

Eastman polymers for the medical market

Summary of drying and processing conditions

Condition	Eastman Tritan™ copolyester		
	MX711 and MX731	MX811	MXF221
Drying			
Dryer air dew point, °C (°F)	≥-29 (≥-20)	≥-29 (≥-20)	≥-29 (≥-20)
Drying time, hr	4	4	4
Drying temperature, °C (°F)	88 (190)	88 (190)	88 (190)
Dryer airflow, m³/hr	≥3.7	≥3.7	≥3.7
Moisture content, %	≤0.03	≤0.03	≤0.03
Processing temperatures			
Zones, °C (°F)	Set barrel temperatures to reach target melt temperature, up to 10°–20°C (50°–68°F) below target, depending on shear heating.		
• Rear			
• Center			
• Front			
Nozzle, °C (°F)	282 (540)	282 (540)	282 (540)
Hot runners, °C (°F)	282 (540)	282 (540)	282 (540)
Melt temperature, °C (°F)	282 ± 10–20 (540 ± 5–10)	282 ± 10–20 (540 ± 5–10)	282 ± 10–20 (540 ± 5–10)
Mold temperature, °C (°F)	60 (140)	66 (150)	60 (140)
Machine conditions			
Fill/injection speed	slow		
Screw speed, rpm	30–60 minimum required		
Pack and hold pressure, MPa (psi)	34–52 (5,000–7,500)		
Cushion size, mm (in.)	5–10 (0.2–0.4)		
Back pressure, MPa (psi)	10–15 (1,500–2,250)		

Some dos and don'ts for medical injection molders

Drying

Do

- **Use air with a dew point of –30° to –40°C (–20° to –40°F).**
- **Dry material for a minimum of 4 hours.**
- Keep drying system clean to prevent contamination of Eastman Tritan™ copolyester.
- Dry thoroughly with a dehumidified drying system to prevent
 - Bubbles or appearance problems on finished product.
 - Degradation due to hydrolysis, which causes loss of toughness.
- Air flow 3.7 m³/hr/kg (1.0 cfm/hr/lb).
- Check dehumidifying system with a dew point tester.
- Use air temperatures of 88°C (190°F). Air temperatures below 65°C (150°F) will substantially increase drying time. Air temperatures above 108°C (226°F) may cause pellets to stick together.
- Keep desiccant bed clean.
- Check heater circuits and elements.
- Control temperature precisely.
- Use air-drying volume of 1.0 cfm/lb [0.06 (m³/min)/kg] of material processed per hour.

Don't

- **Attempt to decrease drying time by raising temperature above 108°C (226°F). This may cause pellets to stick together.**
- Remove dried material from the drying system until just prior to processing.

Injection molding

Do

- Keep the material free from contamination to produce tough, clear parts.
- Purge the machine thoroughly, preferably with Eastman Tritan™ copolyester.
- Maintain mold surface temperature around 38° to 66°C (100° to 150°F).
- Use slow screw speeds of between 30 to 60 rpm, or even slower if recovery is erratic.
- Use slow injection speed to reduce streaking and gate blush. If injection speed is programmable, a slow/moderate/slow profile may be used to produce the best appearance and a reasonable fill time.
- Use an actual melt temperature near the recommended 282°C (540°F) when at the recommended 5–6 minutes or less melt residence time. Cooler melt may contribute to residual stress or screw recovery issues. In cases of longer residence time (big barrel and small shot), consider and test parts from lower melt temperatures approaching 260°C (500°F).
- Plan shot size to be at least 40% and preferably 75% to 80% of machine capacity.

Don't

- **Use high-back pressures except when including color concentrates.**
- Rely on visual inspection to judge the physical properties and quality of a molded piece. Test it under exacting conditions.

