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 is more hygroscopic than Absorbent Desiccant

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).

Types of Desiccant Dryers

Dual Tower, Regenerative Type

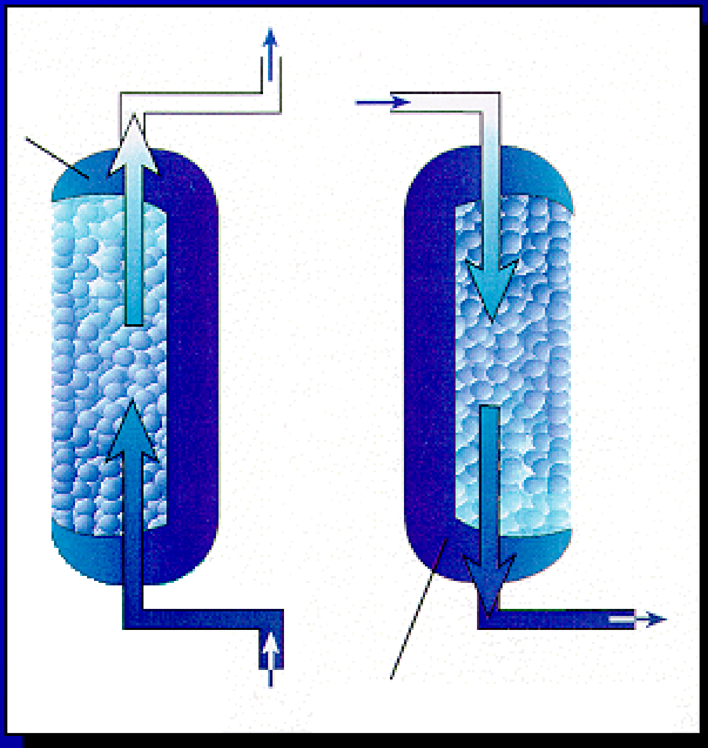
For:

- A continuous supply of compressed air at low dew points.

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.

Left Tower Drying



Right Tower Regenerating

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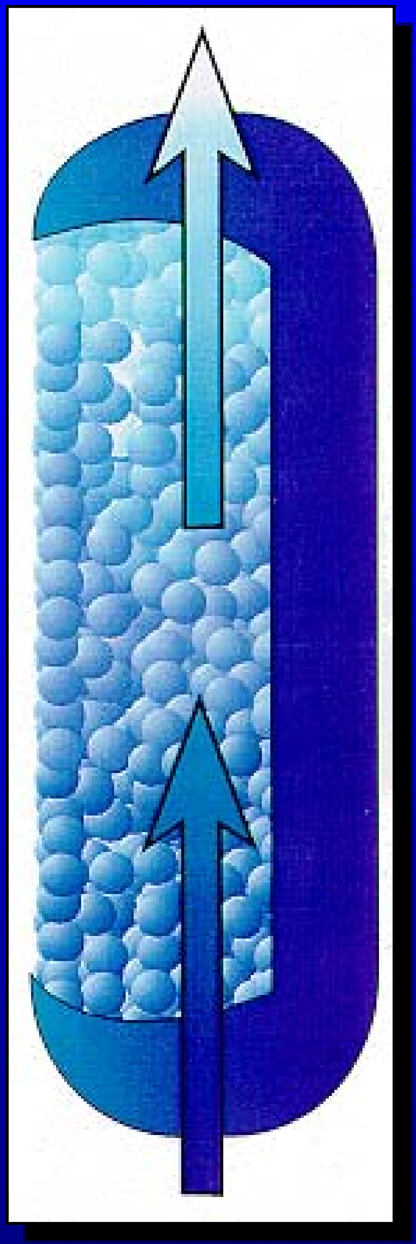
How They Work



- ☞ 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.

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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.

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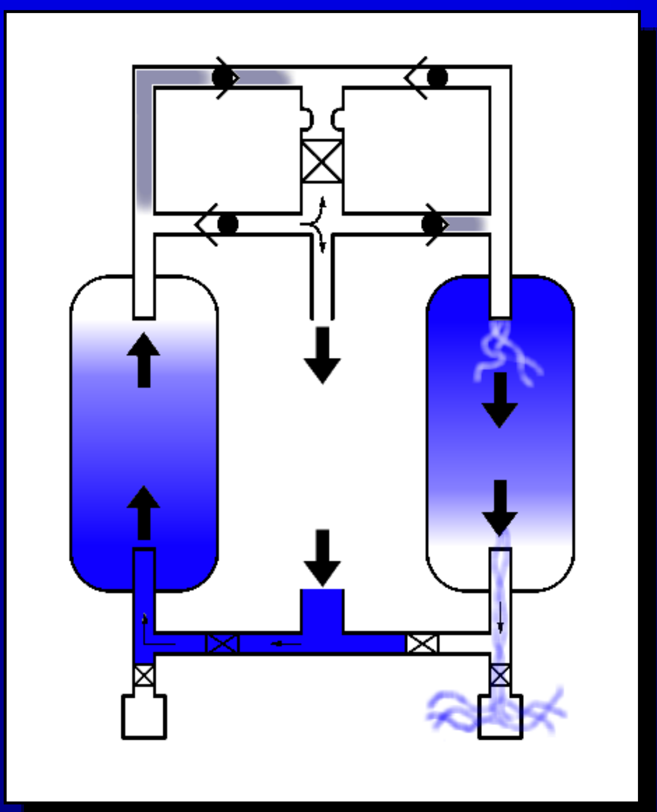
Methods of Regeneration

