

CHILLER SYSTEMS AND GLYCOL USE Seven Considerations



Presented by:
Martin P. King
Legacy Chiller Systems

Glycol use in process chiller applications can be a challenging subject. Its impact on both design and operation of process chiller systems can be dramatic therefore understanding the basics is a must.

The goal of this paper is to provide the chiller service or design professional with an understanding of glycol use and application within process chiller systems. By putting this information to use, costly operational challenges can be avoided while improving overall system performance.

1. Types of glycols most commonly used in Chiller applications

Most process chiller application being deployed today use two types of glycol. These types are: Ethylene Glycol (E.G) and Propylene Glycol (P.G.). The table below, outlines the basic characteristics of each:

Property	Ethylene Glycol	Propylene Glycol	Comments
Freeze point depression	More effective	Less effective	More antifreeze is needed of propylene glycol to achieve the same freeze point
Heat transfer efficiency	Less	Better	Ethylene glycol can't carry as much heat as propylene glycol. More fluid must be circulated to transfer the same amount of energy. Pumps volume increased.
Viscosity	Lower	Higher	Propylene glycol increases major head loss in the systems. Pumps head increased.
Flammability	Low	Low	
Chemical oxygen demand	Low	Higher	
Biodegrading	Degrades in 10 - 30 days	Needs more than 20 - 30 days to degrade	
Carcinogenic	No	No	A carcinogen is any substance or agent that promotes cancer
Toxic	High level of acute when taken orally, targets the kidneys	Lower level of acute	Ethylene glycol should never be used in any drinking water or food processing system
Skin irritant	Low	Low	Propylene glycol is used in small amounts in cosmetics

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2. What Glycol to use in your system?: There has been some debate as to what type of glycol to use in process chiller applications. Speaking from a manufacturer's perspective, we will outline some of the key considerations of both Propylene and Ethylene glycols:



Glycol Concentration: The lower you need your process fluid freeze point, the more glycol concentration you need in your system. In this category, Ethylene Glycol is the better performer as you will require less volume to achieve your desired level of freeze protection. For Example: At a concentration of 50% Ethylene Glycol, you can achieve a freeze point of about -34F compared to about -24F using Propylene Glycol. Depending on what you pay for these products and the total fluid volume of your system, reduced concentration by using Ethylene Glycol could potentially result in significant cost savings.

Environmental Considerations: Over the last decade, environmental concerns have impacted Ethylene Glycol usage dramatically. In many states, Ethylene Glycol is considered a toxic material therefore deployment of this material comes with increased operating costs by way of special training for handling, disposal and oh yes the ever dreaded spillage. In this category, Propylene Glycol is the clear winner with its very low environmental impact.

3. Chiller Cooling Capacity: If your chiller system requires Glycol, capacity loss must be considered. Although there are some differences between Glycol brands, as the concentration increases, heat transfer between the chillers Evaporator (Barrel) will slow since glycol is less conductive to heat transfer than water. In the table below, chiller btuh reduction factors have been provided.

Glycol Type	20%	30%	40%	50%	60%
Propylene Loss Factor	.93	.90	.87	.83	.76
Ethylene Loss Factory	.90	.86	.91	.76	.71

Important Note: Excessive glycol concentration can be more costly than most people realize. For example, if your chiller's operating environment only requires 20% P.G. concentration and "Just Because" the decision is made to run the system at 60% P.G. , the above table indicates a net loss in cooling capacity between these two concentrations of 17%. If you run a 24/7 operation, this additional loss could result in a dramatic increase in energy costs.

Above data is based on ThermalStar® (P.G.) and ThermalCool® (E.G.) concentrated inhibited glycol at 35F

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4. Chiller Pumping Capacity Considerations: Glycol tends to be heavier than water. In open loop applications, this added weight can also increase energy costs as more pumping power is required to overcome vertical lift. In both closed loop and open loop systems, glycol also produces increased friction losses as it passes through fittings, valves, filters and even straight pipe. Another factor to consider are the changes in glycols viscosity when process loop temperatures drop to within five degrees F of the freeze point. As glycol approaches its "Slush Point" process loop friction losses increase requiring even more pumping power.



