Regenerative Air Dryers

Methods of Regeneration

Types of Regenerative Air Dryers

How They Work

Regenerative Dryer Sizing Factors

How to Calculate Annual Operating Cost

Presented by

Sahara Air Products

A Div. of Henderson Engineering Company, Inc.

Regenerative Air Dryer Terms

Regenerate:

Renew - restore.

Absorbent Desiccant:

Used in HP deliquescent 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:

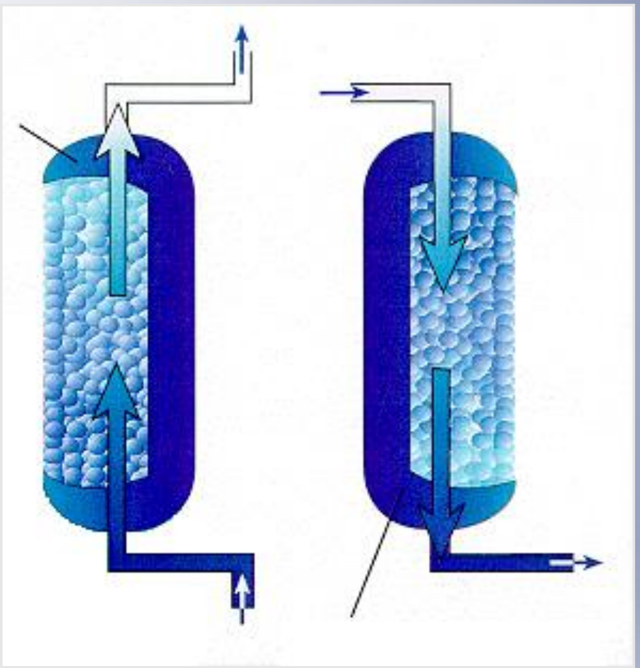
A continuous supply of compressed air at low dew points.

Operation:

One tower is online drying the air while the other tower is offline being regenerated.

Towers alternate so that the air stream is always exposed to dry desiccant.

Left Tower Drying



Right Tower Regenerating

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.

Types of Regenerative Dryers

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

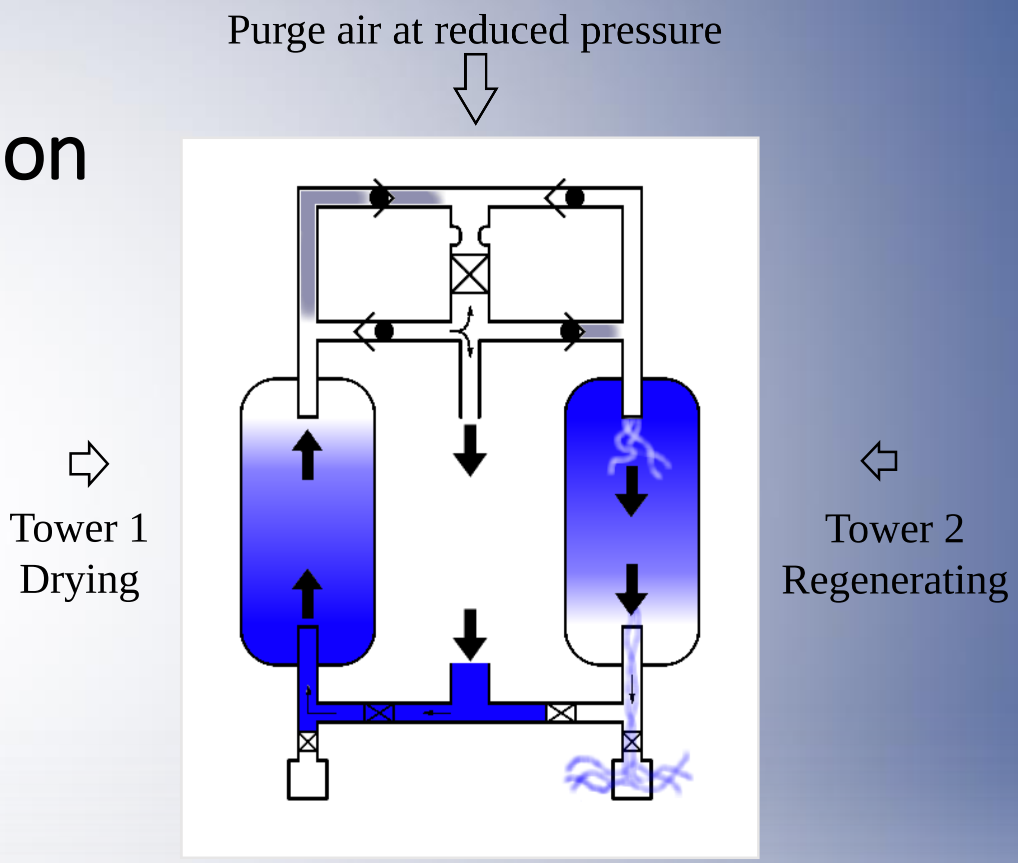
- Heatless
- Exhaust Purge
- Blower Purge
- Heat-of-Compression SP
- Heat-of-Compression HC
- Closed System/Split Stream

