Eastman Cristal™ One family of resins

Eastman Cristal One, Cristal One Pro, Cristal One Renew, and Cristal One Pro Renew copolyester

PROCESSING GUIDE

EASTMAN

Eastman Cristal™ One is a portfolio of resins which carry the designation of Resin Identification Code 1 (RIC1). They are engineered specifically to meet the exacting demands of thick-walled packaging for luxury cosmetic packaging applications. Furthermore, this family of resins meets the California (AB 906 /ASTM 7611 guidelines for RIC1 definition and has achieved Association of Plastic Recyclers (APR) Critical Guidance recognition and the European PET Bottle Platform (EPBP) endorsement for compatibility in the existing mechanical recycling PET stream. These resins provide RIC1 recyclability and all the benefits of standard copolyesters—an excellent combination of color and clarity, toughness, and thick-wall processing capabilities.

Eastman currently offers two grades: Cristal One, suitable for molding thick-walled (up to 8 mm) transparent containers or parts, and Cristal One Pro, tailor made to mold thick-walled jars up to 12 mm. In addition, Cristal One and Cristal One Pro are available with up to 100% certified recycled content as Cristal One Renew and Cristal One Pro Renew, respectively.[a] The Renew grades process identically to their virgin counterparts.

This manual will assist molders in producing the best parts from Cristal One while enhancing the ease of molding. Unless otherwise noted, the same processing recommendations outlined for Cristal One also apply to Cristal One Renew and Cristal One Pro Renew. For clarity, the Renew versions of these products are indistinguishable from their virgin counterparts. So, where information is provided for Cristal One, it applies to both the Renew and non-Renew versions.

Property	Cristal One	Cristal One Pro
Clarity	Excellent	Excellent
Maximum part thickness[b]	8 mm	12 mm
Flow	Excellent	Excellent
Prevents hazy gate blemish	Good	Excellent
Passes Calif./ ASTM definition for PET	Yes	Yes
Two-shot processing	No	Yes

[a] The recycled content is achieved by allocating the recycled waste plastic to Eastman Renew resins using a mass balance process certified by ISCC.

[b] Maximum part thickness depends on tooling, one-shot vs. two-shot processing, cooling capability, and many other factors. The stated maximum thickness is intended to represent an approximation for what can be achieved under most standard process setups.

PROCESSING

General equipment considerations

Cristal One can typically be molded on conventional injection molding equipment using the established techniques practiced in the plastics industry. Regardless of the equipment used, the general guidelines provided in this document should be helpful for achieving optimum results.

Several factors must be considered when injection molding Cristal One into finished parts. These factors include machine selection, mold temperatures, polymer melt temperatures, screw speed, hydraulic pressure, injection speed, back pressure, screw design, and melt cushion. The following are key molding parameters that should be considered for optimal processing of Cristal One:

Shot capacity

The suggested shot size for molded parts should be from 25%–75% of the total barrel capacity of the molding machine. This includes runners, sprues, and material in hot runner manifolds. A shot size at the upper end of this range will reduce the material residence time at processing temperatures and prevent thermal degradation. Processing within the suggested range will provide adequate plasticating time without causing excessive hold time in the melt. Exceeding the suggested range can result in a nonhomogeneous melt.

Clamping tonnage

Required clamping force can be calculated by using 3–5 tons/square inch of projected area of the part and runner. The mold should occupy approximately two-thirds of the platen area between the tie bars to prevent possible damage to the mold from "platen wraparound."

Injection speed and profiling

Injection speed will depend on the part and the molding machine. The molding machine should be capable of profiling injection speeds necessary to optimize part quality and aesthetics. Injecting at slow speeds until the melt front clears gate restrictions and then increasing the speed to fill the part is helpful in reducing gate shear. Erratic injection speed can cause a variety of part defects. In general, injection speeds should be within 0.2–3 sec for approximately 95% filling of the part. High injection speeds will create excessive shear as the polymer passes through the runners, gates, and along cavity surfaces. Like most polyester resins, Cristal One is a shear-sensitive polymer. As such, increasing the shear rate will decrease the polymer viscosity which allows the material to flow easier and aids in filling thin-walled parts. However, excessive injection speed may result in flash, thermal degradation of the material due to shear heating, or burning due to inadequate venting.

Melt cushion

The use of a “cushion” or residual polymer melt in the barrel after injection helps ensure that the proper amount of material is injected into the mold cavity. During the packing phase of injection molding, the material in the mold cavity is shrinking. To compensate for this shrinkage, additional material must be supplied from the melt cushion to the cavity until gate freeze-off occurs. A small melt cushion provides a source of additional polymer to use during the packing stage. If the screw is allowed to “bottom out,” the packing pressure cannot be transferred through the polymer melt to adequately pack out the mold cavity. This condition will result in poor part consistency due to short shots, poor dimensional stability, excessive sink marks, and poor molded-part aesthetics.

