Thermal Fluids for Ground Source Heat Pumps

Ensuring System Efficiency & Longevity

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Agenda

1. What is a Thermal Fluid?
2. Choosing a Thermal Fluid
3. Handling, Installing & Monitoring (Best Practice)

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2. Choosing a Thermal Fluid

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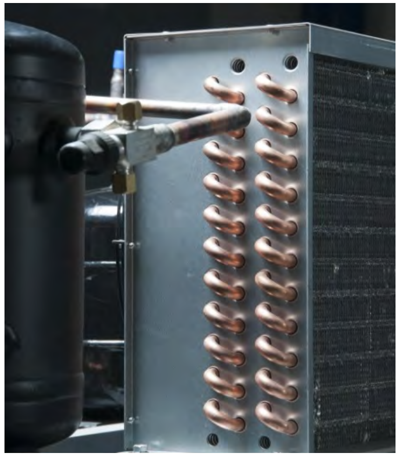
Requirements for ground source heat pumps



Heat Transfer

Freeze Protection

System Protection

Thermal fluids

Thermal fluids are formulated speciality products of a base fluid & inhibition technology

<u>Base Fluid</u>

Examples

Glycols
Glycerine
Methanol & Ethanol
Acetates
Formates

<u>Inhibition Technology</u>

Examples

Corrosion inhibitors
Scale reducers
Preservatives/Biocide
Anti-oxidants
pH Buffers

Thermal fluids are designed to fulfil the specific requirements of the systems they operate in

1. What is a Thermal Fluid
2. Choosing a Thermal Fluid
3. Handling, Installing & Monitoring (Best Practice)

Choosing a thermal fluid

Property	Consideration	Determined by
Human & Environmental impact		
Physical Hazards		
Biodegradability		
Heat Transfer Efficiency		
System Protection		

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Physical Hazards		
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Biodegradability	In the event of a leak the fluid should not persist in the environment	Base Fluid & Additives
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System Protection	The fluid should prevent freezing, corrosion, biological fouling & scaling	Base Fluid & Additives

The glycol base fluids

Base Fluid:	Mono Ethylene Glycol (MEG)	Bio-1,3-Propylene Glycol (1,3-MPG)	Mono Propylene Glycol (1,2-MPG)
Human & Environmental Considerations	Toxic to mammals Moderate aquatic toxicity	Non-toxic to mammals Moderate aquatic toxicity	Non-toxic to mammals Higher aquatic toxicity
Physical Hazards	Low risk		
Biodegradability	High		
Hydraulic Efficiency	**Decreasing Efficiency** →		
Heat Transfer Efficiency			

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Facts about MEG & MPG

	Mono Ethylene Glycol (MEG) $C_2H_6O_2$	Mono Propylene Glycol (MPG) $C_3H_8O_2$
Mammalian Toxicity	MEG is toxic to mammals	MPG is of very low toxicity to mammals
Oral LD50 (mg/kg)	~4700	~20,000
Biodegradability	Very High **Does not persist in the environment**	Very High **Does not persist in the environment**
COD (mg/l)	$\sim 1.29 \times 10^6$	$\sim 1.56 \times 10^6$
BOD_5 (mg/l)	$\sim 0.7 \times 10^6$	$\sim 1.36 \times 10^6$
Aquatic Toxicity EC50 Water Flea (mg/l)	~ 74,000	~ 10,000
German Water Hazard Classification	WGK1 (Slightly hazardous to water)	WGK1 (Slightly hazardous to water)

Fluid viscosity & Heat transfer coefficients

Base Fluid:	Mono Ethylene Glycol	Bio-1,3-Propylene Glycol	Mono Propylene Glycol
Hydraulic Efficiency	Decreasing Efficiency →		
Heat Transfer Efficiency			

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

V = Fluid velocity
D = Hydraulic Diameter of Pipe
ρ = Fluid Density
μ= Fluid Dynamic Viscosity
Cp = Fluid Heat Capacity
k = Fluid Thermal Conductivity

