INDUSTRIAL SOLUTIONS

How to interpret your Dow heat transfer fluid analysis report

This guide is meant to provide a comprehensive overview of a Dow fluid analysis report for current customers who have submitted DOWFROST™, DOWFROST™ HD, DOWTHERM™ (SR-1 or 4000), AMBITROL™ (CN, FL, NTC or NTF), NORKOOL™ (SLH or LTC) or UCARTHERM™ heat transfer fluid samples to the Midland heat transfer fluid testing lab for analysis. Annual analysis is available at no cost to the customer for systems greater than 250 gallons of concentrated fluid. Sample kits are also available and can be requested by e-mailing FMDTFLL@dow.com.

APPEARANCE	
Color	Fluid color is a visual description of the sample, as received. Commercially available heat transfer fluid should be colorless (DOWFROST™), fluorescent yellow (DOWFROST™ HD and NORKOOL™ LTC), fluorescent pink (DOWTHERM™ SR-1 or AMBITROL™ FL), fluorescent orange (DOWTHERM™ 4000), blue-green (NORKOOL™ SLH or AMBITROL™ CN, blue (AMBITROL™ NTC) or yellow (UCARTHERM™). DOWFROST™ heat transfer fluid will often be dyed a color, such as blue, for leak detection. Fluids which are dark brown or black may indicate substantial glycol degradation products, excessive contamination, and/or corrosion by-products.
Clarity	Clarity is a visual description of the sample, as received. Fluids should be clear. Fluids with a cloudy appearance may contain suspended solids or insoluble liquids such as oils. Suspended solids may be due to fabrication debris or are formed by precipitation with hard water ions (calcium and magnesium). The presence of oil can suggest leakage of oil cooled equipment has occurred or that residual oils and greases were not properly removed prior to fluid installation.
Sediment	When sediment is observed in a fluid sample, this can be caused by many things. Fabrication debris is commonly found in fluids which were not properly cleaned prior to installation (e.g., welding flash, pipe scale, corrosion deposits, dirt, sand, etc.). Sediment can also indicate active corrosion within a system. When a fluid with high sediment levels is circulated through a system, erosion of piping and premature wear of mechanical pump seals can occur.
Note on appearance:	The presence of cloudiness or sediment is not typically cause for fluid disposal as it can usually be remedied by in-line filtration. However, samples with high levels of suspended material or insoluble liquids may not be analyzed by our lab as the contaminants can cause damage to our analytical instruments and costly downtime. For similar reasons, high levels of contamination likely means the material is no longer suitable as a heat transfer fluid for your system. The degree of sediment, if any, will be noted in the recommendations section at the end of the report (e.g., slight, moderate and high).

CONCENTRATION & FREEZE POINT	
Propylene glycol & ethylene glycol	All Dow heat transfer fluids are either ethylene glycol (EG) or propylene glycol (PG). There are no blends of the two. Gas chromatography is used to determine the EG and PG concentration as well as the presence of other contaminant glycols such as diethylene and triethylene glycol. If both EG and PG are detected in your fluid, it is an indicator that different fluids have been mixed or the system was not completely flushed before filling with new Dow fluid. Based on the glycol concentration, we can calculate the freeze point of the fluid. In addition to providing the necessary freeze protection, the concentration of glycol is important for other reasons. Heat transfer fluids used at 25% glycol or greater are considered bio-static, meaning sustained growth of bio-organisms is not possible (NORKOOL™, AMBITROL™ and UCARTHERM™ should always be used at 30% by volume of glycol). The reason for this is that glycols hinder growth of microbes and fungi because osmotic pressure for the solution is high enough to create dehydrating conditions which are not life sustaining for bacteria and fungi. On the other hand, overly dilute concentrations of glycol are very bio-degradable and create a growth sustaining environment for bio-organisms. In fact, operating below 15% to 20% concentration of glycol invariably leads to significant bio-fouling of system equipment. Operating over 60% glycol will impede heat transfer, reduce fluid lifetime and provides no additional freeze protection.
Freeze point	It is recommended to choose a glycol concentration that has a freeze point being at least 5°F below the lowest anticipated temperature that the fluid will be exposed to. **HVAC applications:** Choose a concentration between 25-60% by volume of glycol **Oil & Gas applications:** Choose a concentration between 30-60% by volume of glycol

