

# Preventing moisture problems in your dust collector

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**This article discusses how moisture can hinder dust collector performance and the causes of moisture in dust collection systems. The article also explains how monitoring airstream temperatures in your dust collection system can help you prevent moisture problems and describes methods for drying compressed air for reverse pulse-jet cleaning systems.**

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**M**oisture can be very disruptive to a dust collection system. Dust collector filter media tends to become plugged with material when wet, particularly if the dust is hygroscopic and absorbs water. The dust-liquid mixture clogs the pores in the filter media, creating an impermeable coating that can resist most types of filter cleaning systems. The plugged filter media resists airflow through the dust collector, causing the pressure drop across the media to rise and the dust collector's process airflow rate to decrease.

Typical fabric bag filters exposed to intermittent moisture can sometimes regain permeability if the moisture is removed and the filters are allowed to dry. With cellulose cartridge filters, however, moisture can ruin the cellulose filter media even if the dust isn't hygroscopic, causing the filter to permanently lose its permeability.

Moisture often goes undetected in a dust collection system until the damage has already occurred and begins to reveal itself through high differential pressure readings and low airflow rates. Solving a dust collector moisture problem typically involves providing a mechanism to keep the moisture in vapor form or remove excess moisture from the air before the vapor can condense into its liquid state. Before discussing solutions to moisture problems, however, it's important to understand what causes excess moisture in a dust collector and how to identify the moisture's source.

## **How to recognize an intermittent dust collector moisture problem**

A dust collector can experience moisture problems even if moisture is only occasionally present. The moisture may appear only during certain times of the day, during certain seasons of the year, or as a result of special occurrences affecting the process airstream. If the dust collector is located outside and exposed to daily and seasonal weather changes, moisture may condense on the collector's inside surfaces when the outside air temperature drops below the dew point.

The dew point is the temperature at which an air-vapor mixture becomes saturated and incapable of holding more water vapor. The dew point temperature varies depending on the amount of moisture in the air at any given time, and hot air can hold more water vapor than cooler air. As the air temperature falls below the dew point, water vapor begins to condense out of the air

and form liquid water droplets. Examples of this phenomenon include fog forming in very humid air, dew forming on grass, and frost forming on a car windshield.

To determine whether moisture is intermittently present in your dust collector, check inside the dirty air chamber when the possibility of moisture is high and the dust collector isn't operating. Inspect the inside walls of the dust chamber for drops of moisture, wet dust clumps, or areas of rust formation. While wearing appropriate protective clothing, carefully remove some dust and place it onto a paper towel. Squeeze the paper towel with the dust sample inside and see if any moisture or oils transfer to the paper towel. If any noticeable amount of moisture transfers, a moisture problem is present and should be corrected. Don't perform this test if your dust is toxic, however. Toxic dust should only be handled by professionals trained in handling such materials. And remember, while the moisture may be intermittent and can disappear before anyone notices, the damage may be permanent, especially to cellulose cartridge filters.

### Causes of moisture in dust collectors

Key factors that can cause moisture to be present in a dust collector include:

**Hygroscopic dust.** The dust being collected may be hygroscopic and contain moisture. Sawdust, for example, typically has a moisture content of 19 percent.

**Mists or sprays.** Mists or aerosol sprays may be intermittently or continuously added to the process airstream. For example, machine cutting tools often require coolant sprays to prevent overheating during operation. A hood collecting dust generated by the cutting tool may also draw moisture from the coolant spray into the dust collection airstream.

**Ambient humidity.** Humidity changes caused by wind direction or other weather conditions can increase the moisture content of the process airstream.

**Process airstream cooling.** The air temperature at the system's dust collection points may be considerably hotter than in the dust collector, particularly if the dust collection point is located over a heat source, the dust collector is located outside the building in an area with cold weather conditions, or the process airstream travels a long distance between the dust collection point and the dust collector.

**Compressed air moisture.** The compressed air for the pulse-jet cleaning system may contain excessive

moisture. A pulse-jet cleaning system directs intermittent high-speed pulses of compressed air at the clean side of the dust collector filters to dislodge caked dust and prolong filter life. If the compressed air contains excessive moisture, the filter media can become soaked, preventing caked dust from dislodging from the filter during the cleaning cycle and causing problems for both bag and cartridge filters.

