

**WATER TREATMENT PROGRAM**  
**FOR**  
**GLYCOL SYSTEMS**

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by

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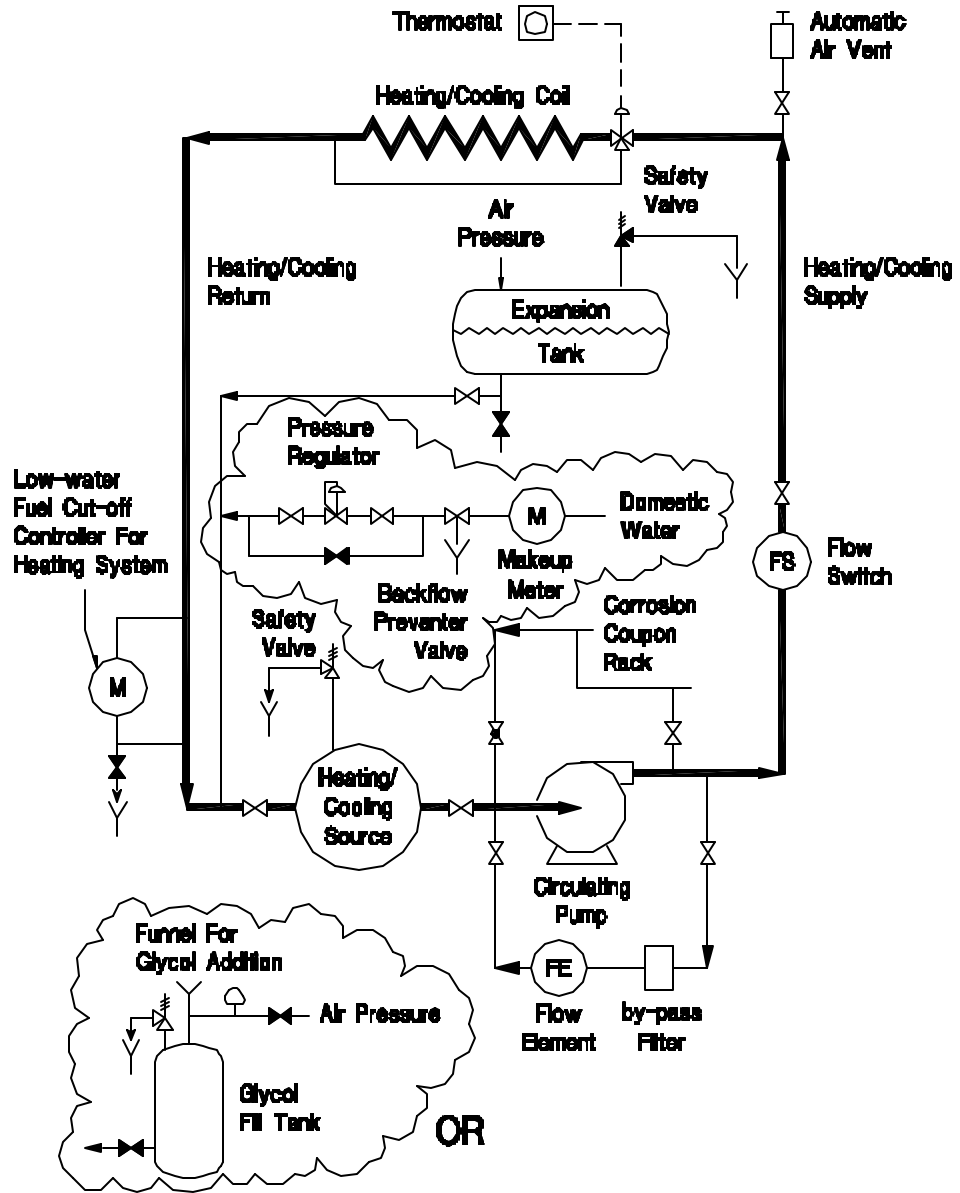
## **DESCRIPTION**

A glycol system (see schematic diagram overleaf) is a cooling or heating system in which an ethylene or propylene glycol-water solution is circulated throughout the building or through cooling/heating coils in an HVAC system in order to provide space cooling/heating without the inherent risk of freeze damage.

