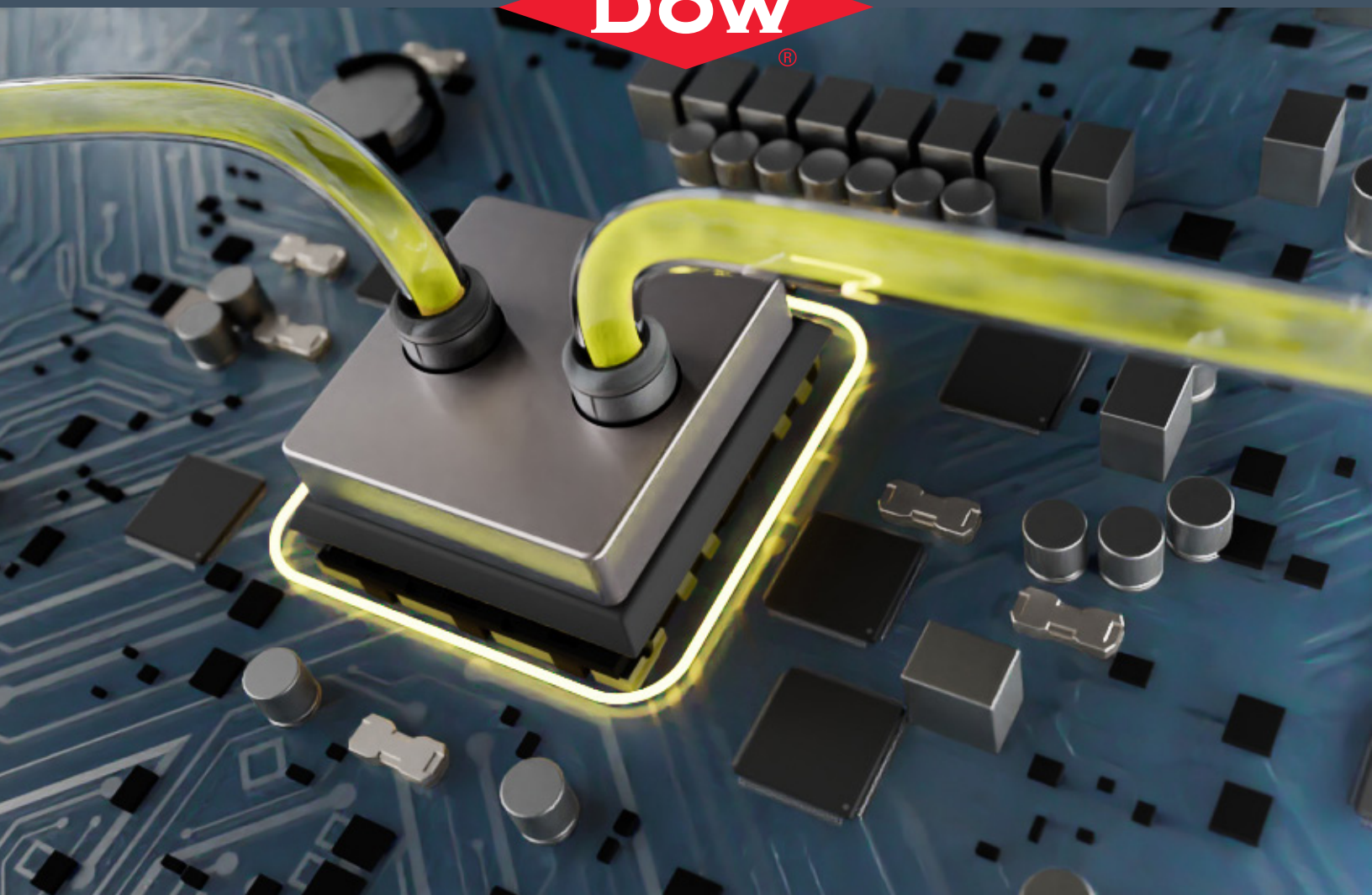
DOWFROST™ LC Heat Transfer Fluids

PG25 and PG55 Inhibited Propylene Glycol-Based Heat Transfer Fluids

Heat management and corrosion protection in liquid cooled data center applications

Engineering and Operating Guide



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1.0 Introduction

Continual advancement of micro-processor technology has led to increasingly higher heat loads incurred by Technology Cooling Systems (TCS). As power density increases, conventional air cooling is no longer economically viable as the cost to operate air cooling equipment within a data center exceeds the cost of the equipment being cooled (over a typical three-year equipment life span). This has caused the industry to move toward liquid cooling of TCS. DOWFROST™ LC Heat Transfer Fluids are specifically formulated for liquid cooled, direct-to-chip applications, offering exceptional corrosion protection, even in high surface area copper components.

