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Common Desiccant Compressed Air Dryer Sizing Errors

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Introduction by Rod Smith, Publisher,
Compressed Air Best Practices® Magazine

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All materials presented are educational. Each compressed air system is unique and must be evaluated on its own merits.

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About the Speaker

Hank van Ormer, Air Power USA

- Founded Air Power USA in 1986
- Over 50 years of experience in the compressed air and gas industry

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Common Desiccant Compressed Air Dryer Sizing Errors

Air Power USA Inc.

July 28, 2016

AIR POWER USA

Independent and Brand Neutral

Compressed Air Dryer: Rating Conditions

Most commercial standard compressed air dryer performance and flow ratings are based on the Compressed Air and Gas Institute (CAGI) standard ADF 200 conditions of inlet air pressure of 100 psig (7 Bar) and inlet air temperature saturated of 100°F (38°C).

- **Lower pressure** will allow more water vapor than rated to enter the dryer.
- **Higher air temperature** will allow more water vapor than rated to enter the dryer.

Typical OEM Inlet Temperature Correction Chart - Heated

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Pressure (psig)	Inlet Temperature °F (°C)						
	60 (15.6)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.8)	110 (37.8)	120 (48.9)
60 (4.2)	1.03	1.01	0.99	0.80	0.58	0.43	0.32
70 (4.9)	1.10	1.08	1.07	0.94	0.68	0.50	0.37
80 (5.6)	1.17	1.15	1.14	1.08	0.79	0.58	0.43
90 (6.3)	1.24	1.22	1.20	1.18	0.89	0.66	0.49
100 (7.0)	1.30	1.28	1.26	1.24	1.00	0.74	0.55
110 (7.7)	1.36	1.34	1.32	1.30	1.11	0.82	0.61
120 (8.4)	1.42	1.40	1.38	1.36	1.22	0.90	0.67
130 (9.1)	1.48	1.46	1.44	1.42	1.33	0.99	0.74
140 (9.8)	1.53	1.51	1.49	1.47	1.44	1.07	0.80
150 (10.6)	1.58	1.56	1.54	1.52	1.50	1.16	0.87

Typical OEM Inlet Pressure Correction Chart – Heated & Heatless

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Operating Pressure	PSIG	60	70	80	90	100	110	120
	Bar	4.2	4.9	5.6	6.3	7.4	7.7	8.4
Multiplier		0.65	0.74	0.83	0.91	1.00	1.04	1.08
Operating Pressure	PSIG	130	140	150	175	200	225	250
	Bar	9.1	9.8	10.5	12.3	14.1	15.8	17.6
Multiplier		1.12	1.16	1.20	1.29	1.37	1.45	1.52

What Pressure Dewpoint do you Need?

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Identify the pressure dewpoint first and design to it.

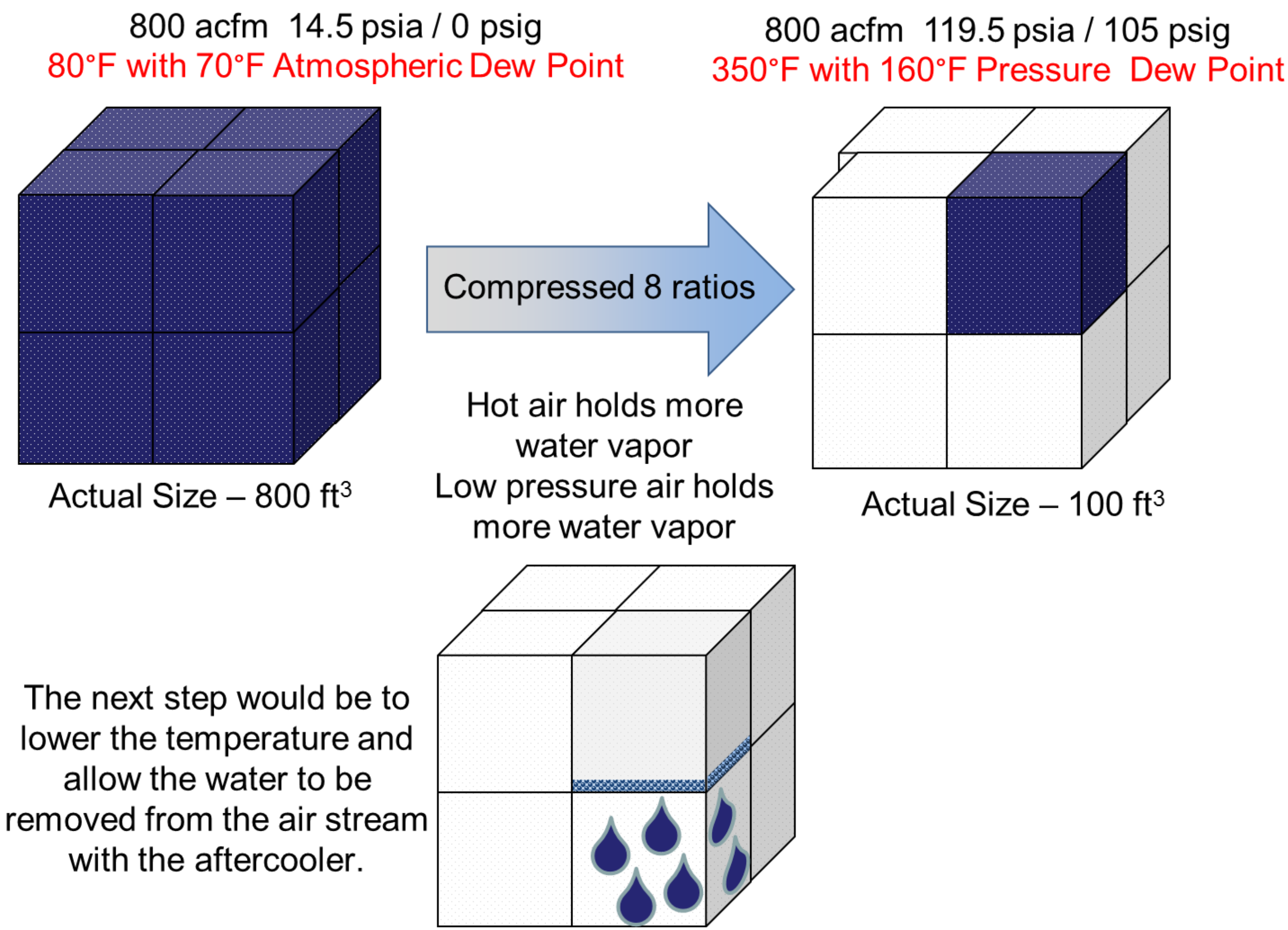
ISO 8573.1 Quality Classes

"As dry as possible is not a class"

Some processes with hydroscopic material are very low relative humidity (RA) dependent and may require a very low constant pressure dewpoint.

