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A Primer for Air Dryer Selection

Energy and maintenance costs are key factors in choosing these important components

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World Leader in Regenerative Dryer Technology

Drying compressed air doesn't cost . . . it saves.

Condensed water is still a major cause of downtime in compressed air systems. Air quality which was good enough for the old hand-controlled valves or wide-tolerance air tools is just not dry enough when used in today's sophisticated air systems.

Water causes rust, pitting, blockages, and freeze-ups, with resultant component failure and product rejection.

The only way to prevent condensation of water in air lines is to lower the dew point of the air in the system. This can be done by installing an air dryer after the compressor.

It is less expensive to own and operate an air dryer than it is to live with the problems it can prevent.

Table: gallons of water carried into a 1,000 scfm system in 24 hours by a compressor operating at 100 psi.

Ambient air temperature °F	Relative humidity		
	60%	80%	100%
110	386	515	644
100	292	390	488
90	219	292	360
80	162	216	270
70	118	155	194
60	85	113	141
50	60	80	100
40	42	56	70
30	28	38	47
20	18	24	30
10	11	15	19
0	7	9	11
-10	4	5	7
-20	2	3	4

CONDENSATE SOURCE

Some knowledge of the reason water vapor condenses easily in compressed air systems is helpful before investigating the different types of available air dryers.

The table shows the amount of liquid water which could be condensed from a 1,000 scfm system during a 24 hour period at varying ambient temperatures and saturation levels. For example, air at 100°F and 100% relative humidity (rh) contains 488 gallons of water, while air at 0°F and 100% relative humidity contains only 11 gallons.

The capacity of air to hold water vapor increases with increasing temperature. For this reason, discharge air from a compressor is dry. The heat-of-compression has raised the air temperature several hundred degrees. Typical relative humidity is 2 to 10%. Because of its high temperature, the air could hold much more water vapor and still be dry.

But most air systems cannot use hot air directly from the compressor for reasons of personnel safety and component temperature limitations. Air must be cooled prior to use.

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His company developed the patent on the heat-of-compression air dryer.

COMPRESSOR EXAMPLE

Here's an example with a 2-stage compressor designed for a discharge pressure of 120 psi. Intake air is at 80°F and 100% rh. Each cubic foot of free air under these conditions holds 11 grains of water.

The first stage of the compressor takes in 9 scfm and compresses it into 3 cubic feet of air at 30 psi approximately ¼ the final discharge pressure). Air temperature is 300°F. Each cubic foot of air now contains 33 grains of water, but actually could hold much more because the relative humidity is only 2%.

Before the air enters the second stage, it will be cooled to 105°F by the intercooler. At this temperature and pressure, each cubic foot can hold only 7 2/3 grains of water. The remainder condenses in the intercooler. The compressor is actually taking water out of the air; however, the air now is saturated.

In the second stage, pressure rises to 120 psi and temperature goes back up to 300°F. Each cubic foot of air now contains 23 grains of water, but relative humidity is only 5% because of the elevated temperature.

When the aftercooler brings the temperature down to 100°F, each cubic foot can hold only 2 ¼ grains. The remainder condenses into liquid water.

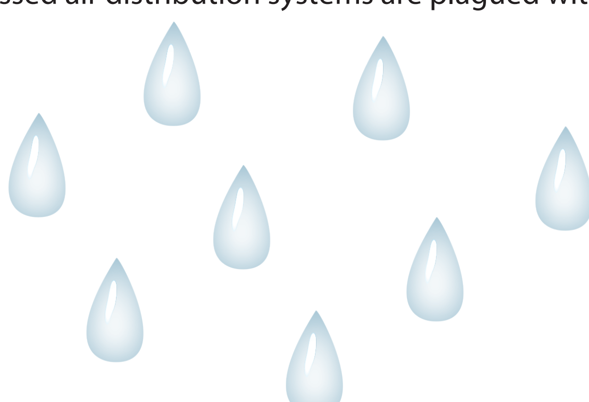
Although 2 ¼ grains doesn't sound like much, with a 1,000 scfm system operating around the clock for a year, 2,251 gallons could be drained from the aftercooler; enough to fill a small swimming pool.

CONDENSATION

As long as the saturated compressed air leaving the aftercooler stays at 100°F, no water vapor will condense. But if the air cools only 20 degrees to 80°F, 876 gallons of water per year will condense in the piping system.

If the system supplies air tools or spray guns, another problem surfaces…adiabatic expansion. As exhaust air expands to atmospheric pressure, it cools approximately 10 degrees. More liquid water will drip from air tools or ruin paint jobs.

Because actual plant ambient temperatures often are even lower than this, it's no surprise that most compressed air distribution systems are plagued with liquid water.



When compressed air expands to atmospheric pressure, it cools.

AFTERCOOLERS AND SEPARATORS

Every compressed air system should have an aftercooler and separator. The aftercooler is the first stage of moisture removal because here the bulk of potential condensate is taken out of the air. But remember, compressed air leaving the aftercooler is saturated at a relatively high temperature. The separator is a filter and can remove only liquid water from the air. By definition, a dryer is a device to lower the dew point of air. Therefore, although aftercoolers and separators are important components in an air system, neither of them is a dryer.