DOWFROST™ LC 25 and DOWFROST™ LC 55, commonly referred to as PG25 and PG55 in this application, may be used in these systems to provide freeze protection and to limit corrosion, helping to ensure a long life of the system. The TCS may be supplied with fluid from an in-rack Cooling Distribution Unit (CDU) or supplied by an external CDU that services multiple racks.

This guide provides basic product performance information, engineering data and operating guidelines for DOWFROST™ LC used in TCS loops. Topics covered in this guide are:

- Brief introduction to DOWFROST™ LC Heat Transfer Fluids
- Typical properties
- System design and preparation guidelines
- Fluid testing and maintenance
- Detailed engineering data

If you would like additional product information, please contact Dow at (800) 258-2436.

2.0 Properties of DOWFROST™ LC Heat Transfer Fluids

2.1 Appearance and typical properties

DOWFROST™ LC Heat Transfer Fluids are dyed a fluorescent yellow-green color which helps to identify the location of any possible leaks within a system. Fluids which are in use for an extended length of time may not exhibit the same bright color and can be darker or less vibrant in appearance but should remain relatively clear with no evidence of cloudiness or suspended solids.

Tables 1 to 3 outline the typical properties of unused DOWFROST™ LC.

2.2 Propylene glycol quality

In order to provide effective long-term corrosion protection of TCS, a heat transfer fluid must be made from highly purified propylene glycol that meets United States Pharmacopeia (USP) specifications in addition to containing appropriate corrosion inhibitors (providing acceptable pH and reserve alkalinity).

Propylene glycol that does not meet USP specifications may have higher levels of impurities which can impart strong odors and cause excessive foaming. The harmful effects of these unwanted impurities cannot be negated by the addition of corrosion inhibitors or additives. DOWFROST™ LC Fluids are made from high purity Dow PURAGUARD™ USP/EP grade propylene glycol (>99.8% purity) and contain industrial strength corrosion inhibitors, pH buffers and stabilizers specifically designed for operation within Technology Cooling Systems.

2.3 Glycol concentration

The acceptable operating range for in-use DOWFROST™ LC 25 is between 24-29% by volume of propylene glycol. For in-use DOWFROST™ LC 55, the acceptable range is between 53-57% by volume of propylene glycol.

The inhibitors are formulated to provide optimal performance and fluid lifetime at these recommended levels. Lowering the glycol concentration reduces the inhibitor concentration to a level that may not provide adequate corrosion protection for a system.

Additionally, diluting the fluid below 24% propylene glycol may put a system at risk for bacterial contamination as glycols are very biodegradable below this level. When glycol is maintained at a concentration of 24% or higher, the osmotic pressure of the solution is high enough to cause dehydration of bacteria and fungi, creating bio-static conditions.

Propylene glycol concentration and subsequent freezing point can be estimated by measuring refractive index (RI) on-site and referencing Tables 4 and 5. Refractive index values are temperature dependent and may vary slightly depending on the condition or age of the fluid being tested. It is recommended to utilize a digital refractometer that is temperature compensated to either 20°C or 25°C.

2.4 Electrical conductivity

The necessary use of corrosion inhibitors, pH buffers, stabilizers and other additives specifically designed for Technology Cooling Systems will impart higher electrical conductivity (lower electrical resistivity) than is commonly seen for water.

