

# The Behavior of Compressed Air

## History of Dry Air

In the 1960's few air systems were equipped with dryers. Specially dried air was used mainly for special applications such as machine controls, laboratory apparatus and special instruments. Drying techniques were developed, introduced, and refined. Drying added considerably to the cost of the compressed air. Drying equipment was added only when the cost of the process, the surface preparation, or the machinery warranted the special equipment. Eventually, various levels of water free, oil free, and filtered air became available to all industries at costs matched to the requirements.

## Problems With Compressed Air

Compressed air is adaptable to more types of plant operations than any other type of power transmitting method. The main problem has always been that the atmospheric air which is being compressed is full of moisture. The high temperatures in the compressor create corrosive oil decomposition products. Dirt is concentrated by the compression process and rust particles are created inside compressed air pipework system.

One cubic foot of air at standard temperature and pressure can contain 2.5% water vapor at saturation and over a billion microscopic particles. This mixture of moisture, dirt, active bacteria, ions, gas molecules, and reactive fumes must be thoroughly dried, cleaned, and treated before it is used by sensitive pneumatic equipment. Otherwise, the corrosive and abrasive particles would damage the air pipework, the equipment being operated by the air, the products, or the painted surface.

## Compression Increases Pressure and the Problems

A compressor must take in 7 atmospheres to build a pressure of 100 psi ( $7 \times 14.3$  psi = 100.1 psi). This process also concentrates the contamination. After compressing, one cubic foot has 7 times the amount of contamination than it had at one atmosphere. In addition, oil vapors and acids have been introduced by the compressing process.

## The Oil in Compressed Air is Harmful to Equipment

Oil which lubricates the compressor cylinders partially decomposes in the 350 degree Fahrenheit heat of compression. Some of the corrosive acids vaporize from the oil and its additives and combine with the other contamination in the air. When this pollution is carried downstream entrained with the air and water it can result in failures, constant repair, product spoilage excessive downtime and contaminated surfaces. All these contaminants must be removed and where necessary, clean lubricating oil injected into the surface of the air-line near to the air tool.

## Atmospheric Air is Always Wet

Many people believe that plants located in dry climates don't have air line moisture problems. This is not true. The earth is surrounded by moisture laden air. Regions which are both hot and dry still have moisture problems in their air lines-Why is

this?

In a hot humid location, the temperature may be 80 degrees Fahrenheit and the relative humidity 100%. In that condition one atmosphere contains 10 grains of water vapor. In a location where the temperature and relative humidity is lower, one atmosphere might contain 5 grains of the water vapor. In a location that is very hot and dry, one atmosphere might contain only 1.5 grains of the water vapor. When the very hot and dry atmosphere is compressed, (7 atmospheres  $\times$  1.5 grains = 10.5 grains) the result is more than enough to completely saturate the compressed air.

#### Compressing Removes Water

If a 20 HP compressor discharging 100 CFM for 40 hours were moved from place to place water would always be created by the compressor. In a hot wet climate, the compressor would create 32 gallons of liquid water. In a location where the temperature and relative humidity lower, 13 gallons per week would be created. And in a very hot dry location, the same compressor would create 2 gallons.

#### Line Air is Always at 100% Relative Humidity

Compression creates 350 degree Fahrenheit air which must be cooled by the aftercooler. As the temperature drops, the amount of moisture which the air can hold drops and the water vapor turns to liquid water. If the air is cooled to 80 degrees Fahrenheit, the compressed air is at 100% relative humidity with 1.4 grains of moisture per cubic foot. The important point to remember is that all air coming from the aftercooler ALWAYS SATURATED WITH 100% RELATIVE HUMIDITY.

#### Are Aftercoolers Necessary

Aftercoolers are a great help to removing liquid water. They are expensive to install. If the pipe from the compressor can run for fifty feet the compressed air will naturally reach 10 degrees over the ambient temperature. At that point, a low cost EXTRACTOR/DRYER can be fitted thereby eliminating the need for an aftercooler. Where a run of 50 feet was not possible, a copper 50' pipe was coiled near the compressor and then piped to the EXTRACTOR/DRYER.

#### How is Air Dried Once it Has Passed the Aftercoolers?

There are several drying methods all work well and have various levels of use cost:

<u>Type</u>	<u>New Cost</u>	<u>Running Cost</u>
A. Deliquescent	2	2
B. Refrigeration	4	3
C. Regenerative	3	4
D. Extraction	1	1

1 is lowest, 4 is highest

1. Deliquescent dryers are vertical towers which separate heavier particles of dirt and moisture below a desiccant chamber. As the air passes up through the absorbent chemical desiccant deliquesces with the finer particles to form a solution which drains down into a condensate accumulation section section. The condensate is then manually drained. The absorbent chemicals must be frequently changed or regenerated.
2. Refrigeration dryers cool pre-filtered air to about 35 degrees Fahrenheit to separate the water. The air is reheated before it is returned to the system. The

condensate is discharged through a drain line. These massive freezers consume vast amounts of electricity as they run.

3. Regenerative dryers usually consist of two absorbent desiccant filled drying towers separated by an electric heater coil. Pre- filtered air flows through the working side while the saturated desiccant is dried electricity. This is the most expensive way to make dry air as the electric heat is switched from column to column throughout the day.

4. Extraction dryers have three chambers and are installed close to the compressor (at a distance where the temperature has leveled off) and close to the point of use. The first chamber coalesces the larger particles and, moisture droplets into a second chamber which is constantly draining. The third filters the air, converts the liquid, moisture to moisture vapor, uniformly meters the vapor into the air line and adiabatically warms the air before it is returned to the system. Extraction dryers are the least expensive way to make dry clean air as they require no outside energy or weekly maintenance to work.