The principal components of these systems consist of a cooling/heating source (ie., chiller, boiler, converter, etc.), automatic air vents, circulating pumps, flow switch, expansion tank, heat exchangers, either a water make-up line (containing a water meter, backflow prevention device & pressure regulator) or a pumping system to introduce the glycol/water solution into the system, and interconnecting piping, valves & fittings of mixed iron, copper & bronze metallurgy (note that galvanized piping is not recommended in glycol systems since its presence may lead to the precipitation of certain components in the glycol's corrosion inhibitor).

After the system is initially charged with the desired glycol-water solution, the quantity of make-up water should be negligible. Therefore, glycol systems are referred to as being closed systems.

# SCHEMATIC DIAGRAM OF A TYPICAL GLYCOL SYSTEM



## **OPERATION and MAINTENANCE**

Industrial grade glycol is composed of either ethylene or propylene glycol, a corrosion inhibitor, and water. Note that automotive grade glycol should **not** be used in commercial or industrial glycol systems because their corrosion inhibitors have a limited useful life and they contain silicates which can foul or plug the system.

If there is a concern that the glycol may be orally consumed, an industrial grade propylene based glycol should be used because of its low oral toxicity, otherwise an industrial grade ethylene based glycol is the preferred choice.

Since dissolved oxygen in the system will decompose the ethylene/propylene glycol into organic acids, particularly at elevated temperatures, thus causing corrosion & fouling, both types of glycol contain corrosion inhibitors. The corrosion inhibitor in propylene based glycol consists of dipotassium phosphate in order to maintain the low oral toxicity of this product, whereas the corrosion inhibitor in the ethylene based glycol consists of a proprietary mixture of numerous corrosion inhibitors.

The water which is used in both types of glycol systems must be of the highest possible quality (ie., softened, demineralized, deionized, boiler condensate), otherwise the hardness and corrosive salts in most domestic water supplies will deplete the inhibitor concentration in the glycol.

Once the system is filled with the glycol-water solution, every effort must be made to minimize the entrance of additional hardness salts and dissolved oxygen into the system by the operational type methods indicated overleaf.

1. Limit the amount of make-up water as follows:
  - (a) ensure that a water meter is installed in the make-up line;
  - (b) locate & repair system leaks immediately;
  - (c) adjust pump seals with packing so that there is minimum leakage;
  - (d) ensure that pumps with mechanical seals have zero leakage;
  - (e) do not drain & fill the system seasonally;
  - (f) minimize the amount of glycol-water solution lost from the system during maintenance, water sampling.

2. Ensure that there is a positive pressure at the top of the system at all times by maintaining a minimum static system pressure according to the following equation by the addition of air to the expansion tank:

$$P = (H/2.31) + 5$$

where P: pressure at the circulating pumps with the circulating pumps shut off, psig;

H: elevation of the system piping above the circulating pumps, feet

3. Ensure that the expansion tank is properly sized so that there is water in it at all times.
4. Replace faulty automatic vents as required.
5. Confirm the operation of the make-up water meter by noting the changes in its reading before & after such activities as maintenance, sampling, etc.

In order to prevent excessive decomposition of the glycol into organic acids, the operating bulk temperature of the glycol-water solution must be limited to 120 °C (250 °F).

## CHEMICAL TREATMENT

In order to provide freeze protection (ie., a glycol concentration which is sufficient to prevent the formation of ice crystals at the lowest temperature experienced by the fluid) down to -35 C, the acceptable glycol concentration range for cooling systems which are operational year round and for heating systems is 48-85 vol% for ethylene glycol systems and 49 vol% minimum for propylene glycol systems; however, for the economic reasons, the preferred range is 48-52 vol% for both types of glycol systems.