Methods of Regeneration

Pressure-Swing (Heatless) Regeneration

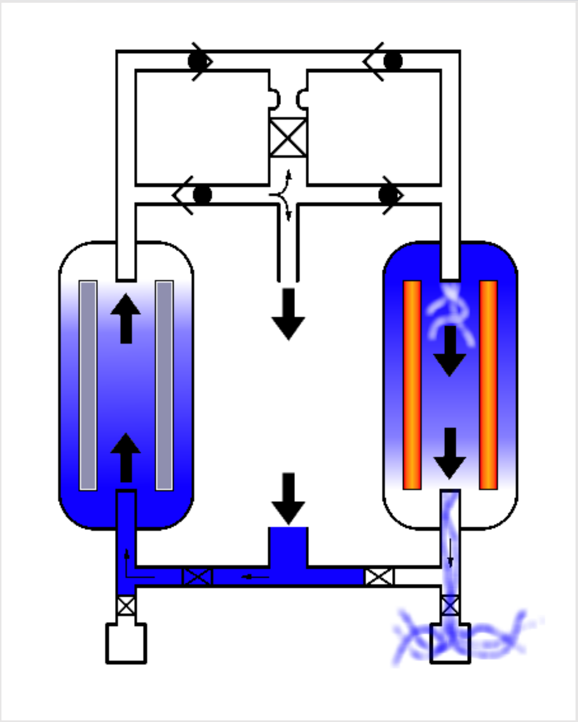
Dried compressed air is expanded to near atmospheric pressure.

This low pressure, extremely dry air pulls water from the desiccant and carries it out of the dryer.



Methods of Regeneration

Internally Heated



Heat Regeneration

Heat forces desiccant to release the adsorbed water.

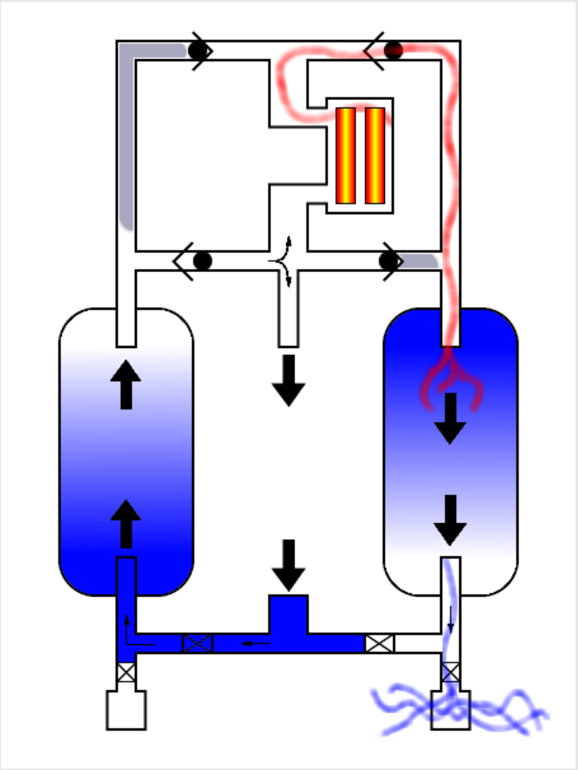
Internally Heated

Internal heaters warm desiccant.

