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Benefits of Desiccant Dryer Dew Point & Purge Control

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Introduction by Rod Smith, Publisher
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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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Benefits of Desiccant Dryer Dewpoint and Purge Control

Air Power USA

January 19, 2017

AIR POWER USA
Independent and Brand Neutral

Introduction

- This presentation will review the operating expense and benefits of an effective pressure dewpoint control system
- We will review three of the MOST common twin-tower desiccant dryers
  - Heatless
  - External heat
  - Blower purge
- Due to time limitations we are not reviewing Heat-of-Compression type

Dual or Twin Tower Desiccant Dryers

Capabilities:

- ❖ Capable of delivering consistent pressure dewpoint at 100 psig / 7 Bar of -40°F to -100°F when properly installed and maintained – and other specified requirements
- ❖ These can meet the most rigorous specifications for compressed air users.
- ❖ Proper selection, installation, maintenance and **MOST** importantly operating controls have a significant impact on **TOTAL OPERATING COST**.

Key Benefits:

Proper controls have two key target benefits.

- Deliver the required specified air pressure dewpoint accurately and consistently
- To keep the dryer operating at all times in the most efficient energy consumption operation, while delivering the required quality air

What Affects Performance and Operating Cost?

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

Desiccant dryers can only remove water vapor – not liquid. Any liquid water entering the dryer will pass through and/or cause operational issues.

Typical OEM Inlet Pressure Correction Chart – Heated & Heatless

Operating Pressure	**PSIG**	60	70	80	90	100	110	120
	Bar	4.2	4.9	5.6	6.3	74.0	74.7	8.4
Multiplier		0.65	0.74	0.83	0.91	1.00	1.04	1.08

The higher the inlet temperature entering the dryer after the compressor aftercooler and pre-filter the more water vapor it can deliver to the dryer at saturated conditions.

Typical OEM Inlet Temperature Correction Chart - Heated

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

What Pressure Dewpoint do you Need?

Identify the pressure dewpoint first and design to it.

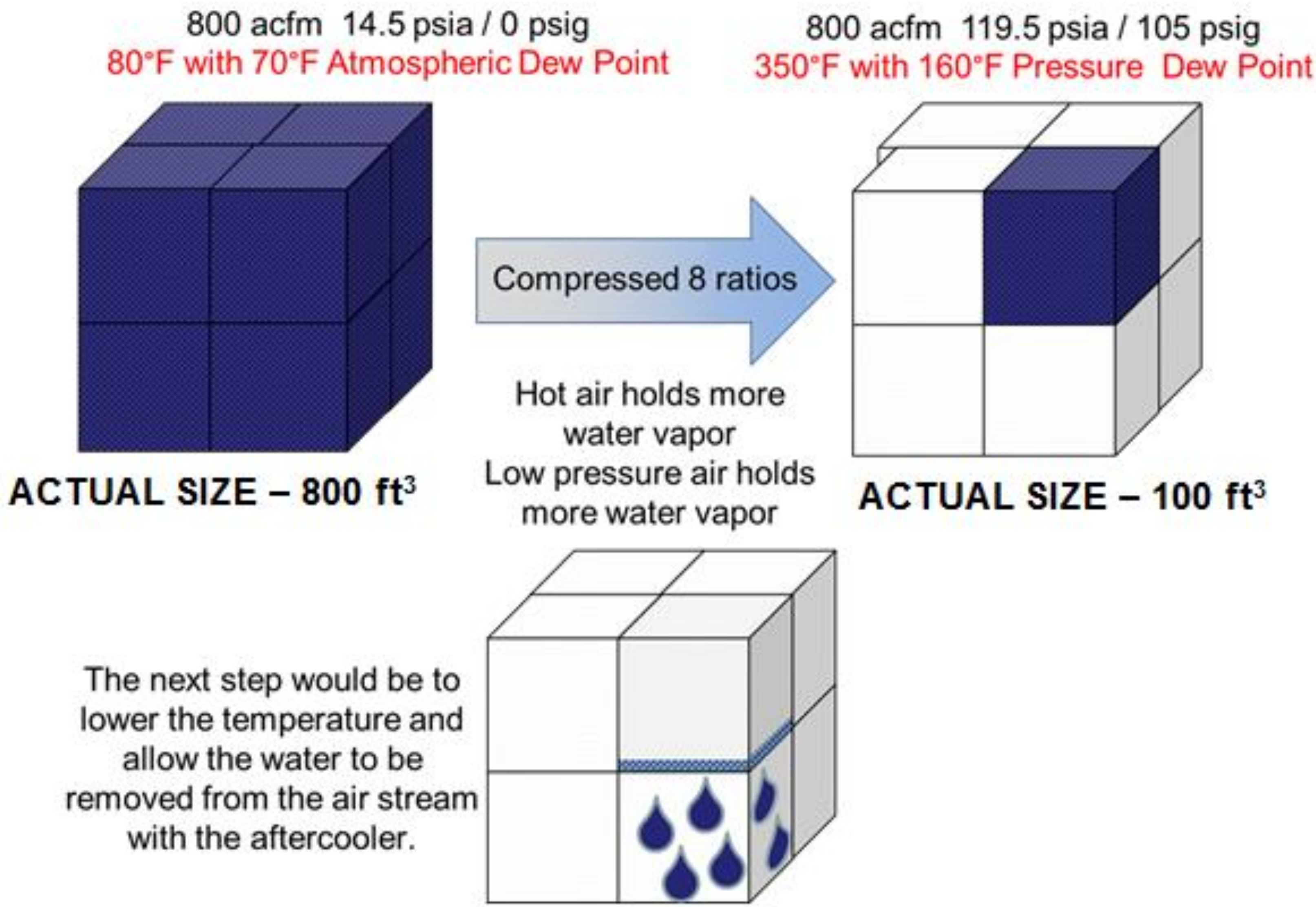
ISO 8573.1 Quality Classes

"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?