HOW DRY?

The major consideration in dryer selection is the degree of dryness required. Because the system is under pressure, pressure dew point determines the degree of dryness. (Ambient atmospheric dew point is irrelevant to the closed system.) As a rule of thumb, a dryer should deliver a pressure dew point 15 degrees below the lowest ambient temperature the air distribution system will encounter in service. To lower the dew point any further requires unnecessarily expensive equipment and raises operating costs dramatically.

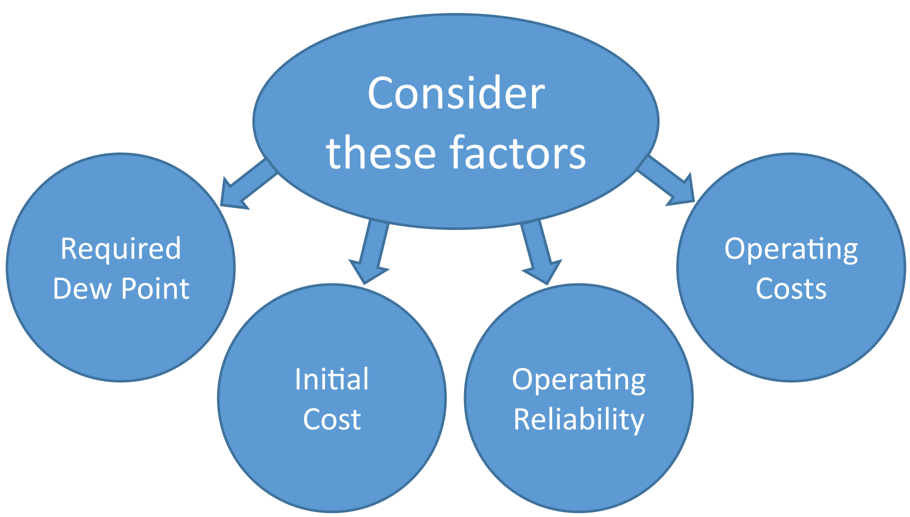
In most situations, moisture vapor is harmless, provided it does not meet lower temperature air and turn into liquid water.

What does this mean?

The dew point of compressed air must be reduced to a point safely below the lowest ambient temperature it will encounter.

Any type of dryer will pay for itself in less than a year, by reducing air system downtime and damage to components.

To maximize dryer payback, carefully evaluate operating costs, along with initial cost, when making a selection.



THREE BASIC TYPES OF DRYERS

DELIQUESCENT

The *deliquescent dryer* is simply a pressure vessel filled with deliquescent desiccant. Air enters at the top and flows down a central pipe which contains prefilters to remove dirt, liquid water, and oil. The cleaned air then flows up through a desiccant. The desiccant removes water from the air, and in doing so, slowly dissolves. An afterfilter prevents any desiccant material from carrying over downstream.

The exit dew point from a deliquescent dryer is determined by inlet air temperature. The dryer will lower the dew point 20 to 30 degrees below this. With no moving parts, the deliquescent dryer is very reliable. It consumes no energy. Operating costs include monitoring and replacing desiccant and filter elements.

REFRIGERANT

The *refrigerant dryer* lowers the dew point by mechanically cooling the air, then removing the condensed water in a separator. These dryers are rated at 35°F or 50°F pressure dew points. Any lower dew point would freeze the condensate and block air flow.

The commercial refrigeration units used in these dryers require a continuous flow of electricity during operation. Other operating costs are minimal, except some large flow capacity refrigerated dryers may require a water-to-air heat exchanger.

REGENERATIVE

The *regenerative dryer* uses a different form of desiccant which can be regenerated for repeated reuse. The basic dryer consists of two pressure vessels and some automatic valving. One vessel or tower dries air for the distribution system while the second regenerates. The desiccant cannot dry air at a temperature over 120°F, so an aftercooler preceding the dryer is essential. Regenerative-type dryers deliver drier air then either deliquescent or refrigerant. Pressure dew points range from 0° to –100°F.

Operating costs depend on which of the five types of regeneration are used.

Heatless regeneration dryers use approximately 15% of the dried compressed air from the drying tower to regenerate the desiccant. This air is lost to the operating system, so it can be a considerable expense at high flows.

Exhaust purge dryers take a smaller portion of the dried air (about 7%), heat it electrically, and use this air for regeneration. Air waste is less, but heating costs must be considered.

Blower purge dryers heat ambient air and blow it through the desiccant. No compressed air is lost, but blower and heater operating costs become a factor.

Closed system dryers produce almost constant dew points for critical air applications by regenerating with a captive air stream. Electricity and water costs are high. Air of this quality is unnecessary in most industrial systems.

Heat-of-compression dryers bring hot air directly from the compressor into the regenerating tower, then cool this air in an aftercooler and port it into the drying tower. The energy for regeneration is provided by the heat imparted to the air during compression. No compressed air is lost, and no external heaters or blowers are needed, so operating costs are negligible.

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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. We have the expertise to review your plant air system and design the optimum engineered solution.

Quality and reliability are built into every SAHARA air dryer and performance is guaranteed.

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

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