CHEMICAL PROPERTIES	
Fluid pH	Dow heat transfer fluids will have a pH of about 9.0 or greater. Fluid pH will typically decrease with time because of thermal-oxidative degradation of the glycol base fluid. Degradation of glycol produces acidic compounds which cause the pH of your fluid to decrease with time. The buffers present in Dow heat transfer fluids minimize pH drop by neutralizing these acidic compounds. Meanwhile, the corrosion inhibitors protect your system from corrosion if fluid pH remains above 8.0 and below about 10.5. Fluids with pH above 10.5 may require special attention and assistance from Dow Technical Service. Fluids with pH between 7.0 and 8.0 can be re-adjusted back to acceptable ranges by suitable addition of a pH booster. When such pH adjustments are necessary, we provide guidance on how to do so. If fluid pH falls below 7.0 we will recommend fluid disposal because insoluble (oil-like) glycol degradation products will form at this low pH range, meaning it is no longer possible to restore the fluid to acceptable condition by simple pH adjustments.
Reserve alkalinity	Reserve alkalinity is a measure of the buffering capacity of the fluid and is equivalent to mL of 0.1N HCl needed to titrate 10 mL of fluid to a pH of 5.5. This may either be displayed as “Unadjusted Reserve Alkalinity” (URA) or “Reserve Alkalinity” (RA), with the difference being that URA is the value of the fluid, as received, and RA is based on a concentrated fluid.

CORROSION INHIBITORS	
Phosphate	The phosphate-based iron inhibitor provides corrosion protection for ferrous metals (iron). The lowest acceptable limit is 2500 ppm (parts per million), although adjustments to the system may be recommended depending on glycol concentration and fluid type. Phosphate levels above ~10,000 ppm can be problematic as the phosphate may precipitate out of solution and lead to under deposit corrosion in your system. In certain scenarios, low phosphate levels can be typically corrected by the addition of HTF Iron Inhibitor or DOWFROST™ Iron Inhibitor. However, once the phosphate has been critically depleted (<1000 ppm) we recommend fluid replacement.
Tolyltriazole	The azole-based copper inhibitor provides corrosion protection for copper and copper alloys. The lowest acceptable limit is 100 ppm, although adjustments to the system may be recommended depending on glycol concentration and fluid type. Low azole levels can typically be corrected by the addition of HTF Copper Inhibitor or HTF Iron Inhibitor. However, if extremely high levels of azoles are present, we may recommend fluid replacement. **Please note:** DOWFROST™ heat transfer fluid does not contain a supplemental copper inhibitor to be compliant with FDA food contact regulations, whereas all other heat transfer fluids contain a supplemental copper inhibitor.

APPEARANCE	
Chloride	Chloride is a corrosive ion that is usually present due to failure to use de-ionized or distilled water during system dilutions and top-ups. It can substantially increase the corrosion rate (most particularly pitting corrosion) of most metals. At high enough concentrations, chloride can render the inhibitor package ineffective. Once present, there is no way to remove it aside from flushing and disposing of the fluid. Properly installed Dow heat transfer fluids will have less than 25 ppm chloride. Systems containing greater than 100 ppm chloride may experience excessive corrosion if other fluid parameters are also outside recommended ranges. The corrosive effect of chloride is more severe at higher fluid temperatures. Excessive corrosion rates caused by elevated chloride levels often can only be corrected by removal and replacement of the contaminated fluid. When diluting Dow heat transfer fluids, it is important to always use a high purity water, such as distilled or deionized, which has less than 25 ppm chloride.
Sulfate	Sulfate is a corrosive ion that is usually present due to failure to use de-ionized or distilled water during system dilutions and top-ups. It may also form as a result of using sulfur-based (non-Dow) corrosion inhibitors such as mercaptobenzothiazole (MBT). It can substantially increase the corrosion rate of most metals, although less so than chlorides. Properly installed Dow heat transfer fluids will have less than 25 ppm sulfate. Systems containing greater than 250 ppm sulfate may experience excessive corrosion if other fluid parameters are also outside recommended ranges. The corrosive effect of sulfate is more severe at higher fluid temperatures. Like chlorides, excessively high corrosion rates caused by elevated sulfate levels often can only be corrected by removal and replacement of the contaminated fluid. When diluting Dow heat transfer fluids, it is important to always use a high purity water, such as distilled or deionized, which has less than 25 ppm sulfate.
Total hardness	Total hardness, expressed in ppm as calcium carbonate ($CaCO_3$), is the amount of calcium and magnesium ions present in your fluid. Hard water ions will react with most corrosion inhibitors, particularly phosphate, to form insoluble scale on heat transfer surfaces. This has the doubly negative effect of reducing the active concentration of corrosion inhibitors as well as decreasing heat transfer efficiency. Systems are susceptible to localized hot spots and excessive corrosion. A high level of hardness is likely caused by using poor quality water such as river, well or even tap water. When diluting Dow heat transfer fluids, it is important to always use a high purity water, such as distilled or deionized, which has less than 100 ppm total hardness.
Ferrous metal corrosion rate	Ferrous metal corrosion rate is a calculated value based on the overall condition of your fluid. Dow has developed an extensive library for all our heat transfer fluids based on thousands of corrosion testing measurements. We can reliably predict the corrosion rate for our fluids to within +0.1 mils per year (mpy). However, it is not possible for us to accurately calculate corrosion rates for non-Dow fluids, mixtures which are predominately non-Dow in nature, or Dow fluids which have been altered significantly from their original design. The reported corrosion rate is an excellent tool in assessing the overall health of your system. As a point of reference, new Dow fluids exhibit a ferrous metal corrosion rate below 0.05 mpy, whereas the recommended maximum corrosion rate as established by ASTM is 0.5 mpy.
Copper corrosion rate	Copper corrosion rate is a calculated value based on the overall condition of your fluid. Dow has developed an extensive library for all our heat transfer fluids based on thousands of corrosion testing measurements. We can reliably predict the corrosion rate for our fluids to within +0.1 mils per year (mpy). However, it is not possible for us to accurately calculate corrosion rates for non-Dow fluids, mixtures which are predominately non-Dow in nature, or Dow fluids which have been altered significantly from their original design. The reported corrosion rate is an excellent tool in assessing the overall health of your system. As a point of reference, new Dow fluids exhibit a copper (and copper alloys) metal corrosion rate below 0.05 mpy, whereas the recommended maximum corrosion rate as established by ASTM is 0.5 mpy.

