# Using Glycol in Industrial Heating System Applications

SIGMA THERMAL INC.

INDUSTRIAL PROCESS HEATING SYSTEMS, AUTOMATION, SERVICES AND PARTS

# USING GLYCOL IN INDUSTRIAL HEATING SYSTEM APPLICATIONS

Ethylene and propylene glycol are commonly used to facilitate heat transfer functions in liquid phase heat transfer systems. Industrial facilities use these solutions for process cooling, but the same fluids may also be used in process heating systems. Some of the properties that make propylene and ethylene glycol so effective include:

- High specific heat capacity
- High thermal conductivity
- Low viscosity
- Water miscibility

Water is a common solvent. While it's also an effective heat transfer fluid, its low boiling point and corrosive nature make it a poor match for heating processes without some sort of additive. Glycol mitigates the disadvantages of pure water by improving the following properties:

- Raises the boiling point above 212° F (100° C)
- Lowers the freezing point below 32° F (0° C)
- Includes corrosion inhibitors to stop water-caused corrosion

If you're considering using glycol or a water/glycol solution in your facility's process heating system, this eBook will address many of the common questions and concerns associated with this method. Readers will learn about the differences between types of heating fluids, what to look for during the selection process, and how water/glycol solutions perform under different conditions.

# Heat Transfer Oils vs. Water/Glycol Solutions

Water/glycol solutions aren't the only heat transfer mediums used in industrial processes. Here's how they compare to other fluids:

## Synthetic and Organic Thermal Oils

Thermal oils work well in high-temperature systems with operating conditions up to 750° F. They create very little vapor pressure at constant high temperatures, which keeps the system stable and predictable.

## Water

Without additives, water only operates well in very limited conditions. Pure water is the best heat transfer medium, but only at low temperature thresholds because of its low boiling point. Above that point it creates significant and dangerous levels of vapor pressure.

## Water/Glycol

Water/glycol mixtures have higher boiling points than water alone.
It is possible to raise the boiling point even higher by increasing the concentration of glycol within the solution. For application temperatures between 250–300° F, manufacturers can use ethylene and propylene glycol. Tri-ethylene glycol may be used effectively in operating temperatures up to 350° F.

Higher concentrations of glycol ultimately lower the heat capacity of the water in the mixture, but water/glycol mixtures still possess a better heat capacity than thermal oils. Ultimately, water/glycol solutions provide ideal performance in low and mid-range heat processing systems that maintain temperatures between 176–247° F (80 –175°C).

# Heater Types for Water/Glycol Solutions

Water/glycol solutions perform well in many different types of heaters. It is possible to use thermal fluid heaters, water-tube style boilers, electric circulation heaters, and in some cases even firetube style boilers. The principal factor in selecting a heater is confirming the manufacturer has a reliable and proven method for determining the maximum film temperature of the fluid within the heater. Exceeding the maximum film temperature of the glycol solution will thermally degrade the glycol, prematurely increasing operating cost as new glycol will have to be added continuously.
Generally speaking, thermal fluid heaters and water-tube style boilers are better suited for controlling maximum film temperature. More specifically, thermal fluid heaters, which are designed to heat oils that are more sensitive to degradation than glycol, will likely deliver the longest fluid life and minimize system maintenance.

Water/glycol is also commonly used in water bath style process heaters. These process heaters typically operate below 190°F, although in some cases they can operate under pressure at higher temperatures. Even if not necessary for raising the boiling point, most glycols are sold with a rust inhibitor package that is beneficial to the longevity of these types of heaters.

# Ethylene Versus Propylene

Ethylene and propylene are similar in function, but they do have some differences. Ethylene has superior heat transfer properties and is less viscous, but propylene is a safer, more environmentally friendly option. Propylene also degrades at a slower rate under higher temperatures and pressures. When making this selection, facility managers must account for containment capabilities, the environmental risk posed by a system leak, the operating temperature required, and the viscosity requirements of the system.

# Not All Glycol Is Created Equal

Manufacturers formulate specific subtypes of glycol targeted to specific applications. Manufacturers who produce glycol for heat transfer systems formulate materials that offer thermal degradation protection and corrosion inhibitors.

It's important to choose the right compound for your system. Otherwise, your process system will experience frequent glycol degradation. The fluid will have to be changed frequently and can cause wear on the system or inefficiencies in heat transfer processes. Using the wrong glycol may also result in corrosion because the degraded fluid can no longer inhibit damage.

# Glycol Is Hygroscopic

When fluids or compounds absorb moisture from their surroundings, this is known as hygroscopicity. Glycol is hygroscopic, and the relative humidity of the surrounding area determines how much moisture it absorbs.

It's essential that facilities store glycol with secure covers to block condensation and humidity from reaching the chemical. If your system requires a water/glycol solution with a high concentration of glycol, the unwanted introduction of unexpected water can degrade the fluid. This will cause a lower boiling point, increase system pressure, and reduce the effectiveness of corrosion inhibitors.

