Which drying technology is the best for your application?

By Herb Wischow
VP of Sales
Dri-Air Industries

DRI-AIR® Industries, Inc.

The History

- Started in 1974
- Purchased from Automated Assemblies in 1985 by Charles Sears



Heritage

- DRI-AIR is a family owned business with a proud heritage of innovation and stability.
- 100% focused on plastics processing equipment with particular emphasis on drying, blending, and conveying equipment.
- Our goal is to provide our customers with high value products and excellent service - our reputation is very important to us.
- We consider our customers a part of our family



Dri-Air Today

- Company led by Jason Sears
- Expansion completed in 2018 added 50% more production floor space





Why dry plastic resins?

Many engineered grade polymers absorb moisture, these resins are known as hygroscopic resins.

When the plastic melts in the extruder, the water trapped in the pellets turns to vapor and expands 1600 times its size!

This is really bad for your multi lumen tubing!



Do all resins need to be dried?

Not really, resins can be classified into three categories:

- **Non-Hygroscopic** – moisture is outside the resin PP, PE
- **Hygroscopic** – moisture is absorbed in the resin ABS, Delrin
- **Extremely Hygroscopic resins –** they absorb water molecules in a hydrogen bond and will absorb much greater amounts of water (1-2.5%) – these require good drying as well as proper handling before and after drying PET's, Isoplast, Bioabsorables, Urethanes



Effects of moisture that is not removed are…

Visible in the appearance and/or structural deficiencies of the part:

- splay/striations
- bubbles in the part
- degradation of the polymer

Properly dried materials eliminate these problems while providing other benefits.



Other benefits for drying materials

- Improved melt uniformity
- Consistent line speeds
- Reduced levels of equipment and die corrosion



4 requirements for drying resins

- Dehumidified Air (Dewpoint)
- Air Flow
- Temperature
- Residence Time



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How to size a drying system

- **throughput = part weight x line speed**

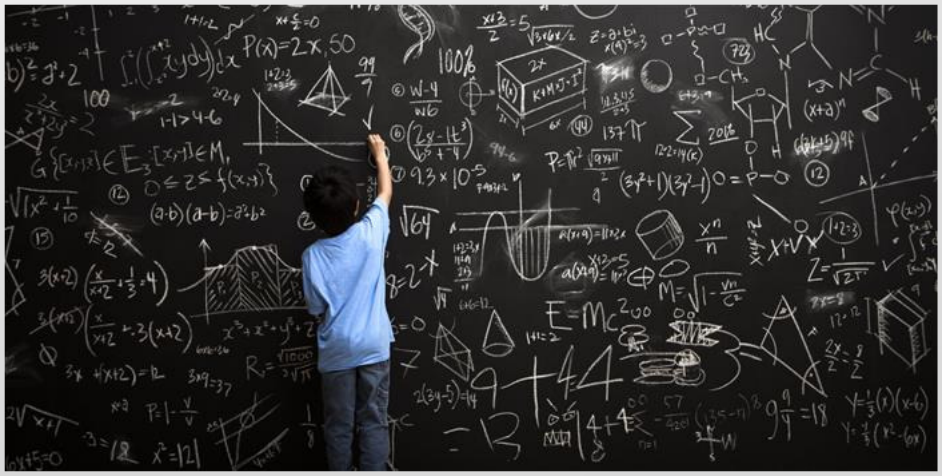
  i.e. - 1 oz/in x 1 ft/min = 45 lb/hr

- **dryer size =1 lb/hr = 1 CFM**

  i.e. - 45 lb/hr = 45 CFM = ARID-X 50 or HP4-X 50

- **hopper size = lb/hr x residence time**

  i.e. - 50 lb/hr x 4 hours = RH200



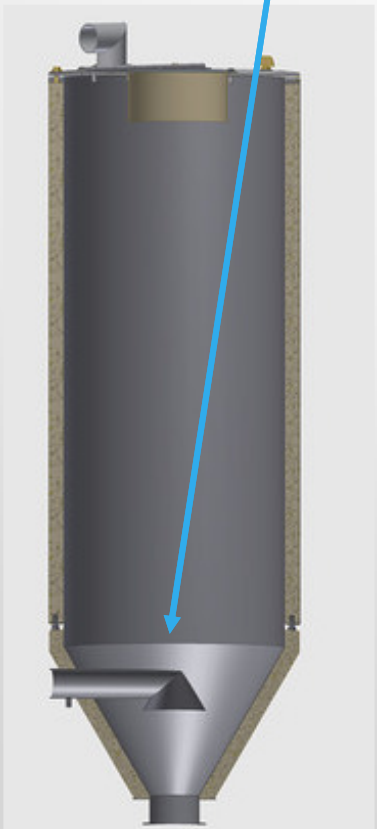
What happens when your temperatures are too high?