Ambient / Inlet Air Conditions:

I. Aftercoolers/ Separators / Pre-filters

1. Control inlet to <100°F / remove all liquid
2. Rating pressure - 100 psig
3. No liquid condensate to dryer – piping and drains before entry

I. Heatless and Heated Desiccant Dryers and Basic Performance Considerations

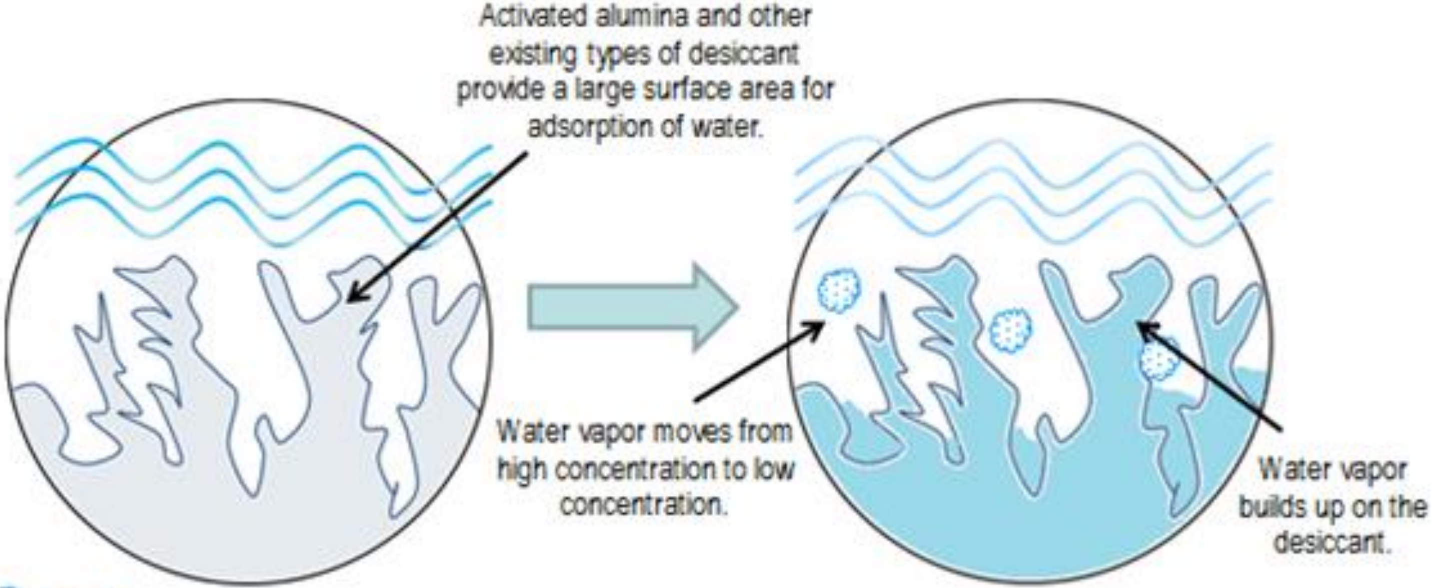
4. Allow for lost purge air
5. Eliminate liquid condensate into dry air tower

Control the Inlet Air Conditions and/or Adjust the Cycle to Fit Conditions!

Desiccant Drying Process

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

Activated aluminum desiccant adsorption of water vapor



NOTE: WILL NOT DRY AT ALL OVER / ABOUT 130°F

Typical Twin Tower Design

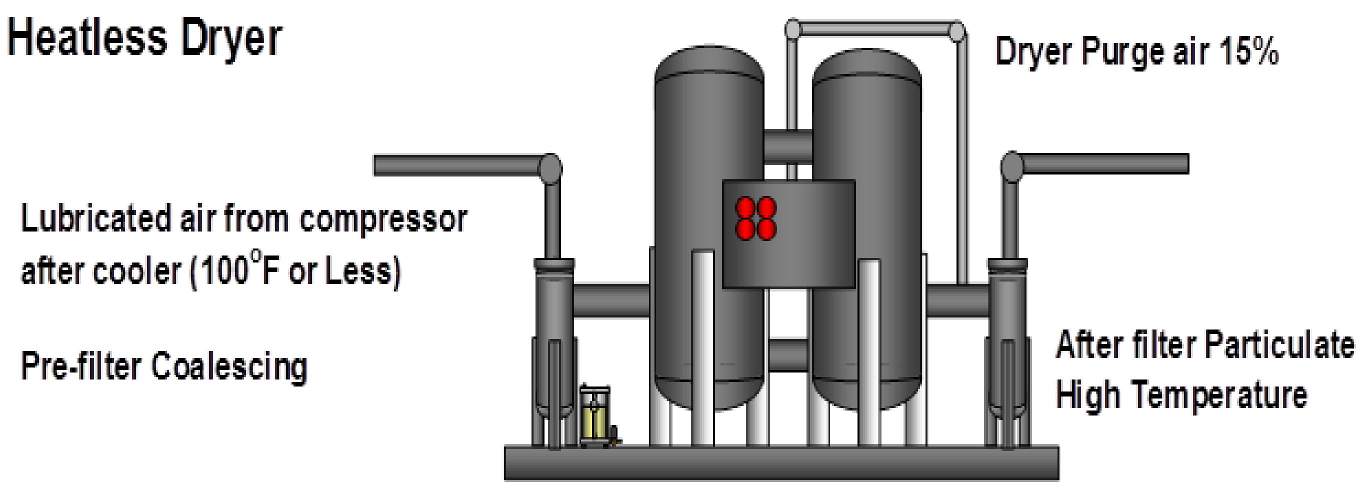
Desiccant Drying Process

- All desiccant dryers dry with the same process; adsorption - 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 additional importance of an effective control