Table 1. Typical properties† of unused DOWFROST™ LC Heat Transfer Fluids

Fluid parameter	Units	DOWFROST™ LC 25	DOWFROST™ LC 55
Propylene glycol concentration	Volume %	25	55
Freezing point	°F	14	-40
	°C	-10	-40
Specific Gravity, 25/25°C		1.030-1.036	1.051-1.057
pH		8.5-10.5	8.5-10.5
Reserve alkalinity	mL of N HCl	>6.0	>6.0
Thermal conductivity at 50°C	W/m.K	0.485	0.336
Specific heat at 50°C	kJ/kg.K	4.13	3.43
Viscosity at 20°C	mPa.s	2.72	8.84
Viscosity at 50°C	mPa.s	1.15	2.95
Volume expansion	%	5.1 (from -10 to 90°C)	8.5 (from -40 to 90°C)
Boiling point at 760 mmHg	°C	101.4	105
Sulfate	ppm	<10	<10
Chloride	ppm	<5	<5
Total hardness	ppm as $CaCO_3$	<20	<20

†These are typical properties, not to be construed as specifications.

Table 2. Physical properties† of DOWFROST™ LC 25 Heat Transfer Fluid

°C	Density (kg/m^3)	Specific heat (kJ/kg K)	Thermal conductivity (W/m.K)	Viscosity (mPa.s)	Vapor pressure* (bar)
-5	1037.3	3.99	0.425	7.88	0.004
0	1036.8	4.01	0.432	6.20	0.006
5	1035.7	4.03	0.438	4.94	0.009
10	1034.3	4.04	0.444	3.99	0.012
15	1032.4	4.06	0.450	3.27	0.017
20	1030.3	4.07	0.456	2.72	0.023
25	1028.0	4.08	0.462	2.29	0.031
30	1025.6	4.09	0.467	1.95	0.042
35	1023.0	4.11	0.472	1.68	0.055
40	1020.3	4.12	0.476	1.47	0.072
45	1017.6	4.12	0.481	1.29	0.093
50	1014.8	4.13	0.485	1.15	0.119
55	1012.0	4.14	0.488	1.03	0.152
60	1009.0	4.15	0.492	0.94	0.191
65	1006.0	4.16	0.495	0.85	0.239
70	1002.7	4.17	0.497	0.77	0.297
75	999.2	4.17	0.500	0.70	0.367
80	995.4	4.18	0.502	0.63	0.450

†These are typical properties, not to be construed as specifications.
* Absolute pressure

Table 3. Physical properties† of DOWFROST™ LC 55 Heat Transfer Fluid

°C	Density (kg/m^3)	Specific heat (kJ/kg K)	Thermal conductivity (W/m.K)	Viscosity (mPa.s)	Vapor pressure* (bar)
-40	1085.9	2.98	0.280	1413.58	—
-35	1083.9	3.01	0.283	703.58	—
-30	1081.9	3.03	0.287	376.40	—
-25	1079.8	3.06	0.291	214.54	0.001
-20	1077.5	3.08	0.294	129.29	0.001
-15	1075.1	3.11	0.298	81.85	0.002
-10	1072.7	3.13	0.302	54.11	0.002
-5	1070.1	3.16	0.305	37.18	0.004
0	1067.4	3.18	0.309	26.42	0.005
5	1064.7	3.21	0.312	19.36	0.007
10	1061.8	3.23	0.315	14.57	0.010
15	1058.8	3.26	0.318	11.23	0.015
20	1055.7	3.28	0.321	8.84	0.020
25	1052.5	3.30	0.324	7.09	0.027
30	1049.2	3.33	0.327	5.79	0.036
35	1045.8	3.35	0.329	4.80	0.048
40	1042.2	3.38	0.332	4.03	0.062
45	1038.6	3.40	0.334	3.43	0.081
50	1034.9	3.43	0.336	2.95	0.104
55	1031.0	3.45	0.338	2.56	0.132
60	1027.1	3.48	0.339	2.24	0.167
65	1023.0	3.50	0.341	1.98	0.209
70	1018.9	3.53	0.342	1.76	0.260
75	1014.6	3.55	0.343	1.58	0.320
80	1010.2	3.58	0.344	1.42	0.395

†These are typical properties, not to be construed as specifications.
* Absolute pressure

