Heat transfer fluids

Definition

The heat transfer fluid is a fluid, usually liquid which is circulated to transport, extract and dissipate energy in the form of heat, from an energy source to a thermal load. Each heat transfer fluid is chosen according to its physicochemical properties, such as viscosity, volumetric thermal capacity, potential heat of evaporation or liquefaction in case of a change in phase, and thermal conductivity. The heat transfer fluid is also chosen according to its anti corrosive properties and its cost. Although unlikely, the leakage of heat transfer fluids from the geothermal circuit could have significant repercussions on the environment and a building's occupants. It is the designer's responsibility to use good judgement when selecting a heat transfer fluid. A complete analysis of the risks, the life cycle and peripheral accessories necessary to choose a heat transfer fluid are all elements which must be taken into account during its selection.

Type

There are two main categories of coolants on the Canadian geothermal market: glycols and alcohols.

Propylene-glycol

Propylene glycol belongs to he glycol category. Propylene glycol is used in the food industy as an emulsifier in sauces and seasonings or as solvent in liquid scents. Thus, it is non toxic, stable and non reactive. However, propylene glycol is viscous, expensive and not as effective for thermal energy transport due to its low volume thermal capacity.

Ethylene-glycol

Ethylene glycol is commonly used as a coolant and a refrigerant. Its freezing point being low, it is also used as a defroster for windshields and jet engines. Less expensive than propylene-glycol, ethylene-glycol's main disadvantage is that it is toxic, even deadly if ingested. Its sweet taste entices kids and animals to ingest it in great quantity. The acceptance of ethylene glycol in Canadian geothermal science is questioned.

Ethanol (ethylic alcohol)

Ethanol is the alcohol found in all alcoholic beverages. It is a colorless liquid which is miscible to water in any proportion. In its pure state, the point of fusion is very low (-117°C), which makes it an excellent antifreeze agent. Ethanol is, however, quite flammable, even at dilution rate of 30% per volume. Its viscosity is comparable to propylene glycol and is not compatible with the materials used in building services. The industrial ethanol used as antifreeze is said to be denatured because it is unfit for consumption.

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Methanol (methyl alcohol or wood spirit)

Because of its toxic properties, methanol is frequently used as a denatured additive made for industrial use ethanol. Methanol has the advantage of not being as viscous as glycols. It also offers a thermal volumetric capacity superior to glycols and ethanol. Like ethanol, methanol is extremely flammable even at a dilution rate of 30% per vol. For ecological reasons, its use is forbidden in geothermal heat exchangers in certain regions of Ontario.

Important factors concerning antifreeze

Flammability

Ethanol and methanol are extremely volatile; as such, their use is not recommended when a geothermal system is of the unpressurized type, that is, open to the atmosphere. The designer must adapt equipment selection (pumps, automatic pressurization tank, sprinkler system, etc.) according to the risks of flammability and to the toxicity of alcohol based heat transfer fluids.

Corrosion inhibitors and additives

There are three main categories of corrosion inhibitors used in the heat transfer fluid industry: phosphates, molybdates and nitrates. All inhibitors present risks of a chemical precipitation if mixed with hard water, that is to say water that has a very high calcareous content. Hence, it is necessary to dilute the heat transfer fluids with neutral pH de-ionized water. A precipitation would decrease the corrosion inhibitors' effectiveness and could cause irreversible consequences on pieces of equipment prone to clogging. It is also necessary to avoid inhibitor mixtures that have conflicting effects when adding a heat transfer fluid to a geothermal network. Adequate identification, meeting the requirements of the Canadian GeoExchange Coalition (CGC) and highlighted at filling points is an excellent way of preventing such mixtures.

Nitrite based corrosion inhibitors are more sensitive to pH variations. A strict follow-up of the coolant's pH development is recommended.

Two to three laboratory analysis of the coolant are recommended yearly in order to follow pH level development as well as corrosion inhibitors concentrations and various additives.

Manufacturers of propylene glycol do not recommend the use of solutions containing less than 30% per volume in order to avoid corrosion and bacteria problems.

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