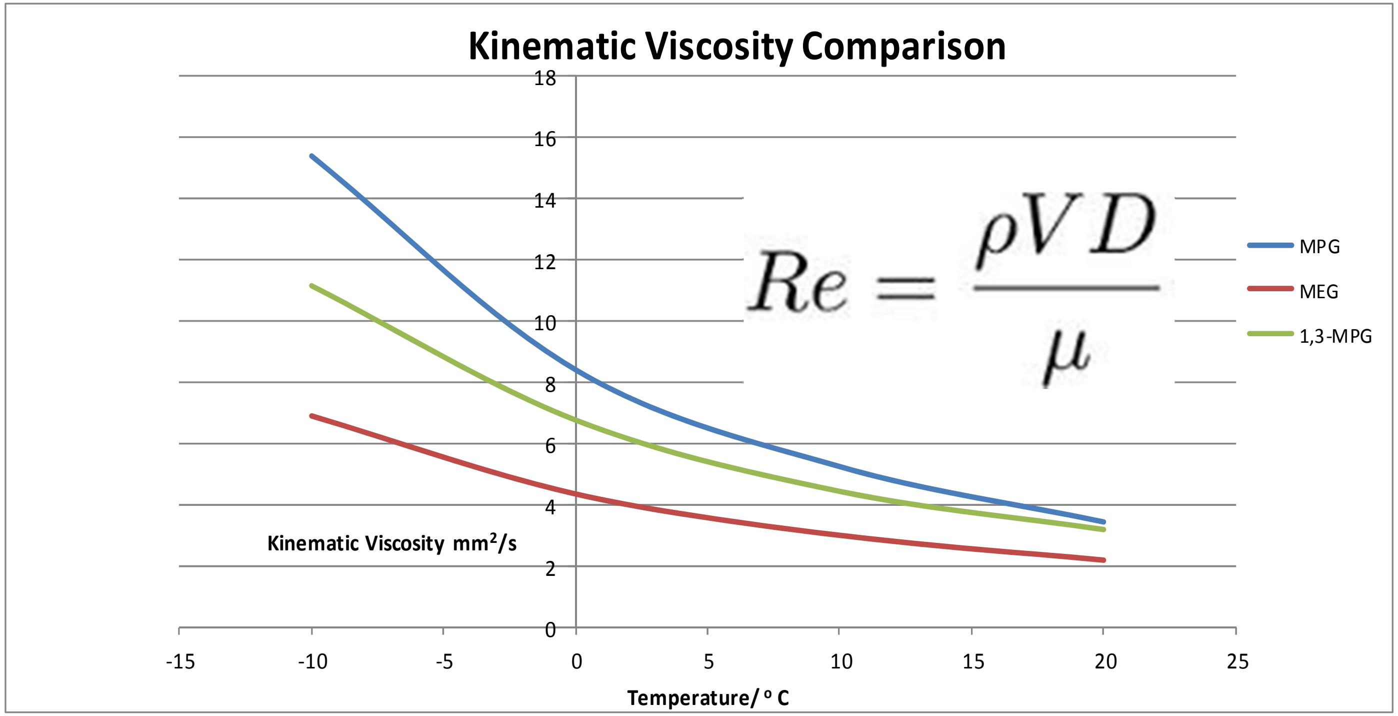
$$Pr = \mu c_p / k$$

The ***Reynolds number (Re)*** describes the type of flow achieved (Laminar or Turbulent)? Will you achieve acceptable pressure drops?

The **Prandtl Number (Pr**) gives an indication of the heat transfer capabilities of the fluid
Thermal fluid viscosity is a key factor in both

Viscosity of glycol based thermal fluids

Consider 3 glycol based thermal fluids @ -15 º C freeze protection



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

MEG base fluids have a significantly lower viscosity than MPG based fluids

You should not install an MPG based fluid in a system designed for MEG

Are all glycol based thermal fluids the same?

There are many glycol based thermal fluids on the market

- **What are the important differences?**
- **What should you look for?**
- **What should you ask?**
- **What is at stake for you?**

How good is the corrosion protection?

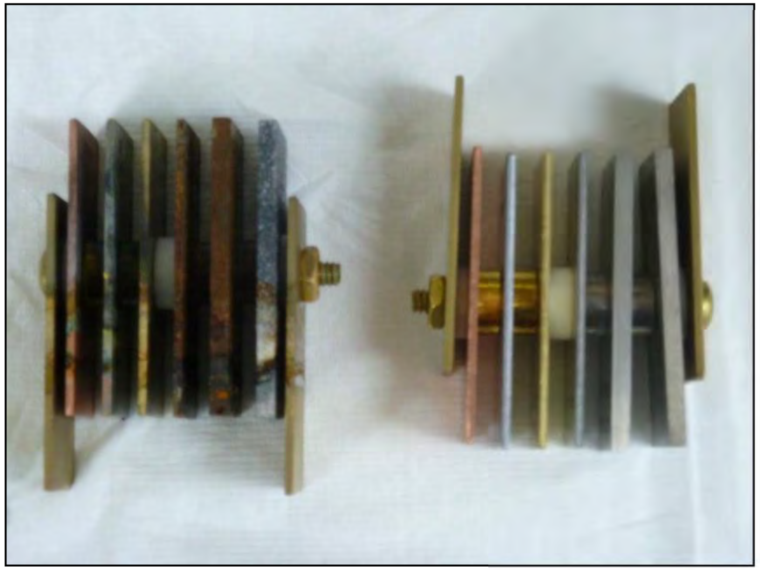
Does the product conform to a corrosion test standard?