Quality Classes	SOLIDS Maximum particle size in microns	MOISTURE Dewpoint		OIL Liquid & Gas	
		°C	°F	mg / m3	ppm / w/w
0	As specified	As specified		As specified	
1	00.1	-70	-94	0.01	0.008
2	1	-40	-40	00.1	0.08
3	5	-20	-4	1	0.8
4	15	3	38	5	4
5	40	7	45	>5	>4
6	--	10	50	--	--

Where Does the Water Come From?



Desiccant Dryer Sizing: Opportunities for Error

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I. Aftercoolers/ Separators / Pre-filters

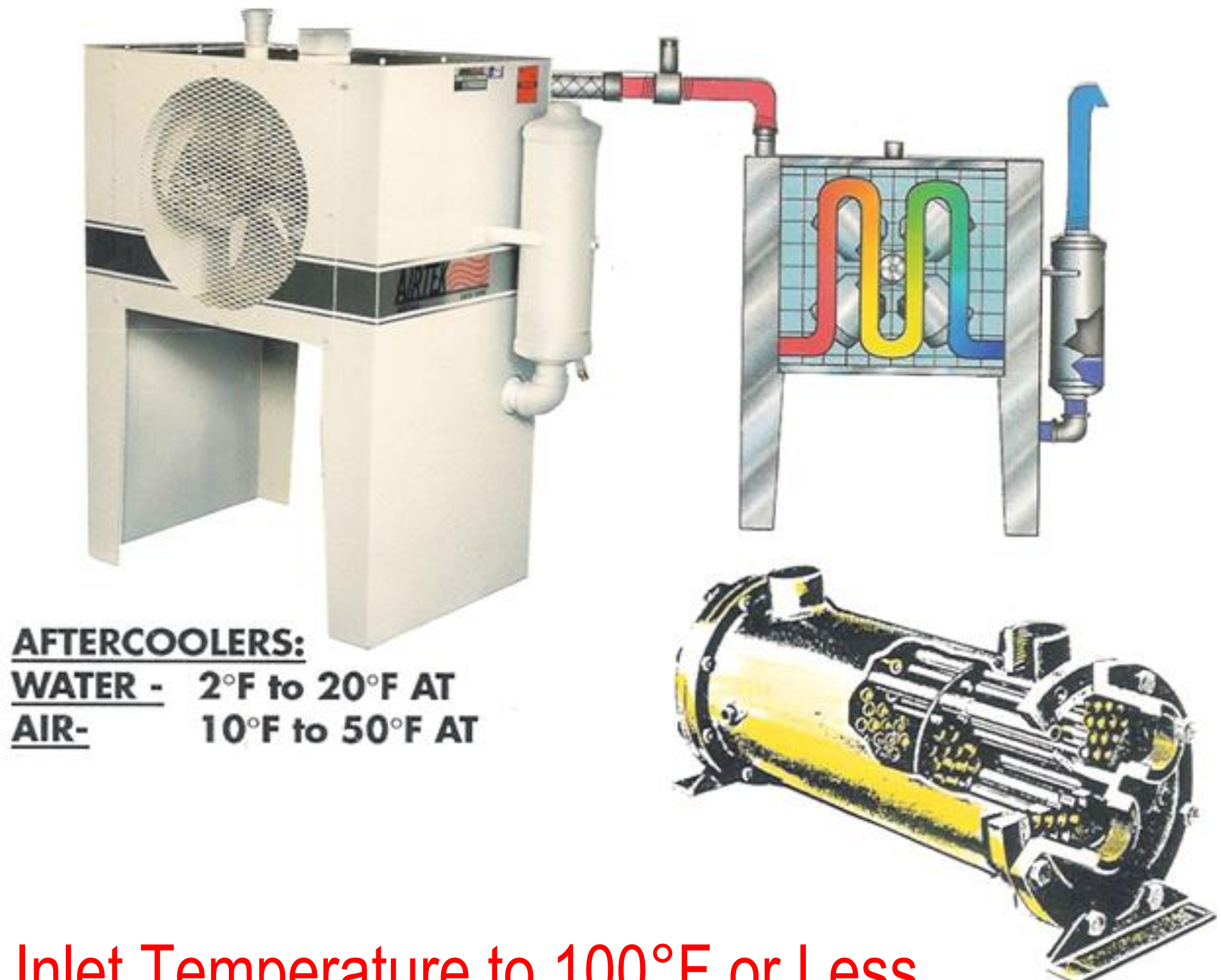
1. Control inlet to <100°F
2. Pressure maximum 100 psig
3. No liquid condensate to dryer

