Drying of Difficult Resins

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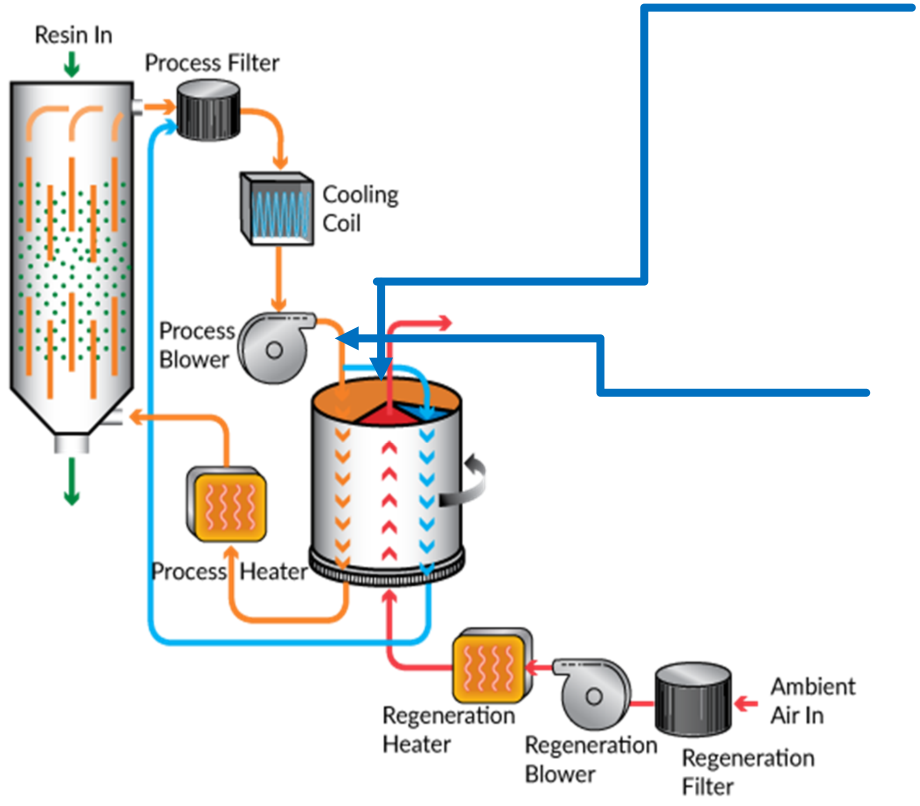
Challenges – What makes it Difficult?

- 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

Drying Temperature - High Temperature Resins - Resins with Drying Temperatures above 225° F

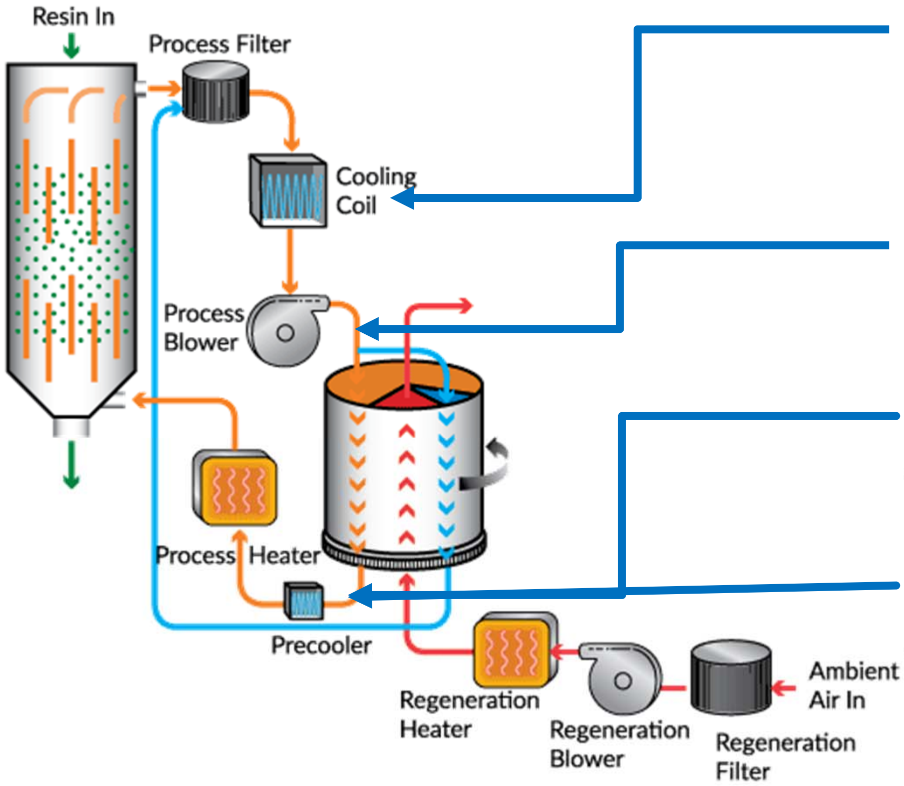
- High temperature resins require the heater sized for the heat load and an aftercooler



- 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

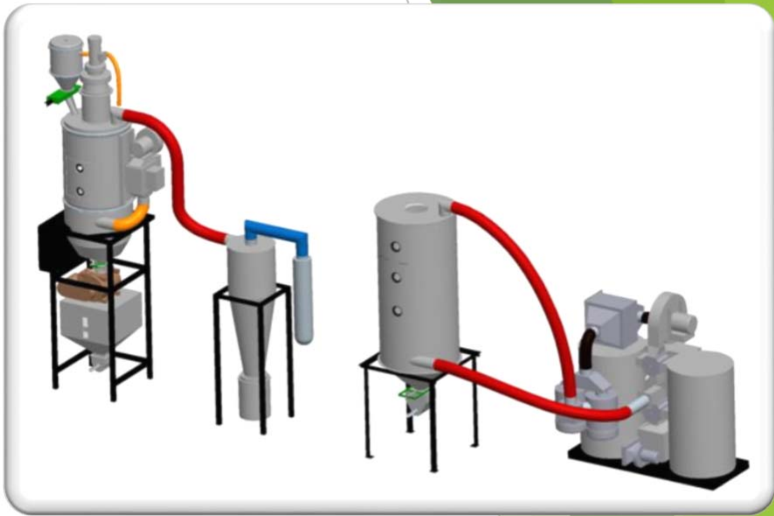
- **PET** – High temperature drying and crystallizing of amorphous regrind
- **PETG** – Low temperature drying
- **Copolyesters/PLA** – Low temperature drying and amorphous regrind with crystallizing and/or drying below the crystallization temperature
- **Nylons** – Drying with variable drying temperatures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