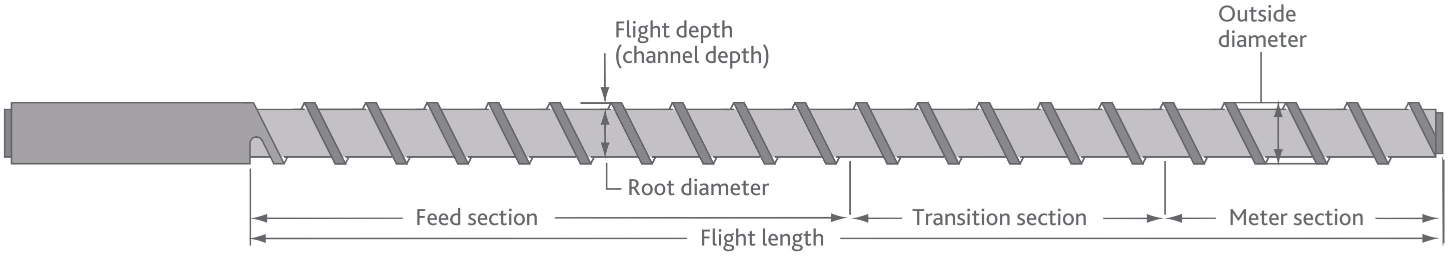
A small cushion of 0.1–0.3 in. is suggested for processing Cristal One. This will help minimize the residence time and heat history of the polymer and reduce the potential for polymer degradation. Minimizing degradation is particularly critical with Cristal One, since it will prevent the resin from crystallizing more quickly during cooling (which could lead to unacceptable whitening in thick jars or around the gate vicinity).

Screw and barrel design

Cristal One can be successfully processed on a variety of screw designs. Using high-compression (2.5:1 to 3.5:1) general-purpose screws with length-to-diameter ratios of 18:1 to 20:1 will provide the greatest degree of processing latitude. When using color concentrates or other pellet-pellet blends at the molding machine, attention to screw design should be considered. In these cases, certain high-performance or mixing screws have been shown to improve melt homogeneity when compared with general-purpose screws.

Vented barrels are not necessary or suggested. Three-piece, full-flow, ring-type nonreturn valves are preferred over ball-type valves to help minimize holdup time and polymer degradation. Check rings should be replaced periodically because they are high-wear items and will eventually fail or break. A faulty check ring can sometimes create the inability to hold a cushion and allow the screw to continue to move forward after the shot and packing are complete.

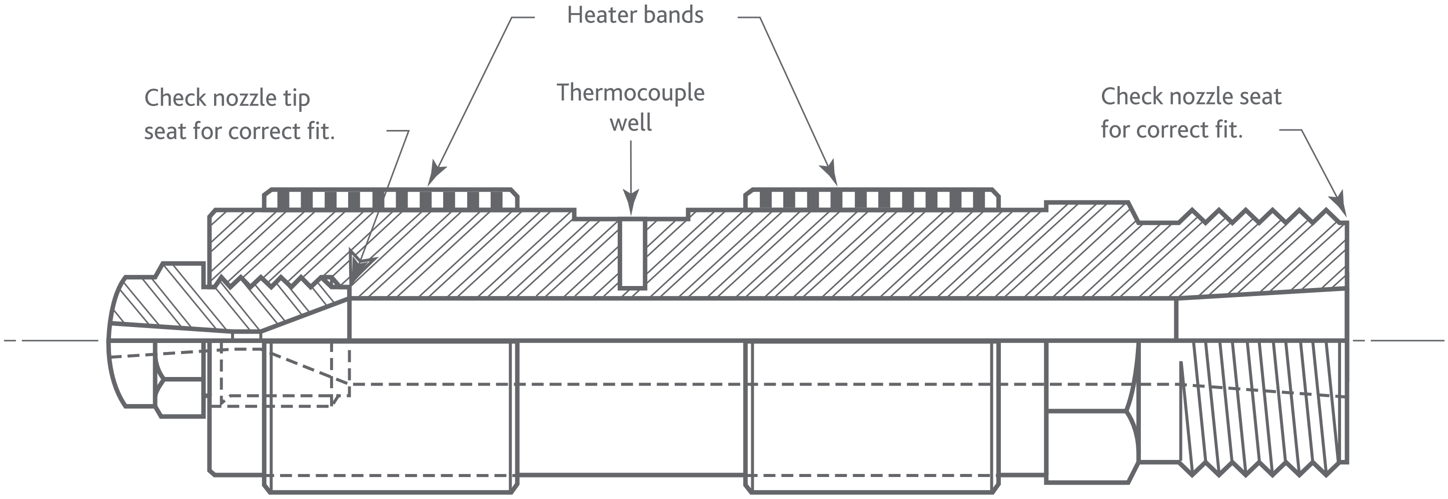
$$\text{Compression ratio} = \frac{\text{Flight depth (feed)}}{\text{Flight depth (meter)}} \qquad \text{L/D} = \frac{\text{Flight length}}{\text{Outside diameter}}$$



