

# Regenerative Dryer Terms

## Regenerate:

- ✦ Renew - restore.

## Absorbent Desiccant:

- ✦ Used in HP dryers.

## Adsorbent:

- ✦ To collect on and within the surface in condensed (liquid) form.

## Adsorbent Desiccant:

- ✦ Used in regenerative dryers. The desiccant does not deliquesce. The liquid water collects on and within the surface of the desiccant. Adsorbent desiccant can be regenerated (renewed).

*Adsorbent Desiccant is more hygroscopic than Absorbent Desiccant*



# Types of Desiccant Dryers

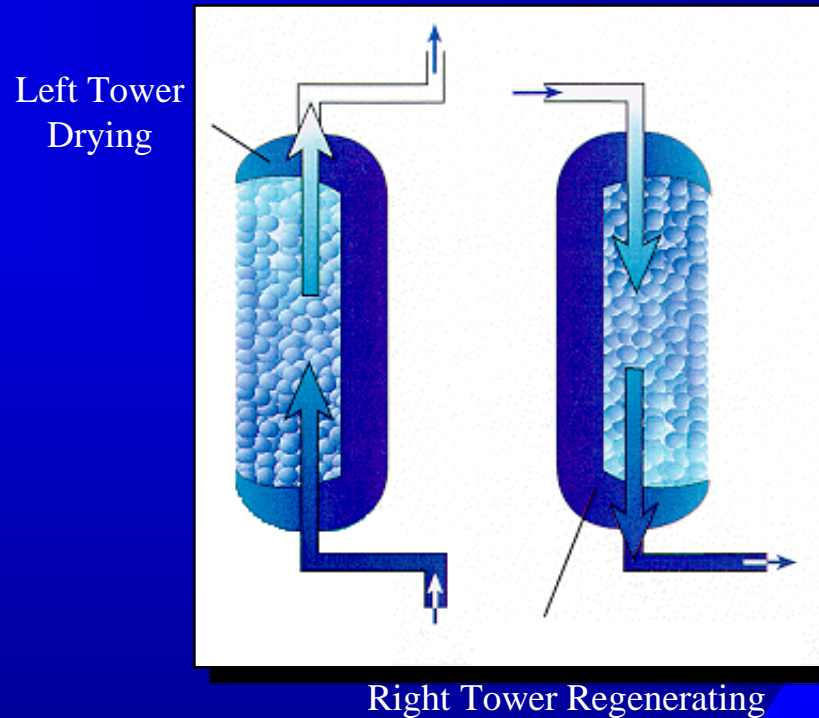
## Dual Tower, Regenerative Type

*For:*

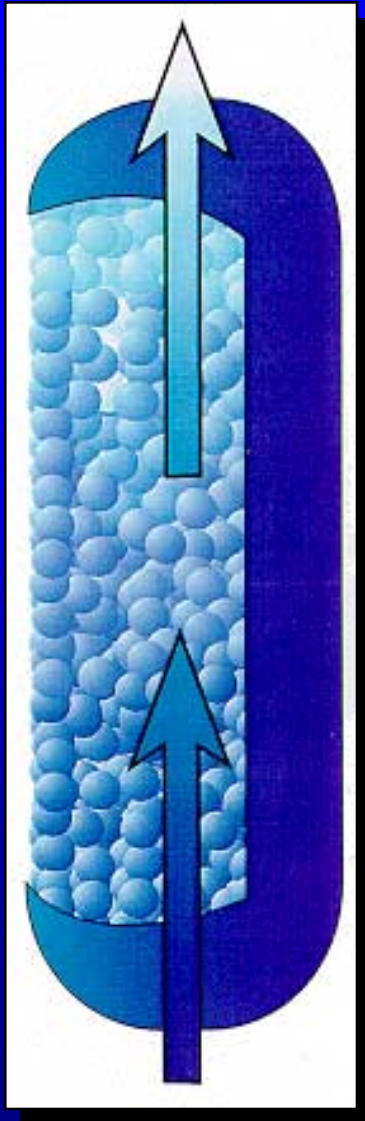
- ✦ A continuous supply of compressed air at low dewpoints.