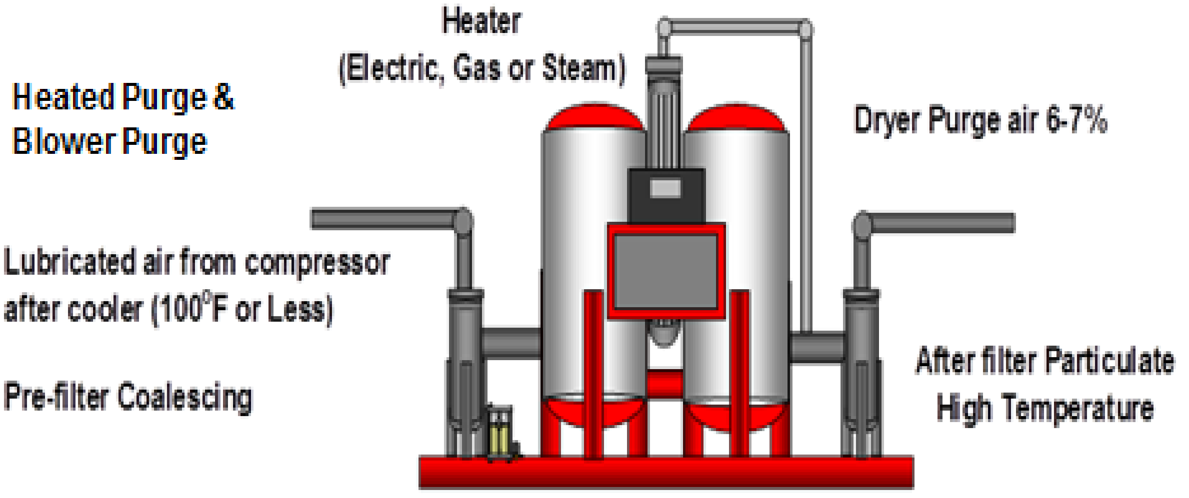
Desiccant Dryer Types: Heatless

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

- Most consistent and predictable – **only dryer capable of consistent -100°F (-73.3°C) performance**
- No dewpoint / thermal bump at tower switch
- Careful monitoring in critical conditions for settings
- Pressure dewpoint control strongly suggested (purge 7-15%)
- High cycles (nominal 5 - 10 minutes)



Heated Purge and Heated Blower Purge Dryers



Nominal Cycle:

8 hours is a standard cycle (4) hours drying and cooling - (4) hours of regeneration.

(3 hours at 300-400°F for moisture removal and 1 hour of bed cooling).

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

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

Controlling Heated Dryers is Challenging

Operating Bed Temperatures and Cooling Cycle Effect

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 drying, the cooling cycle must reduce this temperature to below 120-130°F
- At the tower switch the controls are critical to avoid significant “thermal bump” and “dewpoint spike "in heated dryers
- Blower purge using ambient blower air for cooling may be more prone to higher thermal bumps or PDP spikes without dry air cooling option
- Heated and heatless must be sure regeneration is complete – and maximize the drying cycle

Regenerating the Wet Towers

Optimizing the energy use in twin-tower desiccant dryers and retaining the projected performance is primarily a function of controlling the regeneration cycles and knowing where you are in pressure dewpoint (PDP).

Regeneration – various methods to monitor

- ❖ Relative humidity differential bed to purge air – for timely removal
- ❖ Tracking the bed temperature at critical points
- ❖ Measuring the moisture load in the bed at critical points

Standard dryers are often supplied with fixed timer controls for these functions but the operating conditions are not fixed.

Energy Cost

Drying cycle:

Energy use in the drying cycle is only applicable to Heated type dryers when cooling air for the tower is required. This can be dry compressed air or blower supplied air.

Regeneration Cycle:

The cost varies by type of dryer but the expense generating items remain the same:

- **Purge air – compressed air, blower air**
- **Auxiliary heat**

Fixed Dryer Cycle or Flexible Control

Ultimate Goal – Extend the drying cycle time and minimize the regeneration time – deliver the proper PDP accurately and consistently.

Dryers are Designed for the Worst Case Rated Conditions – Nominal inlet air saturated 100°F and 100 psig.

- Highest temperature; highest flow rate and lowest pressure

Regeneration Costs:

Tied to a fixed cycle time that uses energy and reduces desiccant life regardless of the actual conditions -- Based on worst case conditions.

Key Indicators Utilized in Pressure Dewpoint Control

Moisture In:

- Inlet
- Air flow
- Inlet Temperature
- Inlet relative humidity

Internal Performance:

- Bed temperature and thermal movement at critical point
- Bed moisture level at central points
- Critical mechanical operating components

Flexibility:

- Adjust requirements for delivered air to processes; when possible

Identifying the Operating Cost of Desiccant Dryers

Desiccant Dryers With and Without Pressure Dewpoint (PDP) Controls

Purge Air – dry compressed air used to carry the water vapor out of the tower**.** Volume differs by type – nominal cost $100 scfm/yr. (Based on $.06 kWh/8,000 hrs. / year)

CFM X $100 = $_______ yr.

Purge Air (blower provided) – the input kW to the blower that supplies the purge / cooling air.

kW x $.06 kWh x 8,000 hrs. = $______ yr.

Auxiliary Heater (electric) – to accelerate moisture transfer – input kW (Heater only operates during drying cycle – nominal at ¾ or 75%)

kW x .06 kWh x 8,000 hrs. x (.75) = $______ yr.

All values in the following tables are based on dryers rated for 2,000 scfm at 100 psig and 100°F inlet air.

Operating Energy Costs Without Dewpoint Demand Controls

Typical Desiccant Dryer Operating Energy Profiles with a Fixed Cycle Dewpoint Demand Control

Dryer Type	Heatless	External Heat	Blower Purge
Rated Flow (scfm)	2,000	2,000	2,000
Temperature In (°F)	100°F	100°F	100°F
Pressure In (psig)	100	100	100
Heater Power (kW) FL	N/A	24 kW	72 kW
Blower Power (FL kW)	N/A	N/A	8 kW
Amount of Purge Air (scfm)	300	150	0
Heater kW Percentage Average (FL kW x.75)	N/A	18 kW	54 kW
Utilization (%) Dewpoint Control	N/A	N/A	N/A
Purge and Prospective Energy Costs			
Average Annual Energy Cost ($/yr.)	-	$8,640	$29,760 (62 kW)
Average Annual Purge Air ($100 per scfm/yr.)	$30,000	$15,000	$0
Total Average Annual Cost ($/yr.)	**$30,000**	**$23,640**	**$29,760**