Purge air circulates heat and carries off water vapor.

Methods of Regeneration

Externally Heated



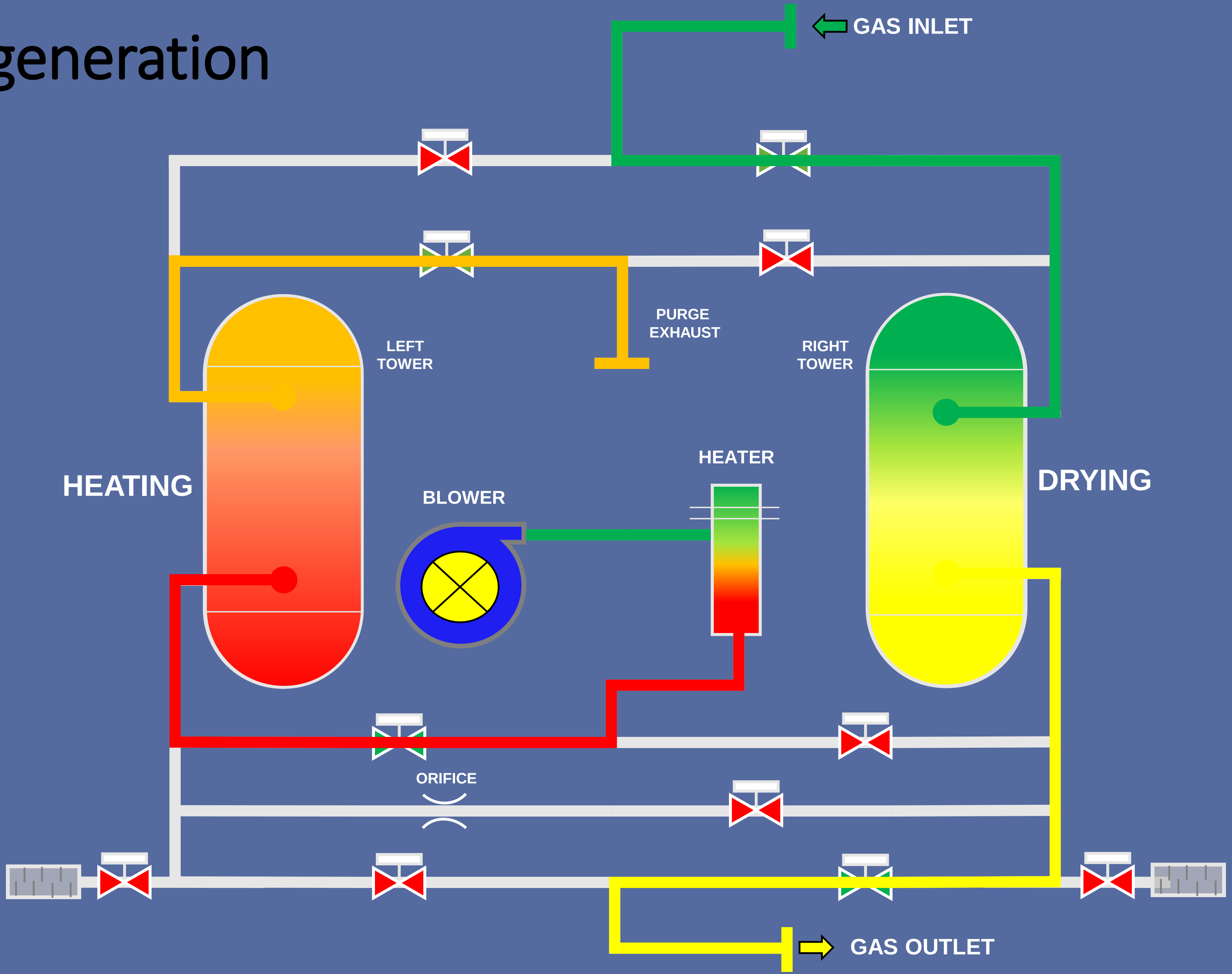
Externally Heated

External heaters heat purge air (dried compressed air or atmospheric air).

