EnviroAqua
CONSULTANTS INC.

# Water Talk

## Glycol Solutions - Ethylene and Propylene Glycol

*Volume 13, Issue 2* *March 2013*

### INTRODUCTION

Water treaters are often asked to recommend a particular heat transfer fluid, either Ethylene Glycol or Propylene Glycol. Furthermore, the question becomes whether or not to use an inhibited Glycol or non-inhibited Glycol.

This water talk is an effort at sorting out the various choices.

### ETHYLENE GLYCOL vs. PROPYLENE GLYCOL

Both products have a long history of very good performance in closed loop heating and cooling systems. The major differences between the two fluids are viscosity, freeze point (of aqueous solutions) and toxicity.

#### Ethylene preferred due to performance

Typically ethylene glycol is preferred over propylene glycol because of its more desirable physical properties (particularly at low temperatures).

Ethylene Glycol tends to be less viscous than Propylene Glycol as temperature decreases. Thus systems using ethylene glycol will require less work to pump the fluid.

**Viscosity comparison of 60% glycol solutions**

| Temperature, °F | Viscosity, 60% Propylene Glycol |
|---|---|
| 0 | 3 x 60% E.G. |
| -20 | 6 x 60% E.G. |
| -40 | 9 x 60% E.G. |

From the table, it is clear that when using propylene glycol, careful consideration should be given to the pumping requirements in systems operating below 0°F.

This lower viscosity also translates into better heat transfer efficiency for systems utilizing Ethylene Glycol.

Additionally lower Ethylene Glycol concentrations are needed to attain the same freeze point depression, as seen in the table below:

**Freeze point comparison, E.G. vs. P.G.**

| Freeze point target, °F | Wt% Ethylene Glycol | Wt% Propylene Glycol |
|---|---|---|
| 20 | 16 | 19 |
| 10 | 25 | 29 |
| 0 | 33 | 36 |
| -10 | 40 | 43 |
| -20 | 45 | 48 |
| -30 | 49 | 52 |
| -40 | 53 | 55 |
| -50 | 56 | 58 |

#### When to use Propylene Glycol

Propylene glycol is preferred in certain applications involving possible contact of the coolant fluid with foods or beverages. Propylene Glycol appears on the list of substances Generally Recognized as Safe (GRAS) for use in food or food processing applications (as published by the FDA).

Conversely, Ethylene Glycol is listed by the EPA as a hazardous chemical. It has a reportable quantity (RQ) for spills of 5,000 lbs or more.

Ironically, even though Ethylene Glycol is listed as hazardous, due to its toxicity, it has a lower BOD than Propylene Glycol. It also tends to persist in the environment for a much shorter period of time, because its half life is less than half of that as compared to Propylene Glycol.

**INHIBITED vs. UN-INHIBITED**

Many commercial grade glycols come complete with corrosion inhibitors. These specially formulated packages of industrial inhibitors help to prevent corrosion of the metals in several ways. These inhibitors are most often phosphorous based formulations that act to passivate the mild steel. They are also designed to act as buffers, preventing the drop in pH resulting from acid formed during glycol oxidation. Glycol oxidation occurs as a result of degradation of the glycol in the presence of heat and oxygen.

Although these pre-inhibited glycol products are fairly good at protecting mild steel components, they often lack several key elements.

One critical component, usually lacking in pre-inhibited glycols is a yellow metal corrosion inhibitor. Most, if not all, heat transfer systems found will contain some sort of yellow metal. Whether the yellow metal exists as heat transfer tubes or even as the pump impeller (bronze), they still are best protected from corrosion by an adequate concentration of free azole.

Another component typically lacking and sometimes needed is a good dispersant, especially in high temperature systems. Evaporative losses could become appreciable if these systems are vented or semi-closed. Dispersants can be helpful in keeping heat transfer surfaces free of deposited debris. This action helps to prevent corrosive conditions, and can act to maintain system efficiencies. Furthermore, if the pre-inhibited products are used, with their phosphorous based inhibitors, and the system has been filled with hard water, and the system does experience some evaporative losses, then the solution could concentrate. Without a suitable dispersant, this concentrating action could result in an increased potential for fouling.