- Color Changes
- Oxidation (leads to polymer degradation loss of lubricants, plasticizers and other additives)
- Oils, or residue in the dryer filter and regeneration exhaust

Dri-Air and other Hopper Comparisons

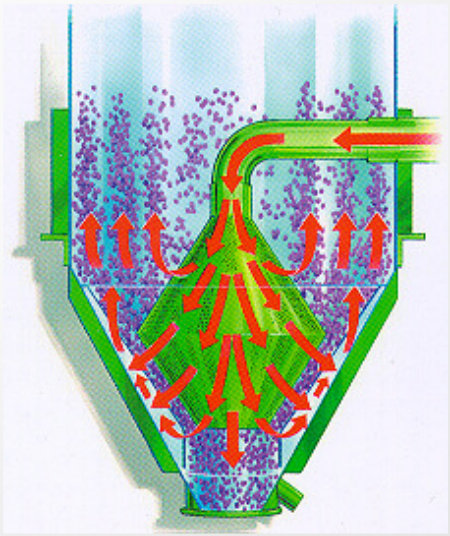


Solid cone diffuser, poor heat transfer through the resin

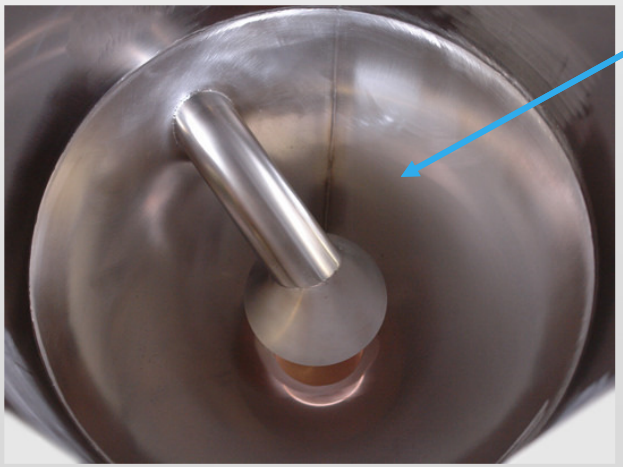


Diffuser basket with perforated top and bottom cone for efficient transfer of heat throughout the resin





Other designs -Solid cone diffuser basket, poor airflow, not removable



How Dri-Air improves on the four requirements to dry material

- **Dewpoint – all Dri-Air dryers use a slip stream of dry air for regeneration for the lowest possible dewpoints (down to -131 F) others use ambient air for regeneration. The dryer the air that is used for regeneration, the lower the dewpoint**
- **Air Flow – Dri-Air uses 1 CFM per pound per hour to dry all materials (not just polycarbonate) Most dryer manufactures are rated in Cubic Meters Per hour 1 CMH = .6 CFM Why buy a dryer today that won't dry tomorrows materials ?**
- **Residence Time - with more airflow, precise temperature control and superior hopper design = resins heat up faster, for efficient, thorough drying**
- **Temperature – Stable temperatures at the hopper are assured as regeneration is based on temperature. Changes from process to regeneration can not occur until the dryer has reached a safe temperature based on the process temperature**

Dryer Configurations

Hopper Mount Dryer - dryer and hopper completely integrated to fit on the feed throat of the Extruder.



Floor Mount Dryer - dryer is beside-the-press and the hopper only is mounted on the feed throat of the Extruder.



Portable Dryer - dryer and hopper are integrated to mount on a compact, castered, floor frame.



Other Dryer Configurations

- **Hopper Banks** – multiple hoppers for drying and pre-drying resins for fast changeovers
- **Dual Hopper Dryers** – a single dryer with two hoppers on one frame for fast changeovers or for multiple extruders on a single line.



