Protect Your Equipment and Save Money: Supply Clean Dry Air

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INTRODUCTION

Protect your equipment now. Whether your business is industrial packaging, processing, conveying, pharmaceuticals or laboratory applications, you are most likely using compressed air systems for energy. Clean dry air is a critical factor in the success and efficiency of pneumatic systems. Without proper treatment, compressed air can be a source of rising maintenance expense causing endless frustration. Many users overlook proper circuit design when creating a system to provide clean, dry air. Cutting corners to save space often results in the hidden costs of dealing with condensation issues. Dry air systems and point-of-use dryers are both cost-effective and compact. These products offer users of any scale protection for their equipment and processes.

Why Invest More Money in Your Compressed Air System?

Contamination and condensation are unavoidable when generating compressed air. Contaminants in a compressed air system result from the quality of air being drawn into the compressor. Dirty, wet air will still be dirty and wet after compression. In fact, compressing air generates heat which increases the air temperature. As the air temperature elevates, the capacity to retain moisture increases and short of filtration, the air will contain all the contaminants of the ambient environment. Types of contamination include atmospheric dirt; water vapor, condensed water and
water aerosols; rust and pipescale; micro-organisms; liquid oil and oil aerosols; and oil vapor (see list of contaminants at the end of the article). All of these contaminants form an unwanted and often acidic condensate, which rapidly wears tools and machines. Furthermore, the contaminants clog valves and orifices causing high maintenance together with costly air leaks. Additionally, condensed water and water aerosols cause corrosion to the storage and distribution system, damaging both production equipment and the end product.

The amount of water in a compressed air system is staggering. A small 100 cfm (2.8m³/min) compressor and refrigeration dryer combination, operating for 4,000 hours in typical climatic conditions produces approximately 2,200 gallons or 10,000 liters of liquid condensate per year! When a compressed air system operates in warmer, more humid climates, or when large compressors run for long periods, the volume of condensate increases significantly. Water, in any form, must be removed to enable the system to run correctly and efficiently. That is why dryers are imperative in order to generate clean dry air.

Get the Water Out!
Compressed air typically contains water in both liquid and vapor form. "Drying" can range from trapping the condensed water and preventing additional condensation of water vapor to removing virtually all the water present. The more water removed, the higher the cost of drying. However, if too much water is permitted to remain in the compressed air supply, the price is paid in maintenance cost, corrosion, product loss and equipment failure. These costs are detrimental in terms of downtime, maintenance and replacement. They are wholly unnecessary with the proper drying technology.

Specifying Air Purity

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There are a range of drying technologies available. Some applications require a single component to achieve the purity goal. Most applications require a multi-step circuit design that includes several progressively aggressive purifying technologies.

Current technologies include:

- **Aftercooler**
  Reduces the temperature and water content of the compressed air.

- **Bulk Liquid Separators**
  Removes bulk liquid condensed in the distribution system.

- **Particulate Filters**
  Removes solid particle contaminants down to 5 micron and separates bulk liquids.

- **Coalescing Filters**
  Removes liquid aerosols and submicron particles (not vapors) down to .01 micron in size.

- **Refrigeration Dryers**
  Dries to dew points of +37°F (+3°C) to +50°F (+10°C).

- **Desiccant Dryer**
  Dries to dew points of -40°F (-40°C); -100°F (-73°C) optional.

- **Membrane Dryers**
  Has variable drying capabilities as low as -40°F (-40°C) to +35°F (+2°C) dew point depending on flow.

The quality of air (its purity) varies depending on the application. As a rule of thumb, compressed air should be treated prior to entering the distribution system and at each point-of-use. This system design approach provides the most economical solution to system purification by removing contamination residual in the distribution system while ensuring that the most critical areas receive air treated to the highest level of purity.

In most environments, one compressed air system supplies air to multiple applications and although the purification equipment specified in the compressor room remains unchanged, the point-of-use air quality requirement will vary depending on the application. Installation of products that improve air purity are required at the point-of-use in order to protect valuable equipment and prevent expensive downtime.

To achieve the stringent air quality levels required for today's modern production facilities, a careful approach to system design, commissioning and operation must be employed. The International Standards Organization (ISO) set the standard for the quality of compressed air, detailed in ISO 8573 (more information can be found at www.iso.org). Point-of-use filtration and air dryers help companies meet these standards.

