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GeoSafe® Geothermal Fluid Product Data Sheet

Inhibited Ethyl Alcohol-based Heat Transfer Fluid

GeoSafe® is an ethyl alcohol (ethanol) based fluid, specifically formulated for geothermal systems. GeoSafe® is useful in colder climates as an antifreeze fluid to offer freeze protection and still provide a high level of heat transfer capability.

GeoSafe® is made from renewable ethyl alcohol with a proven inhibitor package to provide the added benefit of corrosion protection as well as freeze point depression. Although essentially not toxic, it has a bittering agent to render it undrinkable by humans and animals.

Typical Properties	GeoSafe® Concentrate	GeoSafe® 25%	GeoSafe® 20%
Ethanol (~ % by Weight)	90.6	22.6	18.1
Performance Additives/Water (~ % by Weight)	9.4	77.4	81.9
Color	Light Blue	Light Blue	Light Blue
Clarity	Clear	Clear	Clear
Specific Gravity (15/15°C 60/60°F)	0.810-0.820	0.970-0.980	0.980-0.985
pH (min)	9 (at 50%)	9	9
Reserve Alkalinity (min)	0.8	0.2	0.1
Freeze Point °F (max)	-130	10	20
Boiling Point °F	173	187	189
Viscosity @60°F (Centipoise)	1.5	2.1	1.8
Specific Heat @0°F (cal/gram)	0.58	1.02	1.04
Vapor Pressure 68°F (mm Hg)	40	20	19
Flash Point °F (tag closed cup)	60	90	108
Biodegradation % after 20 day BOD test	93		
Oral Toxicity	Low	Low	Low
NFPA Code	0, 3, 0	0,3,0	0,3,0

Typical properties, not to be construed as specifications.

Please read our GeoSafe® Ethanol Handling Alert attached prior to purchase and use.

GeoSafe® is available as a full strength, un-diluted fluid or as a 25% or 20% premixed solution. The premixed product is diluted with water meeting the following minimum requirements:

Water Properties	
Calcium Carbonate	100 ppm (max.)
Calcium	50 ppm (max.)
Magnesium	25 ppm (max.)
Chloride	40 ppm (max.)
Sulfate	100 ppm (max.)

GeoSafe® is intended for use in all geothermal systems, although there may be some States or Provinces that do not allow its use. In those cases we recommend the use of SAFE-T-THERM® GRAS, our food grade inhibited propylene glycol product.

Freeze Point	
Temperature °C (F°)	Percent GeoSafe® Volume %
0 (32)	0
-3 (26)	10
-7 (20)	20
-15 (5)	30
-19 (-2)	40
-29 (-20)	50
-37 (-35)	60
-43 (-45)	70
-48 (-55)	80
-90 (-130)	100

NOTE: These figures are examples only and may not be appropriate to your situation. Generally, for an extended margin of protection, you should select a temperature in this table that is at least 3°C (5°F) lower than the expected lowest ambient temperature.

ATTENTION: These are typical numbers only and are not to be regarded as specifications. As use conditions are not within its control, Houghton does not guarantee results from use of the information or products herein; and gives no warranty, express or implied.



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GeoSafe[®] Ethanol Handling Alert

Personal Protection & Gear:

- DO NOT handle GeoSafe[®] concentrate indoors.
- Wear proper personal protective gear, including a full face shield, long sleeve shirt and pants made from a non-synthetic fabric.
- Have fresh water readily available while handling/diluting the chemical

Storage:

- Keep in closed metal containers to ensure that no liquid or vapors escape.

Transportation:

- DO NOT transport in open containers.

Mixing:

- Dilute in open, well ventilated area, as far away from the job site as is practical.
- Use only a hand pump approved for flammable liquids or gasoline pumping.
- Electrically ground and bond all equipment and containers including the steel drum, pump and receiving container to dissipate any static electricity.
- DO NOT use plastic containers, they cannot be grounded. This can result in sparks and fire.
- No source of ignition within 20' of the mixing/diluting operation, including welding and smoking.
- Ethanol burns with a very light blue flame and may be difficult to see in the sunlight.

Information on Flammable and Combustible Liquids

- GeoSafe[®] concentrate is a flammable liquid with a Flash Point of 16°C, 61°F.
- In a 25% solution mixed with water it is still considered flammable with having a Flash Point of 34.4°C, 94°F.