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Basic properties

Property	ASTM method	Eastman Tritan™ copolyester		
		MX711 and MX731	MX811	MXF221
Specific gravity	D792	1.18	1.17	1.19
Mold shrinkage, in./in. or mm/mm	D955	0.005–0.007	0.005–0.007	0.003–0.006
Tensile strength @ yield, psi (MPa)	D638	6,200 (43)	6,400 (44)	6,800 (47)
Tensile strength @ break, psi (MPa)	D638	7,700 (53)	7,700 (53)	7,300 (50)
Elongation @ tensile break, %	D638	210	140	132
Flexural modulus, psi (MPa)	D790	225,000 (1,550)	228,000 (1,585)	268,000 (1,847)
Rockwell hardness, R scale	D785	112	115	111
Notched Izod impact strength @ 23°C (73°F), ft-lb/in. (J/m)	D256	18.4 (980)	12.2 (650)	20.2 (1077)
Notched Izod impact strength @ –40°C (–40°F), ft-lb/in. (J/m)	D256	2.1 (110)	2.4 (126)	N/A
Deflection temperature @ 66 psi (0.455 MPa), °C (°F)	D648	99 (210)	109 (228)	90 (194)
Deflection temperature @ 264 psi (1.82 MPa), °C (°F)	D648	85 (185)	92 (198)	76 (169)

Drying

- **Proper drying of Eastman Tritan™ copolyester is key to shot to shot consistency and part performance.**
- **Dew point: –29°C (–20°F)**
- **Time and temperature: Minimum 4 hr at 88 ± 3°C (190 ± 6°F). If longer time is required (overnight), reduce inlet air temperature to 82 ± 3°C (180 ± 6°F) for the duration of the drying cycle.**
- **Airflow: 3.7 m³/hr per kg of polymer (1.0 cfm/hr per lb of polymer)**
- **Moisture content: ≤0.03% by Karl Fisher or weight loss method calibrated to Tritan**

Enhanced capability injection molding material

Processing

- **Barrel and melt temperature:** Normal process 260°–282°C (500°–540°F).
 - Faster cycle times utilizing 50%–80% if barrel capacity can be run 292°C (560°F).
 - Slower cycle times utilizing 10%–25% of barrel capacity should be run 277°C (520°F).
 - A flat temperature profile is normally run with 50% barrel capacity as follows:
 - > At 260°C (500°F) flow and screw recovery may become stiff.
 - > At 304°C (580°F) splay may begin with a 10-minute melt residence time.

Generally target 282°C (540°F) with a melt residence time of 5–6 minutes (screw and hot runner).^a

Rear zone	282°C (540°F) ^a
Center zone	282°C (540°F) ^a
Front zone	282°C (540°F) ^a
Nozzle zone	282°C (540°F)
Hot runners	282°C (540°F)
Actual melt temperature (purged on cycle)	282°C (540°F)

^aSince each machine is different, the barrel set temperatures might need to be set as much as 10°–20°C (50°–68°F) lower than the targeted melt temperature because of shear heating. It is good practice to determine actual melt temperature, temperature inside machine nozzles, and inside hot sprues and runners using a pyrometer. Also, it is important that the casting around the throat of the injection molding is colored to provide optimum pickup of material.

- **Screw Speed:** 30–60 rpm, minimum required
- **Pack and hold pressure:** 34–52 MPa (5,000–7,500 psi)
- **Cushion Size:** Minimum typically 5–10 mm (0.2–0.4 in.)
 - Fill/injection speed: Fill speed used for Tritan copolyester is slower than typical plastics. If fill speed profile is available use 13 mm/sec (0.5 in./sec) for the first 5%–15% of the shot, then increase to 43 mm/sec (1.7 in./sec), then slowing to 23 mm/sec (0.9 in./sec) is often successful. The slower initial fill speed minimizes gate bush.
 - Direct Sprue gating a moderate to fast fill rate 38 mm/sec–56 mm/sec (1.5 in./sec–2.2 in./sec) is suggested.
- **Mold temperatures:** 38°–66°C (100°–150°F)

Good mold temperature control is key. High mold temperatures, even in a small area of the mold, can cause sticking. Good cooling of pins and thin steel areas, hot spots near sprues or hot runners, and good water supply with few restrictions should be maintained.

- **Back pressure:** Minimum 10–15.5 MPa (1,500–2,250 psi)
- **Decompression (suck back):** No decompression