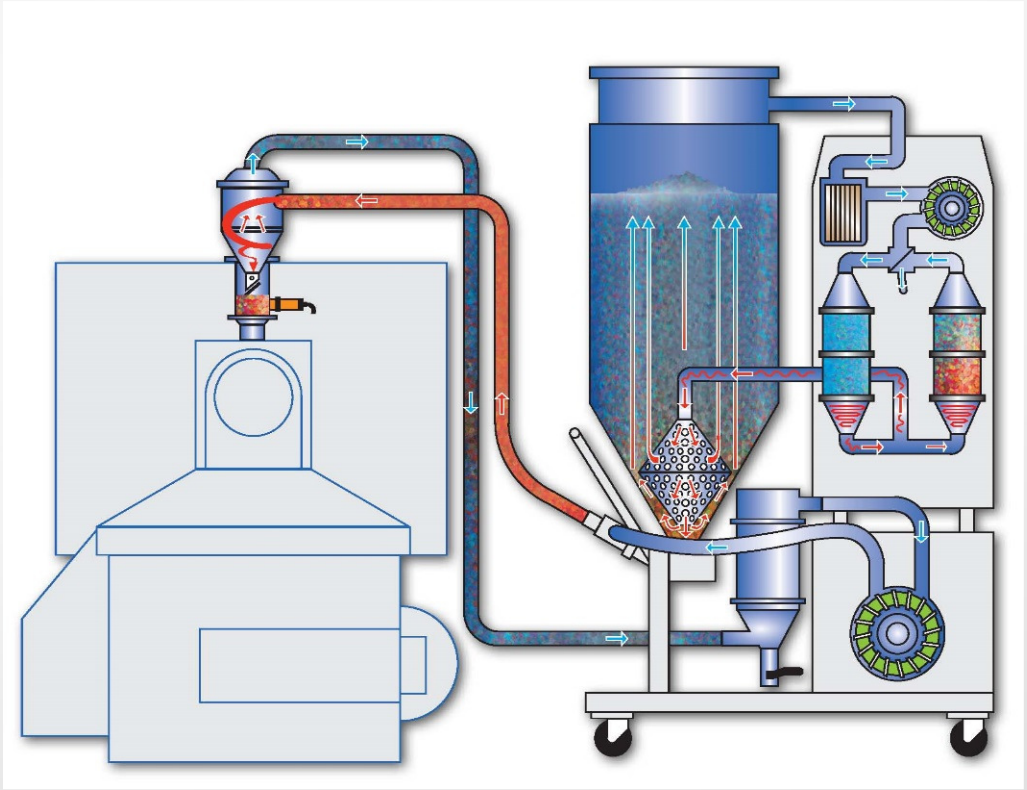
Multiple Hopper Bank



Dual Hopper Dryer

Types of Dryers

- **Desiccant**
- **Compressed Air**
- **Vacuum**
- **Nitrogen**



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Which is best for you?

To determine which drying technology is best for your application, we need to define your application and the utilities / resources available:

Application Questions:

- **Types of resins you will be processing**
- **Pounds per hour**
- **Any colorant / additives / regrind?**
- **Resin changeovers: how often?**
- **How many resins / colors will you be processing ?**
- **Any powders or difficult / unusual resins in the mix?**



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Which is best for you?

Utilities Questions:

- **Room around the Extruder – is there space available on the extruder or nearby? For dryers / raw materials?**
- **Can raw materials be brought into the room? If so, where would they be located?**
- **What are the logistics in getting the resin in the room?**
- **Is Compressed air available? Is it clean? Is it available 24/7 ?**
- **Tower / chilled water?**
- **Other utilities: Nitrogen?**



Compressed Air Dryers

There are two types of compressed air dryers available:

Non-Membrane: Relies on your compressed air to dry material

Membrane type: Dries your compressed air to dry material



Cart Mount



Extruder Mount



Portable Series

Compressed Air Dryers

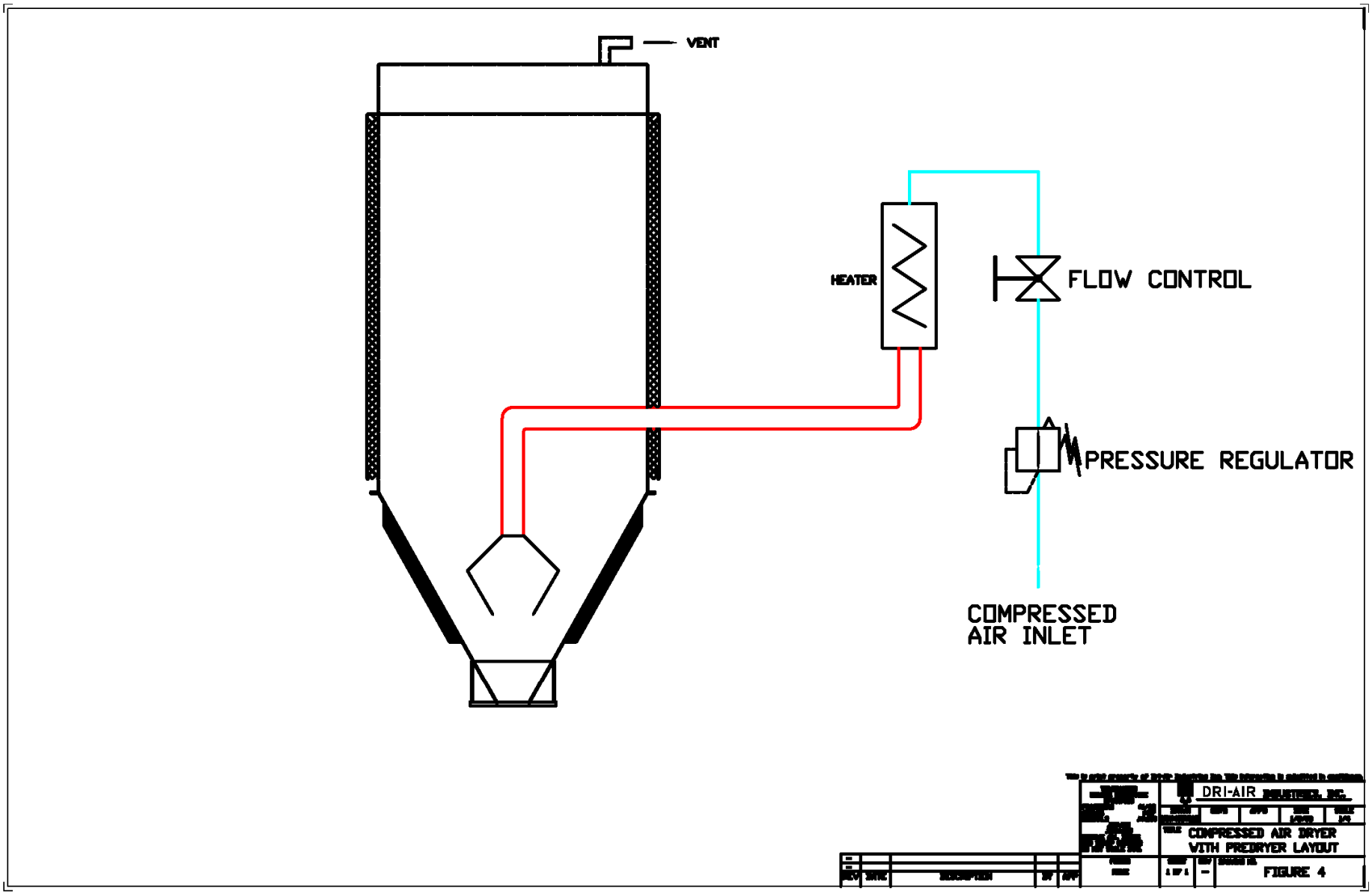
Non-Membrane type:

This type works by releasing compressed air to atmosphere, which lowers the dewpoint of the air by 40 to 50 degrees usually between –10 to +10° F

The released compressed air then goes through a heater and passes through the material hopper to remove the moisture trapped in the resin. The heated wet air then is displaced out of the drying hopper.

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Compressed Air Dryers, non-membrane



Compressed Air Dryers, membrane

Membrane type:

This type works by running compressed air through a membrane, where the moisture is removed from shop air. The membrane has thousands of membrane filaments where the H2O molecules pass through the sides of the filaments and are carried away, lowering the dewpoint of the air down to –40° F.

On dryers with small hoppers (1/3 -2 pound) the dry compressed air then goes through the heater at drying hopper to remove the moisture trapped in the resin. On larger dryers, the dry compressed air passes through an air amplifier to increase the volume of compressed air, this air is then re-circulated back to the dryer.

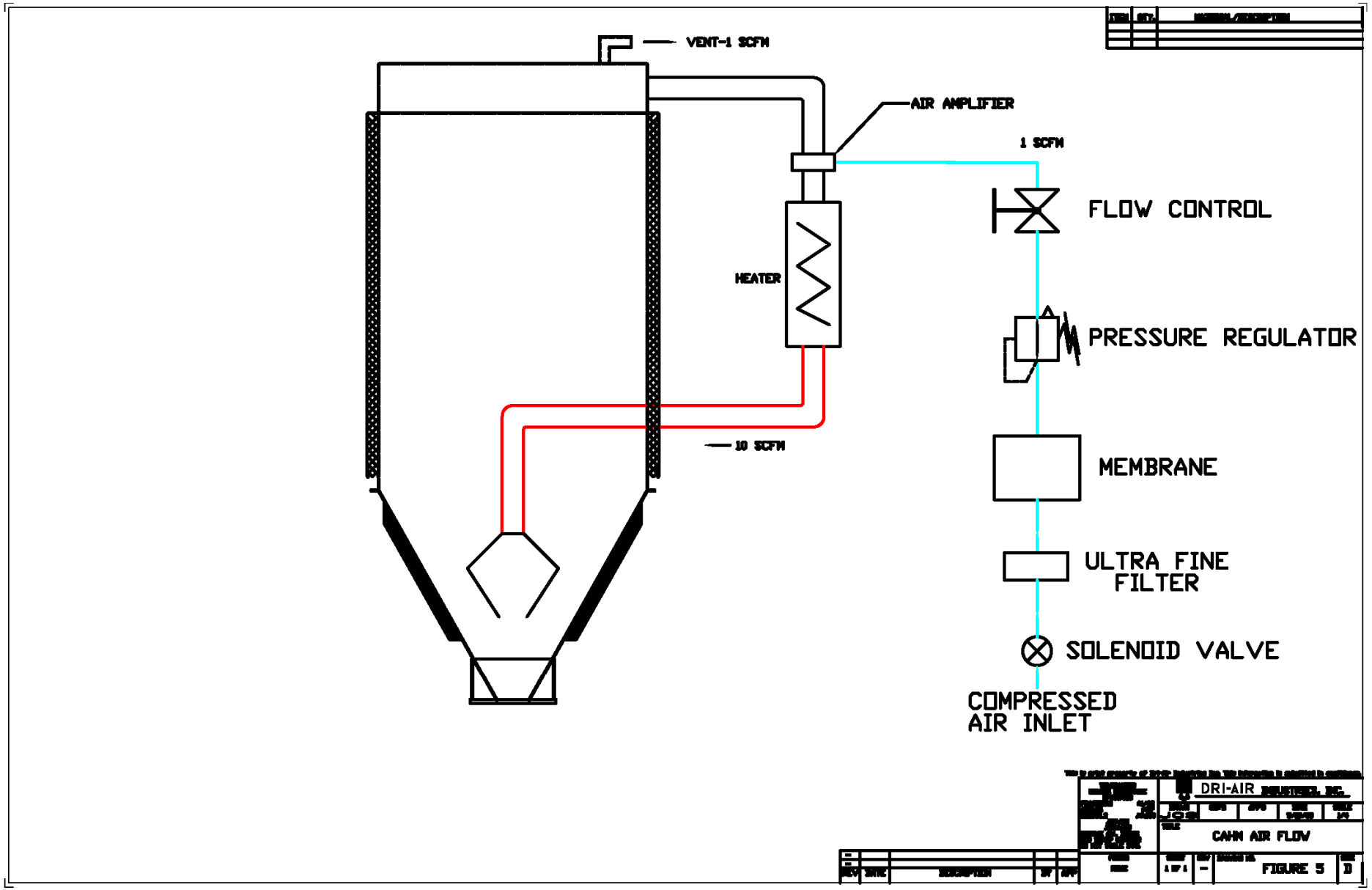


1/3 – 2 pound hopper with external heater



Dryer with 5 lb. hopper & internal heater

Compressed Air Dryers, membrane



Compressed Air Dryers, non membrane

Advantages:

Non-membrane Compressed air dryers advantages:

- Very few moving parts
- Compact design can fit on small extruders
- Run a wide range of temperatures 80F – 350F without cooling water
- Simple to use, operate
- Low cost – lowest of any dryer in the market

Disadvantages:

- Non-Membrane type compressed air dryers should only be used with non- hygroscopic resins or with plants that have very dry compressed air
- Not ideal for cleanrooms as they dissipate compressed air
- When the weather changes, so does your dewpoint!
- You have to have your plants compressed air on to dry materials – weekends? Holidays ? Dry material prior to start up?
- Dryers will use a considerable amount of plant air – 5 pound per hour dryers uses 5 CFM! – Compressed air is your most expensive utility!

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Compressed Air Dryers, membrane

Advantages:

Compressed air membrane dryers advantages, include:

- Very few moving parts, reliable operation
- -40 Dewpoint
- Compact design can fit on small extruders
- Run a wide range of temperatures 80F – 350° F without cooling water
- Good for drying resins with high amounts of plasticizer
- Simple to use, operate
- Ideal for lab / prototype use

Disadvantages:

- If your air is dirty or has oil / water in it filter changes can be expensive
- You have to have your plants compressed air on to dry materials – weekends? Holidays ? Dry material prior to start up?
- Larger dryer sizes uses a considerable amount of plant air – 25 pound per hour dryers use 5.7 CFM, 50 pound per hour 12 CFM! – very expensive to operate !

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Desiccant Dryers

There are many types of desiccant dryers on the market from two bed, 4 bed and wheel dryer technology.