Drying and Crystallization of PET

- **PET presents unique challenges**

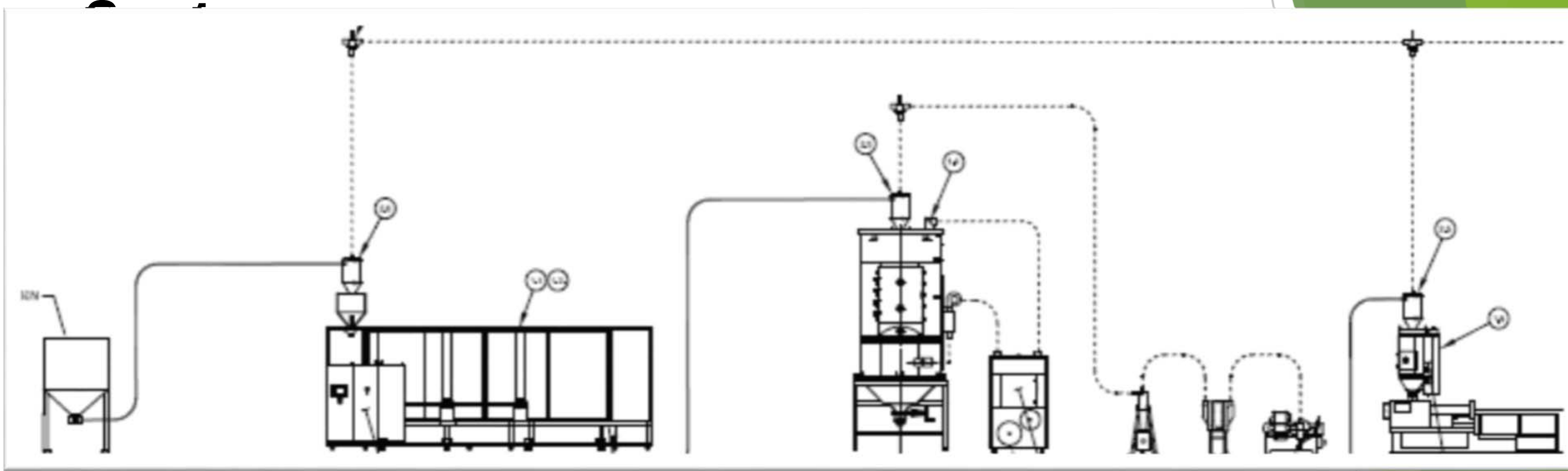
- There is typically a substantial amount of amorphous regrind that (in quantities above 15-20%) requires that a crystallizer be used
- The resin can be either pre-blended to the crystallizer (for material temperature consistency and energy) or blended after crystallization.
- The drying needs to be 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.

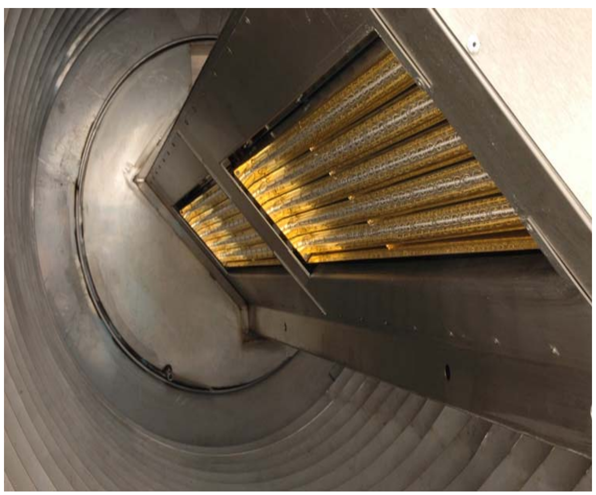
PET Drying & Crystallizing with a Traditional System



- Typical drying of PET for extrusion 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 about 325° F for 4-6 hours to achieve a final moisture of 20-50 ppm

PET Drying and Crystallizing with an Infrared

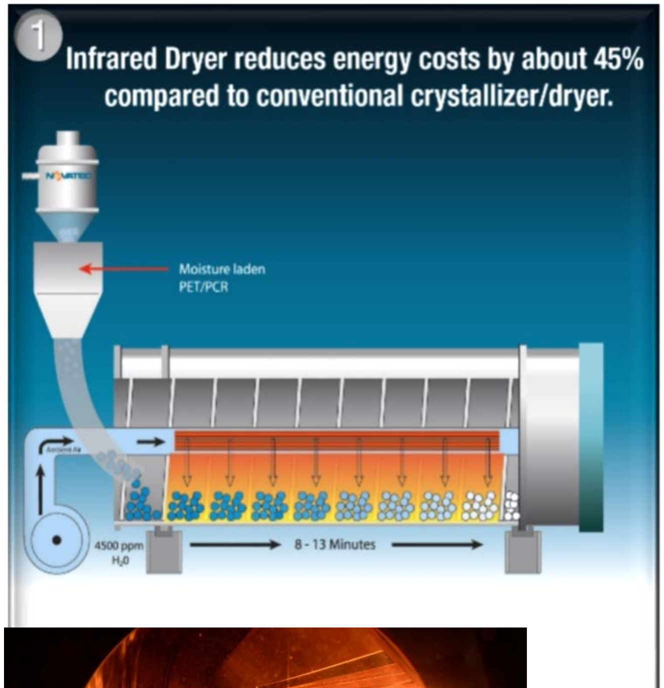


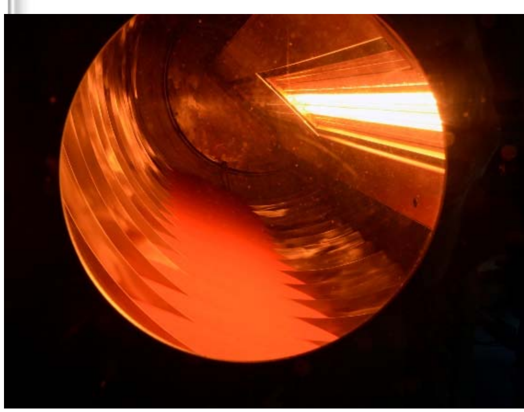


- Crystallizing and drying in an IRD system is primarily done in the IRD in one step