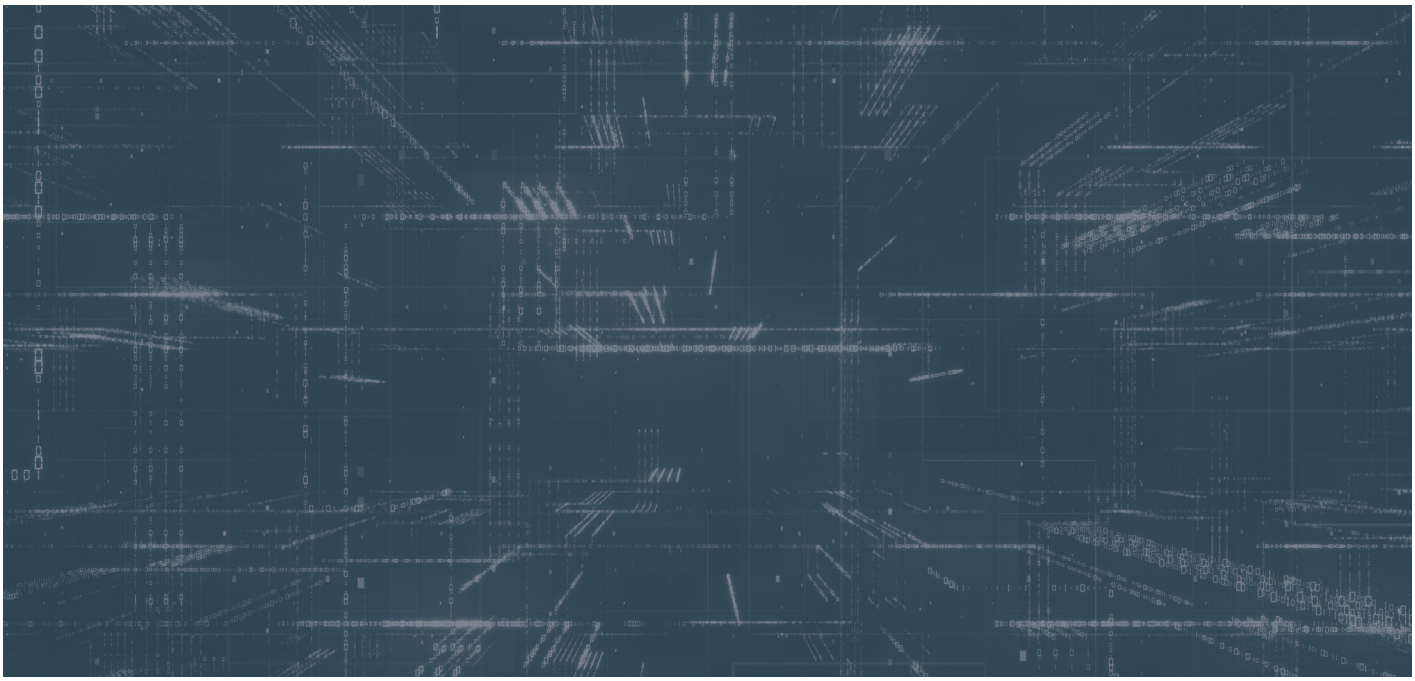


Table 4. Freezing point and refractive index† versus glycol concentration for DOWFROST™ LC 25 Heat Transfer Fluid

