

CPTherm™ Heat Transfer Fluids Handling, Safety and Environmental Benefits

CPTherm™ heat transfer fluids are a family of glycol and methanol free aqueous heat transfer fluids. The unique formulation of the CPTherm™ heat transfer fluids provides the user with superior heat transfer properties and additional benefits not offered by currently used heat transfer fluids based on ethylene glycol, propylene glycol or methanol. Specifically CPTherm™ heat transfer fluids offer:

- Handling benefits
- Safety and toxicity benefits
- Environmental benefits

There are two main products in the CPTherm™ product line

- CPTherm™-F - NSF HT-1 approved heat transfer fluid for low temperature applications in the food and pharmaceutical industry
- CPTherm™-G - heat transfer fluid for closed loop geothermal systems

The two CPTherm™ products share a common technology based on the use of aqueous solutions of potassium formate. The potassium formate provides an optimal balance of low temperature performance and heat transfer properties. The CPTherm™-G and CPTherm™-F products are then further fine tuned with additional ingredients that provide resistance to corrosion and assist to deliver optimized performance tailored to each end-use.

Aqueous solutions of potassium formate have a strong history of use as a deicing fluid for airport runways. Many airports in Europe such as the Frankfurt airport and some airports in the US such as the Hascom Airfield in Massachusetts use potassium formate deicers.¹

A recent EPA study highly recommended the use of potassium formate in airport runway deicing operations. This is mainly due to the benign environmental impact of potassium formate solutions.²

CPTherm™ Heat Transfer Fluids – Handling Benefits

A comparison of the properties that are pertinent to the handling of heat transfer fluids is shown in **Table I**. CPTherm™ heat transfer fluids offers the following advantages when compared to commonly used heat transfer fluids:

- CPTherm™ heat transfer fluids are non-flammable under any operating condition and have low vapor pressure only due to contained water. This minimizes inhalation and fire hazards. In contrast, methanol exhibits low flash points exist even when it is blended with water (see **Table I**).

- There are no OSHA exposure limits established for the ingredients used in CPTherm™ fluids unlike methanol or ethylene glycol. Please refer to the CPTherm™ heat transfers MSDS's
- Reportable quantities in case of a spill are significantly higher for CPTherm™ fluids than competitive products.

TABLE I – Comparative Properties of Heat Transfer Fluids³

Test	CPTherm™	Ethylene Glycol	Propylene Glycol	Methanol*
Flash Point ASTM D92	None	111 °C (232 °F)	99C (210 °F)	13 °C (55 °F)
Autoignition Temperature	None	398 °C (748 °F)	371 °C (700 °F)	455 °C (851 °F)
ACGIH TLV	Not listed	100 mg/m ³ ceiling aerosol	Not listed	262 mg/m ³
OSHA – Final PELs	Not listed	50 ppm	Not listed	200 ppm
CERCLA Reportable Quantity	14591 lbs	5000 lbs ⁴	None	5000 lbs
Risk Phrases	None	R22	None	R23/R25
Inhalation Hazard	None	Nausea, dizziness headache	None	Nausea, blindness
Fire Hazard	Non- flammable	Flammable	Flammable	Highly flammable
Irritation Hazard	Mild	Mild	Mild	Mild
Hazardous Air Pollutant (HAP)	No	Yes ⁵	No	Yes
Vapor Pressure mm Hg at 25C	23.6 (19.63)**	0.092 ⁶	0.129	127.05

* Flash points of methanol: water combinations are as follows:

20:80 = 54 °C (130 °F); 50:50 = 24 °C (75 °F); 80:20 = 13 °C (55 °F)

** 19.63 = vapor pressure for a 50% solution of potassium formate

Like ethylene glycol or methanol, CPTherm™ heat transfer fluids are considered mild irritants. However, they are non-tacky and water soluble and can be easily washed off. The use of gloves and good handling practices is recommended as with the use of other chemicals. Please refer to the CPTherm™ fluid MSDS's for proper handling and use guidelines.