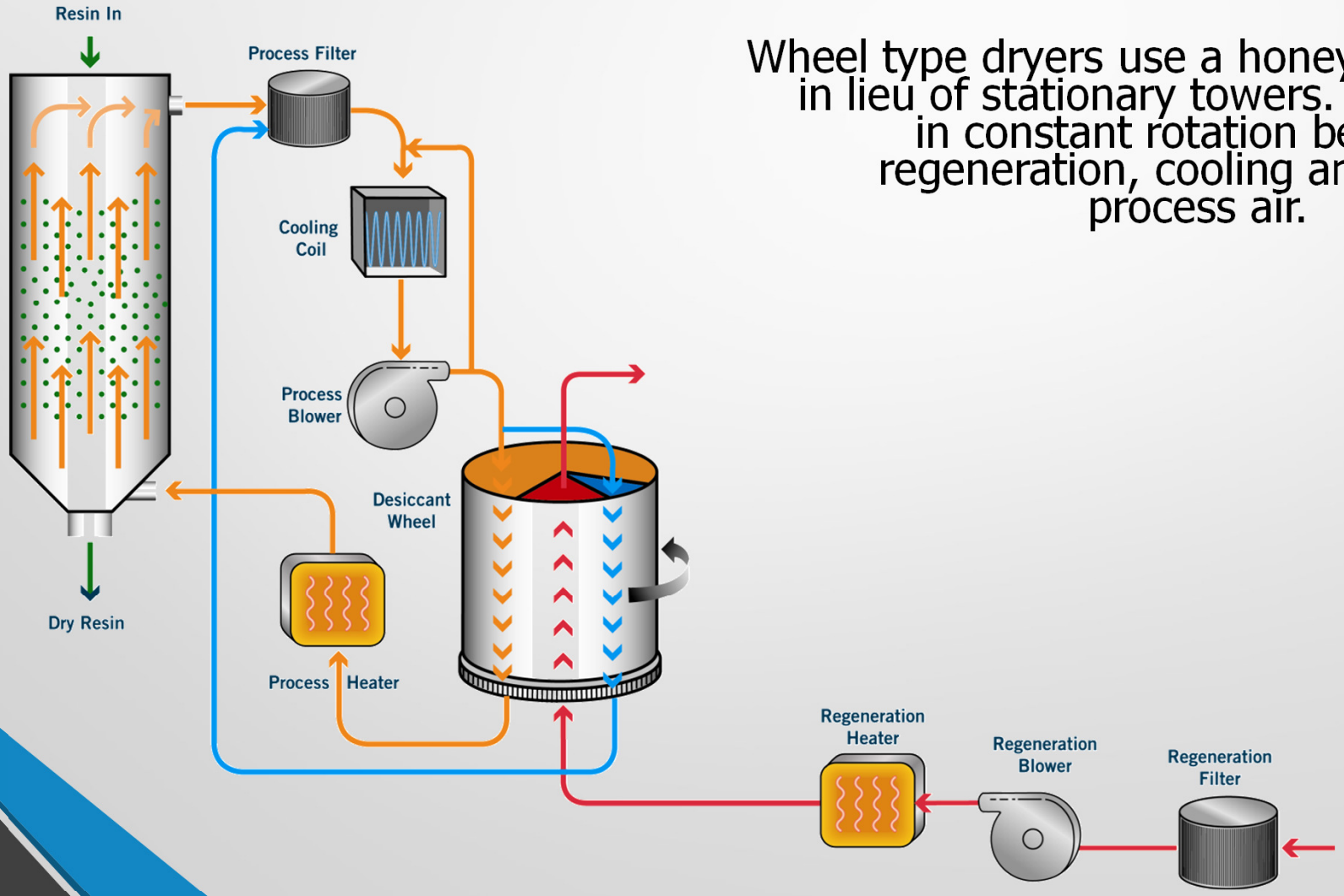
200 pound per hour portable



Table top dryer for 1-10 pounds per hour

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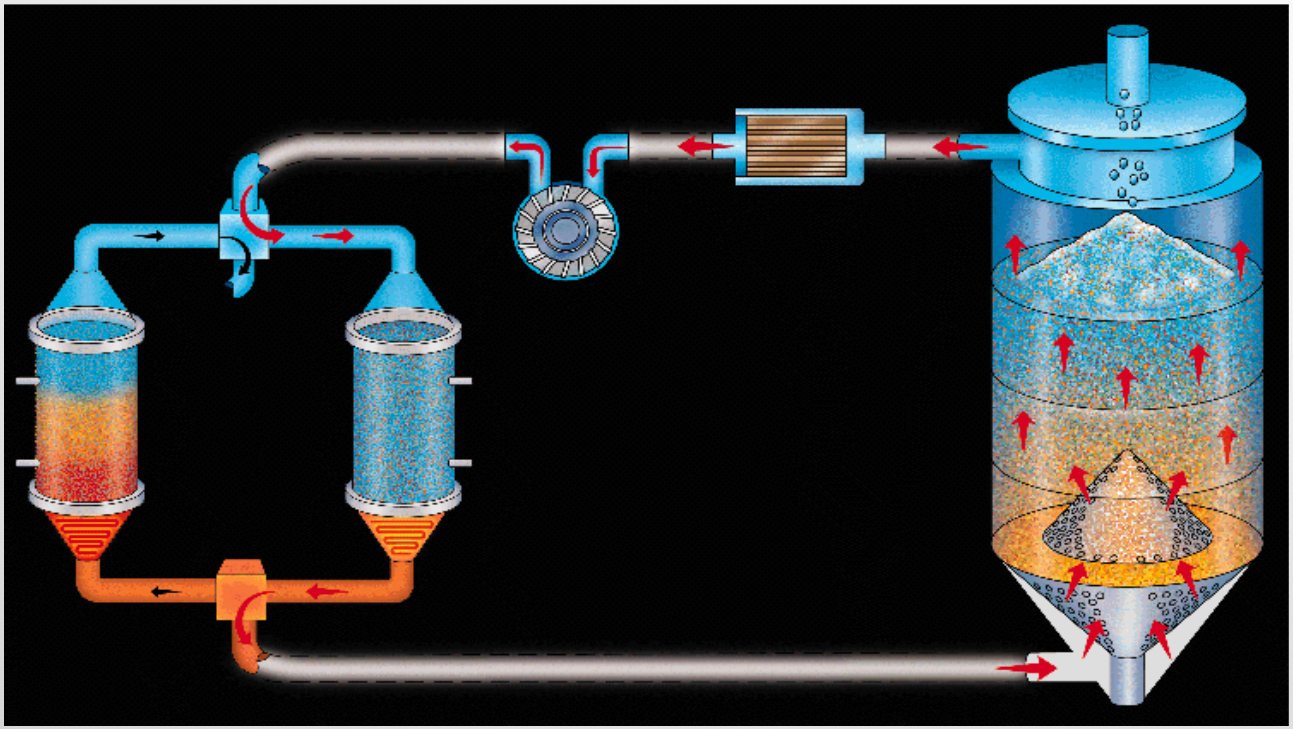
Desiccant Dryers Wheel



Wheel type dryers use a honeycomb wheel in lieu of stationary towers. The wheel is in constant rotation between regeneration, cooling and drying process air.