Operating Energy Costs with Dewpoint Demand Controls

Typical Desiccant Dryers Operating Energy Profiles with "modern proactive" Dewpoint Demand Control

Dryer Type	Heatless	External Heat	Blower Purge
Rated Flow (scfm)	2,000	2,000	2,000
Temperature In (°F)	100°F	100°F	100°F
Pressure In (psig)	100	100	100
Heated Power (kW) FL	N/A	24	72
Average kW / Blower Power (kW)	N/A	N/A	8
Amount of Purge Air (scfm)	150	45	0
Heater kW Percentage Average (FL kW x .75 kW)	N/A	5.4	17.2
Utilization (%) Dewpoint Control	50%	30%	30%
Prospective Energy Costs			
Average Annual Energy Cost ($/yr.)	-	$1,296	$4,704
Average Annual Purge Air ($100 per scfm/yr.)	$7,500	$2,250	0
Total Average Annual Cost ($/yr.)	**$7,500**	**$3,546**	**$4,464**
TOTAL ANNUAL SAVINGS BY ADDING DEWPOINT DEMAND CONTROL (100°F)	**$15,000**	**$8,274**	**$10,096**

Final Thoughts:

FOR OPTIMUM OPERATING COST – DON'T CONTROL THE DRYER WITH A TIMER!

Final Thoughts:

Take Advantage of an Effective Desiccant Dryer Dewpoint Demand Controller

Summary:

- Monitors all your external and internal KEY performance indicators
- Collect the data and display it to properly trained personnel
- Monitor results for management
  - Total operating time
  - Total regenerating time
  - Total drying / standby time

Thank you for the opportunity to present.

Hank van Ormer – Technical Director

Air Power USA

January 19, 2017

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About the Speaker

- Product/Project Manager for BEKO Technologies

Eric Johnson, BEKO Technologies

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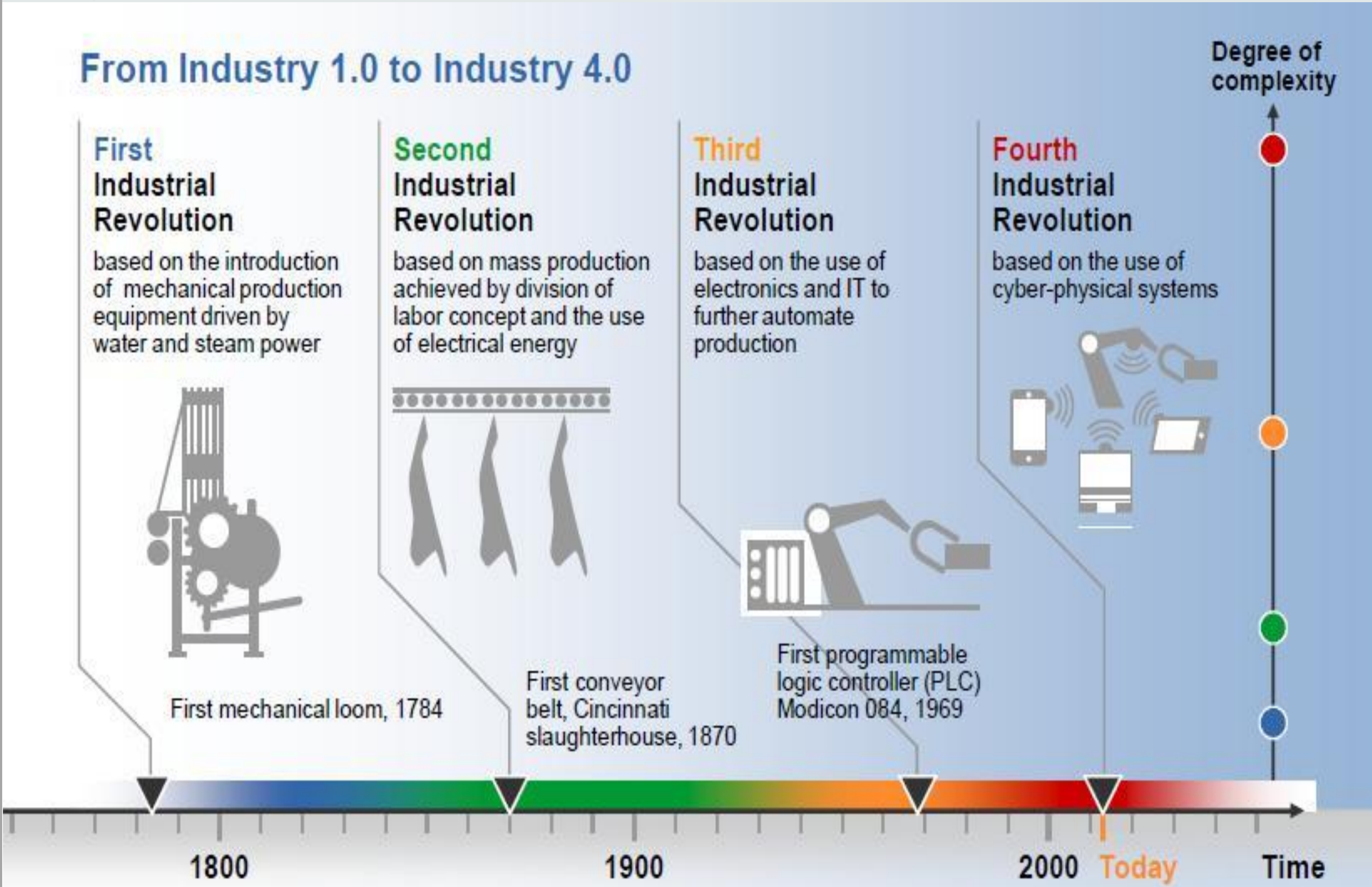
Smart Technology / Artificial Intelligence / Industry 4.0