CPTherm™ Heat Transfer Fluids – Operational Benefits

CPTherm™ heat transfer fluids also offers the following operational advantages:

- The concentration of salts is carefully adjusted to prevent crystallization during use.
- CPTherm™ heat transfer fluids can be used from ~ -70°F to 150°F. Use of methanol containing fluids is limited to about 100°F since the flash point of aqueous methanol solutions is low.
- Glycols have a tendency to oxidize and break down during use. The ingredients in CPTherm™ heat transfer fluids are not known to oxidize under normal operating conditions.
- CPTherm™ heat transfer fluids do not contain any polymerizable ingredients.
- CPTherm™ heat transfer fluids are not known to support bacterial growth, unlike propylene glycol based heat transfer fluids.

CPTherm™ Heat Transfer Fluids – Ecological Benefits

Potassium formate has some key properties that have led to its use in environmentally sensitive areas. It has a low Biological Oxygen Demand (BOD), is biodegradable and is benign to aquatic organisms. The data for these parameters is summarized in **Table II**.

Biological Oxygen Demand (BOD)

The ‘Biological Oxygen Demand’ for potassium formate is significantly lower than other common deicers or heat transfer fluids (**Table II**). This is one of the primary reasons for the use of potassium formate solutions as runway deicers.

The Food and Agriculture Organization defines ‘Biological Oxygen Demand (BOD)’ as “the mass concentration of dissolved oxygen consumed under specific conditions in a given time (BOD₅ 5 days, BOD n days) by the aerobic biological oxidation of a chemical or organic matter in water. It is a measure of how much oxygen is used by aerobic microorganisms in the water to decompose organic matter. An effluent stream with high BOD can result in a stream where there will not be enough oxygen left over for the fish, insects, and other organisms that rely on oxygen. The rich diversity of life on a healthy river is then reduced to a low diversity (but sometimes high volume) of pollution tolerant organisms”

Effects on Aquatic Organisms

CPTherm™ heat transfer fluids are considered practically non-toxic to aquatic organisms (**Table II**). Other heat transfer fluids also belong to this category.

Biodegradability

CPTherm™ heat transfer fluids are expected to be fully biodegradable based on component information. Although other heat transfer fluids based on glycols or methanol are also biodegradable, their high BOD values have a negative impact on aquatic organisms.

TABLE II – Comparative Biological Data on Heat Transfer Fluids

Test	CPTherm™*	Ethylene Glycol	Ethylene Glycol Type I Fluid	Propylene Glycol	Propylene Glycol Type I Fluid	Methanol
BOD ₅ (mg O ₂ /g 5 Day)	100 ⁷	780 ⁸		414 ⁹	522 ¹⁰	600-1,120 ¹¹
Biodegradability (%)	Expected to pass OECD test	90 ¹²		79 ¹³		82 ¹⁴
Daphnia magna 48-hour EC ₅₀	3,000 mg/L ¹⁵	>46,300 mg/L ¹⁶	7100 ¹⁷	43,500 mg/L ¹⁸	6000 ¹⁹	3,289 mg/L ²⁰
Fathead Minnow 96-hour LC ₅₀	3,375 mg/L ²¹	>50,400 mg/L ²²	8,540 ²³	>10,000 mg/mL ²⁴	790 ²⁵	
Rainbow trout 96-hour LC ₅₀	2,740 mg/L ²⁶	18,500 mg/L ²⁷	10635 ²⁸	51,600 mg/mL ²⁹	2096	>10,000 mg/L ³⁰
Algal toxicity 48-hour EC ₅₀	15,235 ³¹ mg/L	112 mg/L	1200 ³²	10,000 – 79,000 mg/L	510 ³³	
Shrimp 48-hr LC ₅₀ salt water		>100 mg/L ³⁴				

* Based on sodium formate for aquatic toxicity for Daphnia magna and Fathead minnow.

