Lowering Dew Point to Protect Expensive Automation Equipment

Failure to remove water vapor from factory air can quickly become a costly maintenance headache.

Water vapor and the resulting water condensate are the foremost causes of costly downtime and maintenance, not the more visible culprit of oil or contaminants, which are easily removed with proper filtration.

Moisture in facility airlines can cause corrosion, rust and pipe scale which can break loose to block or adhere to air passageways that can lead to increased pressure drop and loss in machine performance.

Aftercoolers, drip legs and water separators are used to remove water condensate from factory compressed air. However, this air is still at 100% relative humidity and is still at risk of condensing into water should the surrounding temperatures drop to its dew point.

In order to increase protection of expensive automation equipment, factory compressed air must remove as much water vapor to avoid any condensation further downstream.

This is done by lowering its dew point.

How is Dew Point Lowered in Factory Compressed Air?

Drying compressed air at the highest pressure consistent with the facility's demands will result in the most economical dryer operation. For most industrial applications, the rule is to first set the pressure dew point to meet general requirements, then adjust it 20 °F lower than the facility's lowest ambient temperature.

Hence, factory air dryness or dew point is relative to the application's specific requirements.

Refrigerated dryers are the most common measure to lower dew point. A refrigerated dryer will further cool the compressed air by removing heat at its inlet side and lowering its temperature dew point down to 37 °F, then expelling the condensate through an automatic condensate drain. The dryer will then reheat the dried compressed air back to ambient temperature by recycling the previously removed heat using a heat exchange process. This reheating of the compressed air to ambient temperature will eliminate "sweating" cold pipes when working in humid factory conditions.

It is recommended that a coalescing filter be installed upstream from the refrigerated dryer to remove any compressor oil and other contaminants that may still be trapped in the compressed air to ensure the dryer's proper functioning. Oil coating the cooling surfaces decreases efficiency while coalescing filters saturated with liquid water will reduce its drying capacity.

In circumstances where factory piping is exposed to ambient temperatures lower than the dew point achievable by refrigerated drying, alternate methods of drying must be considered.

Membrane dryers use hollow fibers composed of a macro molecular membrane through which water vapor passes easily, but is difficult for air (oxygen and nitrogen) to pass through. When humid, compressed air is supplied to the inside of the hollow fibers, only the water vapor permeates the membrane and is drawn to the outside due to the pressure differential between the moisture inside and outside the hollow fibers. The compressed air becomes dry air and continues to flow unimpeded out of the membrane dryer.

A portion of the dry air from the outlet side is passed through a very small orifice to reduce the pressure and purge the outside of the hollow fibers. The moisture that permeated to the outside of the hollow fibers is discharged to atmosphere by the purge air which in turn creates a low partial pressure allowing the dehumidification process to continuously perform.

By altering the air flow rate and membrane configurations, pressure dew points from +55 °F to -44 °F can be achieved. Membrane air dryers are a cost effective solution for point-of-use applications for pharmaceutical manufacturing, packaging, laboratory environments and other applications.

Desiccant dryers pass air through beds of desiccant, an absorbent material such as silica gel or activated alumina, which adsorb water vapor to its surface to effectively lower dew points to temperatures well below that which a refrigerated dryer can achieve. Heatless regenerative models use a pair of desiccant beds which alternate in service while the off-line bed is regenerated via a pressure swing adsorption process. Pressure dew points from +16 °F to -40 °F and beyond can be achieved with a desiccant dryer.

Both membrane and desiccant dryers are adversely affected by the presence of oils or liquid water and must be protected with a quality coalescing filter.

What is the Appropriate Dew Point?

Over specifying an application's or a facility's dew point can be very costly due to exorbitant energy bills just as the maintenance costs for water vapor damage to product lines can be for an under specified dew point.

Drying the entire factory compressed air supply to -10 °F dew point is unnecessary and extremely wasteful. It is a sensible practice to dry the compressed air to a dew point 20 °F lower than the factory's lowest ambient temperature then subdivide each compressed air supply by application using zone or point-of-use membrane or desiccant dryers to provide the appropriate level of dryness.

The costs of energy, downtime, replacing production components, end product defects or even loss of brand value are just a few factors to consider when determining an appropriate dew point.