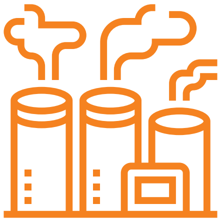
# Other Factors to Consider

Depending on the nature of your facility's heat process system or the surrounding environment, you may face additional constraints when choosing an optimal fluid. Keep these factors in mind as you research your options:

## Boiling Point

By itself, water has a boiling point of 212° F, or 100° C. Adding glycol to the solution increases this boiling point. It also lowers the freezing point and adds corrosion inhibitors to the fluid to further reduce the risk of any system damage.

## Emissions



Many facilities face—or will face in the future—constraints regarding acceptable levels of emissions. Glycol solutions have substantially reduced emissions compared to thermal oils when used in heating systems.

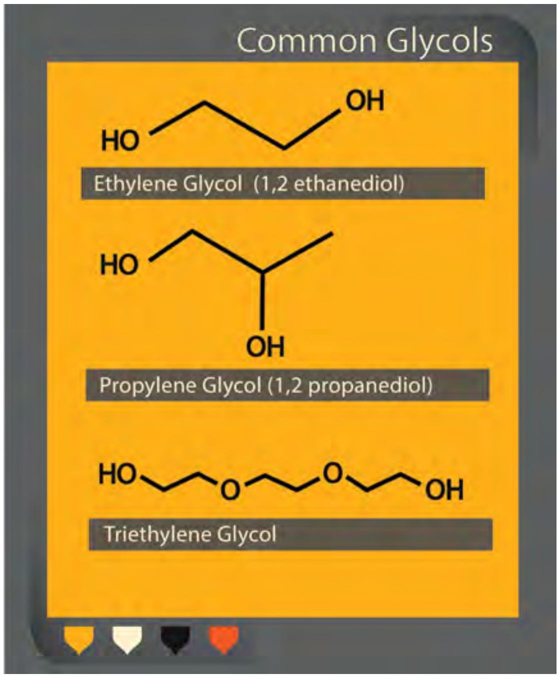
## Expansion Volume

When water freezes, it expands by approximately 9% in volume. Even water/glycol solutions will eventually start to freeze when exposed to constant low temperatures, but the solution controls the freezing process to reduce the risk of pipe bursts or parts damage. Even as the water inside of the fluid starts to freeze, the glycol remains a liquid and will continue to move. The result is a flowable slush mix.

The fluid will still slightly expand to fill any expansion volume built into the system. However, provided it has appropriate expansion space and the concentration of glycol remains high enough, the system will not suffer damage.

## Freezing Point

By itself, water has a freezing point of 32° F (0° C). The introduction of glycol can lower the freezing point to -70° F to -100°F, depending on the glycol concentration. This reduces the risk of fluid expansion as the frozen water increases in volume. Lowering the freezing point also reduces the risk of ice crystals in the circulation system , protecting year-round pumping systems. Glycol is a cheaper and more reliable option than preventing freezing through continuous pumping and/or heating.




Common glycols used for heat transfer and freeze protection.

## Thermal Stability

When chemicals are heated above a certain point, they can start to degrade or become unstable. Water/glycol solutions are thermally stable until they reach high temperatures starting at approximately 220° F, although this point will vary by manufacturer and specific formulation. At that point, the glycol will start to degrade and form organic acids. Over time, these acids can corrode the system's internal parts, as well as foul the heat exchangers and components in the fluid loop.

Once the chemicals become thermally unstable, they also can't transfer heat at the same degree of efficiency. Ethylene glycol degrades the fastest under high temperatures and pressures. For boiler or solar thermal hot water systems, bio-based glycol is a better choice. This fluid degrades five times slower than ethylene glycol and half the rate of propylene glycol. The longer the life of the fluid, the better it can perform and extend the life of the equipment.

## Viscosity

The less viscous a liquid is, the better it tends to be at heat transfer applications. Thinner liquids are more efficient and perform better in low temperature environments. Ethylene glycol is less viscous than propylene glycol, and many facility managers prefer it for that reason.

# Glycol Solutions From Sigma Thermal

If you have more questions about water/glycol solutions for your heating and process systems, Sigma Thermal is here to help. We have many years of industry experience and understand all of the latest technologies and trends in process fluids. Our experts can answer all of your questions. Contact the team about your specific application or project.

# About Us

Sigma Thermal designs, engineers, supplies, and services process heating systems for industry. Our products include thermal oil and thermal fluid heating systems, indirect process bath heaters, electric process heaters, biomass fired energy systems, direct fired process heaters, system automation, parts, retrofits/upgrades, and supporting services. Our staff is comprised of dedicated and experienced industry veterans who are prepared to learn about your application and provide solutions specific to your project needs. Whether you need a standard package heater, a highly engineered process heating system, or just a tuneup on your current system, our engineers and technicians have the knowledge and experience to make your project a success.

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