5. Chiller Customizations Needed for Glycol: Most commercial/industrial chillers on the market are designed at ARI standard that calls for 45F leaving the evaporator. At Legacy, we make adjustments in our evaporator selections for chillers that need to run over 20% glycol concentration. In doing so, evaporator pressure drops tend to be lower and more importantly the added surface areas of our evaporators help counteract the heat transfer losses associated with glycol use. Making such adjustments also helps to maintain lower KW requirements since in most cases we will not need to increase compressor horse power.

6. Chiller Commissioning and Startup Considerations: Commissioning glycol chiller systems should be performed by a qualified technician. Using glycol adds a higher level of complexity to commissioning that must be addressed in order to avoid potential operational issues. As part of the commissioning service, the technician must consider the following service points:

- **Hot Gas Bypass systems:** In most cases, hot gas regulator valves are factory set for water. This is done by design to prevent potential evaporator damage in the event the customer tries to run the process temperature set-point lower than 45 F without first adding glycol. Since hot gas regulators respond to the compressors suction pressure, they will tend to deploy too soon on glycol systems. When this happens the end user will complain that the chiller has a lack of capacity.
- **Chiller flow safeties:** As with hot gas regulators, chiller flow safeties are calibrated for water at the factory. When glycol is added the process loop, viscosity will change with your glycol concentration. In many cases, glycol will change the flow and pressure drop across the chillers evaporator calling for field calibration as part of commissioning.
- **Compressor Low Pressure safeties:** In most cases, the chillers low pressure fault pre-sets will need to be adjusted. These adjustments will prevent nuisance low pressure shut downs of the compressor.

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7. Chiller Maintenance Considerations: Using glycol in chiller systems creates additional maintenance considerations that are very important to assure long term chiller operational reliability.



- **Maintaining Glycol Freeze-point:** After initial chiller commissioning, we have seen circumstances occur in day to day chiller operation that can cause changes in glycol freeze-point. In most cases, small freeze-point changes have little noticeable impact on chiller operations however, over time, small changes can build up to eventually create significant, and in some case catastrophic, system problems. Legacy recommends maintaining a detailed maintenance log especially on glycol chillers.
- **Process Fluid Testing:** Routine testing of the glycol heat transfer fluid is the best way to insure the fluid is within specification and adequately protecting components while providing the cooling required in the system. An outside laboratory can perform most of the tests required with no interruption to service and at minimal cost. Legacy recommends chiller systems that use glycols be tested every six months at a minimum.

The following tests should be performed:

- PH – helps determine the strength of inhibitor. As the pH drops and approaches 8.3, the strength of the inhibitor is also dropping
- Inhibitor concentrations
- Glycol degradation acid byproducts concentrations
- Wear and corrosion metals concentrations
- Glycol concentration

If the system is running normally, regular annual tests should begin after the first year of operation. After six years, process fluid may need to be tested every six months. If the system is run irregularly, there have been changes or modifications to the system, or the pH and Reserve Alkalinity are dropping, the fluid should be checked at more frequent intervals.

- **Process Fluid Replacement:** Through regular fluid testing (above), glycol levels can be closely monitored to prevent potential glycol related system failures. Depending on the operating requirements of your system, testing will begin to present degradation of glycol inhibitors. Once inhibitor levels drop to approximately 70% of initial (New) levels, breakdown of process system materials such as piping, heat exchangers and pump impellers tends to accelerate. When this breakdown starts, it will tend to accelerate if not addressed. A common visual clue of breakdown is discoloration of the process fluid. For this reason, Legacy recommends process fluid replacement once inhibitors get below the 70% level. A ball park range for fluid replacement is every 6-8 years.

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Additional Chiller TechNet Resources

[Video: Closed Loop Chiller Systems](#)

[Video: Open Loop Chiller Systems](#)

[Video: How to use SystemSyzer Tool](#)

[Video: Using Chiller Energy Audit Tool](#)

About Legacy Chiller Tools: Most chiller system design and energy usage tools are offered to our customers and business partners free of charge. To request one of our tools call 877-988-5464 x 101 or email us at: support@legacychillers.com



Martin P. King
Legacy Chiller System
Senior Fluid System Designer
877-988-5464
Sacramento, CA
mking@legacychillers.com

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Article Contributors: Thermal Fluids, Inc. Manufactures of ThermalStar® (P.G.) and ThermalCool® (E.G.) heat transfer fluids. (800)640-8011

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