Nozzles

Use nozzles that have the minimum length needed to reach into the mold. The inside diameter of the nozzle should be very close to that of the sprue end but slightly smaller so that the sprue can be pulled. Eastman polyester resins process well using reverse-taper nozzles.

Accurate temperature control of the nozzle is very important. Thermocouple placement for controlling the nozzle heat is critical, as temperatures can be more than 100°F (37°C) higher than the thermocouple can sense if placed improperly. The ideal configuration is to place the thermocouple controlling the nozzle heater in the center of the nozzle length. Long nozzles may require more than one thermocouple and heater band along the length to allow uniform heating. Temperature control issues in the nozzle generally manifest as appearance problems near the gate of the molded part.



Screw speed

For optimum homogeneity of the polymer melt, slow- to medium-screw speeds are generally suggested. Screw rotations should occur during the cooling cycle, and the screw should be in the fully recovered back position within two seconds of the end of the cooling cycle. This relationship can be managed by properly balancing screw speed and back pressure.

Back pressure

Back pressure is necessary to ensure uniformity of the polymer melt for maximum part performance. Suggested screw back pressures should be in the 75–150 psi range. It is particularly important to use sufficient back pressure when adding color at the molding machine. Operating at the upper end or slightly above the suggested range may be necessary to achieve good distributive color mixing and uniform part color. Excessive back pressure can cause excessive shear heat and can lead to thermal degradation of the polymer and a higher propensity for crystallization and whitening to occur.

Periodic inspection

The screw, check valve, and nozzle assembly should be cleaned and inspected periodically to identify any spots where material may collect and degrade. Ideally, this inspection should occur any time a material is being molded that is different than a material molded previously, as most polymers have varying flow characteristics. Material caught in any holdup area will degrade, discolor (turn black), and cause streaking in subsequently molded parts.

Injection pressure

The injection molding process can generally be divided into two stages: injection and packing. During the injection stage, the molding machine pressure should be set near its maximum limit and the ram speed regulated by using the velocity controls. The molding machine will only use the pressure necessary to move the ram at the set speed. Using this technique will help produce consistent parts because the cavity will be filled at a more uniform rate.

It is important to switch from the injection stage to the packing stage when the part is 90%–95% percent filled. If the injection stage is not switched to the packing stage before the cavity is full, the high pressure of the injection stage can cause the part to flash and can damage the mold. It is suggested to switch from the injection stage to the packing stage based on either position of the ram or the cavity pressure. While maintaining a cushion, the packing pressure should be set at the lowest necessary level to properly pack out the part and achieve the desired surface aesthetics. In general, packing pressure is lower than filling pressure. If the part is underpacked, it can result in excessive sink marks, poor dimensional tolerances, and generally poor part aesthetics. Overpacking can result in excessive molded-in stress, increased part weight, and poor part performance. Pack/hold pressures of 50%–80% of the injection pressures are suggested.

PROCESSING PARAMETERS

Mold temperature

Range: 50°–110°F (15°–40°C)

Generally, cooling time is the determining factor for controlling overall cycle time. Uniform heat removal is critical for obtaining best part qualities and consistent dimensional qualities. Using a mold temperature controller is suggested for minimizing temperature variations. Suggested mold temperatures used for producing Cristal One parts range from 50° to 110°F (15° to 40°C). Cooling times will be dependent on the thickness of the part being molded. For especially thick parts, mold temperature should be set at the lower end of the recommended range with the melt temperature at the upper end of the suggested range. This will help minimize haze formation related to crystallization. Cooling lines should be properly spaced around the part for effective heat removal. They should be adequately sized without restrictions in the connectors or associated plumbing. The flow rate of the cooling liquid should be sufficient to provide for turbulent flow throughout the cooling lines. Cleanliness of the coolant should be maintained to prevent blockage of the cooling channels.