*Operation:*

- ✦ One tower is on-line drying the air while the other tower is off-line being regenerated.
- ✦ Towers alternate so that the air stream is always exposed to dry desiccant.



# How They Work



- ◆ Compressed air passes through a vessel filled with desiccant.
- ◆ Water vapor is attached to the surface of the desiccant by the process called adsorption.
- ◆ Dry air exits the dryer.



## *Activated alumina desiccant - Why is it used?*

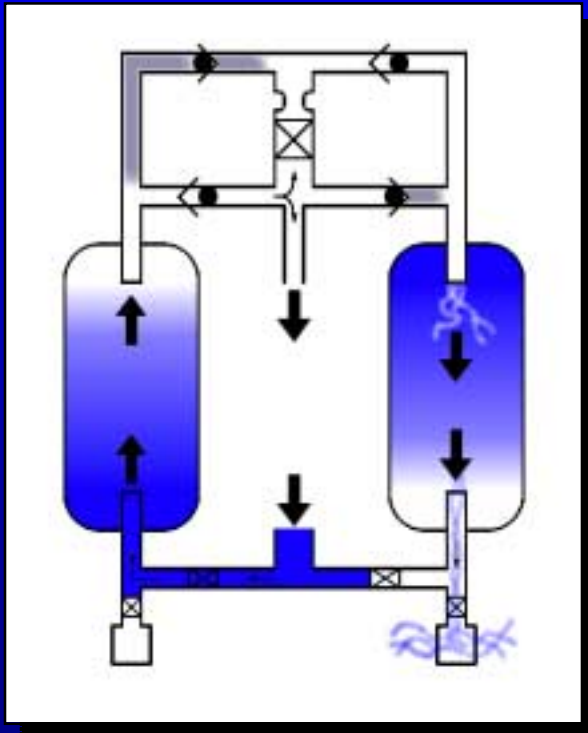
- ◆ Readily available and economical.
- ◆ Performs well at saturated conditions.
- ◆ Doesn't degrade in presence of liquid water.
- ◆ High crush strength.



# Methods of Regeneration

## *Pressure-Swing (Heatless) Regeneration*

Purge air at reduced pressure



Tower 1  
Drying



Tower 2  
Regenerating

- ◆ Dried compressed air is expanded to near atmospheric pressure.
- ◆ This low pressure, extremely dry air pulls water from the desiccant and carries it out of the dryer.



# Methods of Regeneration

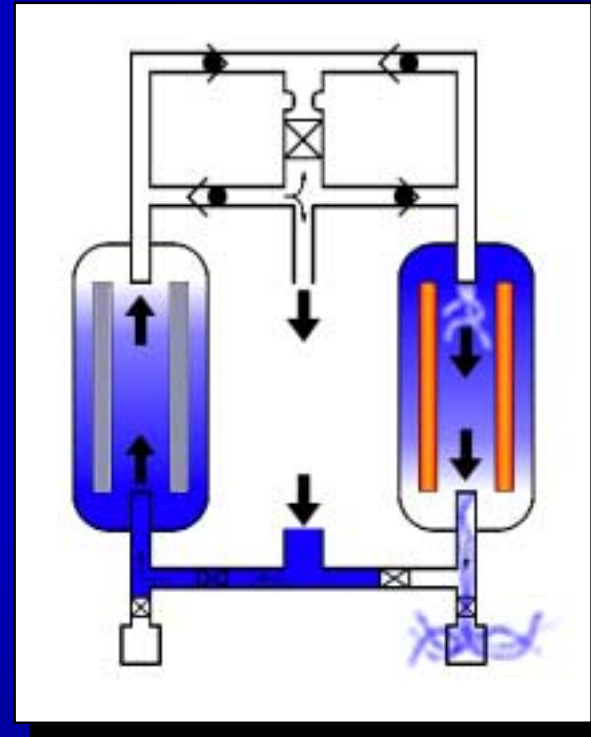
## *Heat Regeneration*

- ◆ Heat forces desiccant to release the adsorbed water.