II. Heatless and Heated Desiccant Dryers and Basic Performance Considerations

4. Allow for lost purge air
5. Eliminate liquid condensate into dry air tower

Control the Inlet Air Conditions

Opportunities for Error: Aftercoolers



Control Inlet Temperature to 100°F or Less

Opportunities for Error: Air / Water Separators

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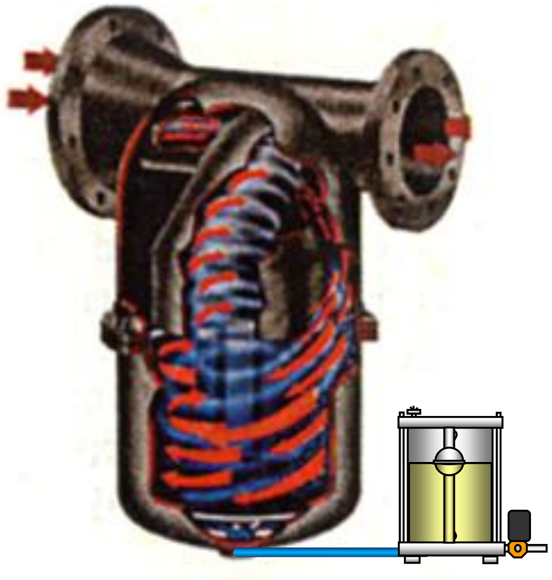
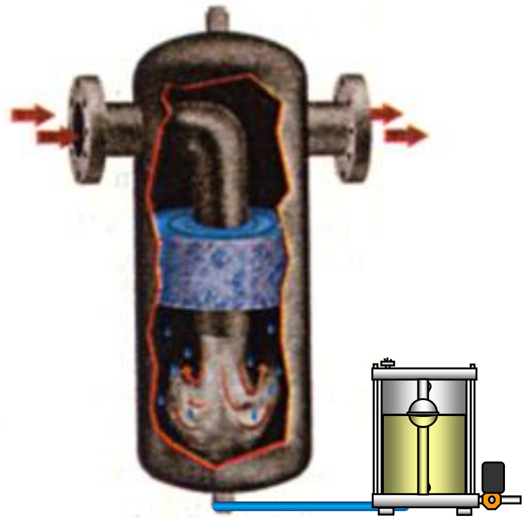


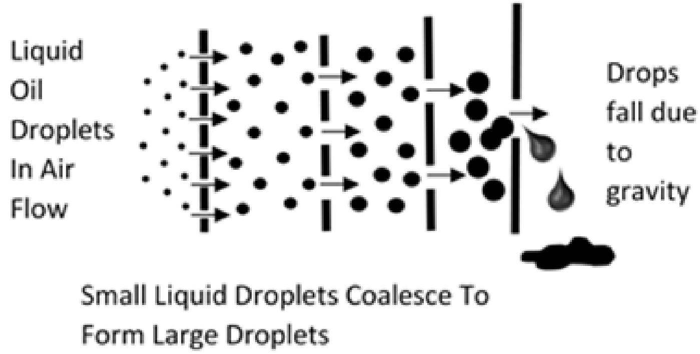
Centrifugal

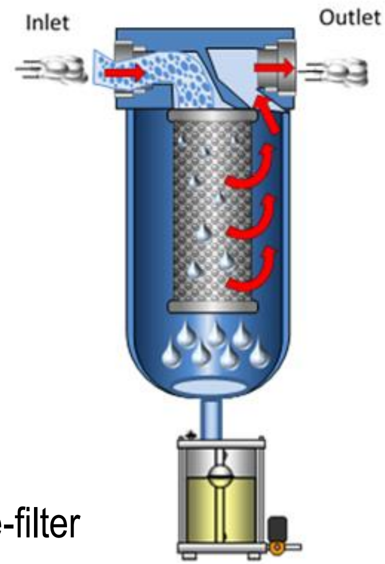


Impingement

Remove Oil and Water

Opportunities for Error: Coalescing Pre-Filter





Coalescing pre-filter

Trap Oil and Water

General Guidelines:

Selecting and Sizing Compressed Air Dryers

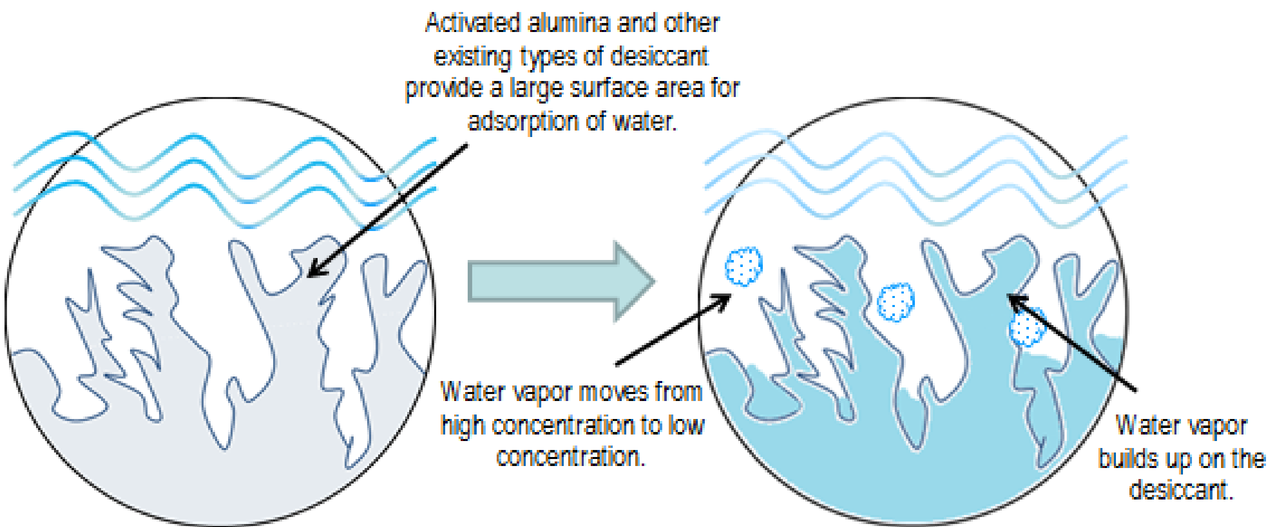
The correct way to eliminate water and oil in the air system is to clean and dry the air immediately after it is produced in the compressor room at its highest pressure. Then clean dry air can be stored in a separate air receiver and can flow to the system, as required.

As the system pressure falls to a lower actual operating pressure the pressure dewpoint will also fall.