### Monitoring airstream temperature

You should monitor your dust collection system's process airstream to identify times or events that cause sudden changes to the airstream moisture. For example, if a dust collection hood protecting an additional factory machine begins to add a cool secondary airstream to the system's warmer main airstream. At these moments of change, measure the temperature at different points in the duct and in the collector to understand the change's effect on each part of the dust collection system. A large temperature differential (approximately 15°F or more) between the dust collection point and the dust collector may indicate a potential condensation risk. The temperature differential that will produce condensation will vary, however, depending on the amount of moisture in the airstream.

Reverse pulse-jet cleaning systems may also contribute to process airstream cooling. The compressed cleaning air passes through a narrow orifice as it enters the dust collector, causing the air to expand and cool. For example, if the compressed-air pressure is 85 psig and the compressed-air temperature is 70°F, this expansion will cause the airjet to cool to 71°F as the air enters the dust collector.

However, the low pressure created by the fast-moving airjet draws at least 4 cfm of surrounding process air into the airjet for each cfm of compressed cleaning air. This warmer process air mixes with the compressed air, raising the airjet temperature from 71°F to about 52°F. Some additional heat is regained because of turbulence in the airjet, so the net effect is that the overall airjet temperature is 5 to 10°F cooler than the compressed air's original temperature. If this temperature is below the airjet's dew point, condensation can occur.

Also, the cool airjet mixing with the warm process airstream can potentially lower the overall air temperature in the dust collector. If the warm process airstream is carrying significant moisture and is close to its dew point, then any significant cooling by the clean airjet could lower the temperature of the mixture and cause condensation to appear inside the collector.

For example, in some areas of North America, winter temperatures can drop below 0°F. If a dust collector is

located outside in those conditions, the temperature of the compressed air in the pulse-jet cleaning system will tend to closely mirror the ambient temperature. The process airstream temperature, however, will likely remain fairly constant and warm year round. A greater temperature differential will exist between the compressed air and the process air during the winter months, which may cause more moisture condensation in the dust collector. Taking periodic temperature readings at the dust collection points and inside the dust collector at different times of day and seasons of the year will help you anticipate potential condensation problems.

### Removing moisture from compressed air

A successful pulse-jet cleaning system requires clean, dry compressed air. A filter can be used to dry the air but isn't nearly as effective as an air dryer. The standard method for drying saturated compressed air is to use an air dryer in addition to a filter. The two main dryer types are: *refrigerant dryers* and *desiccant dryers*.

**Refrigerant dryers.** A refrigerant dryer, as shown in Figure 1, is a relatively low-cost drying solution that uses a combination of heat exchangers and filters to remove moisture from compressed air. The drying process in a refrigerant dryer follows four steps:

**Cooling.** Hot, saturated air from the compressor passes through an air-to-air heat exchanger where it's cooled by the cold, dry air leaving the dryer.

**Refrigeration.** The cooler air travels through an air-to-refrigerant heat exchanger where it's cooled to the dew

point by refrigerant flowing through a constantly circulating refrigeration system.

**Separation.** The refrigerated air passes through a multi-stage moisture filter (or separator) that removes condensation created during the refrigeration step. This step also commonly includes a high-efficiency cold coalescing element immediately following the moisture separator to remove any oils or solid particles larger than 3 microns.

**Reheating.** The cold, dry air flows back through the air-to-air heat exchanger and is warmed by the incoming hot, saturated air from the compressor. This reheating step increases the air volume and prevents the downstream piping from sweating.

**Desiccant dryers.** A desiccant dryer uses a combination of filters and desiccant (or adsorbent) material, such as activated alumina, molecular sieve, or silica gel, to remove moisture from compressed air. The three types of desiccant dryers are: heatless, heated, and heated blower. In a *heatless desiccant dryer*, as shown in Figure 2, is the simplest of the desiccant dryers and tends to have a lower initial cost but a higher operating cost than the other types. The drying process follows four steps:

**Pre-filtering.** Hot, saturated air from the compressor travels through a coalescing filter, which removes oil and some moisture. To prolong the life of the desiccant material, a two-stage coalescing filter system is highly recommended.