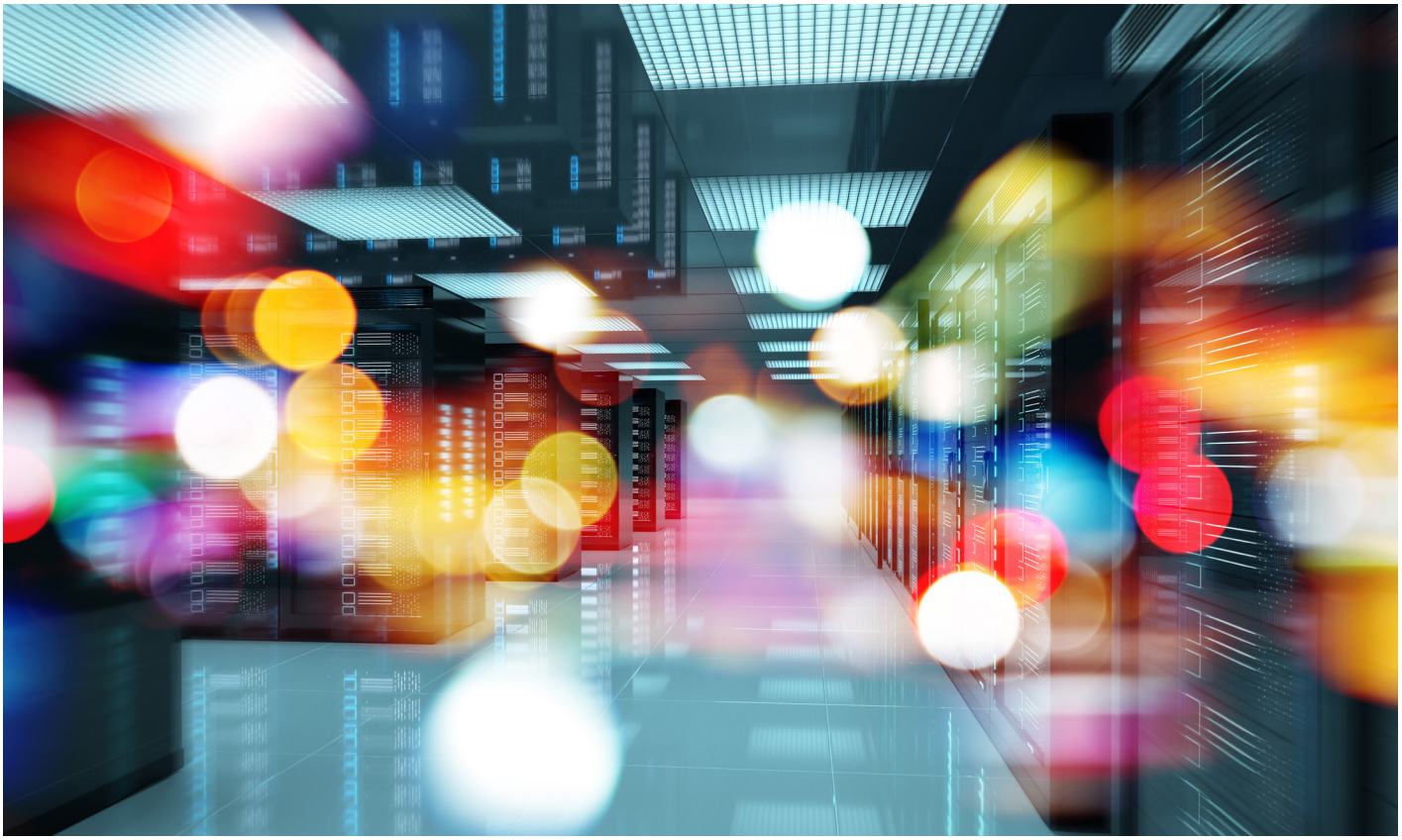
Propylene Glycol		Refractive index		Freezing point	
Wt %	Vol %	20°C	25°C	°F	°C
18	17.8	1.3542	1.3536	19.9	-6.7
19	18.8	1.3555	1.3548	19.4	-7.0
20	19.8	1.3568	1.3561	18.9	-7.3
21	20.8	1.3581	1.3573	18.1	-7.7
22	21.8	1.3593	1.3585	17.4	-8.1
23	22.8	1.3606	1.3598	16.5	-8.6
24	23.8	1.3618	1.361	15.6	-9.1
25	24.9	1.363	1.3622	14.7	-9.6
26	25.9	1.3643	1.3634	13.6	-10.2
27	26.9	1.3655	1.3646	12.6	-10.8
28	27.9	1.3667	1.3658	11.5	-11.4
29	29.0	1.3679	1.367	10.2	-12.1
30	30.0	1.369	1.3681	9.0	-12.8
31	31.0	1.3702	1.3693	7.7	-13.5
32	32.0	1.3714	1.3705	6.4	-14.2
33	33.1	1.3725	1.3716	5.0	-15.0
34	34.1	1.3737	1.3728	3.6	-15.8
35	35.1	1.3748	1.3739	1.9	-16.7

†These are typical properties, not to be construed as specifications.