Desiccant Drying Process

Desiccant Dryers {-100ºF to - 40ºF Pressure Dewpoint Nominal}

Activated aluminum desiccant adsorption of water vapor



Typical Twin Tower Design

NOTE: WILL NOT DRY AT ALL OVER 120°F

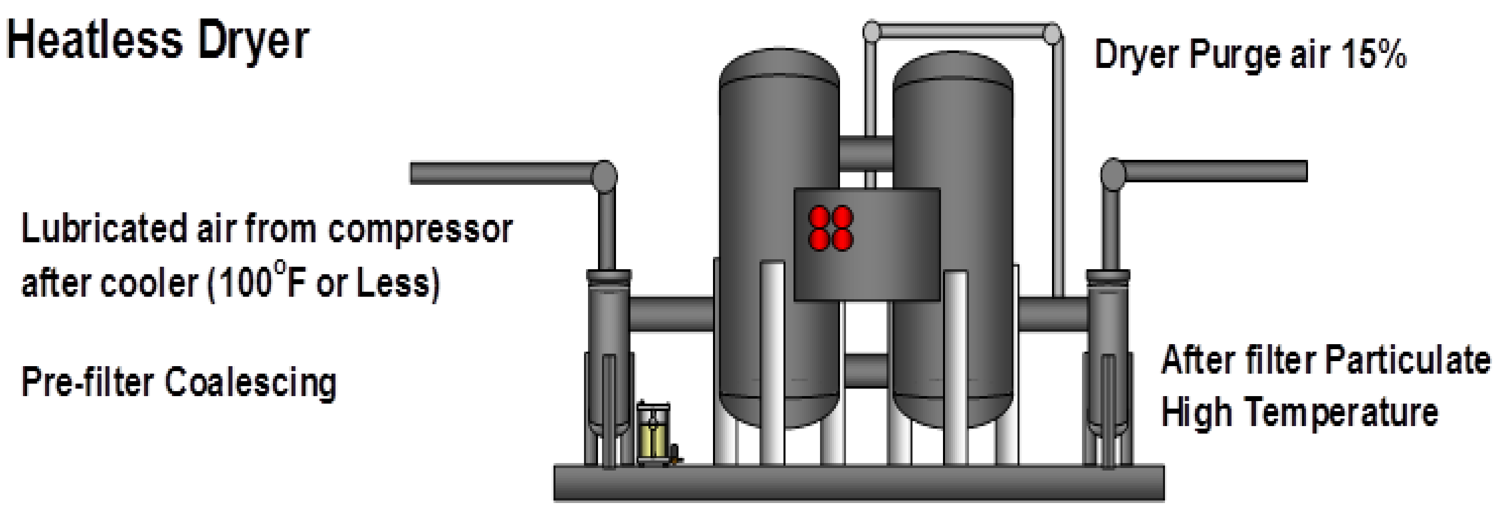
Desiccant Drying Process

- All desiccant dryers dry with the same process – the water vapor moves from the saturated compressed air to the bead surface.
- This works well as long as the water vapor is not of too great a magnitude for the desiccant type; orientation and amount.
- Desiccant dryers differ by how they regenerate the wet tower and this often creates **opportunities for error.**

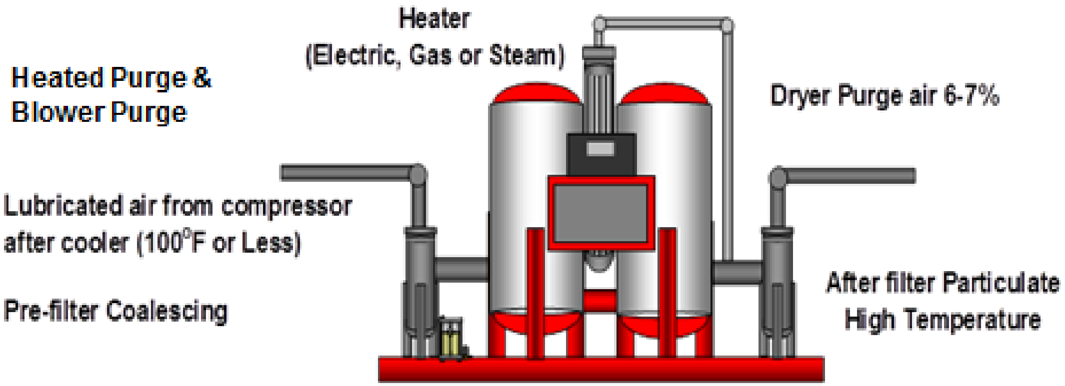
Desiccant Dryer Types: Heatless

Dry cool air is passed over the wet tower bed to be regenerated – maximum required lost purge air 15 to 20+%.

- Most consistent and predictable
- No dewpoint / thermal bump at tower switch
- Careful monitoring in critical conditions for settings.
- Pressure dewpoint control strongly suggested.



Heated Purge and Heated Blower Purge Dryers



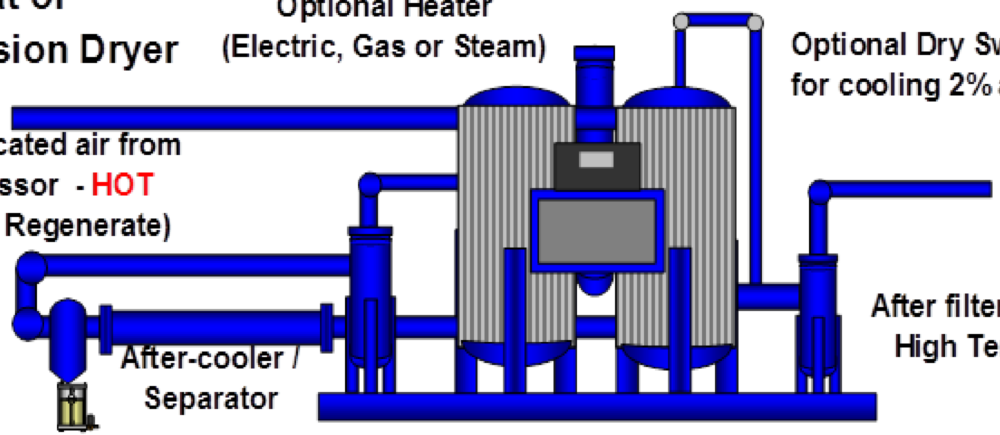
8 hours is a standard cycle (4) hours drying and (4) hours of regeneration.
(3) Hours at 300-400°F for moisture removal and (1) hour of bed cooling.

- Heated Purge (7-8%)
- Blower purge – heated blower air (0-3% purge)
  - Dry air purge assist for cooling 3% (control dewpoint spike / thermal bump on heated dryer.

All heated dryers may experience a pressure dewpoint spike and/or thermal bump at the tower switch.