**Drying.** The saturated air flows through an automatic diverter valve that channels the air into one of two

Figure 1

### Refrigerant dryer

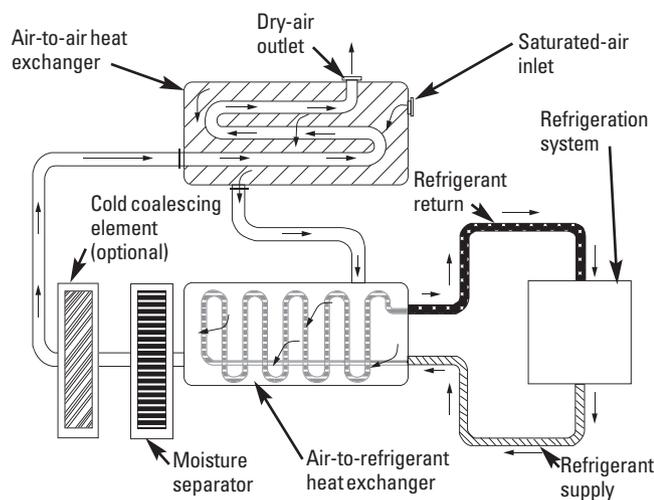
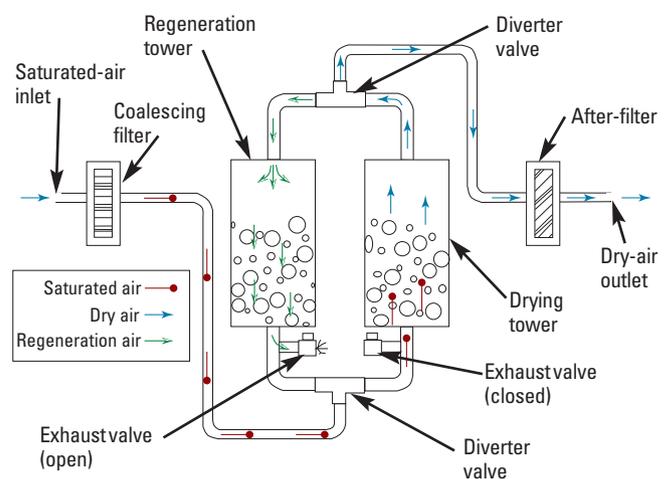


Figure 2

### Heatless desiccant dryer



drying towers (also called beds). The drying towers are filled with the desiccant material, which is very hygroscopic and attracts moisture away from the compressed air as the air flows through the tower.

**Regeneration.** After a short period of time, the desiccant material in the drying tower becomes saturated with moisture and needs to be purged. While one of the drying towers is drying the compressed air, the other tower is purging (or regenerating) the desiccant material. During regeneration, an exhaust valve opens at the upstream end of the tower to be purged and a diverter valve at the tower's downstream end opens to divert roughly 10 to 15 percent of the dry air leaving the other tower into the regeneration tower to purge the desiccant bed. As the dry compressed air passes through the bed, the air carries the moisture out through the open exhaust valve. After a few minutes, the exhaust valve closes and the pressure begins to build back up in the regenerated tower. Once the pressure is built up, the diverter valves simultaneously change position, and the two towers switch operations. For a heatless desiccant dryer, the typical cycle for each tower is to dry for five minutes, regenerate for four minutes, and repressurize for one minute.

**After-filtering.** The dried air that isn't diverted to purge the regeneration tower (85 to 90 percent) travels through an after-filter, which removes any solid particles from the airstream.

A **heated desiccant dryer**, as shown in Figure 3, follows the same steps as a heatless desiccant dryer. The only difference is that, during the regeneration step, the dried compressed air is diverted through an external heater before entering the tower being purged. Since