Table 5. Freezing point and refractive index† versus glycol concentration for DOWFROST™ LC 55 Heat Transfer Fluid

Propylene Glycol		Refractive index		Freezing point	
Wt %	Vol %	20°C	25°C	°F	°C
50	50.4	1.3918	1.3906	-28.4	-33.6
51	51.4	1.3929	1.3917	-31.1	-35.1
52	52.5	1.3940	1.3928	-33.9	-36.6
53	53.5	1.3951	1.3938	-36.7	-38.2
54	54.6	1.3962	1.3949	-39.7	-39.8
55	55.7	1.3973	1.3960	-42.8	-41.6
56	56.8	1.3983	1.3970	-46.0	-43.3
57	57.9	1.3994	1.3981	-49.3	-45.2
58	59.0	1.4005	1.3991	-52.8	-47.1
59	60.2	1.4016	1.4002	-56.4	-49.1
60	61.3	1.4026	1.4012	-60.2	-51.2

†These are typical properties, not to be construed as specifications.



3.0 System design considerations

3.1 General

It is recommended to verify the compatibility of that all system components and materials in direct contact with DOWFROST™ LC at the minimum and maximum expected exposure temperatures.

3.2 Corrosion Protection

All heat transfer fluids used in a Technology Cooling System must be capable of providing long-term corrosion protection of common metals including carbon steel, stainless steel, copper, copper alloys and brazes up to bulk fluid temperatures of 90°C (194°F).

Glycol-based heat transfer fluids can experience oxidation and thermal degradation with exposure to heat and air during normal operation, leading to the formation of acidic compounds. These glycol degradation reactions are often catalyzed by metallic surfaces, so it is critical that the additive package be specifically designed for these systems. DOWFROST™ LC Heat Transfer Fluids contain specially designed corrosion inhibitor packages that are designed for long-term protection in TCS applications

Table 6 shows the low corrosion of widely used metals in contact with DOWFROST™ LC. The tests were performed using ASTM D8040 corrosion test method. DOWFROST™ LC fall well below the generally accepted corrosion limits considered adequate under this test. Open Compute Project (OCP) Guidelines allow for a maximum corrosion rate of 0.2 mpy for copper and brass. These tests also demonstrated that water and uninhibited glycols are highly corrosive, reinforcing the need for inhibited fluid protection.

Table 6. Corrosion Test* Results for DOWFROST™ LC 25 Heat Transfer Fluid

Metal	Units	Water	Uninhibited Propylene Glycol	DOWFROST™ LC 25
Copper	**mpy**	**0.08**	**0.16**	**0.03**
	weight loss, mg	2	4	1
Solder	**mpy**	**3.14**	**34.70**	**0.04**
	weight loss, mg	99	1095	1
Brass	**mpy**	**0.23**	**0.20**	**0.07**
	weight loss, mg	5	5	1
Mild Steel	**mpy**	**9.69**	**9.80**	**0.02**
	weight loss, mg	212	214	0
Cast Iron	**mpy**	**21.20**	**16.20**	**0.02**
	weight loss, mg	450	345	0
Aluminum	**mpy**	**13.20**	**1.80**	**0.31**
	weight loss, mg	110	15	2

*ASTM D8040 testing was performed at 190°F (88°C) for 2 weeks with constant air bubbling, adding the appropriate amount of corrosive salts to the fluids.

3.3 Materials compatibility

A TCS fluid must also demonstrate long-term chemical compatibility with common elastomers and polymers at the bulk fluid temperature. The compatibility of DOWFROST™ LC with the materials used in the system must be verified by the component /material supplier before use. Information in Tables 7 and 8 should be used as a reference until compatibility has been verified.

Table 7. DOWFROST™ LC 25 and DOWFROST™ LC 55 Wetted Materials List

Material	Compatibility with DOWFROST™ LC
Brass	Acceptable up to at least 90°C Brass with <15% zinc is preferred as concentrations >15% zinc are more prone to dezincification. |For higher zinc concentrations it is recommended to follow the OCP Guidelines.
Dezincification-Resistant (DZR) Brass CW602N	Acceptable up to at least 90°C Other grades may be acceptable. It is recommended to follow the OCP Guidelines regarding dezincification resistance.
Brass, chrome plated	Acceptable up to at least 90°C
Brass, nickel plated	Acceptable up to at least 90°C
Brazing Fillers (B-Ni-6, BCup-2, BCup-3, BCup-4, BCup-5, TF-H600F)	Acceptable up to at least 90°C
Carbon steel	Acceptable up to at least 90°C
Copper (CDA 110, CDA 1020, CDA 1220, CDA 1100)	Acceptable up to at least 90°C
Copper alloys	Acceptable up to at least 90°C Alloys with <15% zinc are preferred as concentrations >15% zinc are more prone to dezincification. For higher zinc concentrations it is recommended to follow the OCP Guidelines
Stainless steel	Acceptable up to at least 90°C 304L, 316L or higher grades preferred. Most SS alloys should be acceptable, including 303 and 410.
Zinc	Not Acceptable Zinc is dissolved by glycol-water mixtures. Use of Galvanized components should be avoided.