**Dryer Types**

While all the drying technologies play a role in a compressed air system, refrigeration, desiccant and membrane dryers provide economical, compact solutions and are often overlooked. Businesses sometimes feel they can save money by avoiding installation of point-of-use dryers, but firms are well advised to evaluate new dry air products. New products on the market offer affordable, flexible, compact designs with significant benefits that increase financial value.
Refrigeration Dryers
As the name implies, refrigerated dryers work by cooling the air to low temperatures and condensing much of the water vapor for expulsion through a drain. Ideal for general purpose applications, this type of dryer does not achieve dew points below freezing. These dryers typically provide pressure dew points of +38°F (+3°C), +45°F (+7°C) or +50°F (+10°C). Refrigeration dryers remove the heat from the inlet air and use it to reheat the air at the outlet. Dried air is returned to the air line at ambient temperatures. This process eliminates “sweating” that occurs with exposure to cold pipes or when working in humid conditions.

Refrigeration dryers are not suitable where piping is installed in ambient temperatures that are lower than the dryer dew point. For example, it is not appropriate to use a +37°F (+3°C) dryer in an installation where outside piping is used and the outside temperature is below freezing.

Adsorption (Desiccant) Dryers
Adsorption dryers are used in applications where very dry air is required. They are generally installed downstream of the aftercooler and/or the refrigeration dryer. Inline adsorption dryers feature a desiccant material contained within a vessel. The compressed air passes through the vessel across the desiccant bed and the water vapor is absorbed by the desiccant material. The air exits the adsorption dryer in a very dry state. The dew point achieved varies according to the specific application, but typically the level is -40°F (-40°C) or -100°F (-70°C) optional.

Heatless regenerative desiccant dryers use dry air generated in the drying process to remove water vapor from the desiccant material. Air is redirected to one of two desiccant beds at regular intervals allowing the inactive bed to be regenerated. Dry air is passed over the inactive desiccant bed and water vapor evaporates from the desiccant into the dry air system. This moisture laden air is subsequently vented to atmosphere. The major advantage to using a heatless...
Desiccant dryer is the reduced dependence on expensive utilities, particularly steam, electricity or other heat sources. Minimal electricity is required to run a heatless desiccant dryer.

Depending on the size, adsorption dryers can be conveniently located near the point-of-use to deliver instrument-quality air for critical applications. It is important to note that the actual air temperature after an adsorption dryer is not the same as its dew point. This is beneficial since a pressure dew point of -15°F (-26°C) or better will not only prevent corrosion, but will also inhibit the growth of microorganisms within the compressed air system.

Desiccant dryers should be protected from liquid water by a coalescing filter installed upstream of the dryer. Oil or water entering the dryer will adversely affect the performance of the dryer and/or destroy the desiccant material. It is also good practice to install a filter downstream from the dryer to prevent any carryover of the desiccant to downstream equipment or processes.

**Membrane Air Dryers**

Membrane materials that are selectively permeable to water vapor are an excellent medium for producing dry air from standard compressed air. The membrane consists of bundles of hollow fibers. As the compressed air passes through the center of these fibers, water vapor passes through the walls. A small portion of the dry air (purge flow) is redirected along the outside of each hollow fiber carrying away the moisture-laden air, which is then exhausted to room atmosphere. The remainder of the dry air is piped to the application.

Membrane dryers can be conveniently located near the point-of-use and can supply clean dry compressed air with dew points as low as -40°F (-40°C) to +35°F (+2°C) depending on the flow. As with refrigeration and desiccant dryers, coalescing filters should be installed upstream from a membrane dryer to protect the membrane from being saturated by water or coated by oil. If saturation or coating occurs, the membrane drying function can be seriously inhibited.
Create a Complete Dry Air Solution

The decision to install a point-of-use dryer is based on cost, fit, and function. But the time and expenses saved in maintenance, the reliable system performance, and the higher air quality are all reasons to consider installing a dryer, no matter what size your business or air compression system. When creating a complete, clean dry air solution, keep the following information in mind:

1. **Dryness is relative.**
   For general plant air, the compressed air's dew point should be about 20°F (-7°C) lower than the lowest ambient temperature to avoid freezing.

2. **Inlet temperature is a key factor.**
   A 20°F (-7°C) reduction in temperature condenses 50% of the humidity out of the air.