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.

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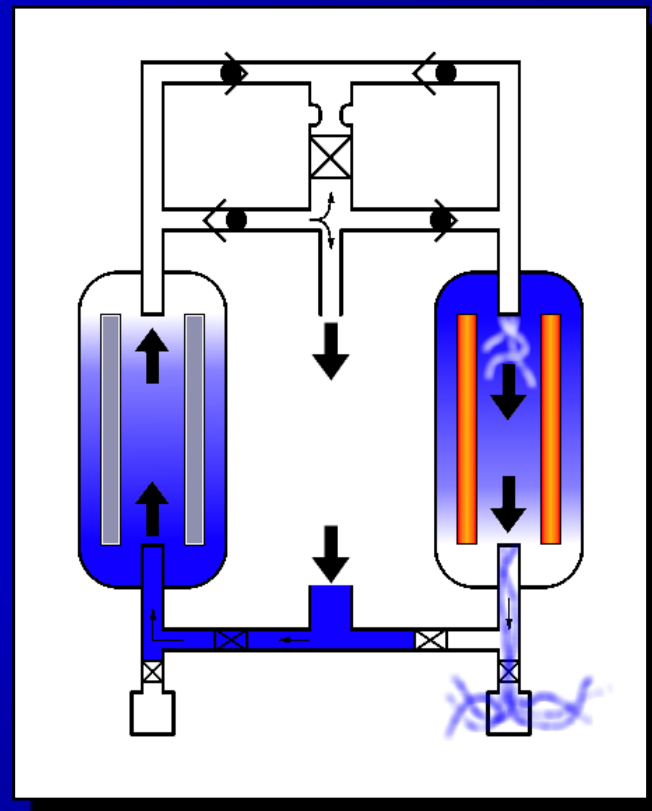
Methods of Regeneration

Internally Heated



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.

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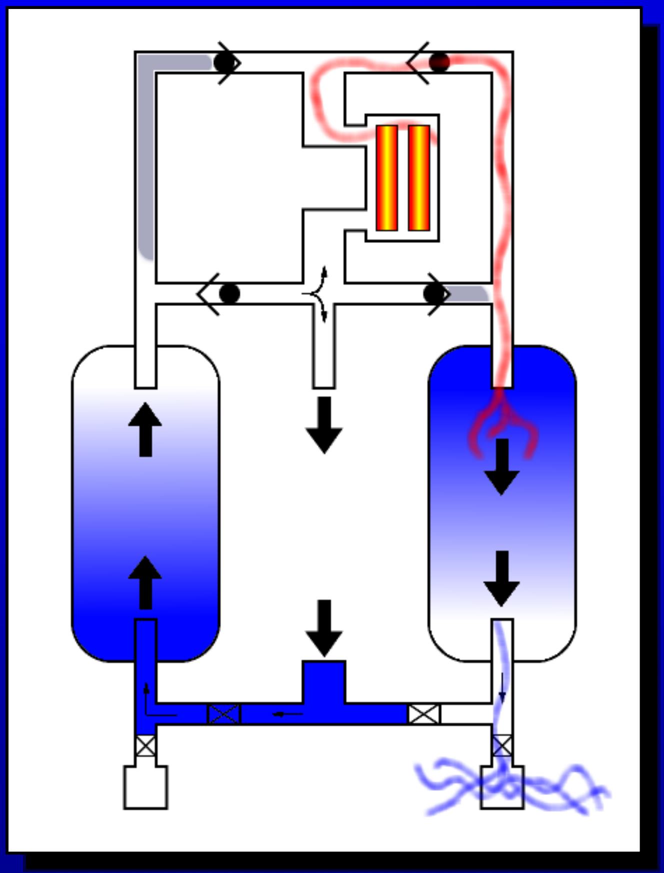
Methods of Regeneration

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

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Regenerative Air Dryers
Sources of Regenerating Power