Barrel temperature

Range: 490°–540°F (255°–280°C)

The optimum barrel temperature profile depends on many variables, including machine capacity to shot size ratio, screw design, mold and part design, and cycle time. Barrel temperature controllers should be set so the material melts gradually without excessive shear. Measured polymer melt temperatures up to 15°F (8°C) higher than the barrel temperature settings are normal. Measured melt temperatures greater than 15°F (8°C) above the barrel temperature settings indicate a source of excessive shear in the melt delivery system. Reverse barrel temperature profiles can be used to compensate for improper screw designs and should help alleviate screw recovery problems. When using hot runner manifolds, the manifold temperatures should be set evenly across all zones to equal the lowest barrel temperature setting being used. Generally, the closer one can operate to the center of this recommended temperature range, the better for optimal part aesthetics. Particularly hot temperatures can cause sticking or prolong the cooling time, leading to longer residence time, more degradation, and potential to crystallize. However, processing too cold may fail to fully erase the crystallinity in the pellet, which could also lead to accelerated rates.

Drying

Temperature: 265°– 285°F (130°–140°C)
Time: 4–6 hr

Thorough drying is critical for proper processing of Cristal One. A desiccant dryer must be used for properly drying the polymer pellets prior to processing in the injection molding machine. Since polyester pellets are hydroscopic, they readily absorb moisture from the environment. And, if this moisture is not removed sufficiently, it will react with the molten polymer at processing temperatures resulting in a significant loss of molecular weight. A loss in molecular weight will lead to reduced physical properties in the molded part and can shorten the crystallinity half-time of Cristal One (leading to haze and whitening in the thickest sections and near the gates).

Drying equipment

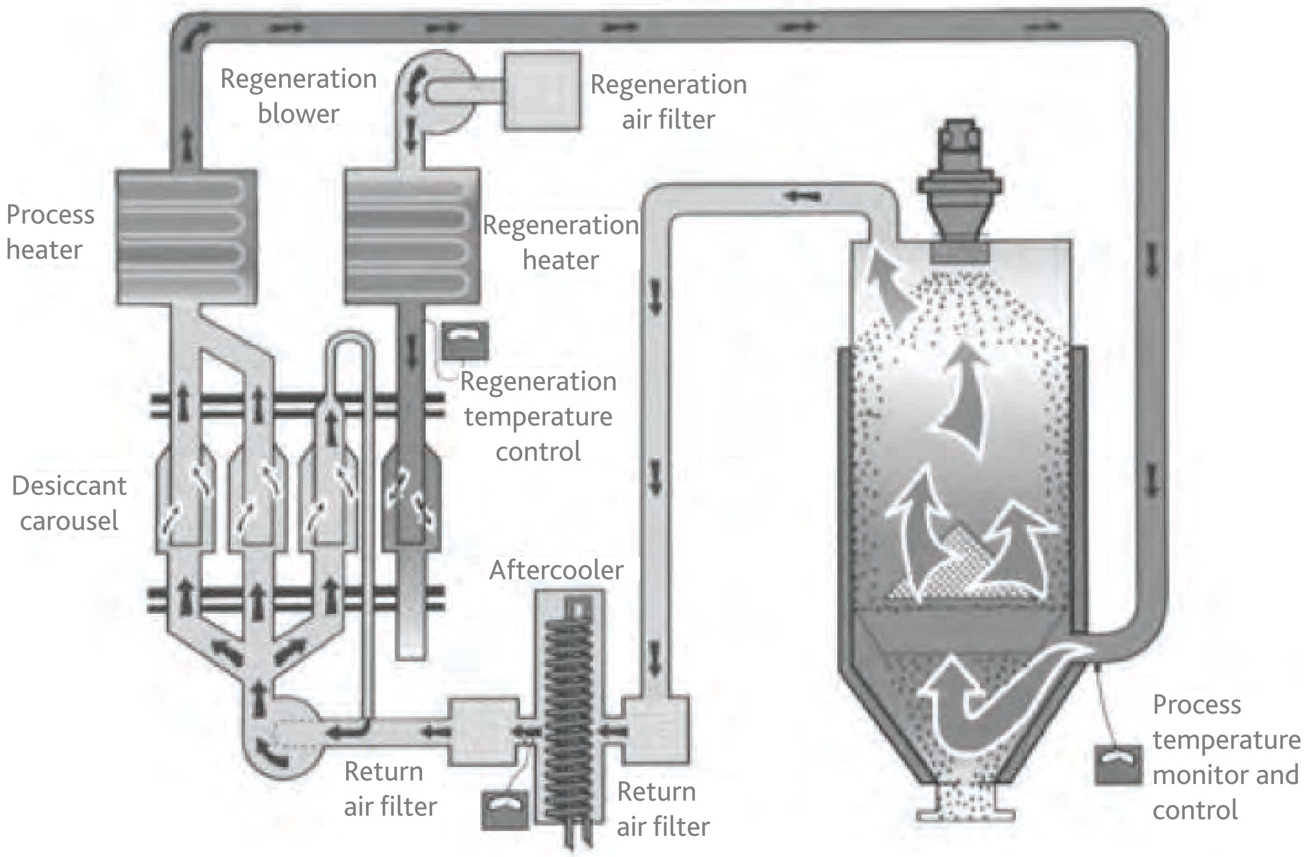
Multibed desiccant dryers are necessary to properly dry Cristal One. These types of dryers have two or more desiccant bed sections. Dryers with three or four desiccant beds typically have shorter start-up times due to faster bed regeneration. Desiccant dryers are available from many suppliers. Consultation with your specific dryer vendor will provide the optimal solution for the molding job. Locating a dryer hopper on the molding machine feed throat—to create a fully closed drying circuit all the way to the machine—is strongly recommended. Proper dryer selection should include consideration of required throughput rate, ease of maintenance, and optimum performance elements necessary, such as drying temperature, drying time, dryness of air (e.g., dew point), and airflow.