Table 8. DOWFROST™ LC 25 and DOWFROST™ LC 55 Wetted Materials List

Material	Compatibility with DOWFROST™ LC
Acrylonitrile butadiene rubber (NBR)	Acceptable up to at least 90°C
Ethylene Propylene Diene Monomer (EPDM)	Acceptable up to at least 90°C Peroxide-cured EPDM is preferred as sulfur- cured EPDM may introduce sulfate into the fluid over time.
Fluorinated Ethylene Propylene (FEP)	Acceptable up to at least 90°C
Fluroelastomers (FKM) VITON A VITON GF VITON ETP	 Acceptable to at least 60°C Acceptable to at least 90°C Acceptable to at least 90°C
High density Polyethylene (HDPE)	Acceptable up to at least 90°C
Hydrogenated Nitrile Butadiene Rubber (HNBR)	Acceptable up to at least 90°C
Perfluoroalkoxy alkane (PFA)	Acceptable up to at least 75°C
Polyamide 11 (PA11) and 12 (PA12)	Acceptable up to at least 90°C
Polychloroprene (CR)	Caution: Some compositions of this polymer are not recommended above 40°C
Polyether ether ketone (PEEK)	Acceptable up to at least 90°C
Polyoxymethylene (POM)	Not recommended above 30°C
Polyphenylene Sulfide (PPS)	Acceptable up to at least 60°C
Polypropylene (PP)	Acceptable up to at least 90°C
Polysulfone or Polyphenylsulfone (PSU, PPSU)	Acceptable up to at least 75°C
Polytetrafluoroethylene (PTFE)	Acceptable up to at least 90°C
Vinyl Methyl Quartz (VQM)	Acceptable up to at least 90°C
Silicone	Caution: Most compositions of this polymer are not recommended above 40°C
Loctite 567 (Thread sealant)	Acceptable for use. Please confirm temperature rating with manufacturer

4.0 System preparation

4.1 System flushing

The cleaning and commissioning process for new Technology Cooling System components involves separate flushing procedures for individual equipment and piping, using either heat transfer fluid, purified water or, if needed, specialized cleaning agents. Cleaning agents should be compatible with the system's components and with the heat transfer fluid. They should be also completely removed from the system before filling with heat transfer fluid as remains can have a negative impact on the system's components and on the heat transfer fluid. After filling the system with DOWFROST™ LC, a fluid sample should be taken and analyzed to detect any potential contamination, and to verify the fluid concentration as any leftover of flush water, if used, can dilute the fluid. Consult Dow's Technical Service Team for detailed guidance.

Table 9. Flushing water quality requirements

Parameter	Acceptable limit
Chloride (as Cl)	<25 ppm
Sulfate (as SO4)	<25 ppm
Calcium (Ca)	<25 ppm
Magnesium (Mg)	<25 ppm
Total Hardness (as CaCO3)	<50 ppm

4.2 Hydrostatic testing and system volume measurement

Hydrostatic testing of TCS piping can be combined with system flushing. Suitable quality water meeting the requirements shown in Table 9 should be used. The addition of cleaning additives will not adversely affect hydrostatic testing.

The system volume can be estimated by metering in the amount of water needed to fill the system for flushing or hydrostatic testing. An estimation of volume based on piping and vessel sizes as indicated on engineering drawings or from actual measurements made in the field can also be used.

4.3 Piping

All piping materials must be known to be compatible with the DOWFROST™ LC to minimize excessive corrosion or incompatibility of system components. Piping diameter must be large enough, as dictated by industry best practices, to avoid excessive flow velocity as well as excessive pressure drop. The selected concentration of TCS HTF will determine viscosity which will affect pressure drop through the TCS.