Static Electricity

Static electricity discharge is a primary ignition source of fire and explosions. Electric charges can build up on an object or liquid when liquids move. Static electricity can be generated when liquids are poured, pumped, filtered, agitated, stirred or flow through pipes. This is called static electricity. Even when liquids are transported or handled in non-conductive containers, something rubbing the outside surface of the container may cause a static charge.

Disposal

- Store waste flammable and combustible liquids in the same way as unused flammable and combustible liquids.
- “Empty” flammable and combustible liquid containers may contain enough liquid and/or vapor to create an explosion hazard – BE CAREFUL. This amount can be trapped in a seam or be present as a thin film on the inner surface of the drum. Do not perform any work (welding, cutting, drilling, soldering) on an “empty” liquid container.

Note: This information is largely an abstract from the attached document of the Canadian GeoExchange Coalition. Read it and the attached MSDS carefully for additional information.

Ethanol Handling

Due to a recent industry accident, a HRAI / CGC industry task group was formed to create a follow up membership alert regarding best practices and safe handling of Ethanol and Ethanol-Water mixtures used in geothermal loops. This document is designed to accompany the ethanol member alert that HRAI sent out in early September of last year and provides further direction to industry practitioners who are involved or working directly with ethanol and ethanol blends. The task group has also developed a more comprehensive document "Safe Operating Procedure for Handling Ethanol".

Please advise all staff and personnel working with ethanol products of the following safety precautions and procedures:

Personal Protection & Gear:

- No pure ethanol is to be handled and used indoors.
- Proper personal protective gear must be worn when working with Ethanol in both its pure and mixed state. This includes full face shield, long sleeved shirt and long pants made from a non-synthetic fabric
- A properly rated fire extinguisher is to be within arms reach while handling and diluting ethanol.
- Fresh water must be readily available while handling and diluting the chemical.

Storage:

- Pure and diluted ethanol mixtures must be kept in closed metal containers to ensure that no liquid or vapors can escape when not in use.

Transportation:

- Ethanol should be transported only in its diluted form to the job site to be used for flushing and filling ground loops.
- Ethanol is not to be transported in open containers.

Mixing:

- All diluting is to take place in open, well ventilated areas and as far away from the job site as is practical.
- Ethanol is to be pumped from 45 Gallon drums only with approved pumps - i.e. hand pump approved for Flammable liquids or gasoline pumping.
- When transferring pure ethanol and ethanol mixtures, all equipment including the steel drum, pump and receiving container must be electrically grounded and bonded to dissipate any static electricity that builds up.
- Do not use plastic containers for ethanol or ethanol blends as it is unsafe. The plastic containers will build

up static electricity and cannot be grounded. This can result in sparks and fire.

- There must be no sources of ignition within 10' of the mixing/diluting operation. This includes, welding and smoking.

Flush Cart:

- Flush carts are to be left outdoors if at all possible while flushing or filling loops.
- Flush carts are only to be used inside a building if the Area can be well ventilated and there is no outdoor alternative.
- When flush carts are used indoors there shall be no trouble lights, open flames, or sparks, torches, fusing irons or other possible source of ignition.
- Cell phones are to be left away from the work area.
- Any other trades working in the vicinity should be advised to cease work in the area until flushing has been completed and until the ventilation system has dissipated all hazardous fumes.

Other:

- For more complete information please refer to Safe Operating Procedure for Handling Ethanol.
- No person shall handle or dilute any ethanol product without training from the manufacturer or its approved agent.
- No person shall be able to purchase these products without the approved training from the manufacturer or its approved agent.
- All legal requirements must be complied with including but not limited to the Transportation of Dangerous Goods Act and Regulations, Occupational Health and Safety Act and Regulations and Ontario Fire Code.

Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI) and Canadian Geo Exchange Coalition (CGC) provide the information contained in these voluntary guidelines in good faith but make no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to be followed voluntarily for the appropriate precautionary handling of Ethanol and Ethanol-Water Mixtures intended for use in geothermal loops (the "Material") by a properly trained person. Individuals receiving this information must exercise their independent judgment in determining its appropriateness for any particular purpose. These voluntary guidelines have not been reviewed or approved by any government agency or authority. HRAI AND CGC MAKE NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WITH RESPECT TO THE INFORMATION SET FORTH IN THESE VOLUNTARY GUIDELINES OR THE MATERIAL. ACCORDINGLY, HRAI AND CGC WILL NOT BE RESPONSIBLE FOR ANY DAMAGES OR INJURY WHATSOEVER RESULTING FROM USE OF OR RELIANCE UPON THE INFORMATION CONTAINED IN THESE VOLUNTARY GUIDELINES.