Drying conditions

Effective drying of Cristal One is critical to achieve shot-to-shot consistency and optimal part performance. For proper drying of Cristal One, it is important to consider the following factors:

- Dew point: Use a desiccant-type drying system that can consistently provide dry air at a minimum dew point of –40°F (–40°C).
- Time and temperature: Dry Cristal One at 265°–285°F (130°–140°C) for 4–6 hr. Times greater than 10 hours should be avoided if possible. If it is necessary to leave the material in the dryer for periods of time beyond this range, the temperature should be adjusted much lower (140°F [60°C]) to accommodate such needs (i.e., overnight). At these lower temperatures, unacceptable color shift is much better mitigated than by leaving at the hotter (265°–285°F [130°–140°C]) set-point conditions. In all cases, the inlet air temperature should be controlled within +/–5°F (+/–3°C) throughout the drying cycle.

The following figure shows a typical, closed-loop desiccant drying system.



ELEMENTS NECESSARY FOR PROPER DRYING

1. Drying temperature

Resin must be dried at a specific temperature. Air circulating through the hopper is heated by the process heater. Air temperature should be measured at the inlet to the hopper and controlled at the recommended drying temperature. Exceeding this temperature will cause premature softening of the pellets to the point of sticking together, causing failure to feed freely to the bottom of the hopper for proper unloading and feeding. Drying at temperatures below the recommended set point will result in inadequate drying.

It is also important to maintain air temperature of at least 400°F (205°C) in the regeneration loop of the dryer. The regeneration loop is separate from the process loop. The presence of hot air in the process loop does not guarantee that the regeneration loop is functioning. A nonfunctioning regeneration heater will cause severe degradation of the desiccant beds and impair the dryer's ability to remove moisture.

2. Drying time

Pellets to be dried should be in the dryer hopper at the proper conditions. If the dryer is powered on from a cold start, it must warm up to the proper temperature and the dew point of the air must be reduced to –40°F (–40°C) or below before drying time can begin.

Choosing the hopper size is critical. Only when the hopper size is adequate for the rate of material processing will the proper residence time be possible. The hopper should be built so that polymer pellets in all parts of the unit will flow down uniformly as material is removed from the bottom. Pellets that funnel down the center of the hopper (while pellets near the outside get hung up) will result in inadequate drying.

In routine drying operation, the drying time is maintained by keeping the hopper filled with pellets. If the hopper level gets too low, residence time of the pellets will be too short and they will not be adequately dried. For this reason and to compensate for less-than-perfect plug flow through the dryer, the hopper should be larger than the actual calculated size.

3. Dryness of air

Dry air comes from the desiccant beds in the closed-air circulation loop of the dryer/hopper system. Desiccant beds must be heated and regenerated before they can properly dry incoming processed air. After regeneration, it is beneficial to cool down the regenerated bed with previously dried air as opposed to ambient air.

Returning processed air from the top of the pellet hopper is filtered before it is blown through the desiccant bed and into the heater and hopper. Dryers used for polymer pellets should be equipped with aftercoolers to cool the returning processed air. Air temperature should be below 150°F (65°C) to increase the desiccant's efficiency for absorbing moisture.

The desiccant in the beds is typically a very fine claylike material in pea-size pellets. The desiccant can slowly lose its effectiveness and should be replaced periodically (consult your dryer vendor for recommendations if unclear). Replacement of filters will help extend the life of desiccant and heater elements.

