

## **TECHNICAL NOTE AVOIDING REGULATOR FREEZE-UP**

When air or other gas expands it tends to get cold. If there is moisture present in the flow it may freeze. The ice may then block flow paths resulting in valve or regulator freeze-up. Cooling comes from two sources. First heat energy of the gas is converted to velocity energy as gas moves through the valve. When there is a pressure drop of more than two to one, say from 5000 to 2500 PSI or from 50 to 25 PSI, the resultant temperature drop can be as high as 50 to 100 degrees F. This effect is seen with all gases. When the gas slows after passing through the valve velocity energy is converted back to heat energy and the temperature returns to its original value.

The second cooling effect is dependent on the type of gas and the pressures involved. It is sometimes referred to as JT cooling. Air expanding from 5000 to 2500 PSI will cool about 60 degrees F and this drop is in addition to the velocity cooling effect. The temperature drop caused by JT cooling remains after the gas slows downstream. JT cooling for air expanding from 50 to 25 PSI is negligible. JT cooling for helium gas is also negligible for pressures up to 5000 PSI and above. JT cooling for natural gas is greater than air and can reach 100 degrees F for expansion from 3000 PSI to 1000 PSI.

Consequently all gases will cool sufficiently to cause freezing when expanding from high pressures. Natural gas is most troublesome because it cools the most and is most likely to contain moisture. Air too can cause freezing if not very dry.

Although Aqua Environment Co. Inc. does not guarantee or warrant that valves or regulators will not freeze-up, a number of precautions can be taken to help avoid regulator or valve freeze-up. They include:

- a. CHANGING DRYING AGENTS MORE OFTEN. Manufactures of drying agents such as molecular sieve, alumina, or silica-gel rate their agents as ability to adsorb x pounds of moisture per pound of agent. where x is typically from 0.1 to 0.2. Manufacturers of air or gas drying systems in turn use these numbers in recommending filter change intervals. In some cases more frequent changes are required. Loss of dryer effectiveness can result from:
  - i. Less than perfect operation of compressor moisture separators resulting in liquid water being carried over to the drying agent
  - ii. Operation of compressor separators at less than rated pressure resulting in more water vapor carrying over to the drying agent.
  - iii. Channeling of air through the drying agent caused by vibration, motions from travel, or improper packing of the agent.
  - iv. Operation of separators or the drying agent at higher temperatures. (Typically every 10 degrees F rise in temperature will halve the life of the drying agent.)

Typically when a new drying canister is installed, the air will exit very dry (dew point of -65F or better) even if some or all of the above problems exist. However, if problems do exist the life of the agent will be greatly shortened.

- b. INSURE THE COMPRESSOR MOISTURE SEPARATOR IS OPERATING PROPERLY. Insure there is no excessive vibration at the separator or filter. Liquid water can get past the separator in the form of mist if water level in the separator is too high. Excessive vibration or flow velocities in the separator can cause water droplets to become entrained in the air.

c. OPERATE THE SEPARATOR AND DRYER AT AS LOW A TEMPERATURE AS PRACTICABLE. This may involve removing them from a hot compressor room or providing enough aftercooler tubing to return the gas to near room temperature before entering the separator and dryer. Every 10 degree F rise in separator temperature doubles the amount of water vapor carried over to the filters and drying agents. The purpose of a separator is to remove liquid water but it can not remove water vapor. Also every 10 to 30 degree rise reduces the drying agents ability to hold water by one half.

d. USE A FLOW ORIFICE EITHER UPSTREAM OR DOWNSTREAM OF THE REDUCING REGULATOR. This reduces the cooling effect at the regulator since some of the pressure drop occurs at the orifice. When using a regulator to limit fill pressure to a tank use an orifice upstream of the regulator sized somewhat smaller than the orifice in the regulator. Consult Aqua Environment for details regarding the best use of orifices.

e. USE AN UPSTREAM FILTER. An upstream filter with a larger flow area such as the Aqua Environment model 1397 tee filter helps keep smaller regulator filters clean. They also facilitate easy maintenance since they are more accessible than filters in a regulator.

f. USE A BACK PRESSURE REGULATOR DOWNSTREAM OF THE SEPARATOR AND DRYER VESSELS TO MAINTAIN AS HIGH A PRESSURE AS PRACTICABLE. The higher the pressure in the separator the more water is removed before the gas reaches the drying agent thus increasing its life. Similarly the drying agent is more effective with higher pressures..

If regulator or valve freeze-up does occur check the valve for internal moisture or corrosion. Corrosion indicates there has been excessive moisture. If internal filters (sintered bronze filters) appear corroded or dirty replace them or preferably replace the entire valve cartridge. If the regulator internal filter becomes partially clogged pressure drop and freeze-up can occur at the filter

Conduct periodic valve and regulator inspections and set up maintenance intervals to rebuild them if conditions so dictate.

Since freeze-up can occur due to lack of maintenance even in the best of systems always use back-up systems if regulators or valves supply life support or other critical systems.