## *Internally Heated*

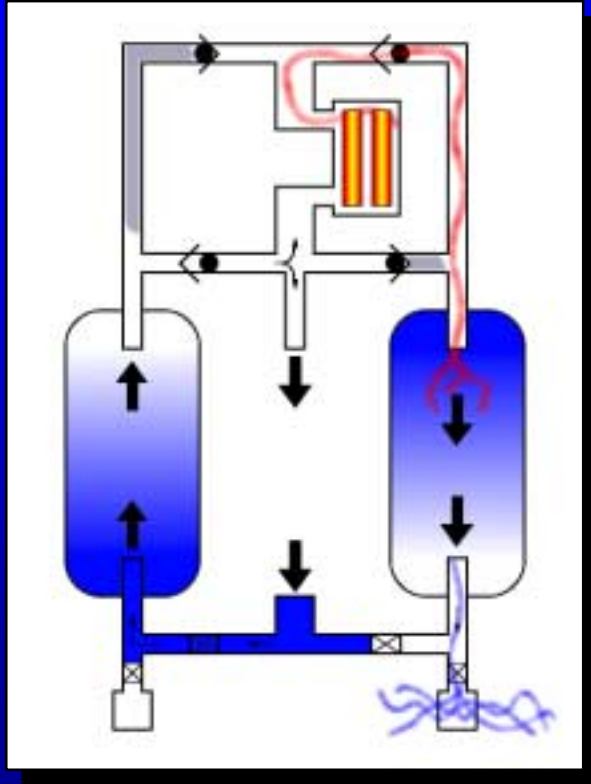
- ◆ Internal heaters warm desiccant.
- ◆ Purge air circulates heat and carries off water vapor.

Internally Heated



# Methods of Regeneration

## Externally Heated



## *Externally Heated*

- ◆ External heaters heat purge air (dried compressed air or atmospheric air).
- ◆ Purge air carries heat to desiccant and removes water vapor.



# Types of Regenerative Dryers

Sahara manufactures all types of regenerative dryers, standards and specials, high pressure and low.

- ◆ Heatless
- ◆ Exhaust Purge
- ◆ Blower Purge
- ◆ Closed System/Split Stream
- ◆ Heat-of-Compression SP
- ◆ Heat-of-Compression HC



# Regenerative Air Dryers

## Sources of Regenerating Power

<u>Compressed Air</u> <u>SCFM</u>	<u>Ambient</u> <u>Air</u>	<u>Additional</u> <u>Power</u>	<u>Type of</u> <u>Dryer</u>	<u>Cost</u> <u>(to purchase)</u>
15%	None	None	HL Heatless	Lowest
7%	None	Heater	EP Exhaust Purge	Higher
None	All	Bigger Heater Blower	BP Blower Purge	Highest

*15% at 100 PSIG  
expands to atmospheric = super dry*

*7% at 100 PSIG  
expands - super dry + heat = super, super dry*

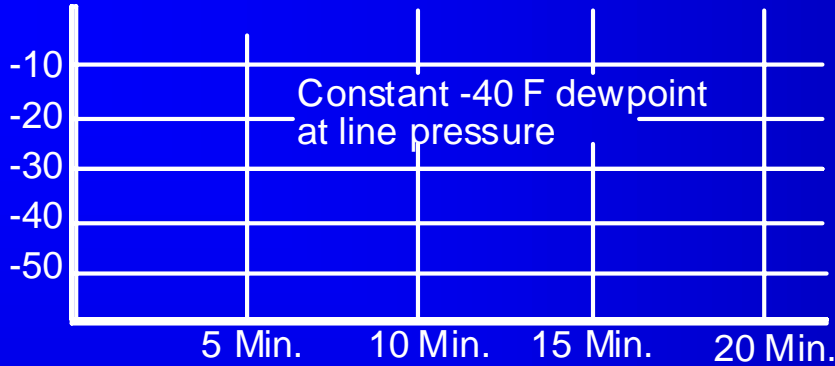
*Ambient at atmospheric blow/heat = same results*



