

Understanding the Difference Between Water Vapor and Droplets

In

Compressed Air Systems

and the

Basic Operating principles of the NEUTEK

Extractor/Dryer

Water Vapor Versus Water Droplets

Water Vapor does not harm air driven machinery or controls, but water droplets, can ruin any operation. If an operation, such as spray painting, can be done on a day when there is 100% relative humidity. Then the water vapor in the air clearly does not interfere with the operation. But spray painting can not be done in the rain. Water droplets as rain in the air or in the compressed air definitely interferes with the operation causing fisheyes, pinholes, and blisters. Every day around the world pneumatic operations are being performed and air tools, equipment and instruments are being run by compressed air which is full of water droplets, corrosive oil droplets, and dirt particles.

How Much Water Is There

The saturation point of air at 80 degrees Fahrenheit and standard pressure is called 100% relative humidity.

At this temperature and pressure, 100% relative humidity means that one cubic foot of air contains 10.934 grains of water. When we compress that air to 150 psi we need about 10.5 cubic feet at standard temperature and pressure to equal 1 cubic foot compressed to 150 psi.

($10.5 \times 14.7 \text{ psi} = 154.25 \text{ psi}$).

An aftercooler will remove all of the grains above the 100% relative humidity temperature to which it cools. If air aftercooler could cool to 80 degrees Fahrenheit, then the compressed air would still contain 10.934 grains of water. The aftercooler would have removed about 104 grains of moisture for each 10.5 cubic feet of air compressed. ($10.934 \times 10.5 - 10.934 = 103.873$ grains) But 80 degrees Fahrenheit can only hold 10 grains so 104 grains have condensed to the form of liquid water. That liquid water is separated in the holding tank or caught by water traps in the system. We can safely perform any pneumatic operation at 80 degrees Fahrenheit and 100% relative humidity if there is no liquid water in that humidity.

But. If you trace the air around the system you would find sections where the air

can cool further and form precipitated droplets or areas of stagnation which allows the highly polar water vapors to clump together and form droplets. An ideal system is one that could continuously remove these liquid droplets or convert them back into harmless vapors before being used by the operation.

Excessive Drying is a Waste of Money

In the winter time, if the temperature is 12 degrees Fahrenheit, air at 100% relative humidity contains only 0.856 grains of moisture so we have fewer moisture related problems. If a special refrigerated aftercooler is used the temperature may drop to -20 degrees Fahrenheit with a 100% relative humidity of 0.106 grains. But refrigeration is very costly. And we have seen that the operation can be done at 100% relative humidity containing 10.934 grains of moisture. Removing more than 10.934 grains costs a lot of money and is inefficient. We do not need to remove more if we can condition the air in such a way so that the condensates are continuously drained away and so that the forming droplets are converted back to vapor form. In addition, water droplets in the compressed air system freeze in the winter and stop equipment, controls, and tools from operating properly.

The Compressor Compounds the Problem

High heat created by the compressor during the compression process volatilizes part of the compressor oil causing potentially corrosive gasses to be mixed with the compressed air. As this mixture cools, the corrosive vapors condense with the water to form acids and electrolytes. When these vapors and mixtures circulate in the compressed air in the compressed air distribution system they act on the pipe work to accelerate the formation of rust, dirt and scale.

The Air Distribution System Compounds the Problem

The water is not always evenly spread out through the air system. As the air is used, pockets of water, oil, oil decomposition vapors and dirt become airborne and pulse through the system. These surges have mass, energy, and abrasiveness. The change from stagnant to dynamic compressed air allows the air to cool which condenses vapors into liquids. In liquid form they concentrate the electrolytes to form corrosives which begin to eat away at the metals in the system.

Liquids are not compressible in the bearings, rotors, and other parts of air tools and instruments. (consider the differences in working outside on a day with 100% relative humidity or outside in the pouring rain). Of course, it never rains in your plant but your equipment might be working every day in an air system full of pouring rain. The compressed air can be conditioned just prior to use. The condensates, oils and larger droplets can be coalesced out and the remaining smaller droplets can be converted back into harmless vapor.

Causing the Liquids to Form Droplets

The most economical method of separating liquids from vapors is with a coalescer. A coalescer has no moving parts and requires no outside energy to work. As the air passes through a coalescer, the polar molecules collide and stick together forming droplets. These droplets adhere to the coalescer media and collect other droplets until they are heavy enough to drain to the bottom of the coalescer. Such a coalescer is used in the first stage of the NEUTEK Extractor/Dryer.

Particle Filtration

The second stage element of the NEUTEK Extractor/Dryer is an effective 5 micron filter with only a 2 psi pressure drop. This element is a depth filter in which air travels through a long distance of filter media with an extremely large surface area. In the majority of other types of air filters, air is forced through a short distance of filter media with a very small surface area. The NEUTEK depth filter element removes:

- 100% of the 5 micron size particles
- 95% of the 4 micron size particles
- 85% of the 3 micron size particles
- 75% of the 2 micron size particles
- 50% of the 1 micron size particles

The Ultimate Design

The best condition would be to have all the moisture and other liquids in vapor form only, without any dirt particles and to have these vapors dispersed uniformly throughout a constantly dynamic air system. But our world is not perfect, and temperatures rise and fall, vapors condense, pipes corrode. The compressor concentrates the pollution in the air and the system has many surges during the day and the heat of compressor volatilizes corrosive gasses from the compressor oil and oil additives.

