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Application Note

Sample Conditioning – Ozone in High Humidity Environments

May 2021

Humidity and ozone are a combination that can be detrimental to a gas sample measurement and an analyzer. Humidity is a challenge to predict as well as manage successfully. What happens to your sample and ozone analyzer when operating in a high humidity environment?

The water vapor content of a gas is defined by the temperature at which condensation occurs. This temperature is known as the dew point. As the gas sample travels, if it is met with a surface that is cooler than its dew point, part of the water vapor contained in the gas will begin to condense.

While water vapor within an ozone gas sample does not affect the measurement, water droplets make ozone measurement impossible. Mitigation steps must be taken to ensure that liquid water is not allowed to enter the ozone analyzer.

Care must be taken in the design of the sampling system to ensure that water vapor does not condense in the sampling lines. The sample lines should be routed to avoid large temperature gradients along the lines. If the gas sample is brought in from a hot, humid area into a much cooler area, then low power heating tape may be wrapped around the lines to keep the temperature of the sample lines up and avoid condensation. The lines should also not have loops or low points where water could collect.

When the likelihood of condensation occurring is unknown, or if there may be exposure to the outdoor elements, there are a few methods that can be used to prevent water from finding its way into the ozone analyzer.

What options are available to combat both liquid and vapor in the analyzer if the ozone sample being measured is part of the vent or safety and leak process? For example, let's imagine that the end user has an application using the Teledyne API 480L monitor and is experiencing condensation and water vapor in the sample.

The 480L can be configured with a combination of a Coalescing filter and a Permeation Gas Dryer to filter liquid water as well as lower sample gas humidity. A pneumatic block diagram showing a simple system on the ozone sample line, is shown in Figure 1, followed by a brief description of each part.

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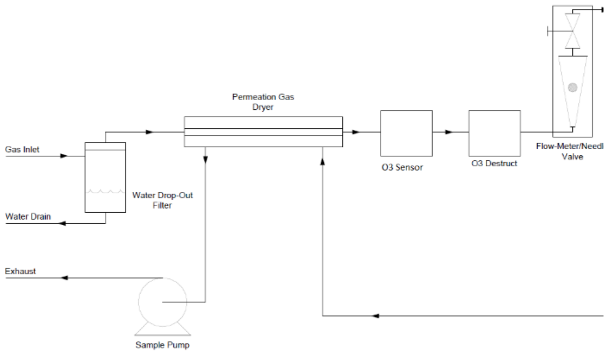

Figure 1: Pneumatic Diagram Sample Conditioning with water coalescing filter and Permeation Dryer

Water droplets of various sizes can be pulled from the sample prior to the sample gas flowing into the analyzer by creating a reservoir filter. This type of filter may be referred to as a water drop out filter or coalescing filter.

In some extreme cases, the water dropout filter method may also be attempted with vent gas to direct larger droplets of water created from exterior environmental conditions, for example, heavy rainwater. The filter is used to divert and collect water running on the sample line to prevent it from being pulled into the ozone analyzer. In this case, an inline filter with a hydrophobic membrane should stop the water from findings its way into the analyzer.

For off gas applications, Teledyne API offers the 480M process ozone monitor, which includes both the coalescing filter and the permeation dryer to ensure water vapor and condensation are removed from the sample prior to entering the analyzer and maintains RH at a relatively constant %.

Coalescing Filter Theory of Operation

A coalescing filter is the first step in the process of removing any liquid water from the sample gas. A typical filter works in two ways:

1. Removing water droplets that are large enough to precipitate out of the air and will fall to the bottom of the filter's reservoir.

2. Removing smaller droplets which stay combined and stream along with the air. The air moves through a membrane at the top of the filter and the droplets collect along the Teflon fibers, collecting until they are large enough to drip down into the reservoir.

The filter is designed to capture small amounts of water condensing in the sample lines. The water collected will periodically need to be drained in this type of system. If water is continuously condensing in the lines, the filter body will fill up quickly, and lead to water entering the analyzer. If it is possible for significant amounts of water to enter this filter, provisions must be made to automatically drain the filter body, for example, adding on a timer-based solenoid valve.

Depending on the application, the Teflon filter may need to be periodically replaced due to solid contaminates becoming trapped in the filter element over time.

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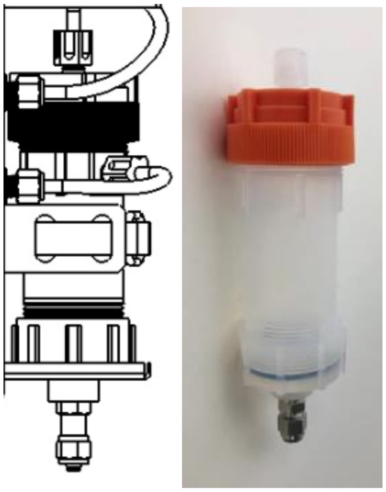

Figure 2: Coalescing Filter used with 480

For more information on products, product configuration options, Teflon membrane physical dimensions and pore size used in dropout filters, please contact Teledyne API Sales by email at api-sales@teledyne.com or visit our website at [www.teledyne-api.com.](http://www.teledyne-api.com)

Permeation Dryer Theory of Operation

A permeation dryer is used for removing water vapor from the sample gas stream which helps maintain a relatively constant RH. It should be connected downstream of the water drop out filter. The permeation dryer is made up of an inner and outer tube, example shown in Figure 2.

As the sample gas flows through the inner tube and water vapor permeates through the wall to the outer tube, the water is carried away by a purge flow, through the outer tube. This process is call per-evaporation and driven by the humidity gradient between the tubes, as well as flow rates and pressure difference between the inner and outer tubes.

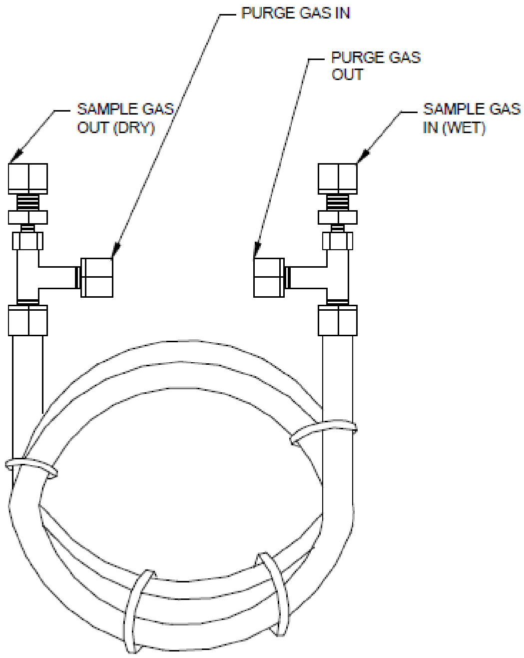

Figure 3: Dryer Assembly

Typical material is a Teflon type compound which should have only a minimal effect on the ozone concentration in the sample stream.

For more information on materials, sample flow rate and purge flow rate, please contact Teledyne API Sales by email at api-sales@teledyne.com or visit our website at [www.teledyne-api.com.](http://www.teledyne-api.com)