



Over the years, entrained moisture in compressed air systems has caused numerous problems in the blasting industry, including clogged hoses, ruined abrasive, flash rusting, lost production time, and increased material costs. For a long time, however, the problems were ignored, mainly because blasting sands were very inexpensive. If problems with blasting arose because of moisture entrainment, contractors considered the loss in sand or time to be minor, so they just added more sand and continued blasting.

Attitudes about the problems associated with moisture in compressed air systems are changing, however, because the blasting and painting industry is changing.

For instance, many companies have eliminated blasting abrasives containing free silica because of the risks of silicosis, a respiratory disease caused by inhalation of free silica. Alternative abrasives are more expensive than blasting sand. In addition, the industry is more competitive than it was 10 or 15 years ago. And, because of lower profit margins and higher operating costs, contractors are reconsidering abrasive performance. Lost production time and increased material costs are no longer considered minor.

This article explains the effects of entrained moisture on blasting operations and recent technology for keeping abrasive dry during blasting.

Moisture in the compressor / How moisture forms

Moisture forms in the compressor as the air temperature in the compressor changes. The temperature of the air at the compressor can be as high as 88° C. Water vapor will not condense until the compressed air temperature drops. When the compressed air temperature drops, the vaporous water condenses, forming water droplets. These droplets of water continue to form as the compressed air temperature drops. Compressors have been known to generate as much as approx. 75 liters) of water in an eight-hour workday. This liquid is carried throughout the airlines and blast pot piping. The condensing water vapor is a problem. Compressors, depending on their age and amount of work required, can also vary in the amount of water discharged along with oil into the air system. (The temperature at which moisture condenses is called the dewpoint. There are charts available within the industry that show the dew point at a given ambient temperature. These charts are also used to determine if ambient conditions are suitable for blasting or painting).



How moisture affects blasting operations

Moisture can affect the blasting operation in the blast pot and at the blast nozzle.

In the blast pot, the airflow is slowest, so air cools down quickly. As air cools, water vapor forms and gradually condenses into water particles in the pot. They, in turn, wet the abrasive. Wet abrasive tends to form clumps, making abrasive flow irregularly or stopping it altogether. The smaller the abrasive particles, the sooner the moisture affects abrasive flow. Blasters often start and stop blasting to achieve constant abrasive flow, and, in most cases, they increase abrasive flow to counter the wet abrasive. But these practices lead to lost production time and increased material cost. In effect, more abrasive is used to clean steel at a slower rate. (With the requirement to treat hazardous blasting debris, when lead paint is involved, the increased use of abrasive can also mean higher treatment costs).

The blast nozzle, by design, is a natural air conditioner. Condensation is immediate when moisture-laden hot air exits the blast nozzle. As most blasters have seen, dry air that leaves the blast nozzle is clear. However, when moisture is present, air leaving the nozzle is hazy or foggy. Sometimes, during blasting operations, a trail of moisture follows the blast pattern on the steel surface. The moisture trail leads to a phenomenon called "flash rusting" on ferrous metals. Because flash rusting can interfere with coating adhesion, specifications may require flash rust to be removed. Enforcement of the specification can mean that the contractor must sweep blast the thousand or so square feet that was already blasted. The contractor's profit begins to dwindle as production time and abrasive costs increase.

For years, the typical "moisture trap" was a large tank with air going into the bottom and the discharge going out the top. Some traps had a stainless mesh on the inside to aid in the removal of water entrained in the compressed air. Another alternative, usually on portable blast pots 10 cubic feet (0.3 cubic meters) and smaller, was a "tee type" or general purpose air filter. Moisture traps are satisfactory for removing water, but water vapor that is entrained in the compressed air and has not condensed to form a solid water particle will not be removed by these types of filters.

Recent technology for removing entrained moisture

There are 4 basic types of technology for removing entrained moisture from compressed air:

1. air-cooled aftercoolers,
2. water-cooled aftercoolers
3. refrigerated dryers, and
4. chemical and regenerative desiccant dryers

The first 2 items will be described in some detail, and the last 2 will be briefly discussed. More attention is given to the aftercoolers because compared to dryers, aftercoolers are more practical for field operations.

Air-Cooled Aftercoolers

Air-cooled aftercoolers, or heat exchangers, as they are more commonly known, are not new to other industries. Petrochemical companies have used them in many different applications. Household or automobile air conditioners use this technology. Older houses and buildings use a similar type of exchanger to dissipate heat from water- or steam-heated radiators. The technology is, however, new to the blasting and painting industry.

The air-cooled aftercooler is simple. Generally, it has a radiator-type cooling coil and a motorized fan to pull or push air over the coil. The main operation is the same as that used to cool the water in an automobile engine. The only difference is that in a compressed air system, air cools air, whereas in the automobile engine, air cools water.



To cool the air, you must size the aftercooler to meet cubic feet per minute requirements (CFM). Oversizing, in most cases, does not hurt performance.

Undersizing may not work as efficiently or at all. Most manufacturers go by CFM requirements and by "temperature approach". Temperature approach is the difference between the temperature of the hot compressed air and the ambient air as the compressed air goes through the aftercooler. In other words, temperature approach refers to how close the temperature of the compressed air comes to the temperature of the ambient air. 6° C difference), 8° C difference, and 11° C difference temperature approaches are most common. That is, the compressed air comes within 6°, 8°, and 11° C differences of the ambient air. Temperature approach also aids in sizing the cooler. As the ambient air temperature is approached, the quality of compressed air goes up (along with the cost of the process).

