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Technical Topics

Understanding Glycol Laboratory Analysis

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Glycol is commonly used for freeze protection in many building closed chilled loops and hot loops. The most common HVAC glycols include ethylene and propylene based compounds. These glycols come in both inhibited and uninhibited forms.

Glycol can break down over time and use. When glycol is exposed to heat or oxygen, it will break down to form six different organic acids. When this breakdown occurs, severe damage can occur to the metals in the system. Microbiological growth in the glycol/water may also begin to form. This may also result in the severe corrosion of system metals. In order to insure that the glycol being used will still protect the system as desired, periodic testing of the glycol/water solution should be done. Depending on the system and type of glycol, a laboratory analysis should be done every one to two years. If the glycol system is extremely tight with little or no loss, testing may be done less frequently.

Most facilities use inhibited ethylene glycol for freeze protection. Inhibited ethylene glycol provides the most efficient heat transfer of the two glycols. Inhibited propylene glycol is used where glycol toxicity is a concern. The inhibitor used by the majority of glycol manufacturers is dipotassium phosphate. This inhibitor buffers the solution when the glycol begins to break down. The measure of protection provided by this inhibitor can be monitored by running a Reserve Alkalinity test. In many cases, secondary corrosion inhibitors may be used to help protect system metals. Corrosion inhibitors such as nitrite, molybdate, silicates and azoles may be employed to protect the base metals in the system.

The Standard Glycol Laboratory Analysis includes the following tests: pH, Specific Conductance, Total Iron, Copper, Sodium Nitrite, Molybdenum, Percent Glycol, Freeze Point, Reserve Alkalinity and Orthophosphate. Each of these tests helps provide an overall view of the glycol solution. Here is a review of each of these tests:

- *pH*: The pH of the glycol is measured to determine if the glycol has broken down into corrosive acids. Most inhibited glycols provide a pH between 8.0 and 10.5. Actual pH may vary based on the percent glycol and the type of water used in the glycol/water mixture. If city water is used to dilute the glycol, the pH may be in the high range, where as if a glycol premix is used, it may be in the low end of the range.
- *Specific Conductance*: The specific conductance is measured in micromhos. Depending on the percent glycol in use, the specific conductance will vary from a low range of 1500 µmhos to a high range of 4500 µmhos. The higher the percent of inhibited glycol, the higher the conductivity. Pure uninhibited glycol may have a very low specific conductance under 100 µmhos.
- *Total Iron*: The level of total iron is tested to determine if corrosion of mild steel or iron pipe is a concern. Ideally, iron levels should be below 2 ppm. Higher levels may be seen if the system does not have filtration as part of the protection package. Inhibitors such as molybdate and nitrite may be used to reduce the level of mild steel corrosion in a system.

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- *Copper*: Copper levels are also tested to determine if corrosion of copper pipe is a concern. Ideally copper levels should be below 0.2 ppm. This level may vary depending on the amount of copper pipe in the system. The use of an azole copper inhibitor can be used to increase the corrosion protection of yellow metals in the system.
- *Sodium Nitrite*: Sodium nitrite is a basic mild steel corrosion inhibitor that is used to provide extra corrosion inhibition. Levels may vary from a low of 500 ppm to a high of 1500 ppm.
- *Molybdenum*: Molybdenum or molybdate is also used as a basic mild steel corrosion inhibitor to provide extra protection to the system metals. Molybdate levels may vary from a very low level of 15 ppm to a very high level of 100 ppm.
- *Glycol Percent by Volume*: This test result will give the tested percentage of glycol based on the type of glycol used. In most cases the percent by volume should be in the range of 20% to 40% for best protection. Levels below 20% have an increased chance for microbiological growth causing the glycol to break down.
- *Freeze Point ^{o}F*: The actual freeze point is determined by the type of glycol and the percentage of that glycol. The freeze point desired varies based on the system treated and the area of the country the building is located in. A 40% solution of propylene glycol provides a -8^{o}F freeze point whereas a 40% solution of ethylene glycol provides a -13^{o}F freeze point. Most freeze points are between 10^{o}F and -10^{o}F.
- *Reserve Alkalinity*: This test is designed to check the level of the buffering agent and metal passivators that are included in the inhibited glycol formulation. The buffering agent functions to buffer the acids as they are formed by the break-down of the glycol. A reserve alkalinity of 10 to 12 is generally adequate.
- *Orthophosphate as PO_4 ppm*: The inhibitor package that is included in the inhibited glycol is dipotassium phosphate. This test, like the Reserve Alkalinity, gives the level of this inhibitor. The level of orthophosphate will vary based on the percentage of glycol used. Ranges are typically 1000 ppm to 5000 ppm.

When sending in glycol samples for testing, it is extremely important that the type of glycol be indicated on the Laboratory Request Form. If the type of glycol is not known, extra testing may be required to provide meaningful results. The lab can test the specific gravity of the glycol/water and then cross-reference this result with the refractive index to deduce what type of glycol is present. This method will not be accurate if there is a mix of ethylene and propylene in the water. If necessary, the sample may be analyzed by gas chromatography (GC) which will determine if the glycol is ethylene, propylene, or a mix of both.

Mixing propylene and ethylene glycols within the same system is not recommended. Both ethylene and propylene glycols are used in automotive antifreeze; automotive grade glycol should not be used for HVAC applications due to its specific design for engines. There are also applications that require special types of glycol, such as high purity loops and loops with aluminum components. In these cases, recommendations from the equipment manufacturer should be followed.