Safe Operating Procedure for Handling Ethanol

To define the Standard Operating Procedures in a manner that informs and instructs operators on the key health and safety points and controls to remember when handling Ethanol.

Hazards can include:

- Fires/Explosions
- Electrocution
- Spills
- Chemical exposure e.g. burns, dermatitis

To avoid these hazards, proper bonding and grounding procedures must be followed when decanting flammable and combustible liquids.

An individual can be exposed to this chemical through many routes of entry including: eyes, skin, inhalation and ingestion. It is important that all safety precautions are taken prior to handling this chemical.

Information on Flammable and Combustible Liquids

Ethanol is a flammable liquid with a flash point of 16°C and Upper Explosive Limit of 19% Volume and a Lower Explosive Limit of 3.3% Volume.

In a 25% solution by volume with water Ethanol's flashpoint is 34.4°C, this is still considered flammable.

An Ethanol mixture of 20% - 27% is recommended. Refer to the standard CAN/CSA 448-02 consolidated standard for direction regarding approved Ethanol concentration mixtures.

Flashpoints and Explosive Limits

The flashpoint of a liquid is the lowest temperature at which the liquid gives off enough vapor to be ignited (start burning) at the surface of the liquid. Sometimes more than one flashpoint is reported for a chemical. Since testing methods and purity of the liquid tested may vary, flashpoints are intended to be used as guides only, not as fine lines between safe and unsafe.

A material's flammable or explosive limits also relate to its fire and explosion hazards. These limits give the range between the lowest and highest concentrations of vapor in air that will burn or explode.

At normal room temperatures, flammable liquids can give off enough vapors to form burnable mixtures with air. As a result, they can be a serious fire hazard. Flammable liquid fires burn very fast. They also give off a lot of heat and often clouds of thick, black, toxic smoke.

Combustible liquids at temperatures above their flashpoint also release enough vapor to form burnable mixtures with air. Hot combustible liquids can be as serious a fire hazard as flammable liquids.

Most flammable and combustible liquids flow easily. A small spill can cover a large area of workbench or floor. Burning liquids can flow under doors, down stairs and even into neighboring buildings, spreading fire widely. Materials like wood, cardboard and cloth can easily absorb flammable and combustible liquids. Even after a spill has been cleaned up, a dangerous amount of liquid could still remain in surrounding

materials or clothing, giving off hazardous vapors.

Static Electricity

Electric charges can build up on an object or liquid when certain liquids move in contact with other materials. This can occur when liquids are poured, pumped, filtered, agitated, stirred or flow through pipes. This buildup of electrical charge is called static electricity. Even when liquids are transported or handled in non-conductive containers, something rubbing the outside surface of the container may cause a static charge to build up in the liquid. The amount of charge that develops depends, in part, on how much liquid is involved and how fast is it flowing or is being agitated or stirred.

Flammable and combustible liquids can present a static electricity hazard depending on their ability to generate static electricity, how well they conduct electricity (conductivity), and their flash point.

According to the NFPA (Code 77), solvents that are soluble in water (or can dissolve some water themselves) do not build up static electricity. Examples of such liquids include alcohols and ketones like acetone. However, when liquids are transferred into non-conductive containers (e.g., plastic, glass), even conductive solvents may build up a charge because the plastic or glass containers decrease the rate at which the charge in the solvent dissipates.

The flash point and vapor pressure of the liquid and the temperature are other factors to consider. The vapor levels will be higher in the air around the container if you are working outside on a hot summer day than in the winter when the temperature is below 0°C (32°F) or colder.

Generally, the conditions for igniting a liquid are optimal when the liquid is used at a temperature that produces a vapor in air concentration (at the surface of the liquid) that is halfway between the upper and lower flammability limits. Recognizing that these conditions represent an "optimal" fire

Bonding and Grounding

To prevent the build up of static electricity and prevent sparks from causing a fire, it is important to bond metal dispensing and receiving containers together before pouring. Bonding is done by making an electrical connection from one metal container to the other. This ensures that there will be no difference in electrical potential between the two containers and, therefore, no sparks will be formed.