Smart Technology / Artificial Intelligence / Industry 4.0

Smart Technology / Artificial Intelligence / Industry 4.0

Foundation

sensors & microprocessors, and the awareness of the environment

Key

programming software enables an autonomous control of the machine

Drying

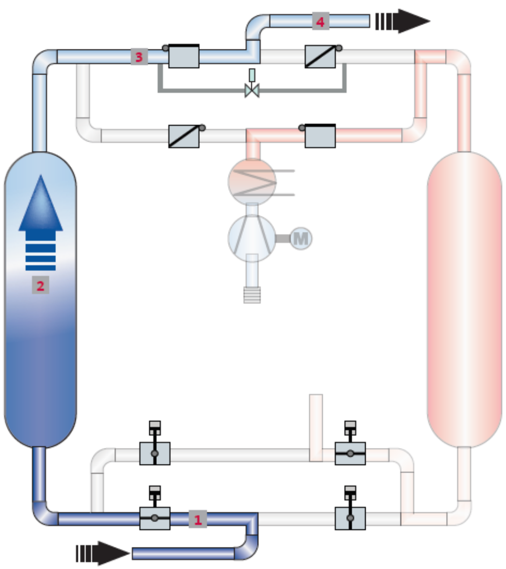
INTELLIGENT Desiccant Dryer

Instrumenting Desiccant Dryers for Optimized Performance

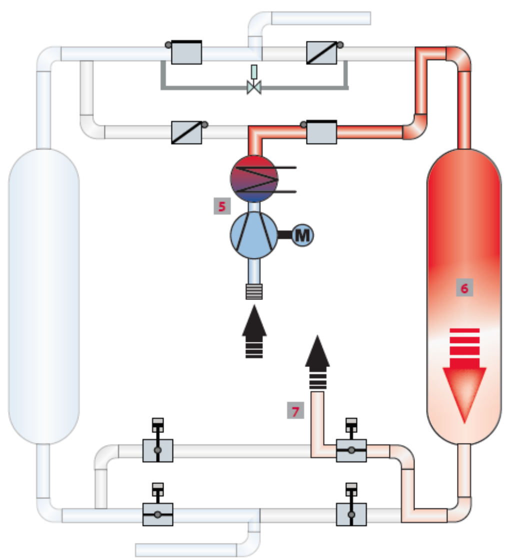
BEKO

Blower Purge Desiccant Dryer

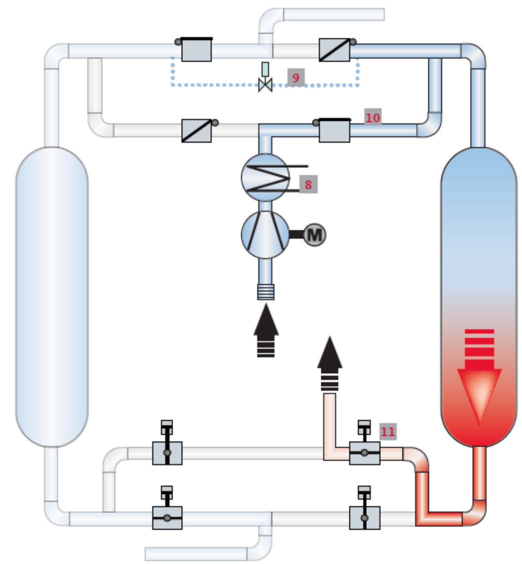
Drying



Regeneration



Cooling



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

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

DRYPOINT® XFi

ecoIntelligent software

is the FIRST environmentally aware, auto-adjusting, ecoIntelligent dryer

suitable for all climate zones

BEKOTOUCH 2

Controls, displays, records & learns

DRYPOINT® XFi

Objective

Smart Technology / Artificial Intelligence / Industry 4.0

Foundation

sensors & microprocessors, and the awareness of the environment

Key

programming software enables an autonomous control of the machine

Intelligent Desiccant Dryer

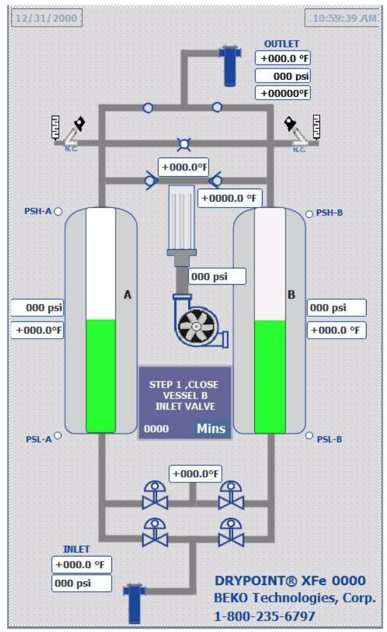
Foundation - Sensors and Microprocessors

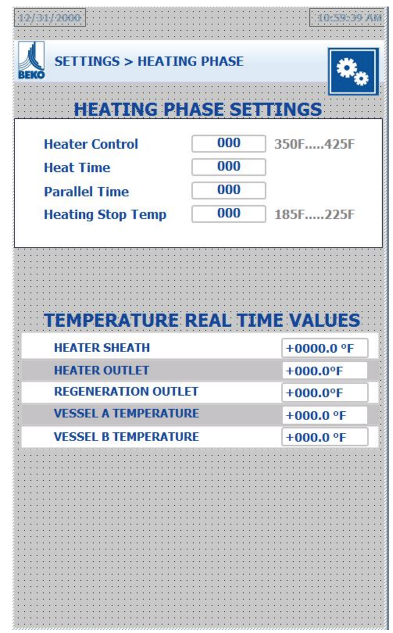
15 Sensors which measure process & ambient conditions:

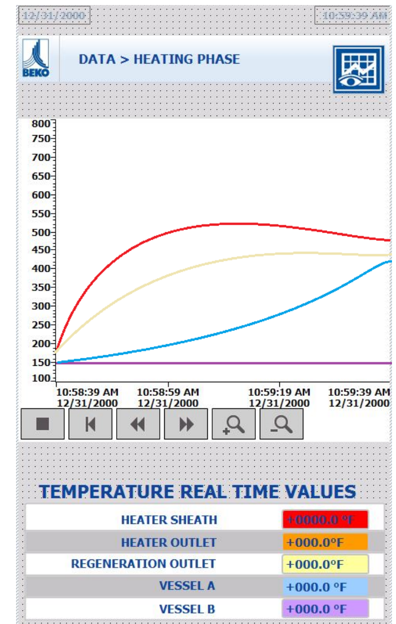
- Humidities
- Pressure Dew Points
- Pressures
- Temperatures