Heat-of-Compression Dryers

- Hot air discharges from the oil-free compressors and enters the dryer at about 50% RH, where it picks up the water vapor.
- The hot, wet air then goes to the aftercooler where the temperature is reduced to 100°F or less.
- The cool after-cooled air then enters the drying tower where the remaining moisture is removed from the air.
- After the towers switch and the process is repeated – same 8 hour cycle.



Opportunities for Error: Allow for Lost Purge Air

Not allowing for lost purge air can have a negative effect on production.

- Heatless = 15-20% (defaults to Heatless = 15-20%)
- Heated Purge = 7-8% (defaults to heatless = 15-20%)
- Blower Purge = 3-4%
- Heat-of-Compression = 0 to ? – depends on pressure dewpoint requirements

Not allowing for dry air cooling to control tower switch pressure dewpoint / thermal bump.

Up to 15% for the 1 hour (estimated) cooling cycle with most heated type dryers.

Heated Dryers are Vulnerable

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Operating Bed Temperatures and Cooling Cycle

The ***challenge*** in operating heated desiccant dryers is to maintain consistent rated performance.

- To dry effectively the bed must be heated to about 300-400°F. When ready for the drying the cooling cycle must reduce this temperature to below 120-130°F.
- At the tower switch the controls are critical to avoid “thermal bump” and “dewpoint spike”.

Desiccant Dryer Sizing: Opportunities for Error Summary

Temperatures – <100°F (38°C) /Limit the water vapor load / 120-130°F (49°C) not drying.

Pressure – >90 psig / Low pressure brings more moisture load.

Liquid Entry – Liquid water and oil entering a desiccant dryer will not be removed by adsorption to the beads – it will either go on through or react with the desiccant dust to plug the dryer and foul the element.

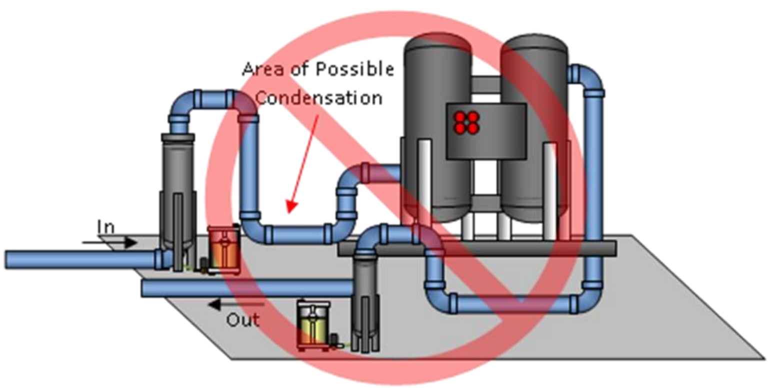
Purge Control – 1,000 scfm heatless dryer allow for 200 scfm of lost purge. You now only have about 800 scfm of air for production from the 1,000 cfm compressor.

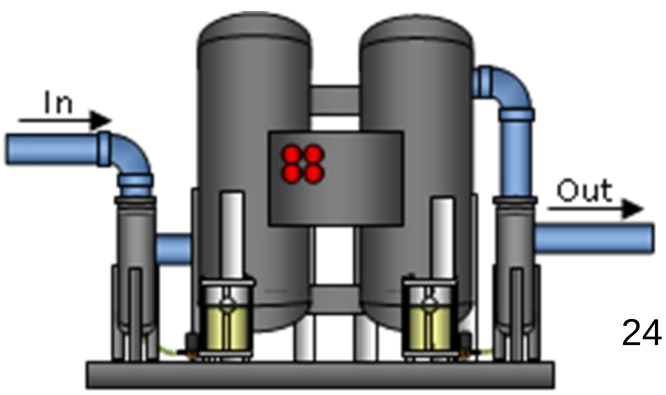
Monitor and Control the Inlet Conditions – Keep the dryer within capabilities and allow performance at the lowest possible operating energy cost with proper dewpoint control.

Controlling Condensate

Controlling condensate liquid from entering the dryer towers:

- Condensate /water and oil will always run to gravity – for example; on the inside of the pipe.
- Condensate water allowed to stand in the separator, traps and filters will re-entrain in the dry air and possibly full out again as liquid.
- Condensate generated in the pipe after the pre-filter may enter the drying bed as liquid oil and water.
- **Controlling the quality of the inlet air is critical.**





Conditions: Drying in Hot Ambient Temperatures

Drying in Hot Ambient Temperatures (over 100°F) with Air-Cooled Equipment

First – You tried refrigeration that didn't work and often "burned out"
Second – Installed desiccant – still have water but doesn't "burn out"
Problem – Sizing the dryer capacity about equal to the compressor capacity

Air-cooled Aftercooler
Dryer inlet air 120°F – doubles the moisture load
Dryer inlet air 120-130°F – desiccant dryer quit working

Avoid replacing "misapplied refrigerated dryers" with equally dismal results.

General Guidelines

In specifying the appropriate dryer, keep the following in mind:

1. Do not over-specify.
2. Do not under-specify.
3. Utilize the drying effect of pressure reduction after the dryer.
4. Always evaluate pressure loss at anticipated flow and the effect on the system and operating cost.
5. Do not ignore the cost of purge air in desiccant and allow for them to maintain system integrity.
6. Always specify dewpoint demand purge controls.

Thank you for the opportunity to present.

Hank van Ormer – Technical Director

Air Power USA Inc.