Purge air carries heat to desiccant and removes water vapor.

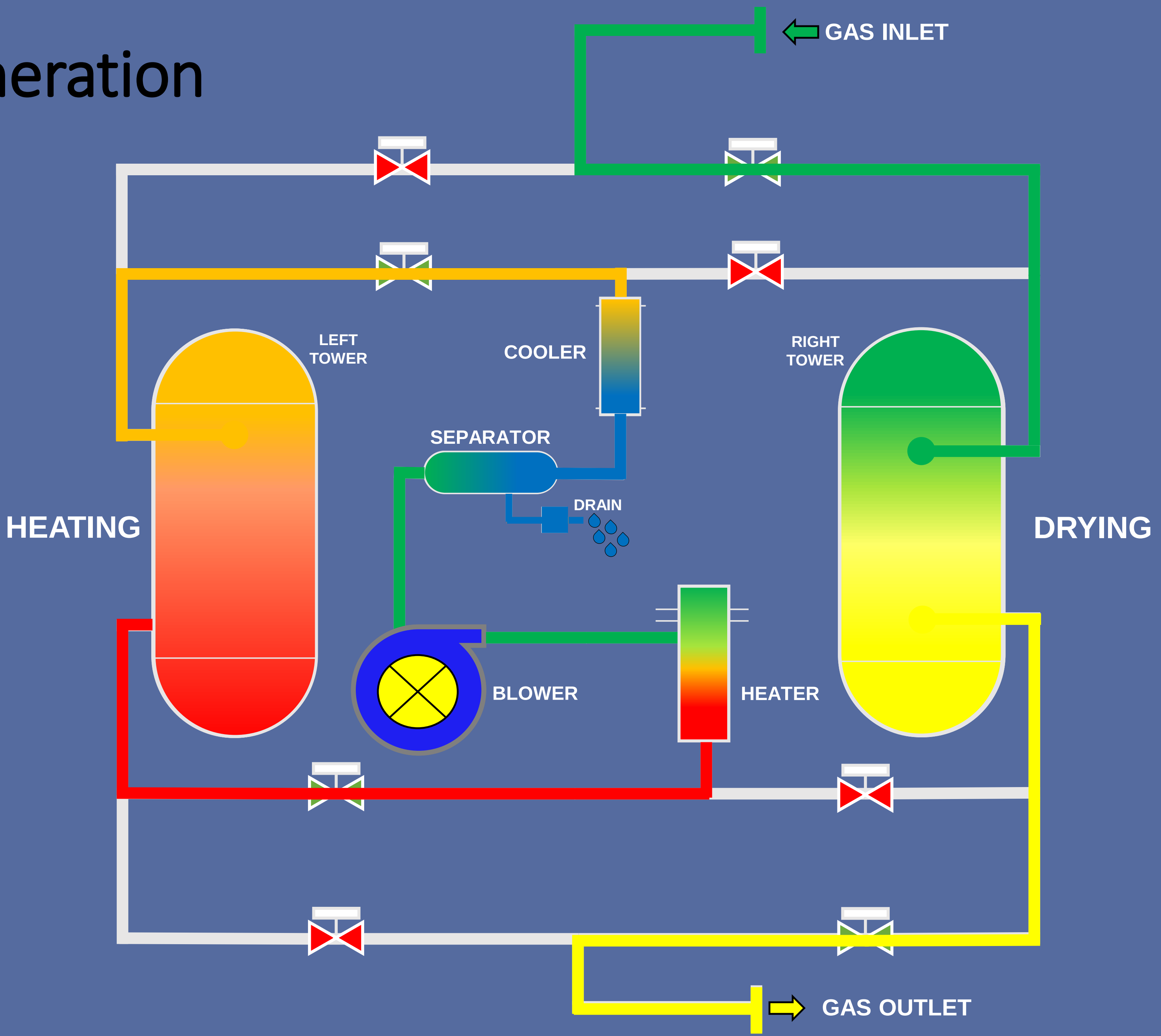
Methods of Regeneration

Blower Purge



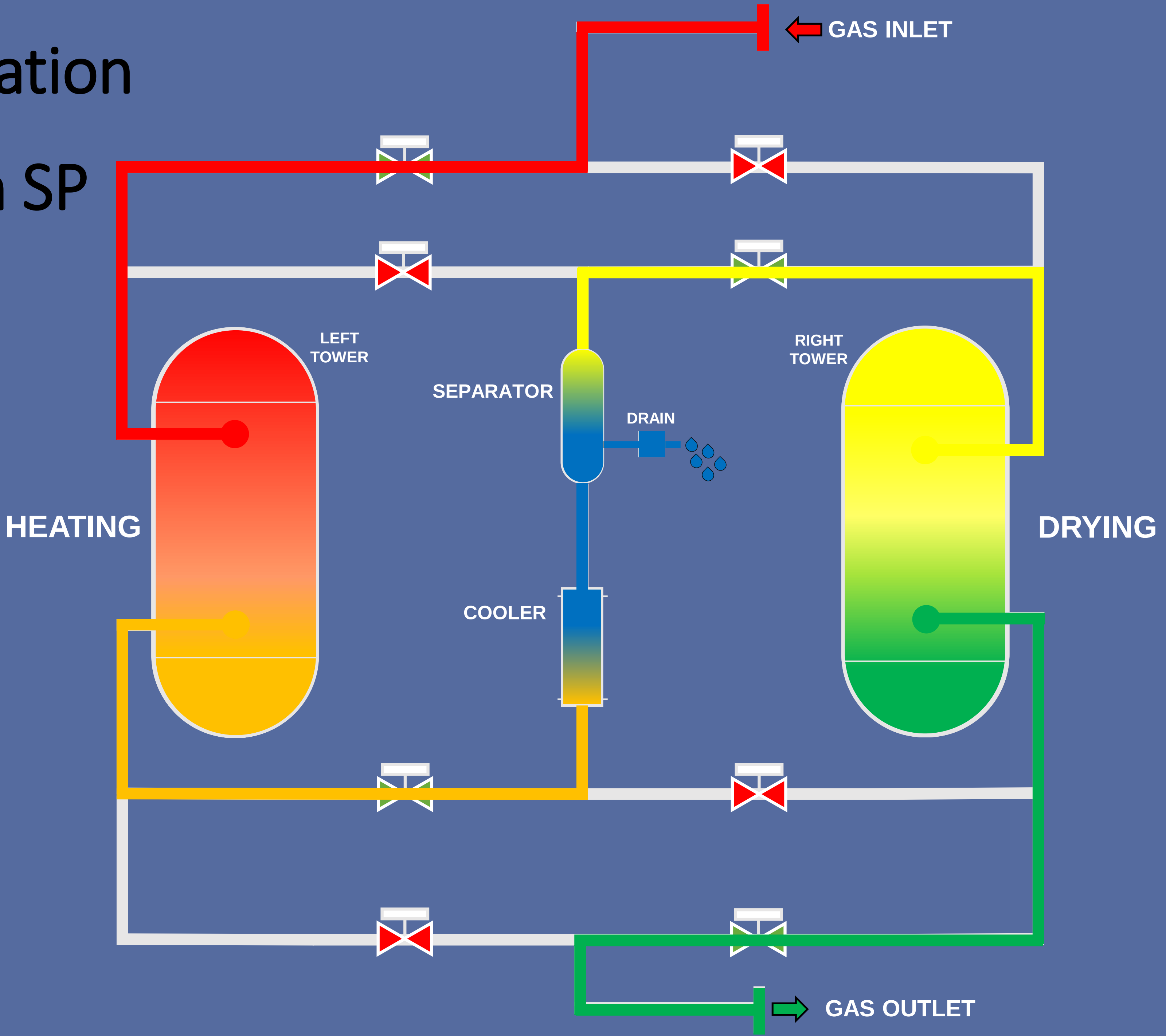
Methods of Regeneration

Closed System



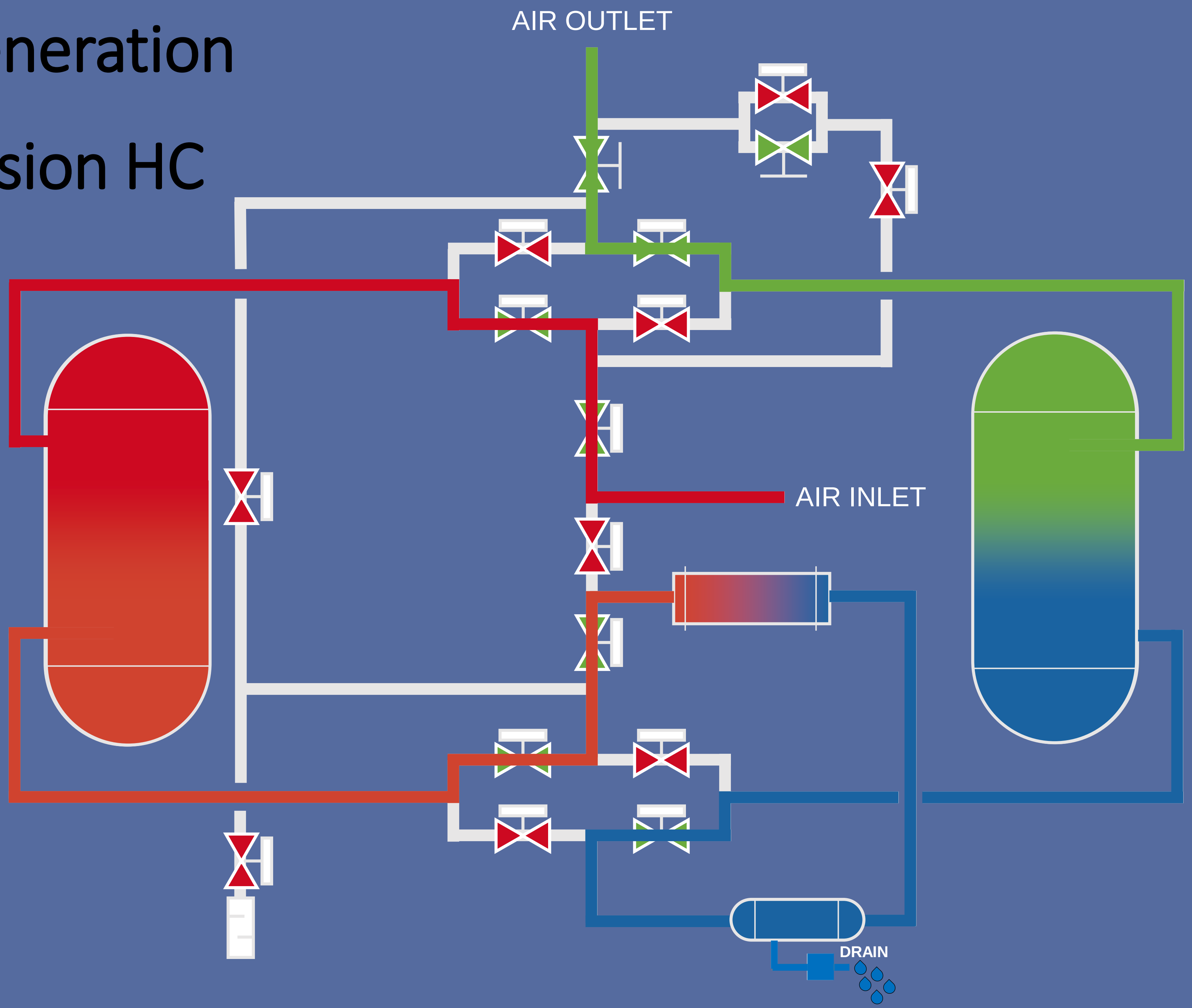
Methods of Regeneration

Heat of Compression SP



Methods of Regeneration

Heat of Compression HC



Regenerative Air Dryer
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

Sahara Electrical

Electrical Controls

Programmable Logic Controller (PLC)