CONTAMINANTS & OTHER GLYCOLS	
Nitrite	Nitrite is not present as a corrosion inhibitor in DOWTHERM™, DOWFROST™, AMBITROL™ or UCARTHERM™ heat transfer fluids. However, NORKOOL™ SLH and NORKOOL™ LTC both contain a nitrite-based inhibitor package. If you are not using NORKOOL™ fluids, the presence of nitrite may signal the use of water treatment chemicals or a “wrong” product such as an automotive coolant.
Nitrate	The presence of nitrate in DOWFROST™, DOWTHERM™ and AMBITROL™ fluids can signal the use of non-Dow products, such as automotive coolants, or the use of water treatment chemicals. NORKOOL™ fluids contain nitrites as an additive to protect the system. If NORKOOL™ fluids are exposed to oxygen over time, nitrates can form due to oxidation of the nitrite. While nitrate is not normally detrimental, it is a good indicator of an aging NORKOOL™ fluid.
MBT	Mercaptobenzothiazole (MBT) is a sulfur-based, non-Dow additive that is commonly used as a corrosion inhibitor by many water treatment companies due to its low cost. MBT oxidizes readily to form disulfides and eventually corrosive sulfates (see above section on sulfates).
Total azoles (MBT & TTZ) **may also be displayed as MBT if fluid is DOWFROST™ HD, DOWTHERM™ (SR-1 or 4000), AMBITROL™ (NTC, NTF, CN, or FL), NORKOOL™ (SLH or LTC) or UCARTHERM™	DOWFROST™ does not contain a supplemental copper inhibitor to be compliant with FDA food contact regulations. If your fluid is being analyzed against DOWFROST™ standards, azoles will be considered a contaminant. Depending on your application, the presence of azoles may necessitate the need for fluid replacement but this determination will need to be made independently based on various regulations.
Diethylene glycol (DEG)	Diethylene glycol is a contaminant glycol found in lower grade products such as automotive antifreeze or those based on recycled ethylene glycols. In special circumstances, DEG may also be formed by excessive thermal degradation of mono-ethylene glycol. Thus, its presence always indicates an undesirable contaminant and it should be less than 1%.
Triethylene glycol (TEG)	Triethylene glycol is typically used in gas dehydrators and may also be used in non-HVAC, industrial type heat transfer fluids. It is not present in new Dow heat transfer fluids so its presence indicates a contaminant product.