July 28, 2016

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About the Speaker

Tilo Fruth, Beko Technologies

- President of Beko Technologies

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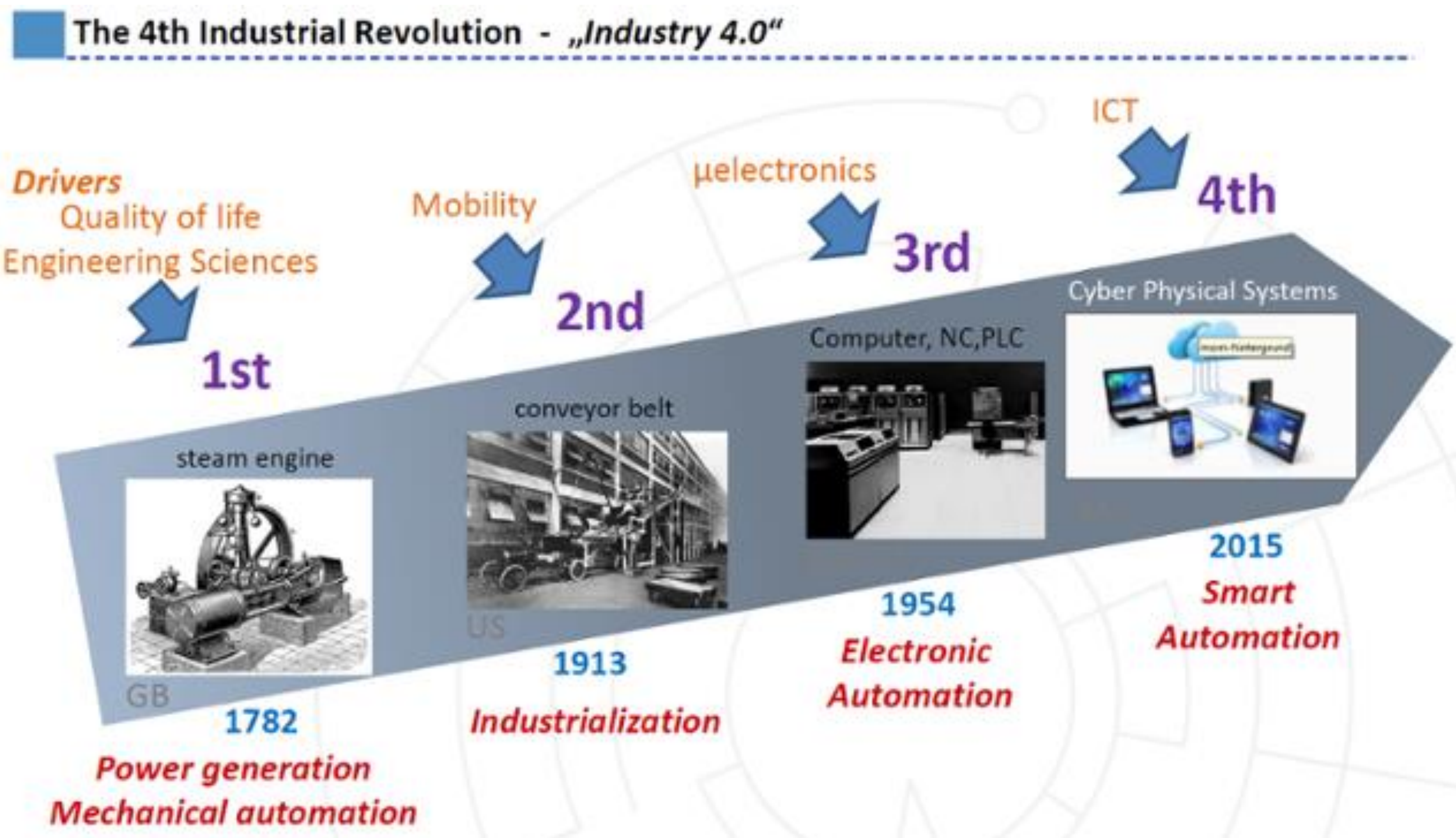
Smart Technology / Artificial Intelligence / Industry 4.0



Smart Technology / Artificial Intelligence / Industry 4.0

<u>Basis</u> of all that are microprocessors, sensors and the awareness of the environment.

INTELLIGENT Desiccant Dryer

responses to inlet and ambient conditions

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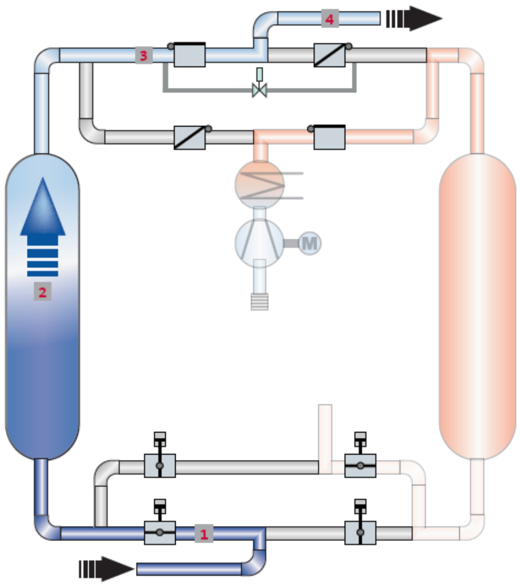
Blower Purge Desiccant Dryer

Flow Diagram



Adsorption Phase

Blower Purge Desiccant Dryer

Heated Blower

Purge Cool

+ All climate zones
+ Lowest investment
+ Stable pdp
- Highest energy consumption

Ambient Cool

- Very limited climate zones
+ Low investment
- pdp peaks
+ Low energy consumption

Closed Loop Inline Cooler

+ All climate zones
- Highest investment
+ stable pdp
+ Low energy consumption

Intelligent Dryer

+ All climate zones
+ Low investment
+ stable & flexible pdp
+ Lowest energy consumption
+ Auto-adjusting to any conditions