- 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





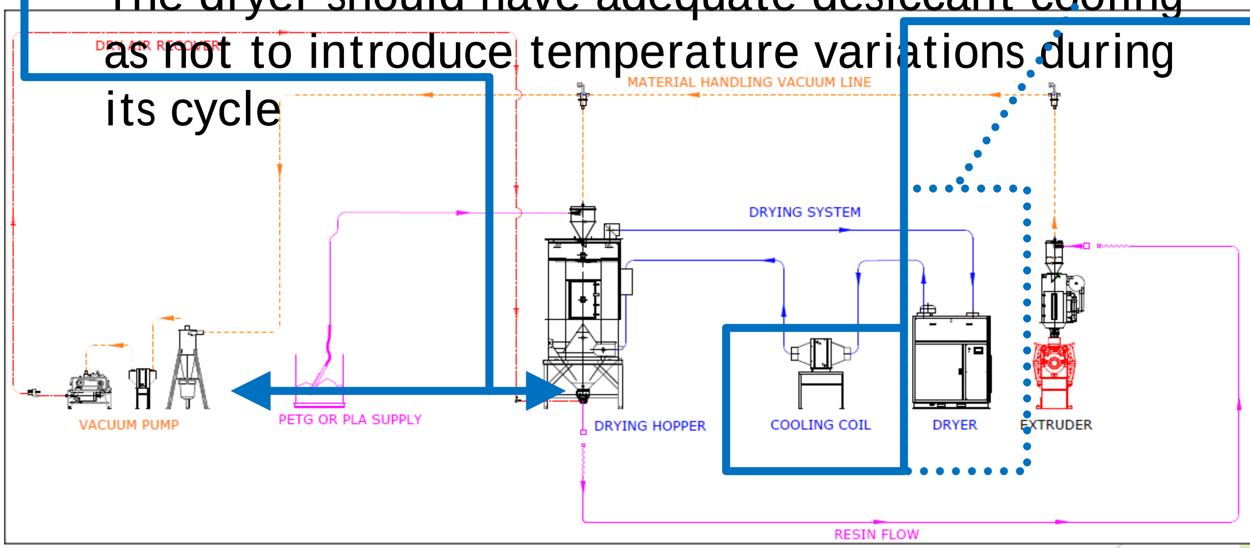
- The IRD is an efficient alternative to an electric-only traditional PET crystallizing and drying system – primarily in sheet/thermoforming applications
- The IRD lamps use a frequency that targets plastic and moisture wavelengths and the exposure is typically less than 15 minutes
- After leaving the IRD the resin spend 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 is trouble discharging from drying hoppers.

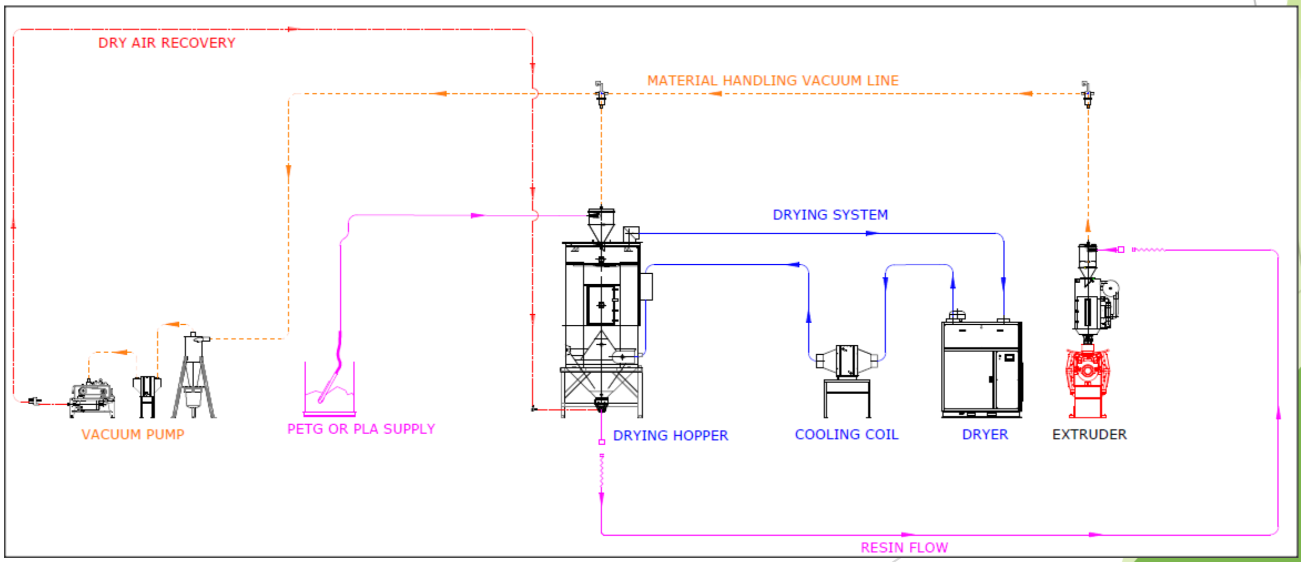
Drying of PETG/PLA - Without crystallizing

- 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



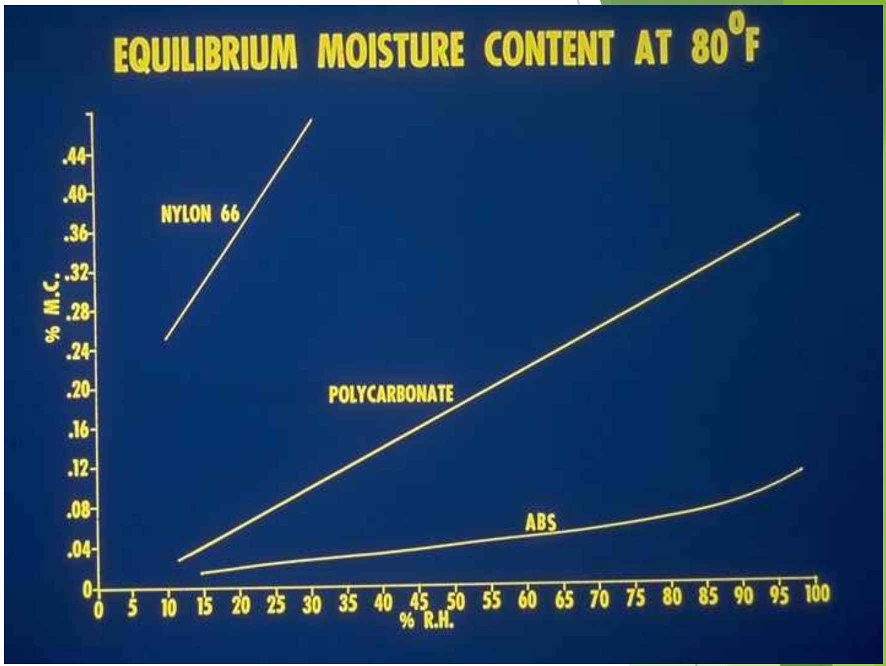
Drying of Copolyesters

- 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.