Intelligent Desiccant Dryer

Key – Software / Programming







Customer mode selection

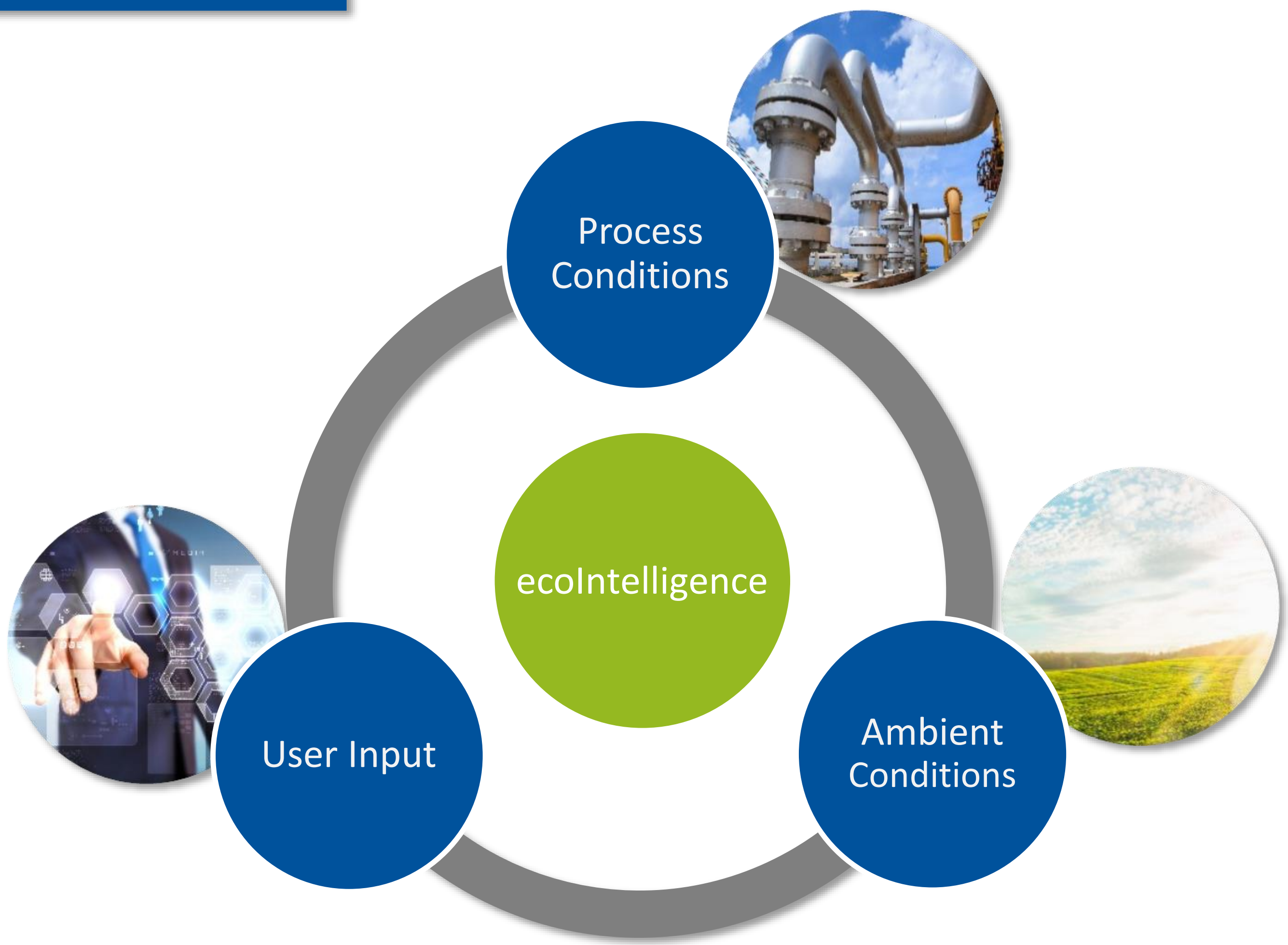
- Performance
  > Stable pdp / minimized E-Save
- Balanced
  > Flexible pdp / optimized E-Save
- E Save
  > Flexible pdp / maximized E-Save
- Manual
  > time or demand controlled