Air dryness can be checked by dew point meters, either portable or installed in-line in the dryer. Built-in dew point monitors and alarms are the preferred choice for drying copolyesters. These meters give a direct reading of the dew point of the air being tested. If a dryer has rotating desiccant beds, the dew point meter must be installed long enough for all the desiccant beds to be cycled. Each desiccant bed can normally be in-line for 20–40 min or longer. A refreshed bed should always be rotated in-line before the dew point rises above –20°F (–30°C).

4. Airflow

The normal airflow rate requirement for drying copolyester pellets is 0.06 cubic meter of dry air per minute for each kilogram of material being processed per hour (0.06 m^3/min per kg/hr) or 1 cubic foot of hot, dry air per minute for each pound of material processed per hour (1 cfm per lb/hr). For example, if 240 lb (109 kg) of material is used per hour, airflow should be at least 240 cfm.

Airflow can be checked by inline airflow meters, by portable meters, or much less accurately by disconnecting a hose going into the feeder and feeling the airflow.

Dust filters in the air circulation loop should be cleaned or replaced periodically to avoid restrictions of airflow.

5. Moisture measurement

Dew point meters only measure the dryness of the air, not the dryness of the pellets in the hopper. Use of a dew point meter in combination with temperature, airflow, and residence time can give an accurate indication of whether the polymer pellets are being dried properly.

Weight-loss-type moisture analyzers are instruments that measure moisture inside polymer pellets. These analyzers can give a good indication of effectiveness of the drying system's ability to remove moisture from the polymer pellets. However, most are usually not accurate enough to use as a quality control method to ensure adequate dryness of polyesters to prevent degradation during processing. A moisture level reading in the polymer pellets below 100 ppm is desirable. Accurate measurement of these low moisture levels often requires more sophisticated analytical methods such as Karl Fischer analysis.

Dryers require routine maintenance and monitoring. A mechanic with knowledge, time, and resources is key in properly maintaining a drying system.

Summary of recommended drying and processing conditions for Cristal One

Drying conditions	
Drying temperature, °F (°C)	265–285 (130–140)
Drying time, hours	4–6
Dryer air dew point, °F (°C)	–40 (–40)
Drying conditions	
Zones, °F (°C)	
Rear	*490–540 (255–280)*
Center	*490–540 (255–280)*
Front	*490–540 (255–280)*
Nozzle, °F (°C)	Equal to front zone
Hot runners, °F (°C)	Equal to lowest barrel temperature setting
Melt temperature, °F (°C)	510–545 (265–285)
Mold temperature, °F (°C)	50–110 (15–40)
Machine conditions	
Injection speed	Slow to medium
Screw speed, rpm	50–150
Pack and hold pressure	50%–80% of injection pressure
Cushion, in.	0.1–0.3
Back pressure, psi	75–150

Purging and start-up/shutdown guidance

Generally, it is not necessary to use a separate purge material prior to running Cristal One. This is particularly true if other similar polyester materials—such as PETG or PET—are directly preceding a Cristal One start-up. Given enough time during start-up, the resin should successfully push out the prior material and associated contamination—eventually producing a high-quality melt stream. For particularly stubborn cases where contamination is expected to be high or the preceding polymer is not a polyester resin, it may be useful to purge with a higher viscosity, amorphous PETG grade. This is not likely to be required in most situations but may prove useful in circumstances where black specks or other contamination visually appear problematic. During transitions to Cristal One, it may be useful to start the machine with the injection unit and manifold both heated to the upper end of the above recommended temperature range (545°F [265°C]). This ensures good flow and successful removal of the predecessor resin. For unique situations or materials vastly different from polyesters (e.g., PP, HDPE, etc.), reference the specific purge/transition guidance of those resins.

Prior to a weekend or overnight shutdown (where Cristal One will be run again at next start-up), it is acceptable to shut down the machine with material in the barrel. However, in this case, always leave the screw in its most forward position upon shutdown to minimize the amount of crystalline material in front of the screw. On start-up, the injection unit and manifold may benefit from being heated to the upper temperature ranges suggested for Cristal One (545°F [265°C]). This strategy efficiently melts all crystallinity and helps remove undesirable contamination from the barrel. Once a clear melt quality has been achieved, temperatures should be lowered back toward the middle of the recommended process temperature ranges. Note that in some machine setups, hot start-ups could lead to more contamination and black speck generation, thus taking a longer time to achieve production quality. If this is the case, you may consider purging with amorphous PETG prior to shutdown, which could possibly enable a faster, less contamination-prone start-up.