Compressed Air SCFM	Ambient Air	Additional Power	Type of Dryer	Cost (to purchase)
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

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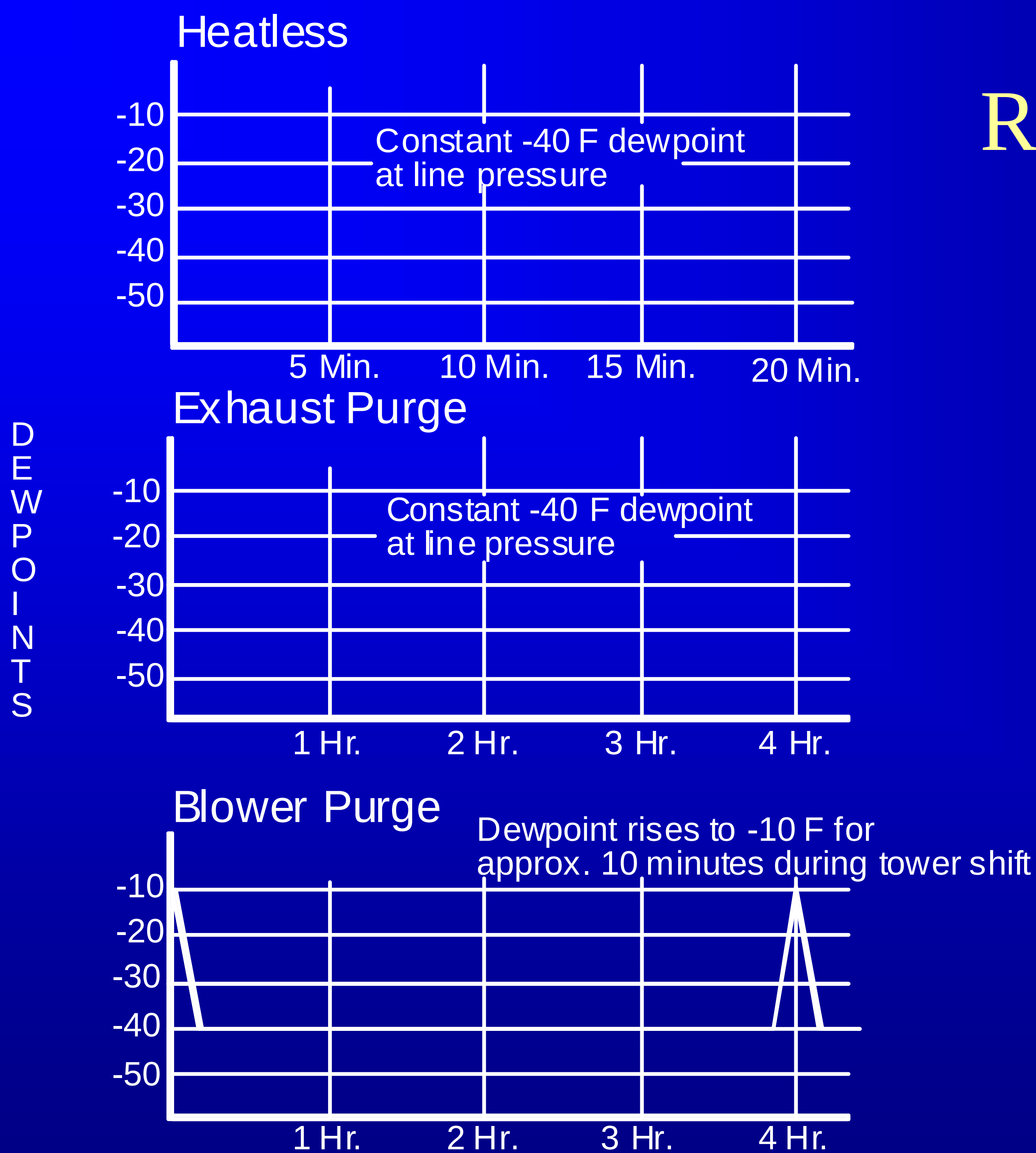
Regenerative Dryer Performance



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Sahara Electrical

Electrical Controls

Direct Reading Dew Point Indicator

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

Dew Point Demand System saves energy
and allows you to monitor
exact outlet dew point.