Software BEKOTOUCH 2

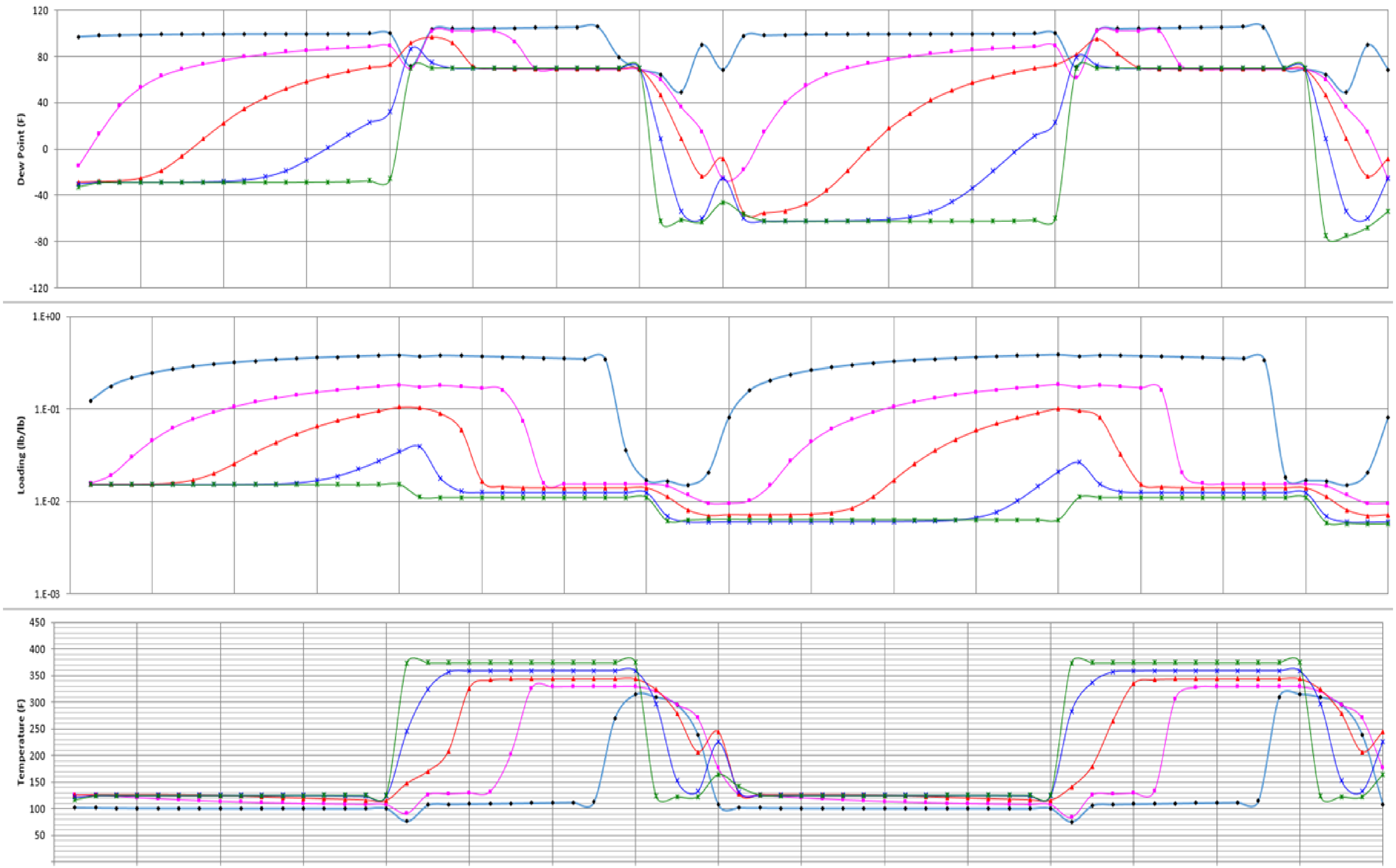
Controls, displays, records & learns

Intelligent Desiccant Dryer

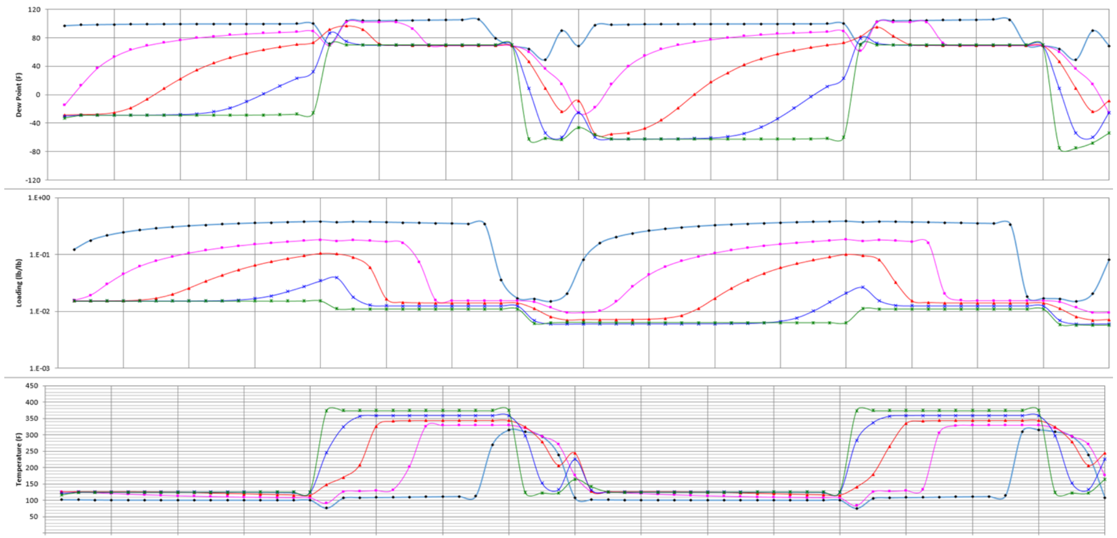
Input



Intelligent Desiccant Dryer



Intelligent Desiccant Dryer



ecoIntelligent Dryer

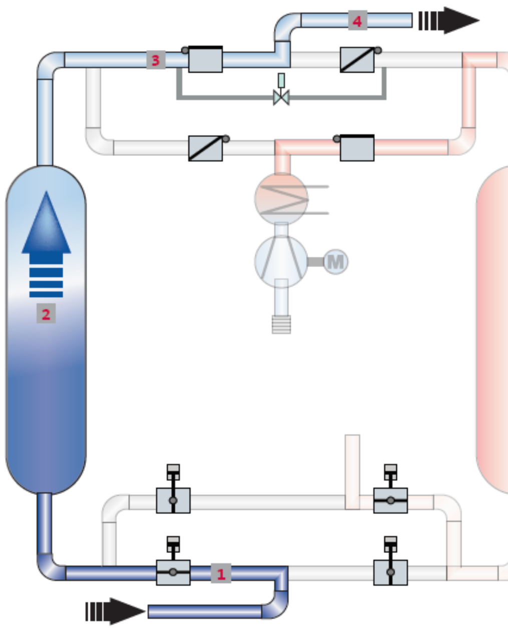
- programming software enables an autonomous control of the machine
- programming software enables dryer to works in any environmental condition
- programming software enables dryer to reach pre-selected performance