- *Note 1:* The US Fish and Wildlife Service toxicity scale considers materials with an LC₅₀>1000 mg/L to be “relatively harmless” which is the least toxic material classification.
- *Note 2:* A 50% solution of potassium acetate has a BOD₅ of 250 mg O₂/g

CPTherm™ Heat Transfer Fluids – Toxicity Considerations

A comparison of the toxicity of commonly used heat transfer fluids is shown below in **Table III**. CPTherm™ heat transfer fluids are free of components that can be classified as carcinogens and also do not contain any heavy metals. Despite the CPTherm™ heat transfer fluids fact that CPTherm™ heat transfer fluids are not expected to be toxic it is recommended that the user takes adequate precautions and uses good handling practices

when using CPTherm™ heat transfer fluids. Please refer to the CPTherm™ fluid MSDS's for handling and use guidelines.

TABLE III – Toxicological Data on Heat Transfer Fluids

Test	CPTherm™	Ethylene Glycol	Propylene Glycol	Methanol
LD ₅₀ (oral rat)	11 g/kg*	4.7 g/kg ³⁵	20 g/kg	5.6 g/kg ³⁶
LD ₅₀ (oral mouse)	11.1 g/kg ³⁷	5.5 g/kg ³⁸	20 g/kg	7.3 g/kg ³⁹
Human Minimum Lethal Dose (MLD)	Not expected to be toxic	1.57 /kg ⁴⁰	Not known to be toxic	143 mg/kg

* Based on potassium formate at 100% with an oral mouse toxicity of 5.5 mg/kg; CPTherm considered as a 50% solution of potassium formate.

CPTherm™ Heat Transfer Fluids – NSF* Registration

CPTherm™-F is registered with the NSF and is approved under the HT-1 category – ‘heat transfer fluids acceptable for incidental food contact’. Methanol and ethylene glycol do not qualify for HT-1 registration.

* NSF = National Sanitation Foundation, Ann Arbor, Michigan, USA; website www.nsf.org

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- ¹ Massachusetts Port Authority, Hanscom Field Deicing Study Report, April 15, 2003, conducted by CDM Report number 1344-35529-W09 ”
- ² EPA Report Number 821-R-016, August 2000 “Preliminary Data Summary; Airport Deicing Operations”
- ³ Data for ethylene glycol ACGIH TLV and PELs obtained from the Matheson MSDS; data for the methanol ACGIH TLVs and PEKs obtained from the Acros Organics MSDS; Data on flash points for methanol water combinations obtained from Ashland chemical website
- ⁴ 40 CFR 302.4; <http://www.gpoaccess.gov/ecfr/>
- ⁵ Clean Air Act as amended in 1990, Sect 112 (B)
- ⁶ Daubert, T.E., Danner, R.P. Physical and Thermodynamic Properties of Pure Chemicals Data Compilation, Washington DC, 1989
- ⁷ Massachusetts Port Authority, Hanscom Field Deicing Study Report, April 15, 2003, conducted by CDM Report number 1344-35529-W09 ”
- ⁸ Johnson, J.J., Varney, N., Switzenbaum, M.S. “Comparative Toxicity of Formulated Glycol Deicers and Pure Ethylene and Propylene Glycol”, Report submitted to the University of Massachusetts, Amherst, Water Resources Research Center, August 2001. (Private communication with Prof. Switzenbaum, University of Marquette, Milwaukee, WI)
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- ¹¹ US Coast Guard, Depart of Transportation, CHRIS – Hazardous Chemical Data, Volume II, Washington DC, US Govt Printing Office, 1984-85 (Reported as 0.6-1.12 lb in 5 days)
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- ¹⁸ Ward, T. et al Comparative Acute Toxicity of Diethylene Glycol, Ethylene Glycol, and Propylene Glycol to Freshwater and Marine Fish, Invertebrates and Algae, ARCO Chemical Company, 1992
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- ³⁵ MSDS General Chemical Corporation, 90 Easet Halsey Road, Parsipanny, NJ 07054
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- ³⁷ MSDS Tetra Technologies, 25025 IH-45 North, The Woodlands, TX 77380
- ³⁸ MSDS General Chemical Corporation, 90 Easet Halsey Road, Parsipanny, NJ 07054
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