Geo-Energie inc.
Because geothermics is Serious.
Infoletter
Winter 2008 Number 2

Antifreeze; Which one to choose

Full Text

In our last publication, we exposed the pros and cons of various families of antifreeze generally used in geothermia and presented six impacts on the whole of a project based on the antifreeze chosen.

We now will dig into more technical aspects of antifreezes selection.

Energy savings is the main reason to choose geothermia, i.e. to set up the most powerful geothermic system possible, at the lowest possible cost. Obviously, cost and the performance are generally two antagonistic principles. It is thus necessary to make judicious compromises to reach our objective, a project which is both effective and profitable.

That being said, which antifreeze to choose? As we mentioned in a preceding article, the choice of antifreeze is mainly to the customer's call, with the designer's technical support of course.

1- For the customer, the following elements will be considered:
   a. Costs (Antifreeze, Filling, Maintenance, Pumping Energy)
   b. Environmental Impact
   c. Security
   d. Impact on the system's type of piping
   e. Impact on the geothermic system's global energy savings.

2- For the designer, the following elements will be affected by the choice of antifreeze:
   a. Low temperature viscosity
   b. Specific mixture heat
   c. Toxicity and flammability of the mixture (necessary safety devices)
   d. Availability
   e. Lifespan and potential reactivity
   f. After use disposal method
   g. Piping materials and other hydronic accessories' compatibility.
   h. Price

3- Reasons that influences a customer to prefer one type on antifreeze over another differs from those of the designer in several ways. All selections are good, so long as their reasons are known, pondered and explainable. Several of these reasons are qualitative or economic. We won't delay ourselves with these elements. We will however go into the technicalities of certain reasoning, to demystify them.

A) Viscocity :

When time comes to choose antifreeze, one often hears the viscosity argument as being justifiable proof for the use of alcohols instead of glycols. We will use an example to thus review several fundamental principles of geothermics.

1- Contrarily to the popular belief, it is not to protect the underground geothermic piping from freezing that antifreeze is necessary in the circuit. The presence of antifreeze in a geothermic circuit, besides some rare exceptions, is justified by only one reason: To prevent the liquid coolant from freezing in... the heat pump's evaporator (cold side heat exchanger).

2- It's the circuit's coldest area, being able to reach, at a molecular level, 10^0F colder than the temperature on the outlet side of the evaporator. For example, if the ground loop is designed to operate at a minimal temperature of 32^0F to the entry of the heat pump (EWT), the temperature on the outlet side of the evaporator will be of approximately 26^0F. The liquid coolant's coldest foreseen molecular temperature will thus be of 16^0F. It is therefore necessary to select an antifreeze mixture for a minimal protection of 16^0F.

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a. Viscocity (μ)
b. Flow (V)
c. L Pipe Diameter (D)
d. Liquid Density (ρ)

$$Re = \frac{\rho V D}{\mu}$$

4- These terms are independent from one another, although viscosity and density are physical properties specific to the liquids used and that they both vary according to the liquid's temperature. The general rule for frequently found antifreezes is that density and viscosity increase, as the liquid cools. The density varies little (a few percent only) in the temperature range to which the geothermic exchange can be subjected to. However, viscosity can vary by a factor of 200 to 600% for the same temperature variation. Viscosity (as the denominator in the equation) thus has an enormous influence on the flow which will be necessary to obtain Re 2500.

5- To design the exchanger and to select the required pumps, one must know the peak loads to which the exchanger will be subjected. These conditions relate to heating and air-conditioning peaks. In heating, the temperature of the exchanger will drop while in air-conditioning, it will increase due to the need to reject the heat extracted from the building to the geothermic loop. What concerns us is the heating peak, that is to say the moment or the temperature when the geothermic exchanger is at its coldest, as it is at this time that our liquid is densest and by far most viscous.

6- Let's use for example a geothermic exchanger whose design temperature in heating is 31^0F EWT. Under this condition, the evaporator's outgoing temperature will be 26^0F for a given type of heat pump. A freezing protection of 16^0F is thus necessary. The first type of antifreeze that we will use is propylene glycol, the worst of all regarding viscosity. This results in a 20% concentration volume of propylene glycol. Since we must ensure a starting heat transfer 26^0F, let us consider this temperature as a calculation bases. A mixture of water and propylene glycol (80-20) at 26^0F has the following physical characteristics:

   a. Density
   b. Viscocity
   c. Specific Heat

7- Let's now consider that the geothermic exchanger is made of PEHD 3408, DR11, pipe of a nominal diameter of 1 ¼ ", that is to say an internal diameter (ID) of 1.36 ". With a mixture at 26^0F, what is the necessary flow in this pipe to obtain Re = 2500? We solve the equation and obtain a flow of xxx GPM

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