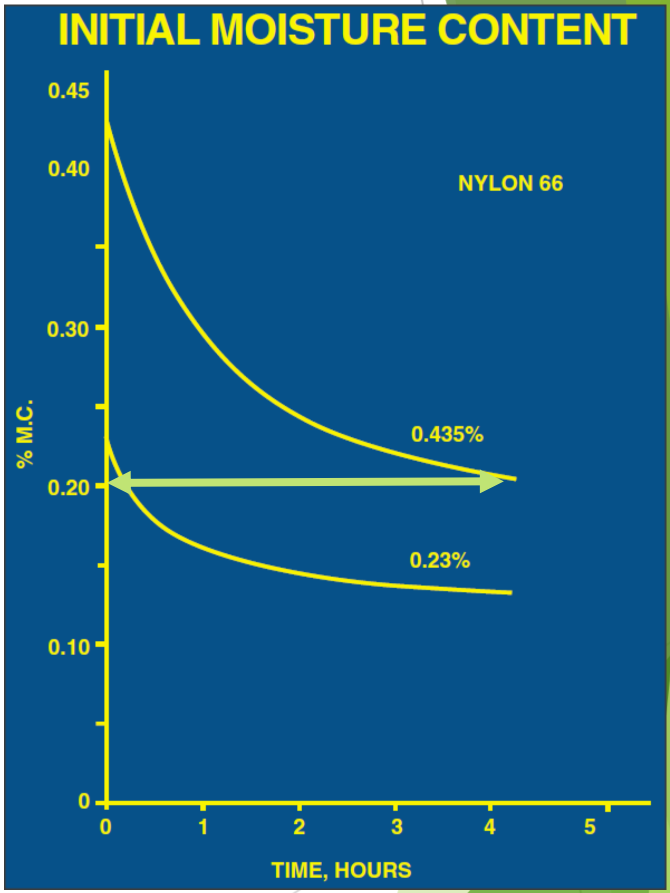
Drying of Nylons

- 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

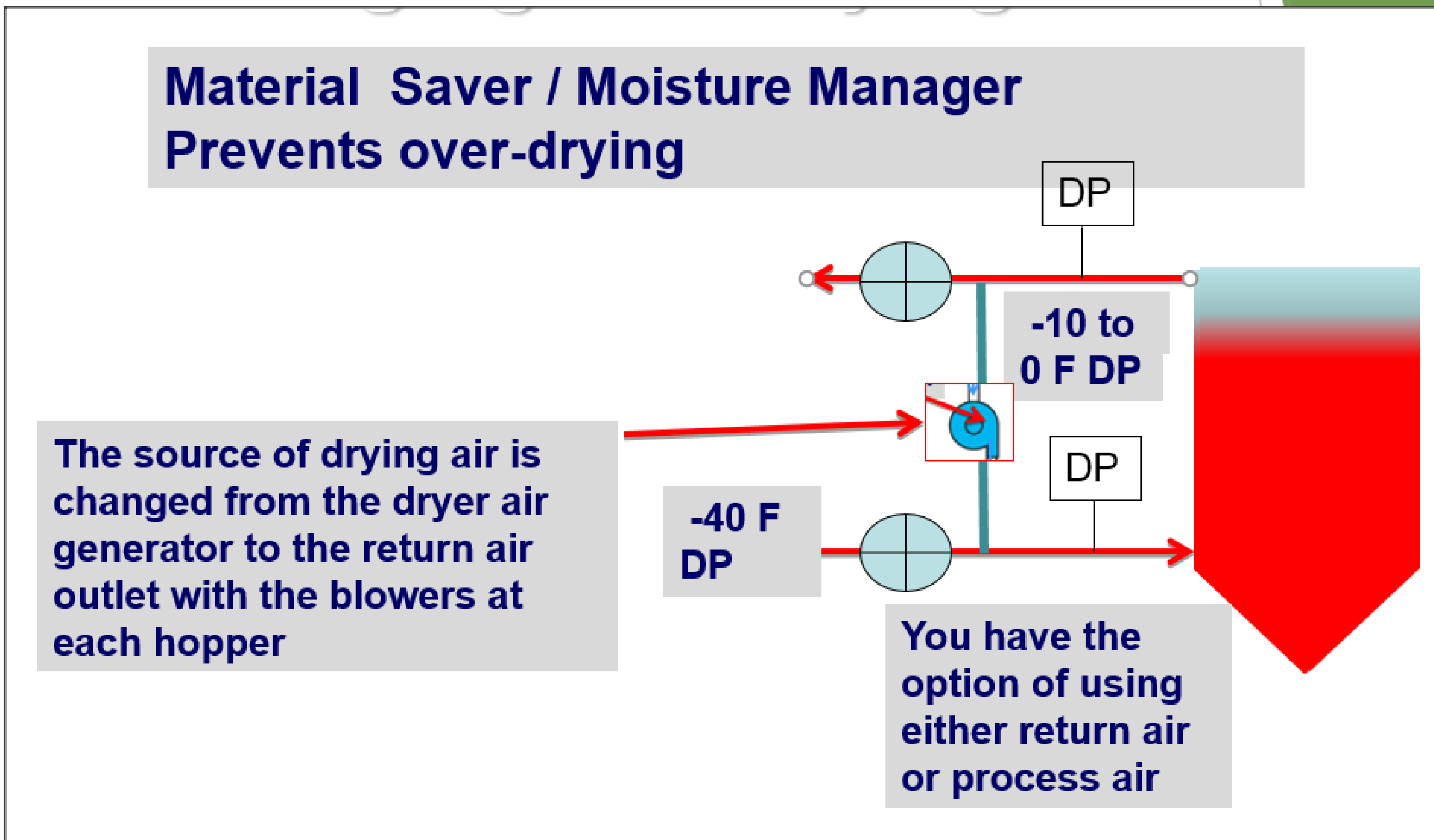
- In the graph, just getting the nylon down to a typical level can add 4 hours to drying

- 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, one 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



Drying of Polycarbonate

- The drying of Polycarbonate is typically considered one of the easier drying practices
- However, when drying polycarbonate for profile extrusion, 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 of the extrusion
- If an excessive period in the machine hopper is often encountered, a dry air blanket will help ensure that the extrusion surface is free of defects

QUESTIONS?

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Thank you!

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How to Get the Right Dryer for Your Process

HOW DO YOU CHOOSE THE DRYER FOR MY MOLDING APPLICATION?

Compressed Air or Membrane Dryer

Portable Wheel Desiccant

Central Drying System

?

Twin Tower Desiccant

Hot Air Dryer

Vacuum Dryer

There are a number of questions to answer?

- What are you Drying?
- Is it Hydroscopic or Non-Hydroscopic? – you may be able to either not dry at all or use hot air if it's non-hydroscopic
- Existing Plant Equipment – How will it fit in?
- Is this a single dryer or a plant expansion or upgrade?
- Does it provide a good energy efficient addition to the plant?
- Is it easy to use and can the operators effectively operate the dryer?
- If it's a dedicated dryer, should it be beside the machine or on the machine?
- Are there special considerations because of the resin properties or drying temperature?