Desiccant Dryers 2-Bed

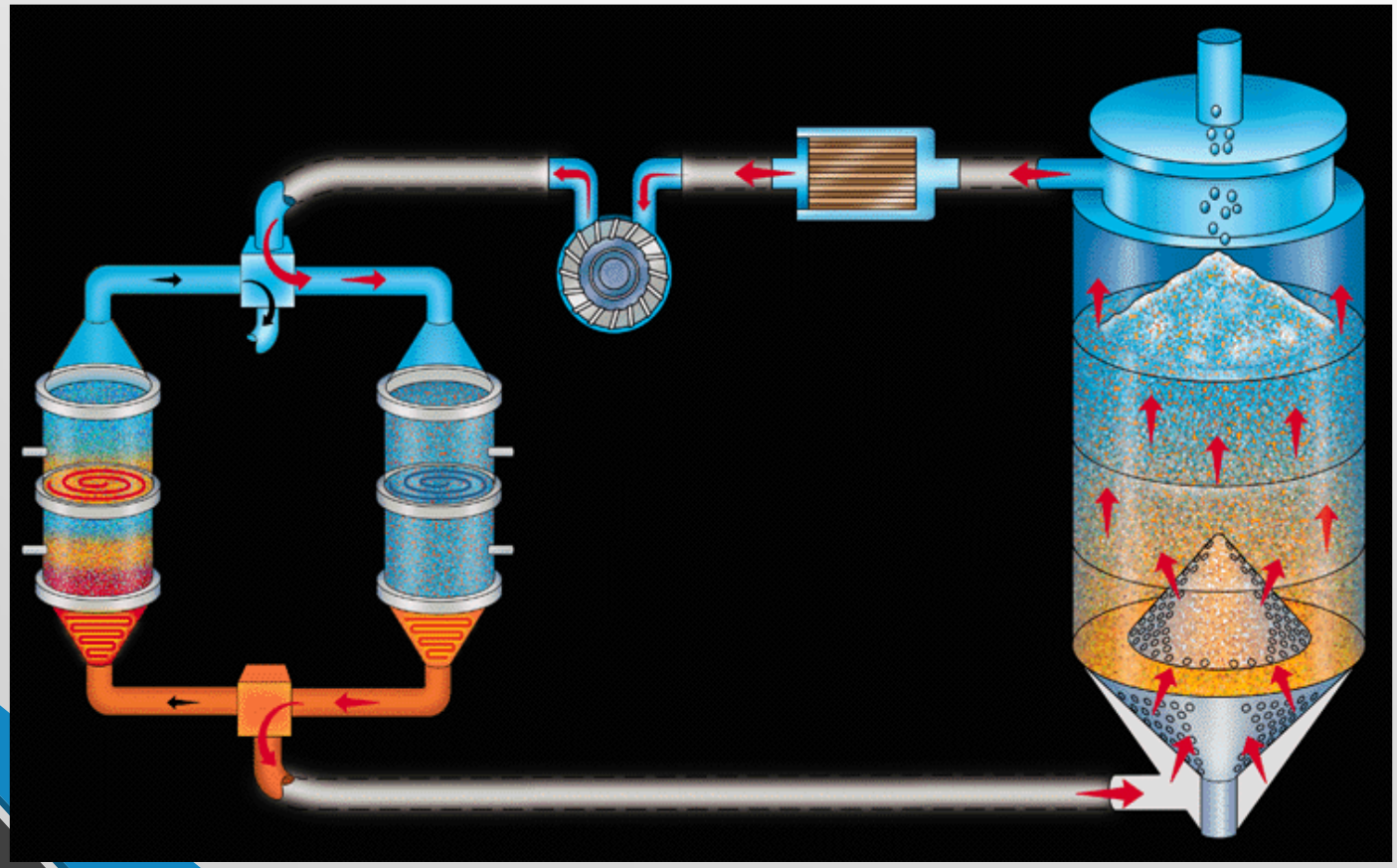
2 Bed dryers feature two stationary towers where one tower is in regeneration, the other in process. A rotary valve which directs the air flow from process to regeneration is the only moving component Thermocouples monitor the regeneration process and adjust regeneration based on demand



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Desiccant Dryers 4 Bed

4 bed dryers feature two "stacked" stationary towers where one tower is in regeneration, the other in process. The additional stacked tower provides maximum moisture removal and – 131° F dewpoints! As we use Dri-Air for regeneration. A rotary valve which directs the air flow from process to regeneration is the only moving component



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Desiccant Dryers Summary

Advantages:

Desiccant dryers offer many advantages, these include:

- Reliable, proven design
- Most energy efficient method of providing dry air
- Can dry any resin, lowest dewpoints possible
- Most models do not require compressed air
- Available in a wide range of sizes (1/2 to 5000 lbs/hr, hopper mount, portable or multiple hoppers)

Disadvantages:

- Not as small as Compressed air models
- They do not like low to high temperature applications (80 – 350° F)
- Some designs require cooling water all the time, (wheel) others just for low to high temperatures (under 160° F over 250° F) (2 bed, multiple bed)

Vacuum Dryers

There are two types of Vacuum dryers – batch and continuous



Batch Process



Continuous

Vacuum Dryers Batch

Batch operated vacuum dryers are ideal for small sample sizes of materials (a few grams) can also dry irregular sized pellets including powders.

Resins are placed in the Vacuum chamber, the chamber is sealed and the pellets are exposed to low pressure air that reduces the boiling point of water to 133˚ F, so it escapes as a vapor.

As this is a batch process, the oven needs to be opened and closed to remove the pellets





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Vacuum Dryers Continuous

The continuous vacuum dryers use multiple canisters that are indexed on a turntable. The canisters index into three positions: fill, heat and vacuum to remove the moisture then conveyance.

By lowering the surrounding vapor pressure, moisture is released at a lower drying temperature then conventional drying giving less heat histories to the resin.