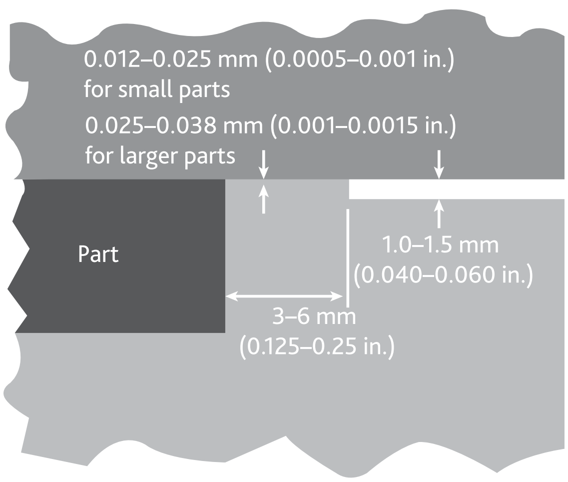
If a campaign of Cristal One is complete and you need to convert the machine to another material, it is recommended that you follow the specific purge guidance of the next resin. In general, it is best to completely empty the machine of all Cristal One and advance the screw to its most forward position. If PETG materials are to be run next, it may be helpful to fully purge with PETG prior to the shutdown and conversion to the next campaign.

MOLD DESIGN

Venting

Venting allows gas replaced by the melt front to escape from the mold. Inadequate venting can cause short shots, burning, and material degradation.

Molds should be well vented around the perimeter of the part and at other areas where a flow front meets a wall or another flow front. A good starting vent depth for molds running Cristal One is 0.0005–0.001 in. (0.012–0.025 mm) for small parts and 0.001–0.0015 in. (0.025–0.038 mm) for larger parts. A typical land is a 0.125–0.250 in. (3–6 mm) long opening into a larger channel that allows gas to escape from the mold. The following diagram illustrates a typical vent layout.



Gate design

Cristal One can be molded using conventional gate designs such as:

- Hot runner systems with custom-designed gates
- Valve gates
- Flash gates
- Edge gates
- Sprue gating directly into part
- Fan gates

The size and appearance of the molded part must be considered in selecting the type and placement of gates.

Gate location guidelines

- Minimize flow length by locating the gate near the center of the mold. Gating near the part center minimizes the injection pressure needed to fill the cavity.
- Weld/knit lines should be considered when determining gate location.
- Low shear gates will help to minimize gate blush. Sharp corners or abrupt angles in the gate or runner should be radiused to reduce blush.
- Gate thicknesses of less than 0.065 in. should be avoided.
- Typical gate diameter should be approximately 50%–80% of the wall thickness of the part being molded.
- Gates should be located where the flow path is continuous and smooth rather than into notches and ribs.

Mold construction

The following guidelines minimize cold sprue sticking or sticking around the gate, reduce cycle time, and broaden the processing window for Cristal One:

- Molds should be designed to maintain a uniform mold surface temperature of 50° to 110°F (15° to 40°C), even when running aggressive cycle times with Cristal One. If sticking is a problem, discuss with Eastman's technical service team about a mold release version of the product.
- Cooling lines should be spaced at 2–2.5 in. (50–64 mm) between center lines.
- Offset placement of air poppets from the center line of the gate as far as possible.
- Runner systems should be balanced so that temperatures and pressures are similar for all cavities.

Cold runner mold construction guidelines for Cristal One

- Taper on sprue bushing to a minimum of 3 degrees.
- Shorten the sprue bushing dimension to less than 3 in. (75 mm) in length.
- Sprue bushing orifice where the sprue bushing meets the nozzle should be $\frac{5}{32}$ to $\frac{9}{32}$ in. (4–7 mm) in diameter. Larger parts will require orifice diameters at the upper end of the range, while smaller parts will require orifice diameters at the lower end of the suggested range.
- The sprue bushing should have a high polish in the sprue area.
- Optimize cooling around the sprue bushing by installing upper and lower water line circuits.
- When aggressive molding cycles are desired, an alloy sprue bushing should be used to optimize heat removal. Alloy sprue bushings have significantly better thermal efficiency than traditional steel sprue bushings.

Hot runner mold construction guidelines for Cristal One

- The hot and cold areas of the mold should be cleanly separated with sufficient insulation so that the melt is uniform and the well-cooled mold is capable of maintaining its uniform surface temperature, especially around the gate.
- In an ideal situation, the polymer melt temperature should be maintained at the same temperature from the screw discharge all the way through the machine nozzle, sprue, hot runner manifold, and hot drops.
- For Cristal One, a hot runner gating system incorporating a water-jacketed valve gate with an insulator is preferred.

