7 STEPS to Chiller Success

Chiller success does not depend on luck. If you consider these seven points, you can help improve chiller system performance.

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 of glycol is a must. This article will provide an overview of glycol use and applications within process chiller systems. By putting this information to use, costly operational challenges can be avoided while improving overall system performance.

1. Understand Glycol Type

Most process chiller applications being deployed today use two types of glycol: ethylene glycol (sometimes called EG) and propylene glycol (sometimes called PG). Some of the key properties are shown in table 1.

2. Select the Glycol for Your System

There has been some debate as to what type of glycol to use in process chiller applications. Speaking from a chiller manufacturer's perspective, here are 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 because less volume is required to achieve the desired level of freeze protection. For example: at a concentration of 50 percent ethylene glycol, you can achieve a freeze point of about -34°F (-36°C) compared to about -24°F (31°C) using propylene glycol. Depending on what you pay for these fluids and the total fluid volume of your system, reduced concentration via the use ethylene glycol could result in 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 (dreaded) spillage. In this category, propylene glycol is the clear winner with its low environmental impact.

The lower you need your process fluid freeze point, the more glycol concentration you need in your system.

Table 1. Ethylene and Propylene Glycol Properties

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.

Table 1. Key properties of ethylene and propylene glycol are compared.

Table 2. Cooling Capacity Comparison

Glycol Type	20%	30%	40%	50%	60%
Propylene Loss Factor	0.93	0.9	0.87	0.83	0.76
Ethylene Loss Factor	0.9	0.86	0.91	0.76	0.71

Note: The data in this article is based on ThermalStar propylene glycol and ThermalCool ethylene glycol concentrated inhibited glycol, manufactured by Thermal Fluids Inc., at 35°F (1.6°C).

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 chiller's evaporator (barrel) will slow because glycol is less conductive to heat transfer than water.

Note that excessive glycol concentration can be more costly than most people realize. For example, if your chiller's operating environment only requires 20 percent propylene glycol concentration and the decision is made to run the system at 60 percent propylene glycol, table 2 indicates a net loss in cooling capacity between these two concentrations of 17 percent. If you run a round-the-clock operation, this additional loss could result in a dramatic increase in energy costs.

4. Chiller Pumping Capacity Considerations

Glycol tends to be heavier than water. In open-loop applications, this added weight also can increase energy costs as more pumping power is required to overcome vertical lift. In both closed- 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 glycol's viscosity when process loop temperatures drop to within 5°F (-15°C) 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 industrial chillers on the market are designed at the ARI standard that calls for 45°F (7°C) leaving the evaporator. Some chiller manufacturers make adjustments in evaporator selections for chillers that need to run over 20 percent glycol concentration. In doing so, evaporator pressure drops tend to be lower and, more importantly, the added surface areas of these evaporators help counteract the heat transfer loss associated with glycol use. Making such adjustments also helps to maintain lower kilowatt requirements because, in most cases, compressor horsepower will not need to be increased.

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 setpoint lower than 45°F (7°C) without first adding glycol. Because hot gas regulators respond to the compressor's 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 to the process loop, viscosity will change with glycol concentration. In many cases, glycol will change the flow and pressure drop across the chiller's evaporator, calling for field calibration as part of commissioning.

Compressor Low-Pressure Safeties. In most cases, the chiller's low-pressure fault presets will need to be adjusted.

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 setpoint lower than 45°F (7°C) without first adding glycol.

These adjustments will prevent nuisance low-pressure shut downs of the compressor.

7. Chiller Maintenance Considerations

Using glycol in chiller systems creates additional maintenance considerations that are very important to ensure long-term chiller operational reliability.

Maintaining Glycol Freeze-Point. After initial chiller commissioning, circumstances can 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 create significant and, in some cases, catastrophic system problems. Maintaining a detailed maintenance log, especially on glycol chillers, is recommended.

Process Fluid Testing. Routine testing of the glycol heat transfer fluid is the best way to ensure 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. Chiller systems that use glycol should be tested every six months at a minimum. Tests should be performed for:

- The pH reading, which 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, glycol levels can be closely monitored to prevent potential glycol related system failures. Depending on the operating requirements of the system, testing will begin to present degradation of glycol inhibitors. Once inhibitor levels drop to approximately 70 percent of initial (new) levels, breakdown of process system materials such as piping, heat exchangers and pump impellers tends to accelerate if not addressed. A common visual clue of breakdown is discoloration of the process fluid. For this reason, process fluid replacement is recommended once inhibitors get below the 70 percent level. A ball park range for fluid replacement is every six to eight years. **PC**

Martin P. King is president of Legacy Chiller Systems, Sacramento, Calif., a manufacturer of industrial and commercial chillers. For more information from Legacy Chiller Systems, call (877) 988-5464 or visit www.legacychillers.com. Engineers at Thermal Fluids Inc., South Easton, Pa., a manufacturer of propylene and ethylene glycol heat transfer fluids, also contributed to this article. For more information from Thermal Fluids Inc., call (800) 640-8011 or visit www.thermalfluidsinc.com.