3 canisters index into position for fill, vacuum and convey

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Vacuum Dryers Summary

Advantages:

- Less heat degradation as they dry at a lower dryer temperature
- Can make changes on the fly (while the dryer is under power)
- Batch designs can be used for powders

Disadvantages:

- Minimal practical throughput of 25 pounds per hour for continuous models
- Each of the three canisters must be completely disassembled and cleaned - many parts to clean and maintain
- Requires compressed air for vacuum
- May not dry all materials
- Only available in a portable (off the Extruder syste

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Nitrogen Dryers

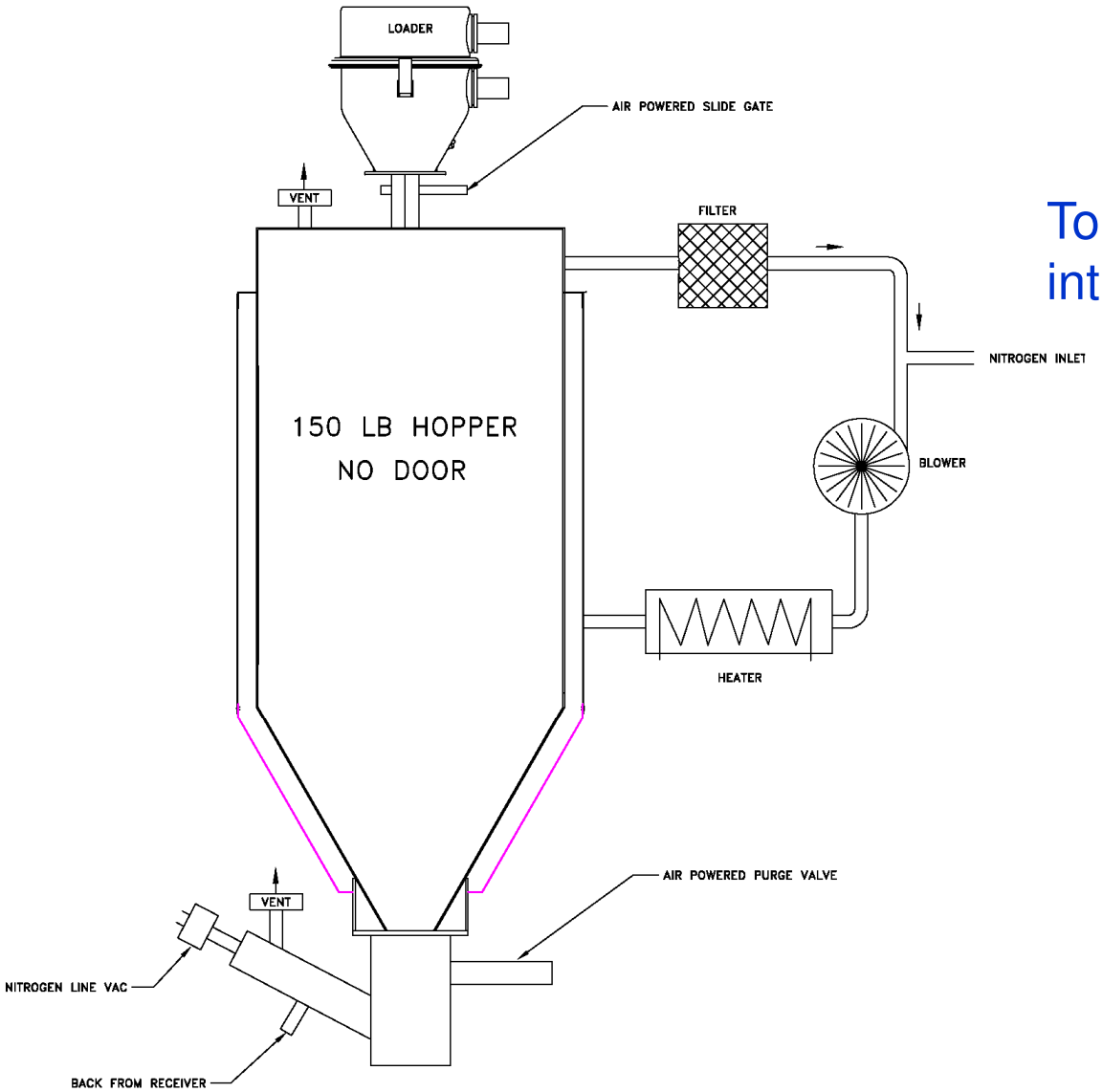
Nitrogen dryers are for resins that have to remain in an oxygen free environment.

Nitrogen can also be used to keep resin dry at the Extruder's feed throat. This is accomplished by introducing a blanket of Nitrogen in the machine hopper or the transition piece between the machine hopper and Extruder's feed throat.



Nitrogen dryer with 1/3 & 2 lb hopper

Nitrogen Dryer – Oxygen Free



To eliminate oxygen, nitrogen is introduced into a sealed hopper

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Nitrogen Dryers Summary

Advantages:

- Operate from 70 – 350° F
- As Nitrogen is -80° -50° F low dewpoint air is assured for drying or keeping resin dry
- Simple, low purchasing cost
- Very little maintenance

Disadvantages:

- Due to the cost of nitrogen, these dryers are only practical for low throughput applications (under 5 pounds per hour)
- Nitrogen might not be available
- Nitrogen generators are a costly alternative
- Excess Nitrogen needs to be vented – or else!



Thank you, any questions?



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