One final word about the common pre-inhibited products. As discussed earlier, these inhibitor packages are typically phosphorous based. These phosphorus based inhibitor packages require special water quality guidelines as found in the table below:

| Typical Dilution Water Quality | |
|---|---|
| **Impurity** | **Level, max** |
| Chlorides | 25 ppm |
| Sulfates | 25 ppm |
| Calcium | 50 ppm |
| Magnesium | 50 ppm |

In most cases this water quality is unattainable without special treatment arrangements (distillation, deionization). This treatment arrangement would also need to be in place for future requirements of makeup of water losses.

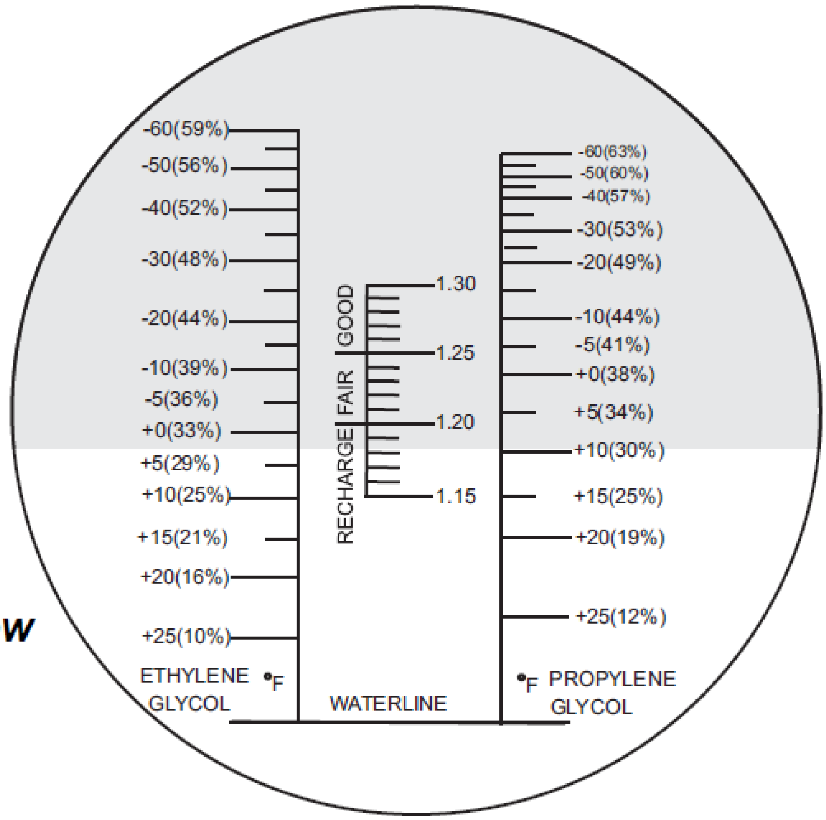
Another issue many have found with the pre-inhibited glycol solutions is the microbial issues caused by the reliance upon a phosphorous based inhibitor. These microbial issues can become compounded in those systems running a glycol concentration less than 30%, because the low glycol concentration acts as a food source for microbes.

Inorder to solve these problems, many water treaters choose to use an un-inhibited glycol product and fortify the system using a formulated, glycol compatible, closed loop treatment, that does not contain phosphorous. Typical formulations could include some combination of molybdate, nitrite, azole, pH buffers, silica, and dispersants (including a copolymer if needed). These formulations are extremely effective and proven in systems that utilize a hard water make-up.

## DETERMING GLYCOL CONCENTRATIONS

The simplest and most reliable method to determine the system glycol content can be made with a refractometer. Portable refractometers measure the concentration of both ethylene glycol and propylene glycol. These typically only need a couple of drops of sample.

Refractometers designed for use with glycol solutions report the freeze point of the fluid, as well as the % glycol, and sometimes even the specific gravity (1.15 – 1.30).



***Field of View***

These meters work on a simple principle, refraction. When light enters a liquid, it changes direction; this is called refraction. A refractometer measures the degree to which the light changes direction. The amount of change in direction is correlated to the % glycol concentrations and indicated at the shadowline. This shadowline is the boundary of the light and dark fields as shown.