GENERAL RULES FOR EFFECTIVE TROUBLESHOOTING

Cristal One can typically be injection molded into high-quality parts with exceptional aesthetics. While molding problems sometimes occur, most issues can be resolved or prevented with attention to the following suggestions:

Develop a plan.

Plan the approach before acting. Injection molding is a complex process with a multitude of temperature, pressure, and speed controls that provide an infinite number and combination of process settings. Decide in advance which controls or other factors should be changed and in which order. Troubleshooting without a plan is likely to create rather than solve problems.

Change only one setting at a time.

It is very tempting to change multiple machine settings when attempting to improve the molding process, but experience suggests that changing only one parameter at a time is most effective. If more than one setting is changed, it is difficult or impossible to know which setting was responsible for improving or worsening the process.

Allow enough time for a change to take effect.

Allow at least 10 shots after each change for the polymer and the machine to reach equilibrium. If enough time is not allowed before making additional changes, it will be challenging to determine whether a change was effective at improving or worsening the process or the part quality.

INJECTION MOLDING TROUBLESHOOTING GUIDE FOR CRISTAL ONE AND CRISTAL ONE PRO

The following troubleshooting guide lists possible causes and suggested corrective actions for problems typically encountered in injection molding processes when using Cristal One. While not exhaustive, it is intended to address the most common challenges. For additional troubleshooting information or details, contact Eastman's technical service team.

Issue	Potential cause	Processing recommendation
Crystalline/white mushroom effect around gate in thick parts	During hold phase, valve pin remains open and material crystallizes in front of the valve pin. When the valve pin closes, crystallized material can be pushed into thick bases of molded parts. This is not uncommon but can be more pronounced with materials that have a propensity to crystallize, such as Cristal One.	• Conformal cooling around gate • Separate cooling control for gate area (dedicated Thermolator®) • Adjust valve pin timing (differs depending on part thickness) • If possible, allow valve pin to open just enough to allow melt flow into cavity around the pin face • Reduce pack/hold just before allowing valve pin to close • Contact Eastman technical service.
Brittle parts	• Poor drying • Excessive residence time • Excessive melt temperature	• Follow proper protocol described in the drying section of this guide. • Reduce cycle time/use injection molding machine with smaller shot size. • Measure actual polymer melt temperature and reduce to suggested temperature range.
Discoloration	• Overdrying • Excessive residence time • Excessive temperatures • Contamination	• Follow proper protocol described in the drying section of this guide. • Thoroughly purge barrel, reduce cycle time, or use a smaller-barrel-capacity molding machine. • Purge thoroughly including manifold. Remove screw and clean barrel if necessary.
Gate blush	• Excessive injection speed • Gate design	• Use slower injection speed until melt front clears the gate restriction. • Increase gate size; change gate geometry; add radius to sharp edges or corners. • Contact Eastman Technical Service.
Haziness	• Material is not cooling fast enough, allowing crystallization haze to develop. • Melt temperature too low • Contamination	• Decrease mold temperature; increase cooling time • Increase melt temperature in combination with lowering mold temperature. • If haziness is contamination related, purge barrel and manifold thoroughly.
Sink and voids in thick-walled parts	• Material not packed sufficiently into cavities • Air conveyed along screw	• Add pack and hold pressure and/or time. • Increase back pressure; reduce screw speed; reduce injection speed.
Chatter/record grooves	• Material and/or mold steel too cold	• Increase injection speed. • Increase mold temperature. • Increase polymer melt temperature.
Black specks in molded parts	• Molding machine/manifold residue from previously processed materials • Dryer hopper/transfer line contamination	• Purge injection molding machine and manifold thoroughly; remove screw and clean barrel if necessary. • Inspect dryer hopper and transfer lines for possible contamination from other materials or dirt/grease. • Contact Eastman technical service.

Issue	Potential cause	Processing recommendation
Unmelts in molded parts	• Pellets/chunks of polymer injected into part before completely molten • Crystallized material on valve pin	• If pellets, then: - Increase melt temperature. - Consider screw design. • If chunks from valve pin, then: - Add separate Thermolator to valve pin area for enhanced temperature control. - Hold valve pin open longer to help reduce material crystallization.
Flow lines in molded parts	Material stuck to valve pin face can dislodge during injection and create flow line blemishes in molded parts.	• Use slower injection speed. • Adjust temperature around gate area by lowering mold temperature at valve gate and increasing manifold temperature around valve gate area. • Contact Eastman technical service.

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The results of **insight**™

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