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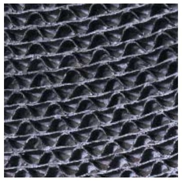
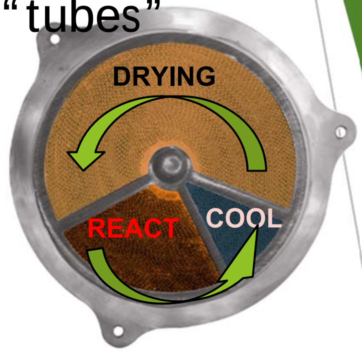
Desiccant Dryers – Wheel

Instead of beads the wheel dryer uses desiccant but in a honeycomb form – forms pure desiccant “tubes”





- Desiccant Drying in a continuous stable operation
- Dew Point and Temperature stay constant
- Can dry high temperature and low temperature resins
- Compact Energy Efficient Operation
- Energy responds fastest of desiccant dryers to changing material rates and moisture levels
- Sizes range from 5-5000 pph

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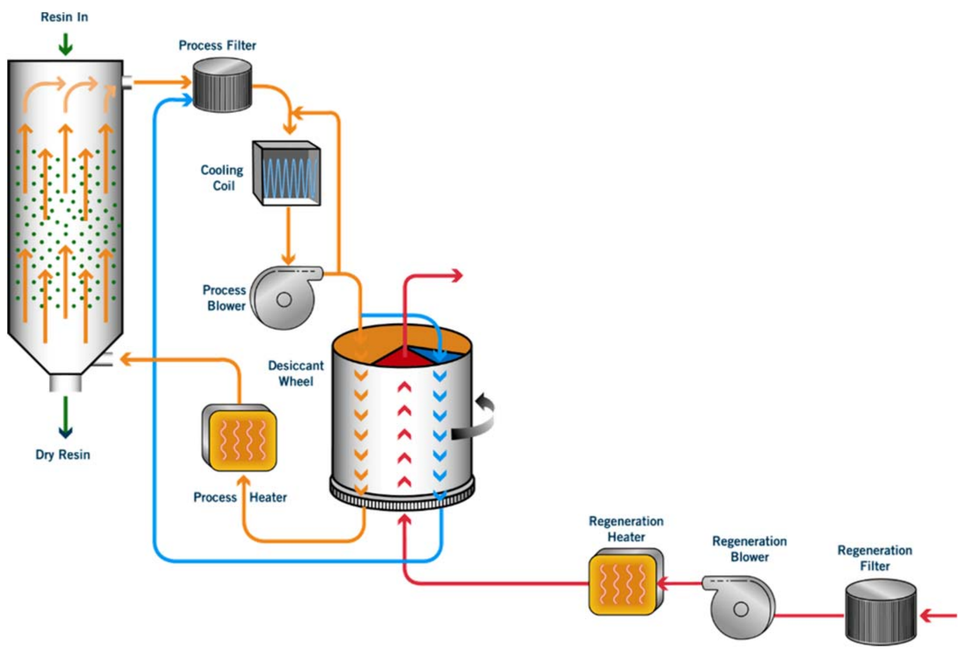
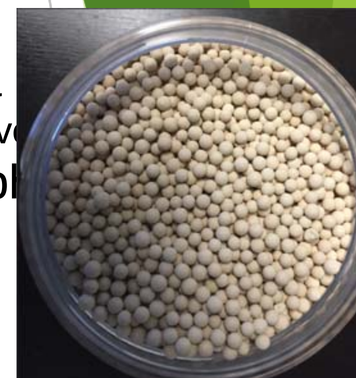
Desiccant Dryers – Wheel



- Two Blowers – one for drying and one for regeneration
- The regeneration can be optimized by reducing the regeneration temperature
- With many resins the process heating can be optimized by basing drying temperature on hopper outlet temperature
- VFD's can reduce energy by reducing drying air to no more than required

Desiccant Dryers – Twin Tower

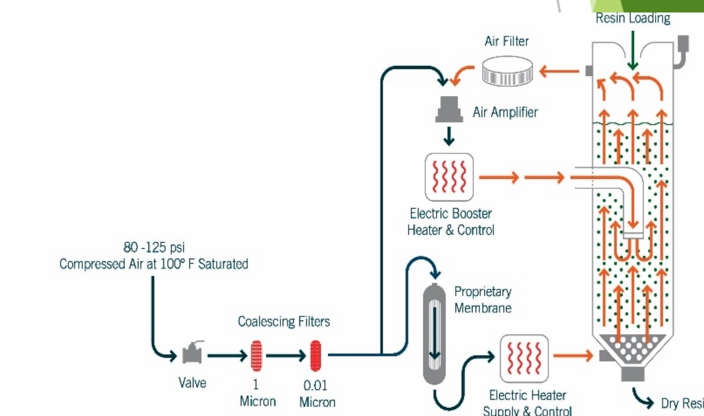
- Twin Tower Dryers are desiccant type with alternating beds
- Use beaded desiccant media
- Composite of clay and molecular siev
- Sizes ranging from 5-5000 ppl



- Twin tower dryer will produce somewhat variable Dew Point performance and may require additional cooling for very low drying temperature resins < 180 F
- Energy performance may not be as good as wheel type with engineering resins
- Generally the process is optimized by changing the total cycle time based on dew point performance

Compressed Air and Membrane Dryers

- Typical Compressed Air Dryers are sold infrequently and compressed air dryers (without membrane) can typically only produce about a +10 F dew point
- Membrane dryers typically produce a -40 F or better dew point by using hollow tube membranes
- Membrane dryers with a dual loop use comparable energy to desiccant dryers while single loop dryers can use 2-3x the power of desiccant dryers
- Membrane dryers have no moving parts and are very good for both machine mounting and mounting on floor stands
- The energy is optimized by recirculating air in the upper loop



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Hot Air Dryers

- Primarily for non-hydroscopic materials such as olefins and PVC
- Designed to remove primarily surface moisture
- Performance varies with ambient relative humidity
- Can use a VFD or temperature setback to reduce energy consumed

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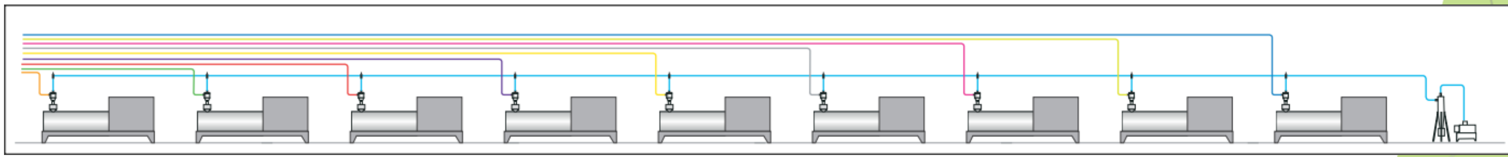
Central Drying Systems

