm (0.625" for large parts. It is imperative that internal corners be rounded to avoid dead spots. Thermocouples should be placed internally in the system, near the melt channels to read accurately. External thermocouples are NOT recommended. Hot runner gates should be externally heated with no internal probes. Internal probes can result in streaking in many cases. Valve gates are not recommended.

Leaving the machine standing idle with heats on over 10 minutes may cause degradation of the polymer and may create dark streaks in future parts. If the machine must be down for more than 30 minutes, Purge the machine clear of FST.

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Purging FST Resins:
Because FST resins have limited residence time requirements, improper purging methods can result in black specs or streaking in subsequent runs if not properly purged clear of resin prior to shut down or change over. While the machine is running FST resin, close the feed throat and let the machine run "dry" of resin in the barrel. Do not turn heats off or down after the barrel runs dry, but immediately introduce either purging compound or a similar viscosity PC resin (recommended). Fully purge until the extrudate is clear and no trace of the FST resin remains in the melt. Purging compounds may be used following resin purge if desired.

Conditions

Typical Injection Molding Conditions	Standard	Metric
TEMPERATURES	ºF	ºC
Rear zone	470 - 505	260 - 280
Center zone	485 - 530	270 - 295
Front zone	505 - 550	280 - 305
Melt	505 - 550	280 - 305
Mold	160 - 220	71 - 104
Nozzle	495 - 550	275 - 305
PRESSURES	psi	MPa
Injection	10,000 - 15,000	69 - 103
Hold	5,000 - 12,000	34 - 83
Back	44 - 100	0.3 - 0.7
SPEEDS		
Fill	1 - 2 in/sec	25 - 51mm/sec
Screw	40 - 70 rpm	40 - 70 rpm
DRYING		
Time & Temperature	4 Hrs @ 220ºF	4 Hrs @ 105ºC
Moisture Content	0.02%	0.02%
MISC		
Shot to Cylinder Size	40 - 60%	40 - 60%

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KYDEX® THERMOPLASTIC SHEET

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Melt Temperatures

Standard melt temperatures for processing PC are between 280 and 320 °C. Lower melt temperatures typically lead to surface defects and could also lead to insufficient part fill. High melt temperatures will decrease the viscosity and improve polymer flow but could lead to discoloration and burning.

Mold Temperatures

Standard mold temperatures for PC should be between 70 and 130 °C. High mold temperatures reduce the level of stress and typically improve the surface quality of the moldings. The holding pressure should also be set at a low level in order to obtain stress-free moldings. A fine balance of melt and mold temperatures will be necessary to achieve a good part.

Short Shots (Insufficient Fill)

Possible Cause	Suggested Remedy
1. Melt temperature too low	Raise melt temperature
2. Mold temperature too low	Raise mold temperature
3. Insufficient material volume	a) increase shot size to maintain a constant cushion b) Inspect non-return valve for wear
4. Air entrapment causing resistance to fill	a) Provide adequate venting b) Increase number and size of vents
5. Restricted flow of material to cavity	a) Increase gate size b) Increase runner size c) Use larger orifice nozzle

These are suggested starting conditions and troubleshooting steps for KYDEX® FST Injection Molding Resin. As with any troubleshooting guidelines, only one parameter should be changed at a time and sufficient time should be allowed between steps for the material and machine to reach equilibrium. A series of trial and error steps may be required to reach the optimum settings.

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