Atlanta Climate

DRYPOINT® XFi

is the FIRST ecoIntelligent Heated Desiccant Dryer

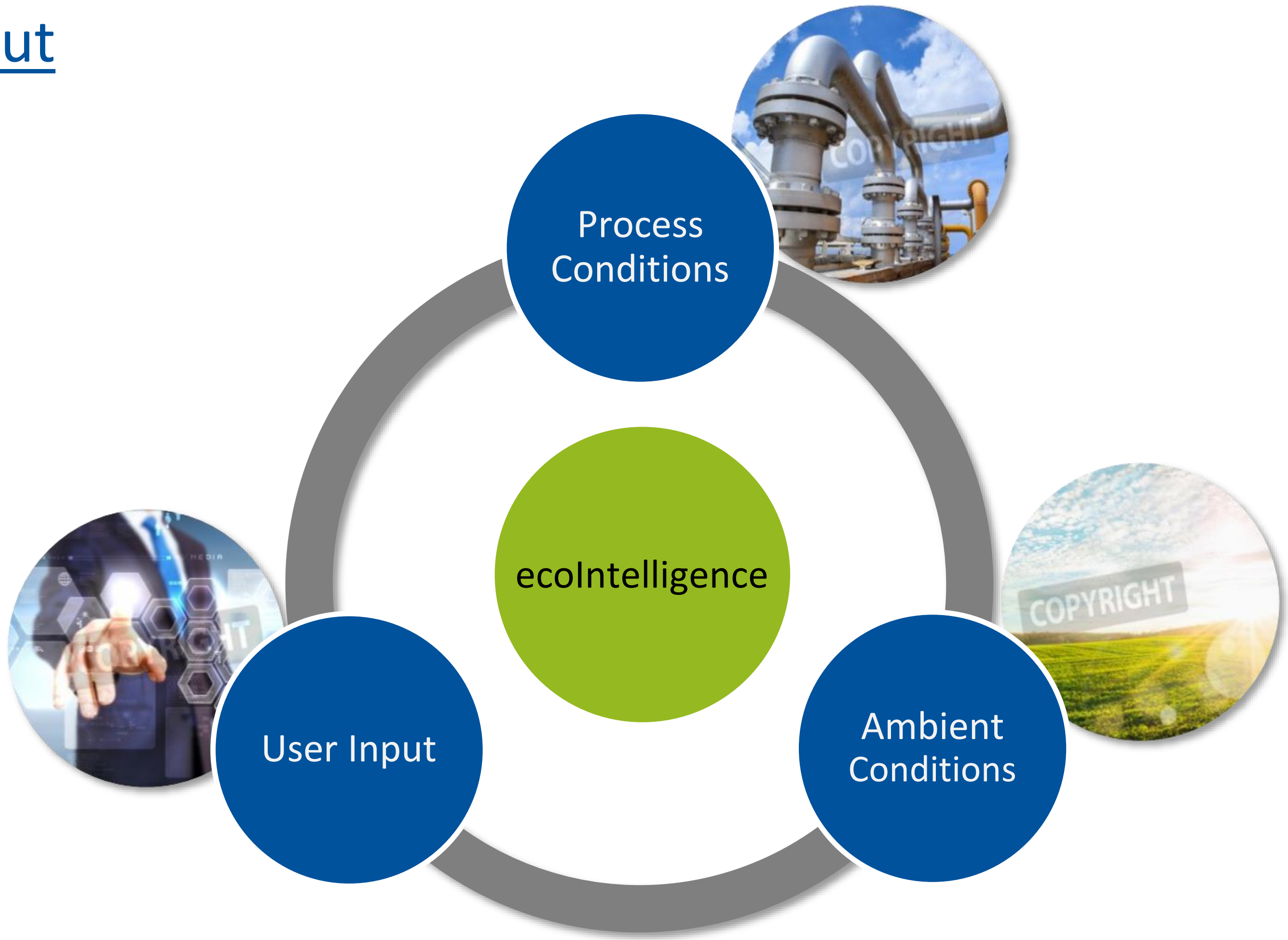
with environmentally aware,
auto-adjusting,
ecoIntelligence software
and
BEKOTOUCH 2 interface

which works in **ANY** climate zone in the world.

Objective

Intelligent Desiccant Dryer

Input



Intelligent Desiccant Dryer

INPUT

Match User Specifications

Customer mode selection

- Performance
  > Stable pdp / minimized E-Save
- Balanced
  > Flexible pdp / optimized E-Save
- E Save
  > Flexible pdp / maximized E-Save
- Manual
  > time or demand controlled

Process & Ambient Conditions

15 Sensors which measure process & ambient conditions:

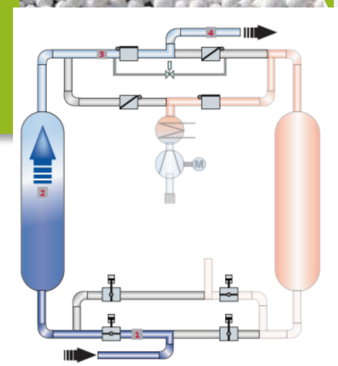
- Humidities
- Pressure Dew Points
- Pressures
- Temperatures

Intelligent Desiccant Dryer

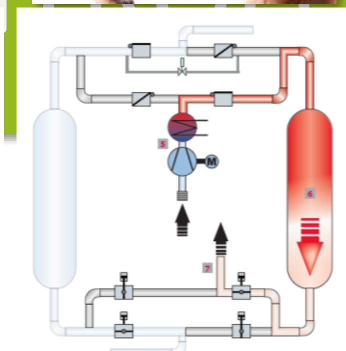
ecoIntelligent Controller

Most Energy Efficient Way

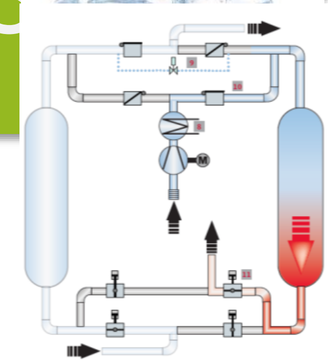
Drying	Regeneration	Cooling



Adsorption Phase



Regeneration Phase

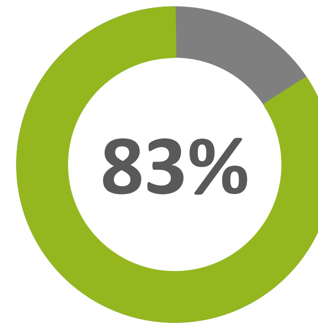


Cooling Phase

Closer Look: Drying

ENERGY SAVING

Drying



With Extended Drying

Drying:

Normal Cycle one vessel	*4 hours*
Max Extended Cycle	*24 hours*

Standard Timer Controlled		4	hours
Intelligent Dryer - XFi		24	hours

Closer Look: Regeneration

ENERGY SAVING

Regeneration

Auto Adjusting Regen Heater
and Blower Operation

Regeneration:

1 hp = 0.745kW

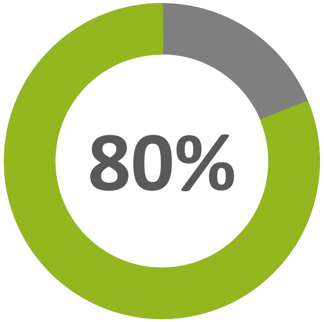
.927 Heater Watt Factor @ 325F

	Blower [hp]	Blower [h]	Blower [kWh]	Heater [kW]	Heater [h]	Heater [kWh]	Total kWh
Timer Controlled or Demand Controlled	7	2.17	11.32	25.5	2.17	55.34	66.65
Intelligent Dryer - XFi	7	0.25	1.30	23.6	0.25	5.91	7.21