The optional Dew Point Demand System saves energy and allows the user to monitor exact outlet dew point

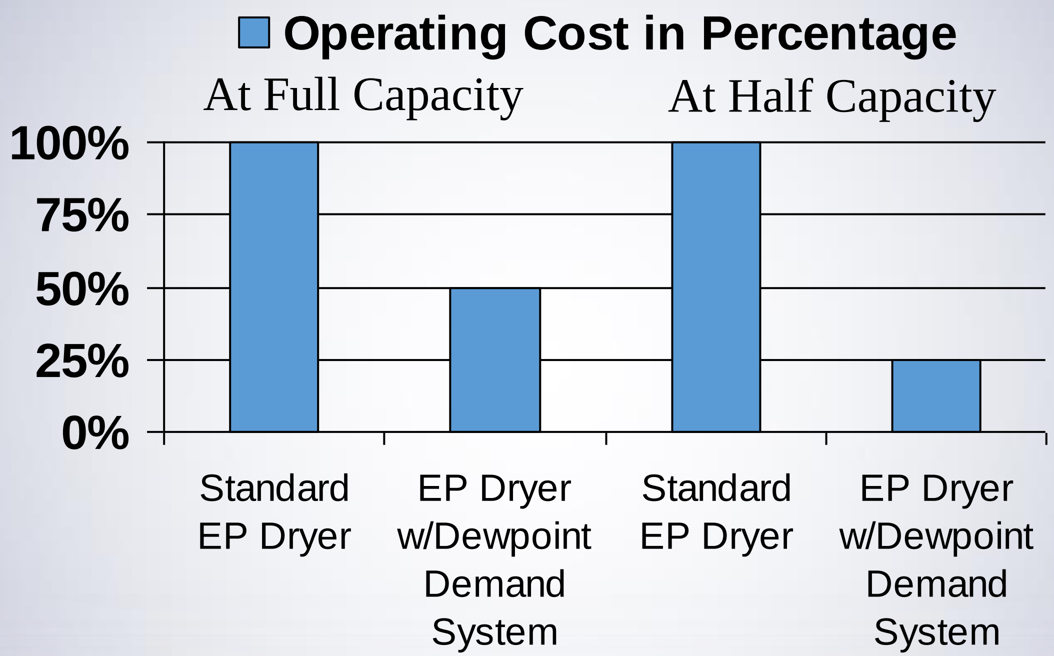
The optional Dew Point Demand System allows the dryer to utilize the full capacity of the desiccant regardless of inlet flow.

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%.

Optional Dew Point Demand System Cuts Operating Costs



Regenerative Air 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.

Pressure Modifier

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

P1 = Pressure Modifier
P = Minimum Inlet Air Pressure

Temperature Modifier

Max. Temperature (°F)	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

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

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 Air 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

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.)

Thank you…

Dryers are purchased to solve plant air problems. The decision to buy is complex and involves many variables; initial price, vendor qualifications, delivery, performance, and operating cost, just to name a few. The selection of a SAHARA air dryer is a safe choice. Our sales engineers will help you select the right system for your application. They have the expertise to review your plant air system and design the optimum engineered solution.

We can build a dryer to meet your strict performance requirements.

One of the world's largest heat-of-compression installations.

Zero Operating Cost

Lower Maintenance Cost

Similar Performance