- Static electricity is present when liquids are dispensed. Static electricity can ignite flammable and combustible material.
- Grounding and bonding wires must be used to prevent dangerous static electricity when transferring flammables or combustibles from one container to another. By grounding and bonding a pathway is provided between the dispensing container, the receiving container and an earth ground so that any static electricity is safely dissipated into the ground.

Manager's Responsibilities

- Managers must prepare post and maintain an inventory of all hazardous material in use.
- Managers are responsible for ensuring storage, providing personal protective equipment; safe handling and spill response are all reviewed for new hazardous materials coming on site.
- Managers shall keep a floor plan readily accessible at the workplace, showing the names of all hazardous materials and their locations and post at a conspicuous location.
- Provide training on handling chemicals, use of personal protective equipment, and bonding and grounding.
- Comply with the Workplace Hazardous Materials Information System Regulation (WHMIS) under the Occupational Health and Safety Act with respect to material safety data sheets, labeling and worker training.
- All employees must attend WHMIS training and have training with respect to the chemical hazards they are required to handle.
- Up to date material safety data sheets (MSDSs) (no more than 3 years old) are kept for each hazardous product listed in the inventory.
- Use the MSDS to develop an emergency plan.
- Emergency Plan must be posted. Employees must be trained in emergency procedures.
- Class B Fire extinguishers must be close at hand in areas where the product is used and stored.
- Employees will be trained on the use of fire extinguishing equipment.

Employee's Responsibilities

- Proper use of all personal protective equipment required to do their job safely
- Follow proper procedures in handling chemicals
- Report any defects in any equipment or personal protective equipment
- Report existence of any hazards

Personal Protective Equipment

The following personal protective equipment must be worn when handling Ethanol:

- Rubber Industrial Gloves
- Leather, steel toe boots
- Long sleeved shirt and long pants made from a non-synthetic fabric
- Safety goggles or Face Shield

Before handling the Chemical:

- Employees must be trained by the manufacturer or its approved agent.
- Review the MSDS
- Employees must be trained in emergency procedures.
- Employees must be trained on the use of fire extinguishing equipment.

Handling the Chemical:

- When handling Ethanol, avoid contact with eyes, skin and clothing. Do not ingest the chemical and avoid inhalation.
- Never cut or weld in the same area where flammable or combustible liquids are present.
- If chemicals are spilled on clothes, remove clothing and wash as soon as possible
- Flammable liquids give off invisible vapors that spread and catch fire quickly from something as small as static electricity.
- Proper bonding and grounding procedures must be followed. Empty containers may contain hazardous product residues; keep these containers closed when not in use.

Before Dispensing

- Ensure all personal protective equipment is being used
- Make sure an appropriate container is selected and that container is clean.
- Ensure the appropriate labels are placed on the container prior to filling. Workplace labels must include name of the material, safe handling instructions and information about where the Material Safety Data Sheets (MSDS) is available in the workplace.
- Ensure that a fire extinguisher is immediately accessible.
- Ensure adequate access to fresh water in the event of eye and skin contact or spill.

Dispensing

- All dispensing should be done outdoors to prevent the buildup of flammable vapors.
- Areas where flammable liquids are being poured should be well ventilated. Use natural ventilation where possible, mechanical ventilation should have explosion proof motors and spark resistant fans.
- Remove all sources of ignition from the area. (Including but not limited to trouble lights, open flames, sparks, torches, fusing irons and cell phones.) There must be no source of ignition within 10 feet of the mixing/diluting operation.
- Smoking must not be allowed in the area.
- Ensure that fixed equipment as well as transfer containers are properly bonded and grounded to prevent accumulation of static charge.
- Pour flammable liquids slowly to avoid the buildup of static electricity.
- Use only an approved pump - i.e. hand pump approved for flammable liquids or gasoline pumping when filling a container with Ethanol and place the hose in bottom of the container (to control static and to prevent spills).
- Place spout into container being filled and gradually open valve, filling to desired level or weight.

- Close valve and pause to ensure all drips remain in the container. Ensure that all containers are tightly closed.

Filling and Flushing

- Flush carts should always be kept outdoors to prevent build up flammable vapors.
- Use of flush carts indoors is only acceptable if adequate ventilation to prevent build up of vapors is present and there is no outdoor alternative.
- All electrical equipment in the room, including but not limited to mechanical ventilation and pumps
- must have explosion proof motors and spark resistant fans.
- All ignition sources are to be removed (Including but not limited to trouble lights, open flames, sparks, torches, fusing irons, cell phones). There must be no source of ignition within 10' of the filling and flushing operation.
- Smoking must not be allowed in the area.
- Any other trades working in the vicinity should be advised to cease work in the area until work is complete and the area has been ventilated to remove all vapors.