Closer Look: Cooling

ENERGY SAVING

Cooling



By Eliminating Purge Air Cooling

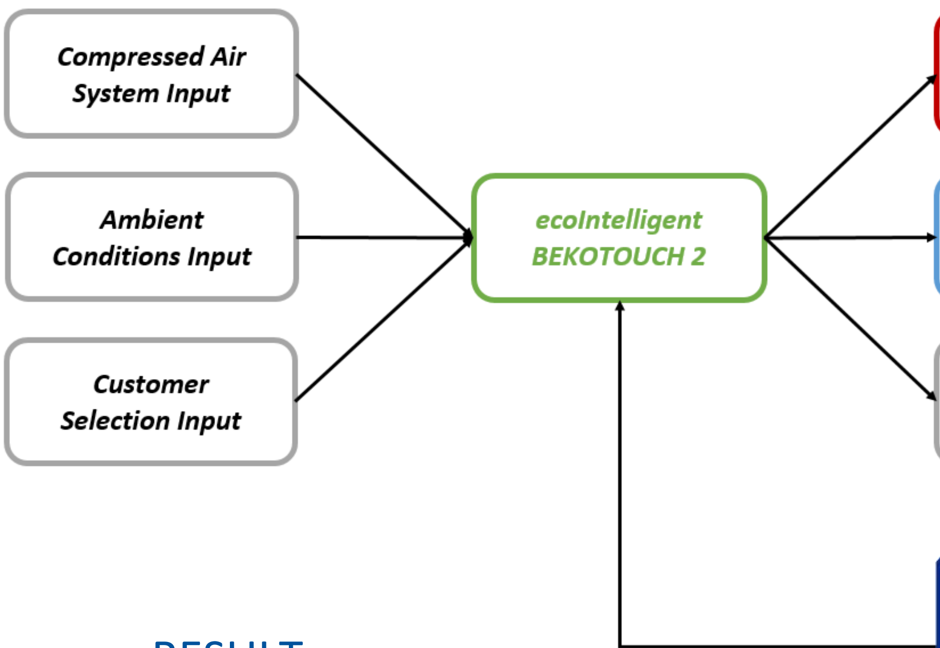
Cooling:

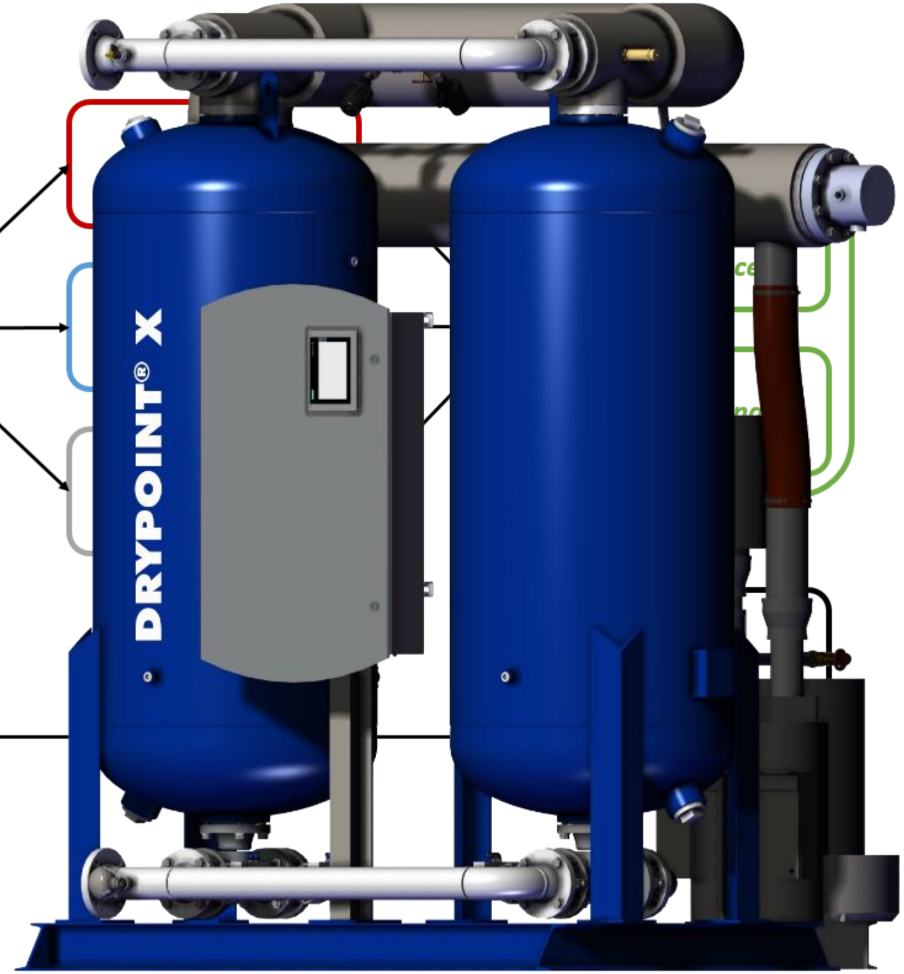
4.5 cfm = 1 hp

1 cfm = 60 cfh

	Blower [hp]	Blower [h]	Blower [kWh]	Avg. Purge	Purge [h]	Purge [kWh]	Total kWh
Timer Controlled or Demand Controlled	7	0.17	0.87	16%	0.75	24.29	25.16
Intelligent Dryer - XFi	7	0.92	4.78	0%	0.00	0.00	4.78

Summary





RESULT

+ an intelligent dryer
+ is able to work autonomous
+ in any environmental condition
+ reaching pre-selected performance

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Q&A

Please submit any questions through the Question Window on your GoToWebinar interface, directing them to Compressed Air Best Practices. Our panelists will do their best to address your questions, and will follow up with you on anything that goes unanswered during this session.

Thank you for attending!

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Mike Flaherty, tekWorx
Keynote Speaker

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