The best and most economical method to even out the problems of compressed air has been the use of the NEUTEK Extractor/Dryer. A large Extractor/Dryer is installed near the compressor at a distance where the compression has stabilized near ambient room temperature. It functions as an aftercooler oil trap and water trap.

Smaller NEUTEK units are installed close to each use point. They function to remove all water, dirt and convert small droplets into vapors. The third location for Extractor/Dryers is at the exhaust outlet of air operated machinery. In that location they silence the exhaust air and catch the oils before they are blown into the breathing air inside the plant. The Extractor/Dryer coalesces out dirt and water droplets in the first stage. The second stage filters and converts the remaining liquid water droplets into harmless water vapor. The idea is to use the air in the process before the vapors can recondense into liquid water.

Three Separate Methods Combined for Efficiency

The NEUTEK Extractor/Dryer converts all (100%) of the harmful liquid airborne water droplets into safe water vapor by three different principles of physics. Liquid water droplets, oil decomposition products and dirt particles are damaging to equipment, controls, instruments, air line systems and can damage products. Water vapor gas has no bad effect on any process, control or equipment. To achieve this state, the Extractor/Dryer has 3 operating principles.

1. The first principle is the coalescing phenomenon. The air expands and is cooled adiabatically when it enters the first chamber. Cool air holds less moisture than does warm air and so some of the water vapor is converted into liquid water droplets. The first stage chamber causes all water droplets above 4 micron in size to coalesce into large drops by providing sites where water droplets collect and ionically

attract other water droplets.

As the air changes directions and spirals, the heavier water particles hit the surfaces of the first stage coalescer and began to grow into large drops. These large drops slowly run down into a second chamber where a honeycomb at the bottom creates a quiet zone. Water drops flow through this honeycomb and drain out the bottom of the chamber through an always open "weep" valve, the honeycomb prevents the water from becoming re-entrained in the air as the air enters the second stage Extractor/Dryer.

A special "T" pin in a drain valve converts into a controllable "weep-valve" which continuously allows air, water and contamination to escape from a closed system even though the compressor is running. This makes the filtration "dynamic". If the line becomes completely closed or "static", then the moisture droplets begin to condense in the air line and will come out in the first blast when the operator opens the line. The weep-valve leaks about 3 cubic feet of air per hour. If the compressed air costs \$0.0025 USD per cubic foot, then the cost is \$0.01 per hour or \$0.08 per 8 hour shift.

2. The second method is the Micro Vorticces Phenomenon. Air borne water droplets smaller than 4 micron size are converted into water vapor gas in the third chamber which holds the second stage filter. Air and water droplets below 4 microns enter the second stage filter at a velocity of 200 to 300 miles per hour. The filter material causes the air stream to spin as it seeks a path through the filter. The spinning causes the air to vortex.

There are thousands of these micro vortices. This disturbance causes the air to accelerate as it spins. Each little spinning vortex is a mini tornado with a vacuum in the center. All small liquid droplets move into the center of the vortex where the energy from the vacuum is higher than the energy holding the molecules of water together and so they instantly separate in vapor form.

This principle of zero velocities can be demonstrated by putting sand into a glass of water and stirring the water around very quickly. The sand particles will collect in the area of least movement, which is in the center at the bottom. This phenomenon is the opposite of the centrifugal force which most people expect to see, yet the principal is also clearly demonstrated when flushing a toilet. The liquid particles in the second stage move into the micro vortices of the spinning air flow just like the salt seeks the vortex of the spinning water. When the water droplets encounter the vacuum they are pulled apart into vapors.

3. The third principle is the Constant volume and pressure of gases phenomenon. Water droplets, dirt, oil and other contaminants are not uniformly dispersed throughout the compressed air system. Some spots collect these contaminants and then reintroduce them when there are surges in the air line. The NEUTEK Extractor/Dryer's second stage filter catches and absorbs the water droplets and other airborne vapors in addition to filtering the dirt and particulates.

As large volumes of air pass through the filter the conditions of the air changes. When these changes occur the filter gives up some moisture as evaporated vapor. By this principle the water droplets are collected and then metered out uniformly in

the air stream. This is the same way that wet clothes dry in a breeze on a day with 100% relative humidity.

Based on the principles involved, the NEUTEK unit should be called an air cleaner/drier/vaporizer.

Energy for Removing Moisture

Energy is required to change liquid water into water vapor, where does this energy come from? The energy contained in the compressed air velocity is the answer. The compressed air is compressed further when it enters the small NEUTEK inlet port and the velocity of the air increases. This increase in velocity accelerates the coalescence action and micro vortices phenomenon.

NEUTEK the and All-In-One-Unit Answer

The NEUTEK Extractor/Dryer represents the first advance in compressed air filtration technology in 60 years. It replaces aftercoolers, it replaces water trap/oiler units, it works without using energy or creating large pressure drops, it constantly removes the accumulated liquids and does not require daily or weekly maintenance. Covered by patents around the world and winner of several "Best New Product" awards it is used and accepted by thousands of prestigious factories and is being installed in plants around the world where compressed air users all need same benefits ...clean dry air.