Drying of Difficult Resins for Molding Applications

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Challenges – What Makes it Difficult?

• Drying temperature
  • High temperature
  • Low temperature

• Resin properties
  • Requires crystallization
  • Has wide range of moisture holding capability
  • Can degrade during processing and drying
  • Regrind quantity and shape variations
  • Becomes difficult to handle during drying
Drying Temperature – High Temperature Resins – Resins with Drying Temperatures above 225° F

- High temperature resins require the heater sized for the heat load and an aftercooler

- The maximum temperature to enter the desiccant is 130 - 150° F.

- The cooler must lower the return temperature after the resin hopper to allow the desiccant to perform properly.

- The temperature after the cooler must be low enough that the heat of compression in the process blower still does not exceed the 130 - 150° F.

- Failure to cool the air sufficiently will result in poor dew point performance and will detract from drying performance.
Drying Temperature – Low Temperature Resins – Resins with Drying Temperatures above 150-160° F

- Low temperature resins require the heater sized for the heat load and an precooler

- When drying low temperature resins, the aftercooler may not be necessary or, in some instances, may cool the air – the use will generally not be an issue.

- After the blower the return temperature, from the hopper will increase by 10 - 20° F due to the Heat of Compression.

- While passing through the desiccant the temperature will increase by 5 - 15° F due to the Heat of Adsorption.

- The **Precooler** ensures that the temperature to the resin is low enough to prevent sticking and allow proper heater temperature control.
Resins That Have Difficult Properties for Drying

- **PET** – High temperature drying and crystallizing of amorphous regrind.
- **PETG** – Low temperature drying.
- **Copolyesters/PLA** – Low temperature drying and amorphous regrind with crystallizing and/or drying below the crystallization temperature.
- **Nylons** – Drying with variable drying temperatures and moisture levels.
- **Polycarbonate** – Drying with variable drying moisture levels.
Drying and Crystallization of PET

Pet presents unique challenges:

• There is typically a substantial amount of amorphous regrind that (in quantities above 15-20%) requires that a crystallizer be used.

• The resin can be either pre-blended to the crystallizer (for material temperature consistency and energy) or blended after crystallization.

• The drying needs to be at high temperatures (in excess of 300° F) and with low dew point air (-40 to -60° F) to provide the driving force to achieve the 20-50 ppm required for proper processing and IV (Intrinsic Viscosity) retention.

• Drying can be performed with a traditional crystallizer and dryer, or Infrared Dryer, and can be done with gas or electric heating.

• After drying, the resin must be handled properly to ensure that there is no moisture regain.
PET Drying & Crystallizing with a Traditional System

- Typical drying of PET for molding is a two-step process with crystallizing and drying (and blending of regrind/virgin).

- The amorphous “flake” and possibly some post consumer materials are crystallized and then dried.

- As much as 70-80% of the moisture on the flake can be removed in the crystallizing process in 45-90 minutes at 300+° F inlet temperature.

- The drying is done separately with dehumidified air at approximately 325° F for 4-6 hours to achieve a final moisture of 20-50 ppm.
• Crystallizing and drying in an IRD system is primarily done in the IRD in one step.

• The IRD lamps, along with tumbling in the drum, accomplish the crystallizing and over 90% of the drying.
PET Drying and Crystallizing with an Infrared System

- The IRD is an efficient alternative to an electric-only traditional PET crystallizing and drying system – primarily in sheet/ thermoforming applications.
- The IRD lamps use a frequency that targets plastic and moisture wavelengths and the exposure is typically less than 15 minutes.
- After leaving the IRD the resin resides 45-60 minutes in a small hopper/dryer to reach the target of 50 ppm or less moisture.
Drying of PETG/PLA

- PETG and PLA are low drying temperature polymers. Some of these dry as low as 150° F.
- Typically special provisions need to be addressed in drying below 160° F because most dryers have discharge temperatures that can be over 160° F under normal operation.
- Additionally, PLA regrind will require crystallizing if it is used in quantities in excess of 10-15%.
- PETG is often used in thin packaging and thus the regrind can have issues with bridging in hoppers and, with any elevated temperatures, can result in trouble discharging from drying hoppers.
Drying of PETG/PLA - Without crystallizing

- There is typically a cooling coil (pre-cooler) prior to the process heater for accurate temperature control.
- The addition of closed loop conveying can help keep the resin dry before being sent to the extruder.
- The dryer should have adequate desiccant cooling as not to introduce temperature variations during its cycle.
Drying of Copolyesters

- Copolyesters such as Triton and others are becoming more popular and their use is increasing rapidly.
- These resins are typically “Slow Crystallizing” and the crystallization rate may be twice that of normal PET.
- These resins often require extended drying periods if dried below their “Glass Transition” or crystallizing temperature.
- If dried at low temperature, the drying flow should be similar to other low temperature resins.
Drying of Nylons

- Drying of Nylons can be one of the toughest tasks because of the wide range in moisture that may be encountered.

- Nylon, shipped to a customer at 1000-3000 ppm can rise to over 10,000 ppm on a summer day exposed to ambient moisture.

- While resins like Polycarbonate and ABS have finite and reasonable limit on moisture adsorption, Nylon can, at times reach moisture levels in excess of 20,000 ppm and be virtually impossible to dry.
Drying of Nylons

- When the moisture level exceeds 10,000 ppm (1% water) drying for excessive periods can damage the polymer and lead to the formation of volatiles that can get into the desiccant and damage it.

- In the graph, just getting the nylon down to a typical level can add 4 hours to drying.

- Once dried for excessive periods, the nylon can lose its properties and result in extruded products that are brittle and do not exhibit the properties required by the end-user.

- The best recommendation for nylons, once opened, is to use them quickly or, if stored, store using precautions to eliminate and chance of moisture getting into the storage container (foil lined and sealed bags).
Drying of Nylons – Moisture Manager

Material Saver / Moisture Manager
Prevents over-drying

The source of drying air is changed from the dryer air generator to the return air outlet with the blowers at each hopper.

You have the option of using either return air or process air.
Drying of Polycarbonate

- The drying of Polycarbonate is typically considered one of the easier drying practices.

- However, when drying polycarbonate for molding, especially in the summer months, care should be taken to ensure an adequate drying time.

- Closed loop conveying will help in moving the dried resin from the drying hopper to the machine hopper.

- Excessive time in a machine hopper, at the machine, can lead to moisture regain and defects in the surface part.

- If an excessive period in the machine hopper is often encountered, a dry air blanket will help ensure that the surface is free of defects.
Drying of Polyurethanes

- Urethanes have the problem that they soften easily during drying.
- There is a fairly wide range of drying temperature that varies from 100-180 F.
- It’s common to use a cooling coil – as with all low temperature resins.
- Often these resins can require an agitated hopper.
- Urethanes pellets often deform because of resin on top of other resin in the hopper and thus have difficulty in flowing from the hopper outlet – this sometimes requires bridge breakers (mechanical means) to start the resin flowing.
QUESTIONS?

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Thank you!