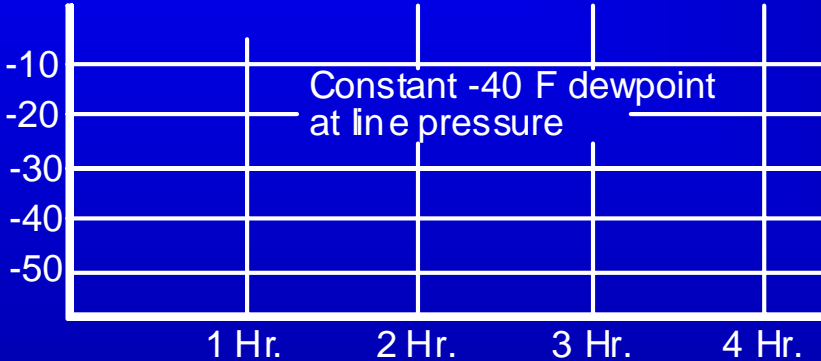
# Regenerative Dryer Performance

D  
E  
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P  
O  
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N  
T  
S

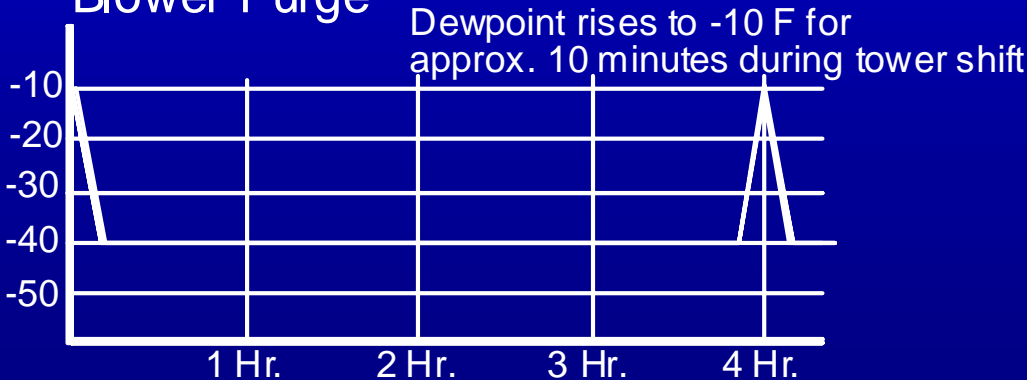
## Heatless



## Exhaust Purge



## Blower Purge



# Sahara Electrical

Electrical Controls

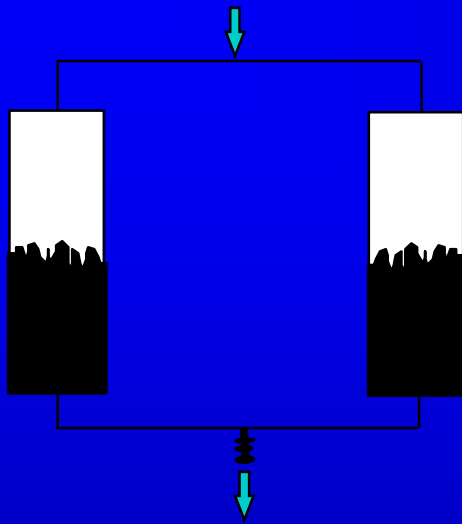
Direct Reading Dewpoint Indicator

Simple, reliable, field-adjustable,  
multi-cam timer controls  
tower switching, depressurization.

Dewpoint Demand System saves energy  
and allows you to monitor  
exact outlet dewpoint.

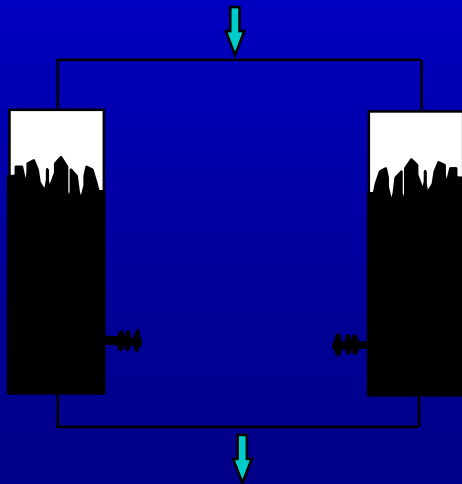


# Dewpoint Demand System



Probe measures the exact outlet dewpoint customer is receiving. Dryer switches “on demand”.

