

# **FREEZE PROTECTION FOR NATURAL GAS PIPELINE SYSTEMS AND MEASUREMENT INSTRUMENTATION**

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## INTRODUCTION

One way businesses in today's natural gas industry can be certain to maintain a presence in a competitive market is to be able to deliver a consistent supply to their customers. To ensure a reliable supply, companies must be aware of potential problems that could lead to interruptions or shutdowns in service and the procedures that can prevent these costly situations.

Freezing is a major culprit not only in these pipeline shutdowns and interruptions, but it can also affect the accuracy of gas measurement.

## PROBLEM

Freezing can occur not only when water in the gas stream mixes with temperatures below 32 degrees Fahrenheit, but also with the presence of hydrates well above the freezing mark. Freezing can occur in natural gas from gas wells and from produced gas from crude oil wells. It can occur at any point from production to delivery.

Knowing the best ways to prevent freezing is critical. A free-flowing gas stream is a sure way to prevent headaches and save companies time and money. A small investment in prevention will pay off in a big way later in a company's bottom line.

The best way to prevent freezing is to anticipate where the problem is most likely to occur. Areas where there will be a drop in pressure or restriction in flow are likely spots for freezing. Temperatures drop about 7°F for every 100 psi pressure reduction, so even if the flow stream of gas is at a temperature above freezing, that temperature could drop below freezing with a reduction in pressure.

For example, gas flowing through a pipeline at 70°F and 800 psi will not see any effects of freezing. However, if you cut the pressure in the pipeline to 100 psi, the temperature of the gas will drop nearly 50°F, plummeting it below freezing. If that gas has any water vapor or condensate present, it can lead to freezing problems.

Knowing the quality of the gas and the pipeline design and operation are also important. Typically, the gas quality will improve from the time it is at production and

gathering systems to the time it reaches Local Distribution Companies. High BTU gas is more likely to form hydrates or freeze.

Hydrates form when water vapor combines with hydrocarbons to produce a compound that will condense and freeze at temperatures above the freezing point of water. They can form balls of ice that can severely damage or block the pipeline. Equipment, such as instruments, probes, and orifice plates, should be removed at the start-up of a new or cold well so that they are not damaged by the ice or hydrates. Once the flowing stream has been stabilized, they can be put back in place.

Additionally, ice and hydrates can lead to inaccurate measurement. Ice forming on orifice plates can reduce the orifice diameter, leading to inaccurate results. Ice forming on controllers or regulators can cause them to malfunction or stop working completely. Even after the ice thaws, problems can remain with them.

## SOLUTIONS

While freezing leads to many problems in a pipeline, there are several cost-efficient and effective solutions to prevent them. The best way to prevent freezing is by dehydration, the removal of water from the gas stream. Simply stated, with no water, there is no freezing.

### **Glycol**

One way to remove water is through glycol absorption. As gas passes through the glycol inside a contactor, the glycol meets up with a mixture of water vapor and hydrocarbons. The glycol absorbs water vapor entrained in the stream, allowing dry gas to pass through. The glycol is then treated by circulating it to a regenerator and distilling the water out of the glycol. The glycol is then put back in the contactor and the process is repeated.

Glycol absorption systems are relatively inexpensive, but are not without some concerns. There can be some glycol carryover during surges. Changes in flow can affect the system's efficiency and there can be contamination by solid particulates.

## Sieve

Another effective method of dehydration is through the use of molecular sieves in large towers. This solid absorption method is used when higher efficiencies of water removal are required. As gas passes through the large towers of the sieve, it is absorbed by the sieve. The sieve eventually becomes saturated and can be regenerated.

As hot gas passes over the sieve to dry it and evaporate the water, the gas stream is directed to a second absorption tower. The sieve in the first tower is then cooled by gas before it is ready to be used again.

When the sieve in the second tower is saturated, the gas is switched back to the first tower and the process is repeated.

Very dry gas can be obtained using this method, although the process is more costly than the glycol absorption method.

## Methanol

Another effective and inexpensive tool against freezing is injecting methanol into a pipeline.

The methanol is put into the gas stream through a pump or drip and works as an anti-freeze by joining with the gas and water vapor to lower the freezing point of the vapor in the stream. Determining the right amount of methanol to use can be calculated using tables for specific applications.

Methanol injection is also sometimes used to prevent freezing in pneumatic controllers, as well as in preventing liquids from reaching small orifices and passages in these instruments. Addition filters are sometimes put in place to prevent methanol from carrying over into the instrumentation.

## Heat

If gas never reaches freezing temperatures, it stands to reason that it cannot freeze. Applying heat will prevent freezing conditions.

There are several approaches. Line heaters can be put in place. Heat can be applied directly to a control valve body where there are pressure and temperature drops. Direct heat can come through the use of a catalytic heater in an enclosed area. The heat will keep the temperature above freezing, but becomes less effective the farther away it gets from the heat source. Other possible solutions are the use of heat blankets and steam systems.

For all the positive aspects of heating, there are several major concerns. Heat is an ignition point for gas. Safety precautions need to be put in place and followed. It can also be an expensive solution to freezing because of the

equipment required. To maintain the heated environment, additional energy is also required, which means more expense.

## System Design

Careful planning during the design stage for measurement and regulating systems can reduce the chances of freezing. To avoid liquid accumulation, pipe configurations should be set up such that drainage slopes toward drain fittings in low spots. Prevent restrictions by using full opening ball valves and large diameter tubing. Liquids will be drawn toward leaks, so have a leak-free system with tubing that slopes back toward the pipeline. Any steps that reduce restrictions or prevent areas where liquids can collect will minimize the possibility of freezing.

## Drip Pots and Liquid Dumps

In cases of severe liquid problems or when there is a slug of liquid in a gas supply used for instrumentation, drip pots and coalescers can be used to eliminate or reduce the amount of water. For more extreme cases, an automatic liquid dump might be a better solution because it can act as a drip pot collection vessel and will release the collected liquid at a lower pressure point.

## Instrument Filters

Filter dryers provide a clean, dry supply of gas to controllers and other instrumentation that functions using instrument gas.

These units function under high pressure and can eliminate both liquids and particulates. Their removable media cartridges can be filled with various media, from desiccant to charcoal, molecular sieve or material to remove dangerous  $H_2S$ . They can provide protection down to 2-4 microns.

For critical locations, where shutting down the pipeline is not an option, the filter dryers can be built into a dehydration system with offset regulators to provide uninterrupted service. If one side of the system shuts down due to desiccant that becomes saturated, causing the regulator to freeze, the other side kicks in so that there is no interruption in service. The media on the first side can then be replaced and the regulator thawed. The filter dryer can come with a tattletale desiccant that changes color when the desiccant becomes saturated, indicating it needs to be replaced.

Another option is a system that provides regulation, filtration, heat, and a manifold all in one tower. It is designed for pneumatic controllers and process control instrumentation systems, but can be used for other applications that require a clean, dry gas or instrument supply system.

## CONCLUSION

Freezing is a major issue in any natural gas system. Being aware of the problems it can present and taking steps to prevent it are critical for the integrity of the system and operations. Proper planning, regular maintenance, and anticipating potential problems should be a priority. Attention to those preventative details will ensure a smooth operation. Failure to do so can lead to costly problems and affect a company's bottom line.

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