- Central Drying System advantages
- All material handling in one area can reduce manpower requirements
- Leaves more floor space for processing machines
- Centralized handling generally leads to less material loss
- Faster material changes



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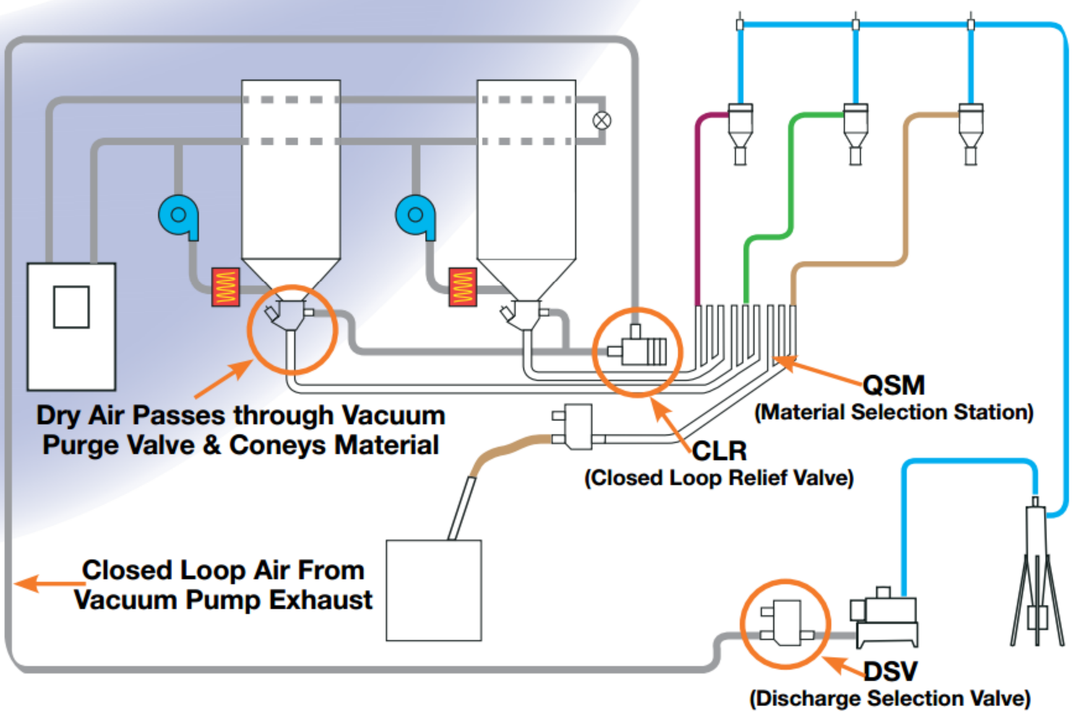
Central Drying Systems

How Central Drying Works

Closed Loop Conveying System Air Illustration



- The central dryer is your single source for -40° dew point air.
- A heater/blower at each hopper provides proper air flow and drying temperature.
- Dry air conveying or dry air purging of lines is available.
- Integrated central conveying system with auto ID of materials minimizes waste.
- Change materials in minutes … not hours for increased production time.

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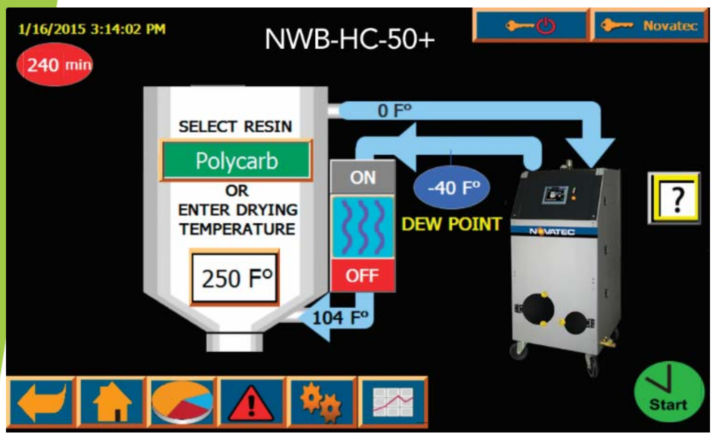
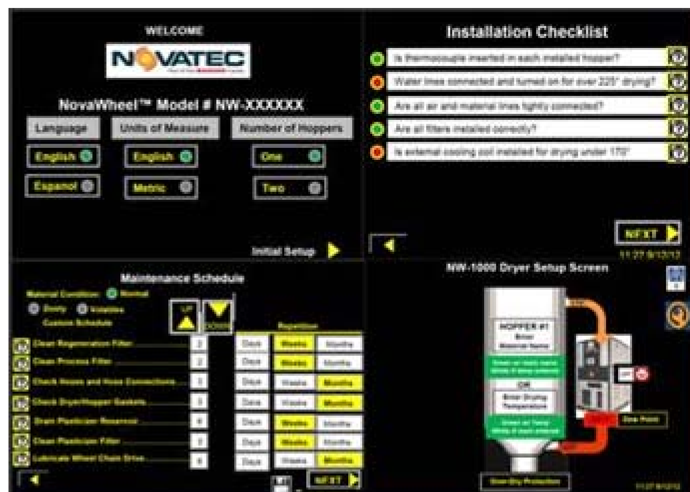
Controls



- Todays controls make drying systems so much easier to use than past systems
- With Touchscreen HMI's dryers can be as easy to use as you smart devices

- Language capabilities
- Maintenance schedule prompts
- Installation checklist
- Visual prompts and text type alarm systems with diagnostics