Dewpoint controller is equipped with Direct Reading Dewpoint Indicator.



One probe in each tower can not indicate outlet dewpoint, only measures moisture front - not as energy efficient - switches more often.

AMLOC



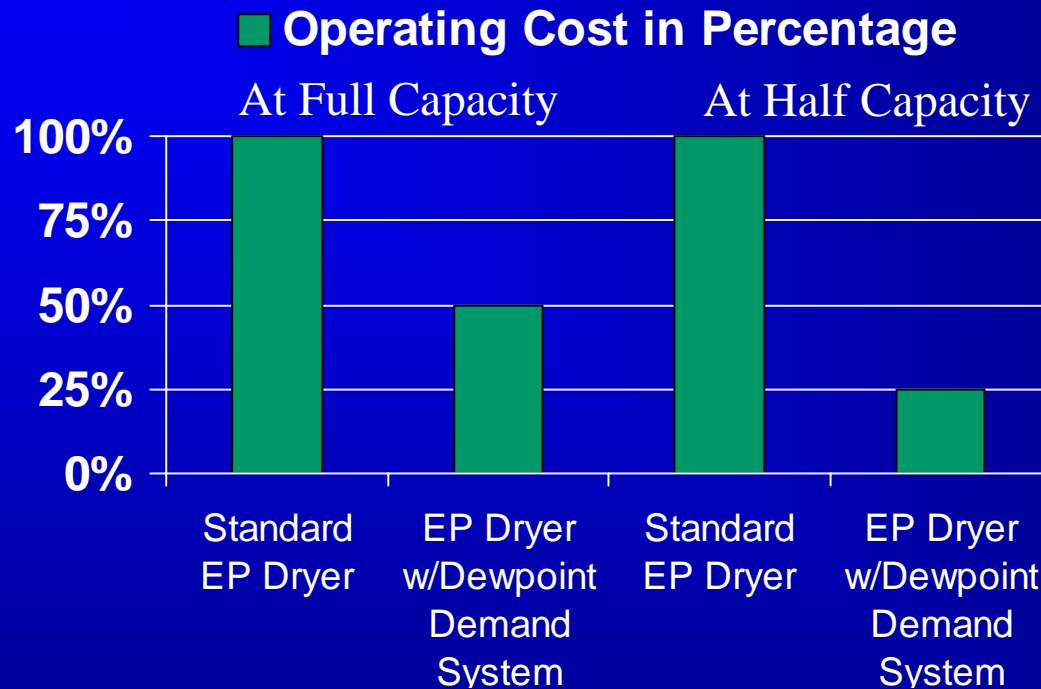
The Dewpoint Demand System allows the dryer to utilize the full capacity of the desiccant regardless of inlet flow.

After a complete regeneration, the regeneration system is turned off and the dryer sits dormant, simply drying the air. When the full capacity of the desiccant is used and the outlet dewpoint rises to a preset level, the dryer automatically switches towers.

The net result is a reduction in the operating cost of the dryer. With new desiccant, the operating cost will be reduced by at least 50%.



# Dewpoint Demand System Cuts Operating Costs



# Regenerative Dryer Sizing Factors

**Three factors determine the proper size of a regenerative dryer:**

- ◆ Maximum inlet flow rate
- ◆ Maximum inlet temperature
- ◆ Minimum inlet pressure



# To Determine Correct Dryer Size Use Temperature & Pressure Modifiers:

<i>Maximum Temperature</i>	<i>Multiplier</i>	<i>Minimum Pressure</i>	<i>Multiplier</i>
120° F	1.78	150 PSIG	.70
115°	1.55	140	.74
110°	1.34	130	.79
105°	1.16	125	.82
100°	1.00	120	.85
95°	.86	110	.92
90°	.73	100	1.00
85°	.63	90	1.10
80°	.53	80	1.21
75°	.45	70	1.35
		60	1.54
		50	1.77
		40	2.10

Maximum flow x temperature  
multiplier x pressure multiplier =  
corrected flow.