Air-cooled aftercoolers are dependent on ambient air temperatures. In the summer, this means that at 32° C, the best temperature approach that could be achieved would be 38° C. Granted, this does not sound like much, but when looked at from the other perspective, 88° C down to 38° C is not too bad. During fall and spring, the temperature approach will get better, which will produce even dryer compressed air.

Cooling of the air is one facet of the problem of keeping the abrasive dry. Some manufacturers even reheat the treated air. They claim reheating adds to the efficiency by eliminating a potential problem at the nozzle. Reheating will prevent the air from recondensing at the higher temperature. Some manufacturers also say that reheating allows the operator to use cooled air in the summer and heated air in the winter for the blast hoods. The other problem is that aftercoolers require some means of water removal. Just cooling the air (or water vapor) is only part of the solution. Once the air is cooled, water particles form. The particles need to be removed. Two common and inexpensive ways to remove them are described below.

A pressure vessel can be used with the aftercooler to remove water. The pressure vessel removes the water particle from the air stream by slowing the velocity of the air moving through the system, thus allowing the water particle to fall out by gravity. With a pressure vessel, a general rule of thumb is to size the vessel to let the air velocity slow down to 0.9 mtr. per second or less based on the cubic meters of air per minute. This velocity will ensure that the water particles do not stay entrained in the air.

Another "filtering" or water removal system used in place of the pressure vessel is a general purpose filter that has a centrifugal action for water removal. As the water-laden air enters the filter at a high velocity, the water particles are forced against the wall. From there, they drain or fall to the bottom. The clean or dried air continues out through the chamber.

Now, what effect does using an air-cooled aftercooler have on operating cost? A contractor who does bridge painting stated that after he started using his first air-cooled aftercooler, consumption of coal slag abrasive went from 64 kg/sq mtr. to 34 kg/sq mtr. Assuming that problems with entrained moisture occur half of the time, an additional 1500 tons of abrasive are consumed based on 280.000 sq mtr) of blasting production per year. Assuming a cost of \$ 50/ton for the abrasive, this difference adds approximately \$ 75,000 to the operating cost, exclusive of costs associated with increased production time and decreased efficiency.

Water-cooled Aftercoolers

Water-cooled aftercoolers, known as shell and tube heat exchangers, are also used to cool the compressed air. Compared to air-cooled aftercoolers, they are more efficient and generally can attain lower compressed air temperatures because water transfers heat more efficiently. A simple example to illustrate this is to take a hard-boiled egg out of a boiling pan of water and try to hold it. You might get burned. Yet take that same egg and put it under running tap water and you can hold it all day long.



Water-cooled aftercoolers can be 5 to 10 times more efficient than their air-cooled counterparts, depending on the applications. Another advantage of the water-cooled aftercoolers is that they come in smaller packages. In addition, they can be mounted directly on the equipment.

One major disadvantage is that they require a pressurized water system for cooling, which may not always be available.

At this time, we are treating only the compressed air that goes into the blast pot. Since the blast media is hygroscopic (it absorbs water), moisture entrained in the air entering the blast pot caused many problems. Moisture, whether it is vapor or water particles, can affect the ability of the blast media to flow.

Refrigerated Dryers

Refrigerated dryers are the best and most expensive equipment for drying compressed air. They are not very common in portable field applications because they require AC voltage to operate. However, this type of equipment is used with pressurized steel grit blasting because as with freshly blasted steel, the potential for flash rust in the abrasive itself is high when moisture is introduced. Thus, rusted balls of steel grit can accumulate throughout the blasting abrasive. Refrigerated dryers are used in railcar shop blasting, for instance, where steel grit is used. With the refrigerated dryers, dew points of 2° C are readily achieved, which are far superior to dew points achieved with air- or water-cooled systems. This system virtually removes all water. Again, as with the air- or water-cooled aftercoolers, the treated air must be filtered to remove the contaminants. To achieve this low dew point, an air- or water-cooled aftercooler is used as a pre-cooler to drop the compressed air temperature to 38° C or lower. Refrigerated dryer systems do not function well with inlet air temperatures above 38° C. They are expensive, big and the very best in achieving the ultimate in dry air.

Deliquescent Dryers

Deliquescent or desiccant dryers are a type of chemical dryer. A desiccant is put into a pressure vessel, and, as the air passes through, the desiccant absorbs condensed water droplets and water vapor. When used as a filter, this system can maximize the drying capability of a compressed air system. Various desiccants are available, depending on the application. Silica gels and carbons are 2 readily available types. Desiccant dryers generally require no electrical power and have no moving parts. They do, however, require a recharge of the pressure vessel with new or regenerated desiccant. Some manufacturers even offer desiccants that can be dried and reused without shutting down the system.

Conclusion

Any time compressed air moisture is eliminated during blasting, material and operating costs are decreased, and operating efficiencies are increased. Today's marketplace demands better controls and more efficient equipment to maximize productivity as well as profits. Aftercoolers and dryers help contractors achieve both goals.