FLUID MAINTENANCE RECOMMENDATIONS	
Actionable items	If we can recommend any adjustments to your fluid, these actionable items will be noted first in this section. Adjustments may include, but are not limited to: • Addition of a pH booster to increase fluid pH as well as reserve alkalinity • Addition of an iron inhibitor to increase the phosphate level (as well as pH and reserve alkalinity). Copper inhibitor level may also be boosted, depending on the inhibitor added. • Addition of a copper inhibitor to boost the level of tolyltriazole • Glycol adjustments such as adding distilled or deionized water to dilute the fluid down to 60% or less OR the addition of new Dow fluid to bring glycol concentration up. If you need help determining how to make adjustments, please contact Dow TS&D via FMDTFLL@dow.com • Filtering fluid, if possible, due to the presence of sediment • Removal of a portion of system volume and replacement with an equivalent amount of new Dow fluid to bring system to within Dow specifications.
Non-actionable items	Non-actionable items, or warnings and other fluid information, will typically be listed at the end of the report following “Please also note:”

Dow heat transfer fluid quick reference guide




	NORKOOL™ SLH	NORKOOL™ LTC	AMBITROL™ CN	AMBITROL™ NTC
Fluid type	91% Ethylene glycol	92% Propylene glycol	96% Ethylene glycol	94% Propylene glycol
Color	Blue-green	Fluorescent yellow	Blue-green (fluid may also be pink when purchased as pre-mixed AMBITROL™ FL)	Blue (fluid may also be pink when purchased as pre-mixed AMBITROL™ FL)
Optimal operating temperature (if properly diluted and pressurized)	-20°F-275°F	0°F-275°F	-20°F-275°F	0°F-275°F
	-29°C-135°C	-18°C-135°C	-29°C-135°C	-18°C-135°C
Freeze/burst protection (50% glycol in water)	-34°F/<-60°F	-28°F/<-60°F	-34°F/<-60°F	-28°F/<-60°F
	-37°C/<-51°C	-33°C/<-51°C	-37°C/<-51°C	-33°C/-51°C
pH (50% glycol in water)	8.5-10.5	8.5-10.5	8.5-10.5	8.5-10.5
Toxicity	Moderate acute oral toxicity	Low acute oral toxicity	Moderate acute oral toxicity	Low acute oral toxicity
Free fluid analysis	Systems > 250 gallons concentrate	Systems > 250 gallons concentrate	Systems > 250 gallons concentrate	Systems > 250 gallons concentrate
Minimum concentration for use (by volume of glycol)	30%	30%	30%	30%
FLUIDFILE™ software available	Yes	Yes	Yes	Yes




	DOWFROST™	DOWFROST™ HD	DOWTHERM™	DOWTHERM™ 4000
Fluid type	96% Propylene glycol	94% Propylene glycol	95% Ethylene glycol	92% Ethylene glycol
Color	Colorless	Fluorescent yellow	Fluorescent pink	Fluorescent orange
Optimal operating temperature (if properly diluted and pressurized)	0°F-250°F	0°F-325°F	-20°F-250°F	-20°F-350°F
	-18°C-121°C	-18°C-163°C	-29°C-121°C	-29°C-177°C
Freeze/burst protection (50% glycol in water)	-28°F/<-60°F	-28°F/<-60°F	-34°F/<-60°F	-34°F/<-60°F
	-33°C/<-51°C	-33°C/<-51°C	-51°C/<-51°C	-37°C/-51°C
pH (50% glycol in water)	8.5-10.5	8.5-10.5	8.5-10.5	8.5-10.5
Toxicity	Low acute oral toxicity	Low acute oral toxicity	Moderate acute oral toxicity	Moderate acute oral toxicity
Free fluid analysis	Systems > 250 gallons concentrate	Systems > 250 gallons concentrate	Systems > 250 gallons concentrate	Systems > 250 gallons concentrate
Minimum concentration for use (by volume of glycol)	25%	25%	25%	25%
FLUIDFILE™ software available	Yes	Yes	Yes	Yes

Images: dow_58561823434, dow_67783150968

PRODUCT SAFETY INFORMATION REQUIRED FOR SAFE USE IS NOT INCLUDED IN THIS DOCUMENT. BEFORE HANDLING, READ PRODUCT AND SAFETY DATA SHEETS AND CONTAINER LABELS FOR SAFE USE, PHYSICAL AND HEALTH HAZARD INFORMATION. THE SAFETY DATA SHEET IS AVAILABLE ON THE DOW WEBSITE AT WWW.DOW.COM, OR FROM YOUR DOW SALES APPLICATION ENGINEER, OR DISTRIBUTOR, OR BY CALLING DOW CUSTOMER SERVICE.

NOTICE: No freedom from infringement of any patent owned by Dow or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer's use and for ensuring that Customer's workplace and disposal practices are in compliance with applicable laws and other government enactments. The product shown in this literature may not be available for sale and/or available in all geographies where Dow is represented. The claims made may not have been approved for use in all countries. Dow assumes no obligation or liability for the information in this document. References to "Dow" or the "Company" mean the Dow legal entity selling the products to Customer unless otherwise expressly noted. NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.

2000017497

Form No. 176-01643-01-0622 S2D