In order to provide burst protection (ie., a glycol concentration which is high enough to prevent bursting of pipes and other mechanical damage, but not necessarily high enough to keep the fluid pumpable) down to at least -35 C, the acceptable **ethylene glycol** concentration range for cooling systems which are operational only during the summer months is 30-85 vol%; however, for economic reasons, the preferred range is 30-35 vol%. Similarly, the acceptable **propylene glycol** concentration range is 35 vol% minimum, but the preferred range is 35-40 vol% for burst protection down to -35 C.

If the glycol concentration is less than approximately 20 vol%, there is a possibility of bacteria contamination because glycol at low concentrations is a nutrient source.

The following equation may be used to calculate the approximate amount of glycol required to increase the glycol concentration in a system:

$$G = V \times (CD-CP)/(100-CP)$$

where G: volume of present glycol solution to be drained from the system and the volume of fresh concentrated glycol to be added to the system, litres  
CD: desired glycol concentration, vol%  
CP: present glycol concentration, vol%  
V: volume of the system, litres

In order to provide adequate corrosion protection of the glycol system, the reserve alkalinity based on a glycol concentration of 100% (ie., RA[100%]), which is an indication of the inhibitor level, must be maintained at a level of at least 9.0 for all glycol concentrations by inhibitor additions as required.

If the RA(100%) value is less than 9.0 in an ethylene glycol system, the following equation may be used to calculate the first estimate for the amount of inhibitor required to increase the inhibitor concentration:

$$I = 1.75 \times V/100$$

where I: volume of proprietary inhibitor, litres  
V: volume of the system, litres

If the RA(100%) value is less than 9.0 in a propylene glycol system, food grade dipotassium phosphate must be added as required.

## **CONTROL TESTS**

In order to minimize fouling and/or corrosion of glycol systems, the following control tests must be performed (note that due to the more sophisticated nature of the chemical tests for glycol systems, the glycol, pH & reserve alkalinity levels in glycol samples are performed by the PWS&S Property Management, Operations Division Laboratory):

1. Document the make-up water meter reading at least once per month;
2. Document the glycol concentration in the system at least once per year;
3. Document the pH level in the system at least once per year;
4. Document the reserve alkalinity level in the system at least once per year;
5. Determine & document the visual appearance of the glycol in the system at least once per month;
6. Document the system pressure at the circulating pumps with the circulating pumps shut off at least once per month.

## **HANDLING and STORAGE**

The LD50 acute oral toxicities of ethylene and propylene glycols for rats are 6.1 gm/kg and 33.7 gm/kg respectively; therefore, both materials should be considered to be toxic when they are intentionally consumed in thirst quenching quantities. However, propylene glycol is considered safe for use in foods because of its low chronic oral toxicity, whereas ethylene glycol is too toxic for applications where there is a possibility of ingestion.



Both types of glycol produce a negligible degree of irritation upon eye or skin contact; therefore, washing the affected areas after contact is all that is required.

Although there is no limit for the prolonged inhalation of propylene glycol mist, the limit of 50 ppm for the vapours of ethylene glycol suggests that leaking coils in HVAC systems should be repaired when there is a noticeable odour of glycol in the building.

The freeze point of concentrated ethylene glycol is -17 C; therefore, containers of this fluid must be stored indoors. However, since the freeze point of propylene glycol is less than -50 C at all concentrations greater than 55 vol%, concentrated solutions of these fluids may be stored outdoors.

The high flash points of 121 C & 101 C for the respective concentrated ethylene & propylene glycols should not present a problem under normal storage conditions, but if the ambient temperatures are greater than these limits, the glycol should be diluted to less than 80% since there is no flash point for either glycol type at these reduced concentrations.

Ethylene and propylene glycol solutions are hygroscopic; therefore, their containers must be kept tightly sealed in order to avoid dilution of the glycol.