How to Attach Bonding or Grounding Wires.

- Grounding and bonding wires must be used to prevent dangerous static electricity when transferring flammables or combustibles from one container to another. By grounding and bonding a pathway is provided between the dispensing container, the receiving container and an earth ground so that any static electricity is safely dissipated into the ground. A Grounding wire electrically attaches material to ground.
- Connect a charged object to another object with a conductor such as a copper wire that has an adequate conductive path to the earth (i.e. drains the charge away as rapidly as it is produced).
- Connect one or more conductive objects to the ground (grounding electrodes or a cold water pipe made of steel, copper or cast iron are also acceptable).
- A Bonding wire electrically attaches material to each other.
- Connect the dispensing and receiving containers with a conductor (such as a copper wire) so that static electricity charge is equalized between the objects.
- A Copper Busbar is a grounded electrical connection for multiple grounding wires.

Important Notes:

- Bonding alone does not eliminate the static charge.
- Both bonding and grounding must be done to eliminate the charge.
- A metal connection must be made with the bonding/grounding wires and the containers. All rust, paint and dirt must be removed before trying to make a connection.
- Avoid using plastic containers for flammable/combustible liquids – they can build up static electricity and you cannot ground them.

- Do not use any short cuts! Always ensure proper grounding and bonding procedures are followed.
- If the containers are not properly bonded and grounded, the resulting static spark could cause a serious explosion/injury.

Storage

- Do not handle or store near an open flame, heat or other sources of ignition or electrical or electromagnetic fields.
- Ensure the chemical is stored in a cool, dry, well ventilated area, away from heat and ignition sources.
- Place away from incompatible materials.
- Use of OH&S, CSA or ULC approved storage must be used for storing flammable materials.

Spills and Leaks

- Planning, training and practicing for emergencies are important so that everyone knows what they must do.
- Ensure that an adequate drainage system is available for any spills or leaks
- Be ready to handle emergencies safely. In emergencies like chemical fires and spills, act fast.
- Leave the area at once if you are not trained to handle the problem or if it is clearly beyond your control.
- Alert other people in the area to the emergency.
- Call the fire department and Ministry of Environment immediately.
- Isolate hazard area and restrict access.
- Remove ignition sources and work with non-sparking tools
- For small spills – soak up with absorbent material and scoop into containers
- For large spills – prevent contamination of waterways. Dike and pump into suitable containers, remembering to ground and bond as you work.
- Clean up residual with absorbent material, place in appropriate container and flush with water.

Disposal

- Store waste flammable and combustible liquids in the same way as unused flammable and combustible liquids.
- Clean drums made of compatible material can be used to store waste liquids if they are vented, grounded and bonded similarly to dispensing drums. Approved safety disposal cans are also available for waste liquids.
- Place cloth, paper and other solid materials that are soaked with flammable and combustible liquids in approved oily waste disposal cans. These are made of metal and have self-closing lids. Do not overfill them, and empty them at least at the end of every workday to reduce the chance of spontaneous combustion.
- Clearly label all waste containers with their contents.
- Be careful with "empty" flammable and combustible liquid containers. They may contain enough liquid or vapor to create an explosion hazard. This amount can easily be

trapped in a seam or be present as a very thin film on the inner surface of the drum. Do not perform any work (welding, cutting, drilling, soldering) on an "empty" liquid container until all liquid and vapors have been cleaned out.

- Never pour waste flammable liquids down sinks or drains.
- Dispose of them through hazardous waste collection and disposal companies.

References

Canadian Centre for Occupational Health and Safety http://www.ccohs.ca/oshanswers/prevention/flammable_static.html

<http://www.ccohs.ca/oshanswers/chemicals/flammable/flam.html>

Material Safety Data Sheet for Ethanol

Ontario Fire Code

National Fire Protection Association (NFPA) 30: Flammable and Combustible Liquids Code

NFPA 77: Recommended Practice on Static Electricity

Regulation 851: Regulation for Industrial Establishments

(Sections 22, 23 Fire Prevention – Protection, 63 Material Handling and 79, 81-84 Protective Equipment).

Health and Safety Advisory Geothermal Systems: Ethanol and ethanol/water mixtures.

DISCLAIMER

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