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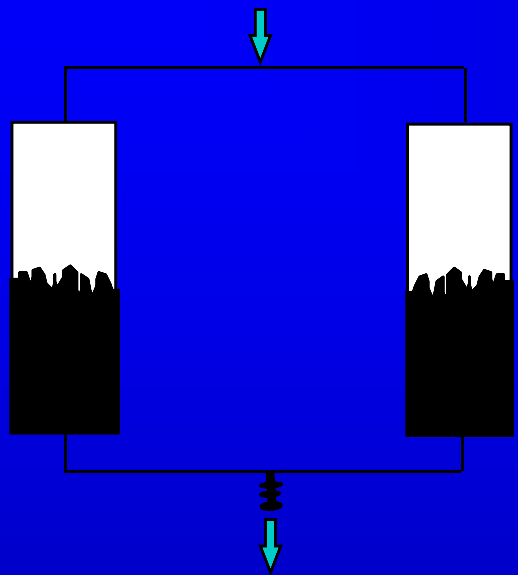
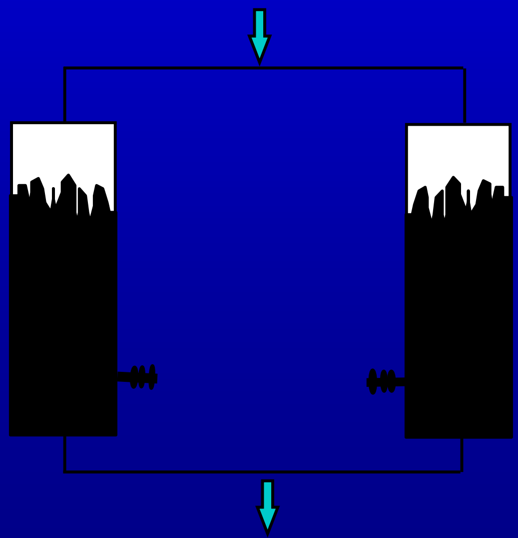
Dew Point Demand System



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

Dew point controller is equipped with Direct Reading Dew Point Indicator.



AMLOC

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

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The Dew Point 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 dew point 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%.

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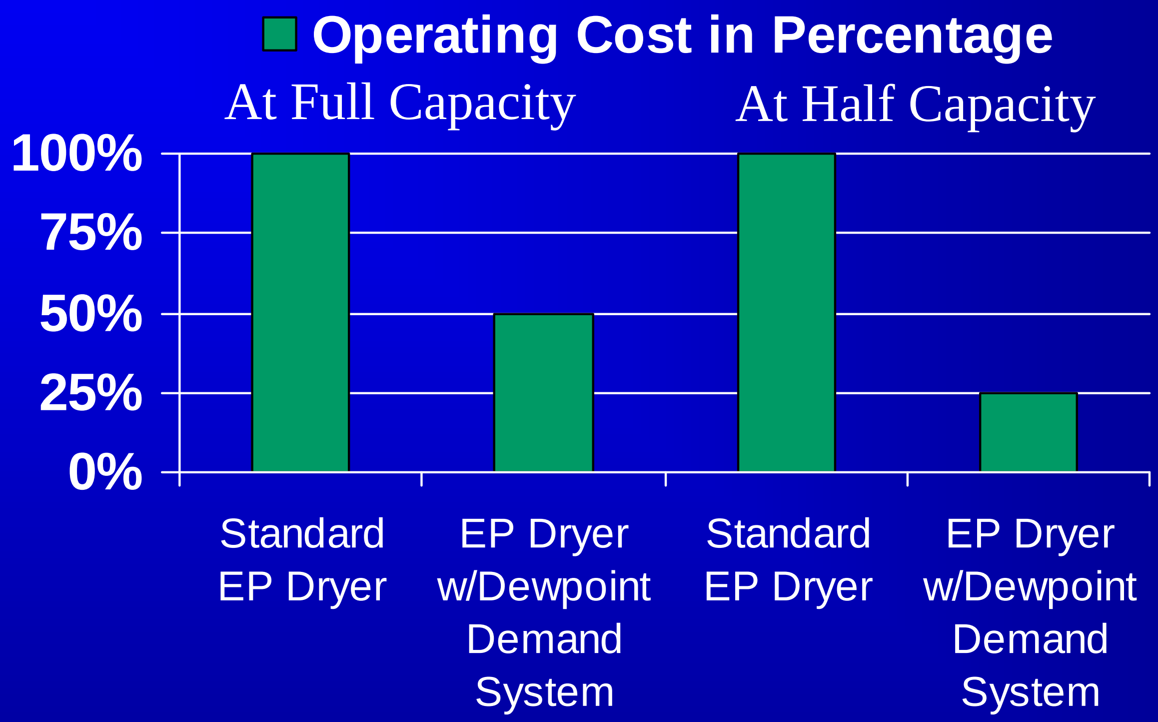
Dew Point Demand System Cuts Operating Costs



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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

Maximum Temperature	*Multiplier*	*Minimum Pressure*	*Multiplier*
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 Henderson Engineering Co., Inc.

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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

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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

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Vapor Pressure of Water

Temperature	Absolute Pressure PSIG
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

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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

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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

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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

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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

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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

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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

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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.)