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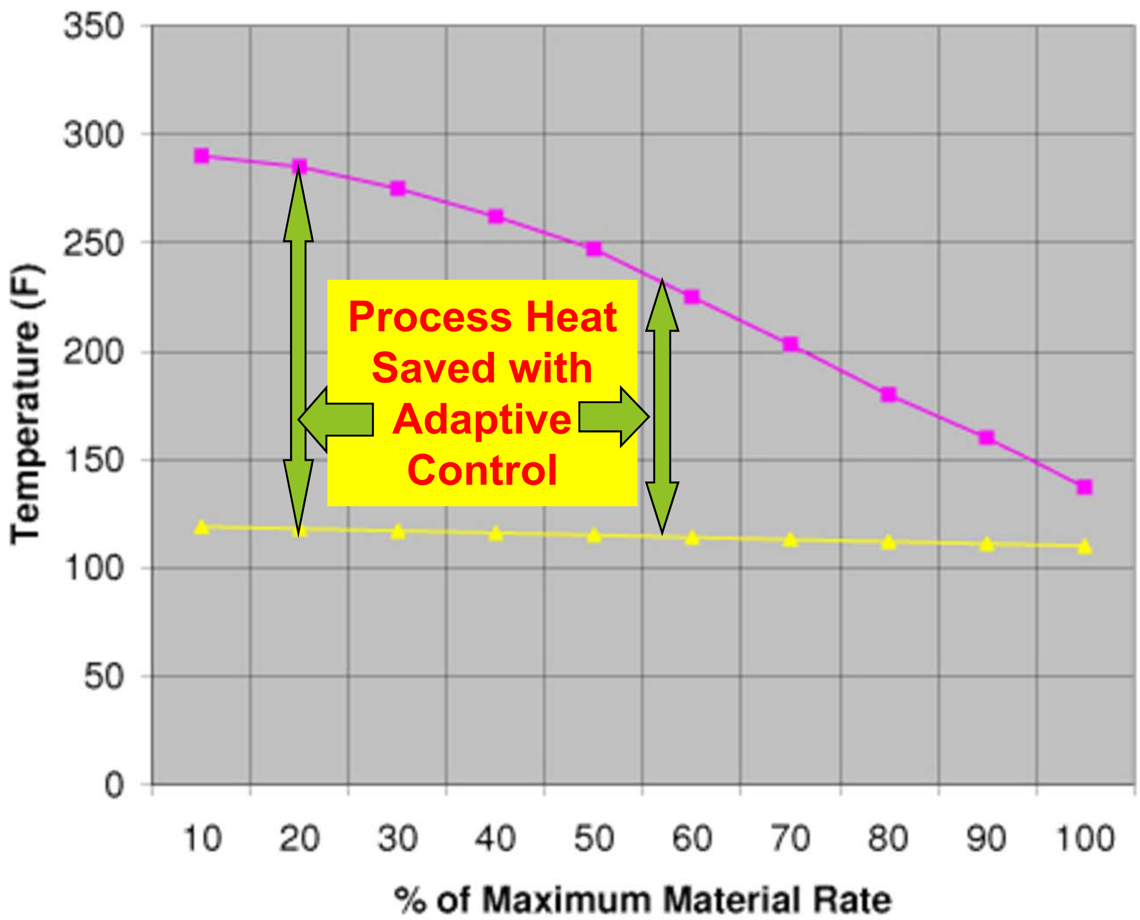
“Right Sizing”

- Many molding facilities have dryers of various vintages and most older dryers use considerably more energy than todays dryers
- In addition, most older dryers don’t have energy saving features so they use about the same power drying, for instance, 400 pph as drying 100 pph thus have 4x the specific power usage of modern dryers that adapt to the rate being used at any given time
- The only way to get a reasonable power consumption using an older dryer is to pick the dryer that exactly matches the current machine rate
- Newer dryer can “Right Size” themselves to the application
- Central system do this the best but even portable and machine mounted dryers can exhibit Adaptive Control

"Right Sizing"