Closer Look: Drying

ENERGY SAVING

Most Energy Efficient Way

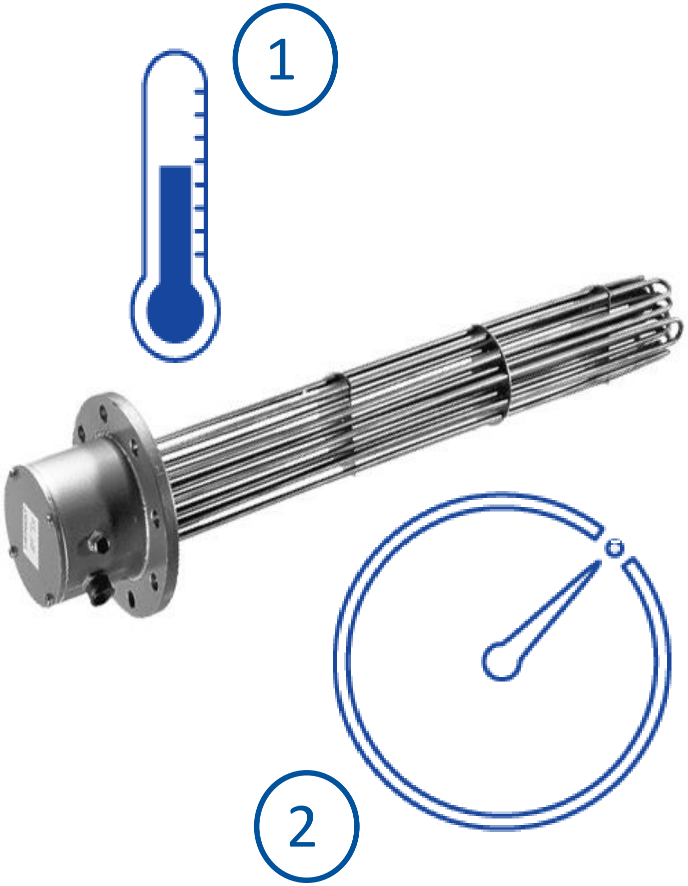
Drying



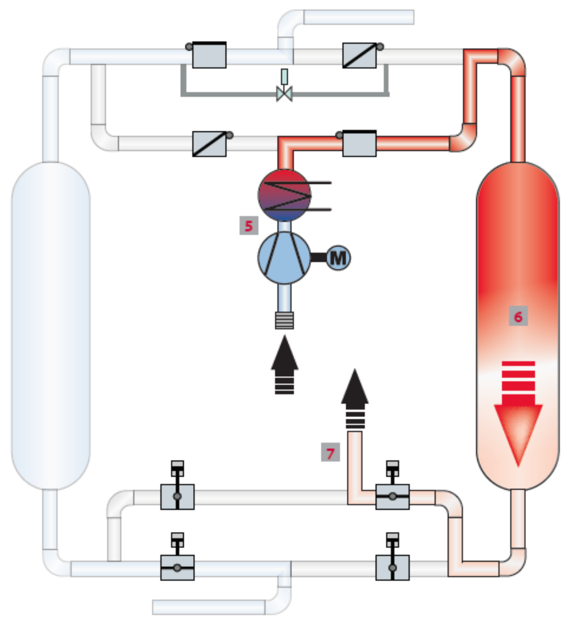
Closer Look: Regeneration

ENERGY SAVING

Most Energy Efficient Way



Regeneration

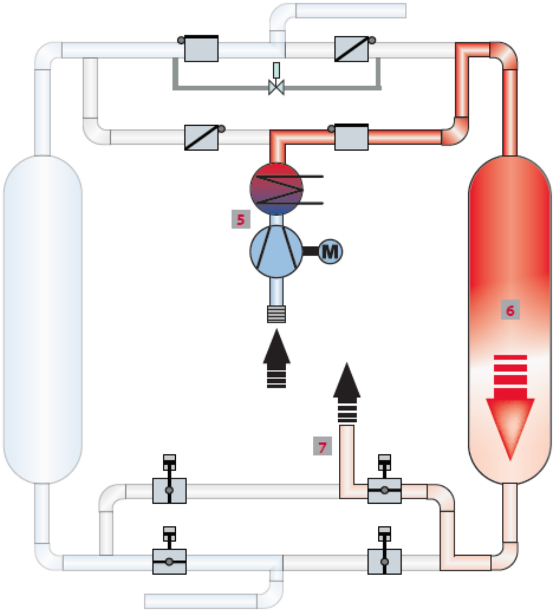


Closer Look: Regeneration

ENERGY SAVING

Most Energy Efficient Way

Regeneration



Closer Look: Cooling

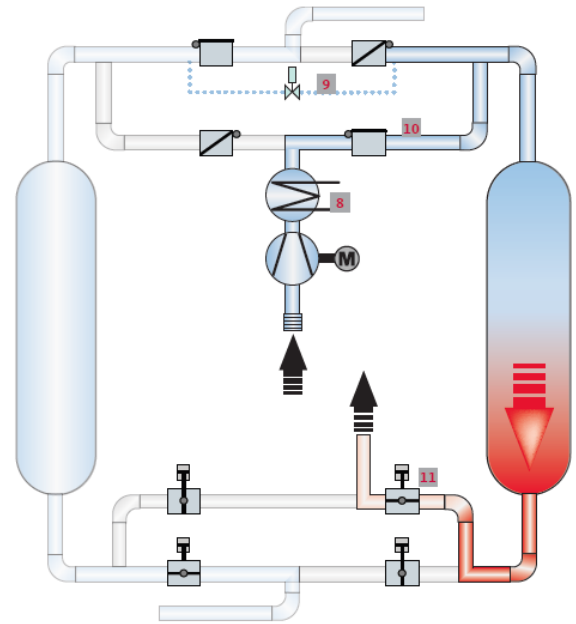
ENERGY SAVING

Most Energy Efficient Way

1

2

Cooling



Summary

Compressed Air System Input

Ambient Conditions Input

Customer Selection Input

ecoIntelligent BEKOTOUCH 2

RESULT

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

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Benefits of Desiccant Dryer Dew Point & Purge Control

Q&A

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Establishing Best Practice Compressed Air Flows

Hank van Ormer, Air Power USA
Keynote Speaker

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