Note: For temperature lower than 80° F  
consult factory.



# Pressure Modifier

$$P1 = \frac{114.7}{P + 14.7}$$

P1 = Pressure Modifier

P = Minimum Inlet Air Pressure



# Temperature Modifier

Max. Temperature

Multiplier

120° F	1.78
115	1.55
110	1.34
105	1.16
100	1.00
95	.86
90	.73
85	.63
80	.53
75	.45



# Calculating Water Load

$$\frac{S \times V \times TC \times 18}{P \times 379}$$

S = inlet flow rate in SCFM

V = vapor pressure of water

TC = time cycle (hours and minutes)

P = absolute pressure; PSIG plus 14.7

18 = (constant) molecular weight of water

379 = (constant) molal volume

Example: 1000 SCFM, 125 PSIG, 100° F

$$\frac{1000 \times .950 \times 60 \text{ min.} \times 24 \text{ hrs.} \times 18}{139.7 \times 379} = 465$$

465 lbs. of water per day



# Vapor Pressure of Water

<u>Temperature</u>	<u>Absolute Pressure PSIG</u>
120	1.693
115	1.472
110	1.275
105	1.102
100	.950
95	.816
90	.698
85	.596
80	.507
75	.430
70	.363
65	.305
60	.256
55	.214
50	.178
45	.147
40	.122
35	.099



# Calculating Air Velocity through the Desiccant Bed

$$V = \frac{14.7 \times S}{(P + 14.7) A}$$

V = velocity in feet per minute

S = inlet air flow in SCFM

P = inlet air pressure

A = tower area in sq. ft.

To find tower area:

$$A = \frac{TD^2 \times .785}{144}$$

A = tower area in sq. ft.

TD = tower diameter



# Determining Air-to-Desiccant Contact Time

$$CT = \frac{(P + 14.7) 60 \times AA}{14.7 \times S \times 45}$$

CT = contact time in seconds

P = inlet pressure in PSIG

AA = pounds activated alumina per tower

S = inlet air flow in SCFM



# Calculating Pressure Drop through the Dryer

$$PD = \frac{\left(\frac{S}{M}\right)^2 \times 344.1}{P + 14.7}$$

PD = pressure drop in PSIG

S = inlet air flow in SCFM

M = maximum air flow at 3 lbs. drop

P = inlet air pressure



# Determining Kilowatts Needed by the Heater on a Heat Reactivated Regenerative Dryer

$$KW = \frac{PR \times 1.08 \times TD}{3412}$$

KW = actual KW required

PR = purge rate in SCFM

TD = temperature differential between  
375 and inlet air temperature



# Compressed Air Dryer Operating Cost Slide Chart



# Calculating Annual Operating Cost for a Heatless Dryer

$$C = \frac{PR \times 525600}{1000} \times S$$

C = annual operating cost

PR = purge rate in SCFM

525600 = constant, minutes in a year

1000 = constant, cost per 1000 cu. ft.

S = cost of compressed air, normally  
\$.15 per 1000 SCF



# Calculating Annual Operating Cost for an Exhaust Purge Dryer

$$C = \frac{PR \times 525600}{1000} \times CA + (KW \times 6570 \times E)$$

C = annual operating cost

PR = purge rate in SCFM

CA = cost of compressed air per 1000 cu ft.

KW = actual KW required

E = cost of electricity



# Calculating Annual Operating Cost for a Blower Purge Dryer

$$C = [(HP \times 8760) + (KW \times 6570)] \times E$$

C = annual operating cost

HP = blower horsepower

KW = calculated heater KW

E = cost of electricity



# Calculating Annual Operating Cost for a Closed System Dryer

$$C = [(HP \times 8760) + (KW \times 6570)] \times E + \left( \frac{GPM \times 525600 \times WC}{1000} \right)$$

C = annual operating cost

HP = blower horsepower

KW = heater KW

E = cost of electricity

E = cost of electricity

GPM = water rate

WC = water cost/1000 gals.

(typically \$.25/1000 gals.)