Effect on Hopper Exit Temperature With & Without Adaptive Control

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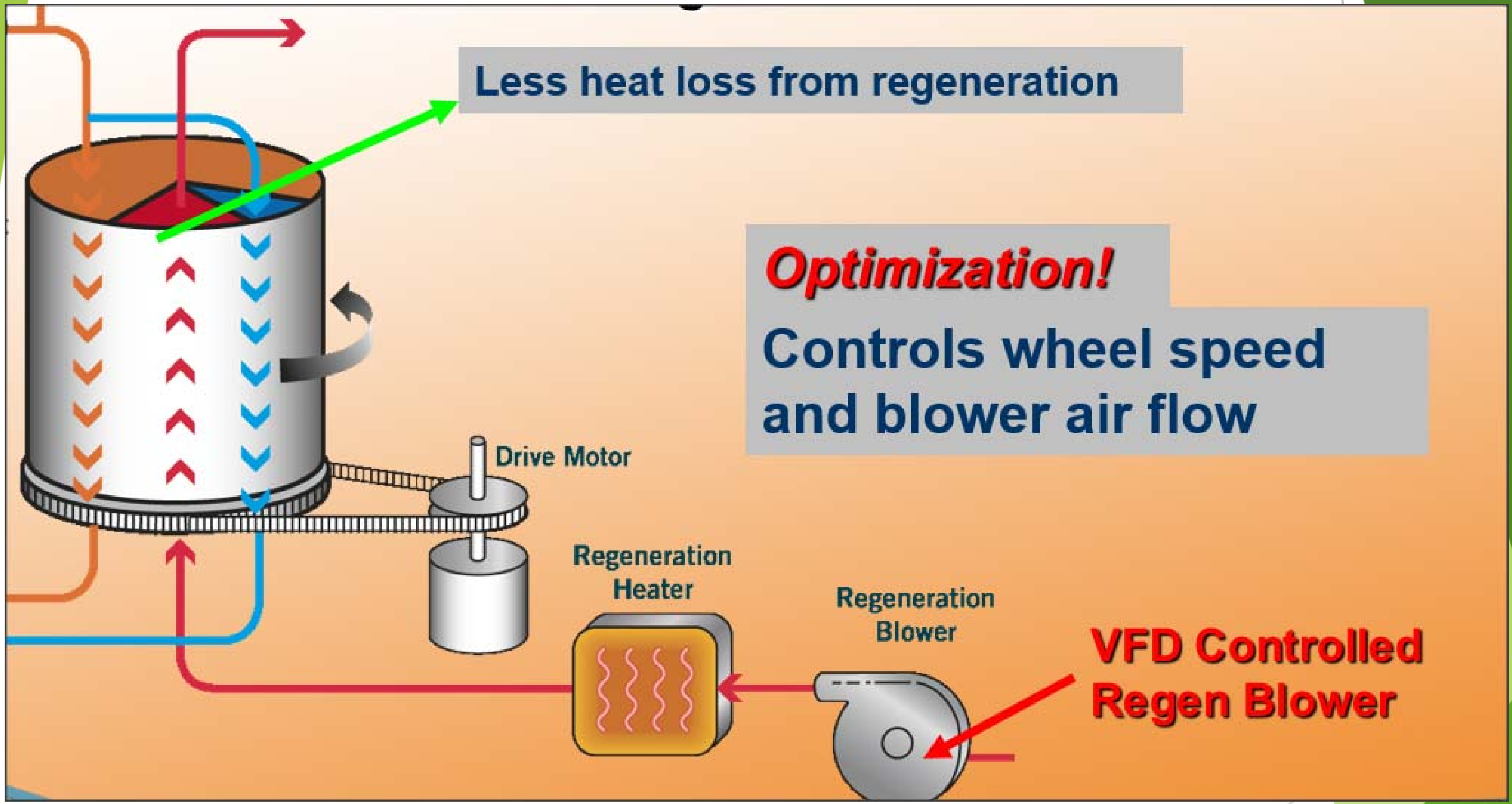
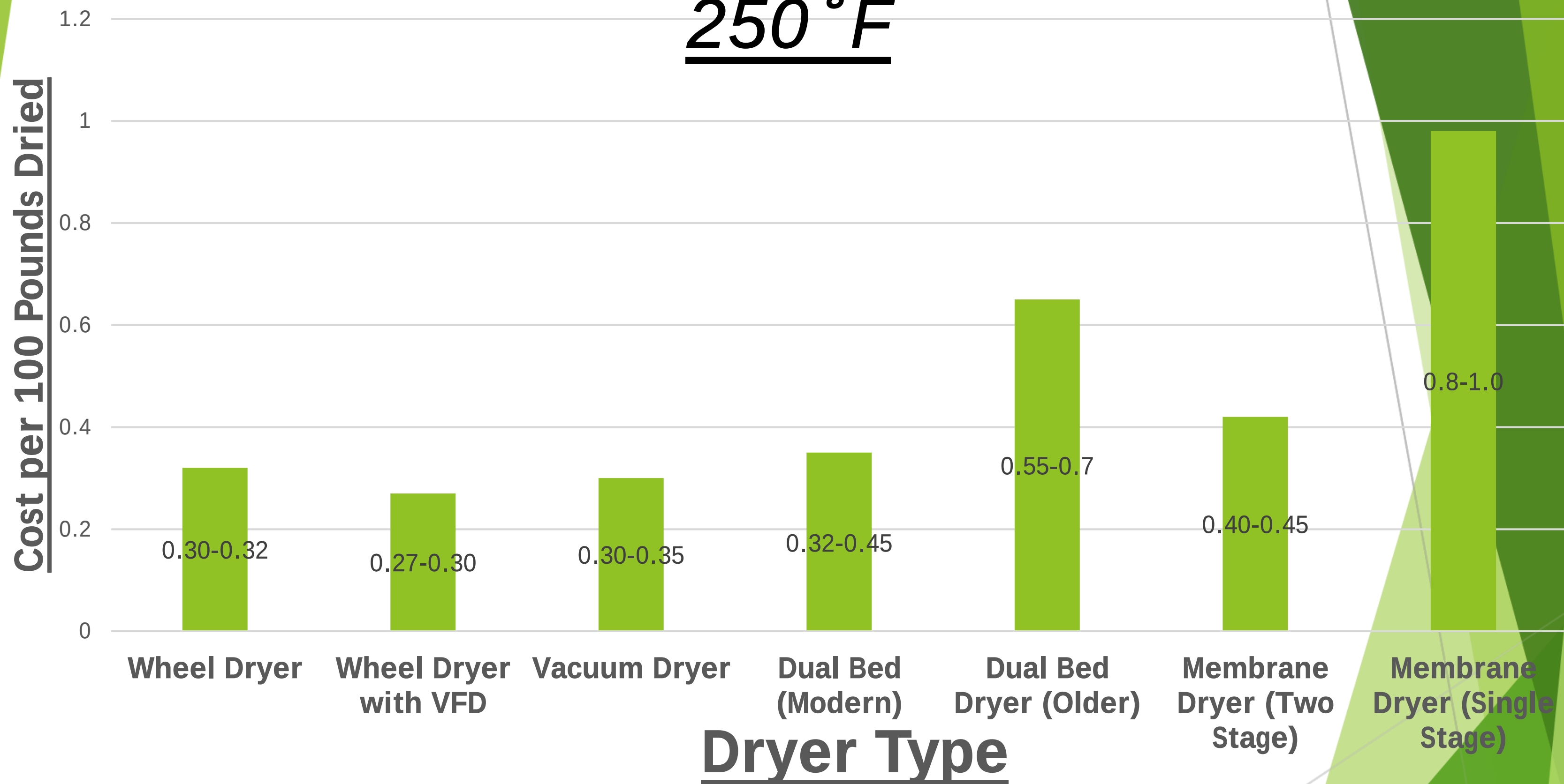
"Right Sizing"



COST of DRYING OPTIONS for PC at 250˚F



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Don’t Let Dryers Run to Failure

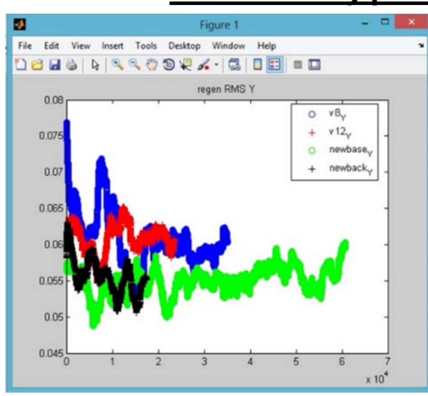
The OLD Way:

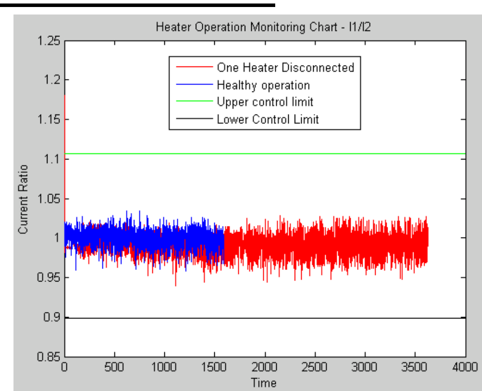
A partial heater bank failure leads to larger failure – and breakdown.

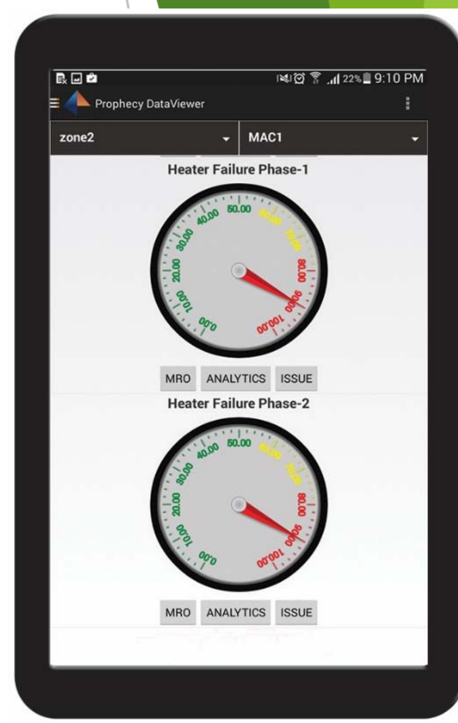
A motor bearing is not at optimum performance – a motor failure can occur

Today:

Your system can be monitored continuously so that maintenance can be performed well in advance of failure type maintenance







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