3. **Do not overspecify.**
   Drying the entire compressed air supply in a factory to dew points less than -40°F (-40°C) is wasteful. It is more sensible to subdivide the compressed air supply by application, treating each end use point as needed to provide appropriately dry air for the downstream application served.

4. **Do not underspecify.**
   Damage caused by wet air costs money in maintenance time and supplies, downtime, and lost product. Design a drying system to meet specific needs.

5. **Avoid potential problems.**
   A drying system that only contains an aftercooler and a coalescing filter could create problems with condensation downstream from the aftercooler. The air is still saturated with water vapor which is likely to condense if the ambient temperature is lower than the compressed air temperature.

6. **Refrigeration dryers are ideal for general purpose applications.**
   This type of dryer does not achieve dew points below freezing.

7. **Desiccant dryers are ideal for applications requiring dry air -40°F (-40°C) or below.**
   The two main types of desiccant dryers are heated and heatless. In general, applications below 1000 SCFM (28.3m³/min) work best with heatless and applications above 1000 SCFM work best with heated dryers.

8. **Membrane dryers are ideal for applications requiring dry air down to -40°F (-40°C).**
   No electricity is required and with proper pre-filtration and post filtration, these dryers are maintenance-free.

**SUMMARY**

Protect your equipment, save money and optimize your energy consumption by improving air purity with the installation air drying products. Work with a supplier who understands the processing requirements. Select properly sized equipment with appropriate dew point and flow in order to preserve assets, eliminate headaches, avoid downtime and increase value. Assure that your air system provides clean dry air.

*NOTE: For more information on point-of-use dryers, including catalogs and specs, visit [www.parker.com/pneu/dryers](http://www.parker.com/pneu/dryers) or contact Michael Nick, Product Sales Manager, Parker Hannifin, Pneumatics Division at mnick@parker.com.*

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Types of Contaminants found in Compressed Air Systems

<table>
<thead>
<tr>
<th>Contaminant Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>Atmospheric Dirt</td>
<td>Atmospheric air in an industrial environment typically contains 140 million dirt particles for every cubic meter of air. Eighty percent of these particles are less than 2 micron in size and are too small to be captured by the compressor intake filter and instead pass directly into the compressed air system.</td>
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<tr>
<td>Water Vapor, Condensed Water and Water Aerosols</td>
<td>Atmospheric air contains water vapor (water in a gaseous form). The ability of compressed air to hold water vapor is dependent upon its temperature. The higher the temperature, the more water vapor that can be held by the air. During compression, the air temperature is increased significantly, which allows it to easily retain the incoming moisture. Condensation occurs at various stages throughout the system as the air is cooled further by the air receiver and piping and the expansion of valves, cylinders, tools and machinery.</td>
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<td>Rust and Pipescale</td>
<td>Rust and pipescale can be found in air receivers and the piping of “wet systems” (systems without adequate purification equipment) or systems which were operated “wet” prior to purification being installed. Over time, this contamination breaks away to cause damage or blockage in production which can also contaminate final product and processes.</td>
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<tr>
<td>Micro-organism</td>
<td>Bacteria and viruses are also drawn into the compressed air system through the compressor intake. Warm, moist air provides an ideal environment for the growth of micro-organisms. Ambient air typically contains up to 3,850 micro-organisms per cubic meter. If only a few micro-organisms enter a clean environment, a sterile process or production system, enormous damage is caused that not only diminishes product quality, but can render a product entirely unfit for use and subject to recall.</td>
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<tr>
<td>Liquid Oil and Oil Aerosols</td>
<td>Most air compressors use oil in the compression stage for sealing, lubrication and cooling. During operation, lubricating oil is carried over into the compressed air system as liquid oil and aerosols. This oil mixes with water vapor in the air and is often very acidic, causing damage to the compressed air storage and distribution system, production equipment, and final product.</td>
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<tr>
<td>Oil Vapor</td>
<td>In addition to dirt and water vapor, atmospheric air also contains oil in the form of unburned hydrocarbons. The unburned hydrocarbons drawn into the compressor intake, as well as vaporized oil from the compression stage of a lubricated compressor, carry over into a compressed air system where they can cool and condense, causing the same contamination issues as liquid oil. Typical oil vapor concentrations vary between 0.05 and 0.5mg per cubic meter of air.</td>
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