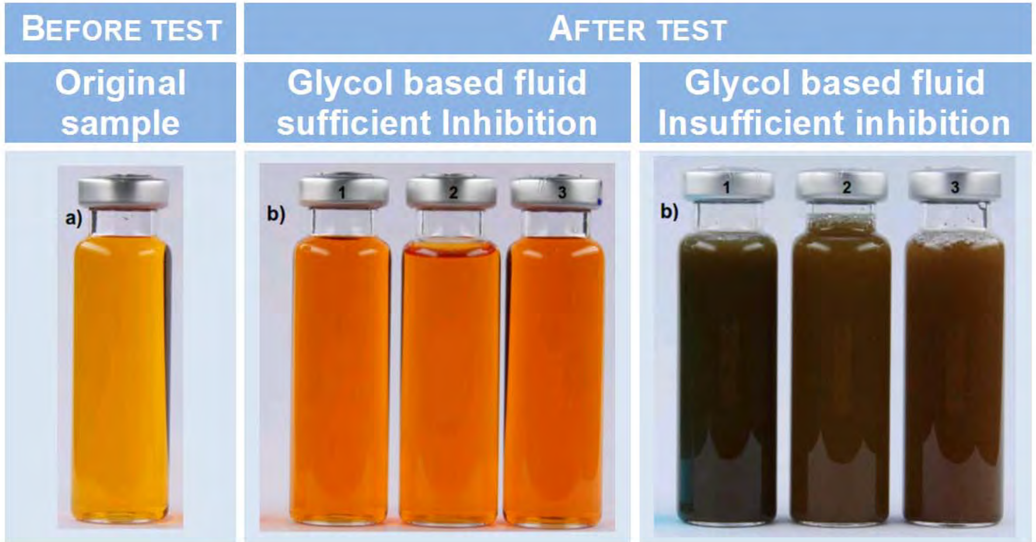
ASTM D1384-05 Test Method

- Test coupons immersed in glycol based fluid diluted with corrosive water at 88 ^{o} C
- Compressed air passed through system for 14 days
- Test promotes corrosion
- Limits on permissible mass loss for a range of metals
- Very difficult test to pass
- Widely used in Europe
- Good indication of the level of corrosion protection

How good is the corrosion protection?

Does the fluid you are using meet a corrosion test standard?





What's happening within your installation?

1. What is a Thermal Fluid

2. Choosing a Thermal Fluid

3. Handling, Installing & Monitoring (Best Practice)

Best Practice

Fluid Selection

Protection

Meeting industry standards

Base Fluid Selection

Assessment of the risks

Maximising efficiency

Installation

Preventing Fouling

Cleaning & Sanitising

Minimising Risk

Water quality considerations

Using the right dilution & freeze protection

After Care

Don't forget the fluid!

Regular health checks

Remedial actions

Consult with fluid manufacturers who can offer solutions to problems

Installing a glycol based thermal fluid

- During installation soil will enter the system
- Many systems are left stagnant with water over extended periods of time
- Soil contains biological contaminants
- Biological contaminants proliferate rapidly
- Serious biological fouling can occur
- Leads to loss of efficiency, downtime, repairs and replacements

Cleaning & Sanitising

Kilfrost recommends a simple two step process for best practice installation

Step 1: Clean

A cleaning agent capable of lifting physical debris such as soil is required at this stage

The cleaning fluid must be compatible with all materials in the system

Step 2: Sanitise

A fast acting biocide is required at this stage

Monitoring of biocide concentration is advised

Ensure biological activity is minimal prior to installation of the thermal fluid

Ready to use & concentrates

Both ready mixed & concentrate formulations are available

	Ready to use	Concentrate
Advantages	Ready to install No errors with dilution Prepared using high quality water Improved corrosion & scaling resistance	Lower volume required Lower transport costs Practical
Disadvantages	Larger volumes & transport costs	Errors on mixing can occur Water quality considerations

Post installation care

Basic Onsite Tests

Product concentration – Refractometer

Freeze protection - Refractometer

pH – pH Meter

Bio fouling – Dip Slides

Visual inspection – Glass sample jar

Laboratory Tests

Corrosion Protection

Compatibility Tests

Contamination checks

Base fluid identification

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Best Practice

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Best Practice

Thermal Fluid Selection

- Hydraulic efficiency
- Heat transfer efficiency
- Choosing a quality product
- System protection meeting test standards

Installation & Aftercare

- Cleaning & Sanitising
- Water quality considerations
- Correct freeze protection
- Monitoring - remedial action is better than replacement

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Thanks for your attention

Any Questions?

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