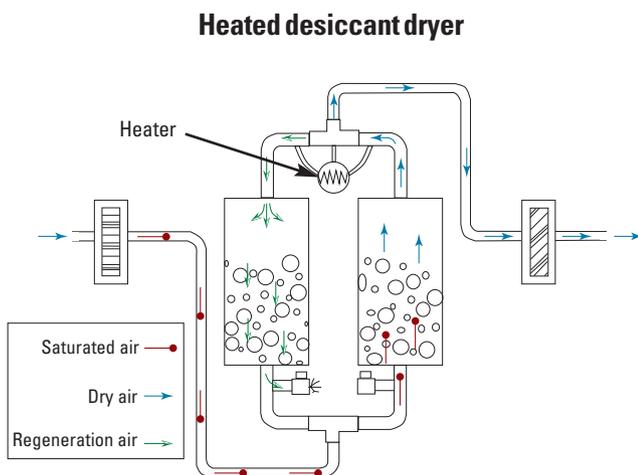
heated air can hold significantly more moisture than unheated air, this system requires only about half as much compressed air as a heatless desiccant dryer for purging. A heated desiccant system is more complex and tends to have a higher initial cost than a heatless desiccant system, but the operating cost is lower.

A **heated blower desiccant dryer**, as shown in Figure 4, uses the same heated-air principle as the heated desiccant dryer. The difference is that the heated blower desiccant dryer uses no compressed air for purging. Instead, a separate pressure blower directs outside air through a heater and then into the regeneration tower for purging. A heated blower desiccant dryer has the highest initial cost compared to the other dryer types, but it also has the lowest operating cost since no compressed air is lost to the purging cycle.

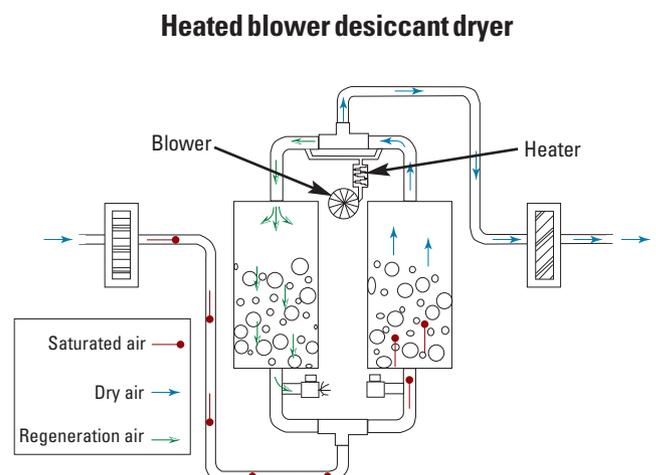
### Comparing dryer types

Each dryer type has advantages and disadvantages. A refrigerant dryer can typically lower the compressed air's dew point temperature to 35°F. If conditions cause the compressed air temperature to reach 35°F or lower, the excess water vapor will condense and potentially hinder the performance of the dust collector filter media. If the compressor and dust collector are both installed indoors, reaching 35°F or lower is unlikely, but if the dust collector is located outside, moisture may be a problem in colder climates. You can usually eliminate the condensation problem, however, by equipping the dust collector's pulse-jet cleaning system with an automatic draining mechanism that frequently drains accumulated condensation from the compressed-air manifold.

**Figure 3**



**Figure 4**



A desiccant dryer can reduce the compressed air's dew point to approximately  $40^{\circ}\text{F}$ . This type of system also doesn't require a secondary draining system to remove excess moisture from the compressed air.

A third alternative combines both a refrigerant dryer and a desiccant dryer, as shown in Figure 5. First, the refrigerant dryer removes the moisture down to a  $35^{\circ}\text{F}$  dew point, then a smaller desiccant dryer system remove the remaining moisture to bring the dew point down to approximately  $40^{\circ}\text{F}$ .

The benefit of this combined system is that the desiccant dryer can be smaller because the refrigerant dryer does about 85 percent of the work. Also, the desiccant dryer can be bypassed during warmer weather when the lower dew point isn't required. This type of combination drying system tends to have the highest initial cost but is the most efficient system and has the lowest operating cost.

Any of these drying systems will function very well if used in the right application. Consult with a qualified equipment supplier for help in specifying your application's present and future requirements. PBE

### For further reading

Find more information on this topic in articles listed under "Dust collection and dust control" in *Powder and Bulk Engineering's* comprehensive article index in the December 2016 issue or the Article Archive on *PBE's* website, [www.powderbulk.com](http://www.powderbulk.com). (All articles listed in the archive are available for free download to registered users.)

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**Figure 5**