4.4 System vents

The TCS needs to be equipped with adequate venting to relieve trapped air at high points during initial filling with DOWFROST™ LC. Failure to remove air will lead to significant air entrainment problems which can impair heat transfer, increase likelihood of localized corrosion, and cause damage to internally flushed mechanical pump seals.

4.5 Filtration

Effective filtration is essential for protecting cold plates and maintaining fluid cleanliness in Technology Cooling Systems (TCS), particularly where microchannel geometries are sensitive to particulate fouling. This can be achieved by implementing side stream (bypass) filtration or inline (full flow) filtration to remove particulates or other solids that can lead to plugging of narrow microchannels, localized corrosion and fouling of heat transfer surfaces. Ideally, a system should be equipped with both types of filtration. Overall, choosing the right filtration strategy ensures long-term system reliability, protects critical components and minimizes maintenance.

Side stream filtration, the most common and cost-effective method, filters 5–15% of system flow continuously and is ideal for systems larger than 250 gallons, although it still offers benefits for smaller volume systems. It poses no back-pressure risk when clogged, making maintenance easier, and enables full system turnover within 24 hours. This method can be paired with inline filtration for added protection, redundancy and extended service life.

Inline filtration provides comprehensive protection by filtering 100% of the system flow, making it best suited for critical applications requiring high fluid purity. It is recommended to install duplex filters for uninterrupted operation during filter changeouts or cleaning. Most Coolant Distribution Units (CDU) are manufactured with 25-50 micron inline filtration already installed.

To ensure effective filtration and protection of system materials, it is important to select the right filter media and size for use. Filters made of polypropylene, polyester or glass microfiber are often used with propylene glycol-based fluids. Regardless of the filter used, it is recommended to choose a filter with an absolute Beta ratio of 5000 or greater and with a pore size between 5-25 micron for side stream filtration or 25-50 micron for inline filtration. For guidance on system setup or to confirm filters will provide effective particle removal at the operating conditions, please consult a filter vendor.

4.6 Spills

Small spills of heat transfer fluid can be cleaned by using a suitable absorbent such as vermiculite or other floor drying sorbents. The absorbed material should be collected in suitable and properly labeled containers. For large spills, the fluid should be recovered by diking and pumping into suitable and properly labeled containers which can then be properly disposed. See Section 13 of the DOWFROST™ LC Safety data Sheet (SDS), Disposal Considerations, for additional information.

5.0 Fluid testing and maintenance

5.1 Representative samples and frequency of tests

A representative sample of DOWFROST™ LC must be collected from the TCS after installation, and circulation of the fluid for at least 24 hours, to establish a baseline. “Representative” means the sample has not been collected from a dead leg or areas of poor circulation and that it represents the majority of the fluid that is present in the system. Afterward, it is recommended that a comprehensive analysis of the fluid in the system is completed annually to verify that the it is still suitable for continued use. Refer to Table 10 for expected characteristics for in-use fluid.

5.2 Fluid identification and appearance

Visual appearance of a DOWFROST™ LC sample conveys important information. Conducting a regular check of fluid appearance, at least once per year, is highly recommended. A brightly colored, fluorescent yellow-green fluid which is free from cloudiness and solids will typically indicate the fluid is in acceptable condition. Over time, an in-use fluid may start to appear darker in color or less vibrant, which is to be expected. Cloudiness, or the presence of solids, indicates a problem has occurred within the TCS. Please contact Dow’s Technical Service if the fluid shows signs of unacceptable appearance.

5.3 Concentration and freezing point

A hand-held refractometer can be used to verify that the glycol concentration and freezing point of the fluid has not changed. (see tables 4 and 5). The refractive index of DOWFROST™ LC should remain nearly the same as when initially installed. Dow’s Technical Service Team can advise on the proper course of action if the fluid is outside of the recommended range.

5.4 Fluid pH

Fluids which have a pH within the range of 8.0 to 10.5 are considered to be in an acceptable condition. Handheld pH meters, or pH paper calibrated to 0.5 units within a pH range of 7 to 11, can be used to verify whether the DOWFROST™ LC has an acceptable pH. In general, the pH of the fluid will decrease, not increase, over time. Dow’s Technical Service Team can advise on the proper course of action if the fluid is outside of the recommended range.

5.5 Reserve alkalinity

Low Reserve alkalinity (RA), or buffering capacity, may indicate low corrosion inhibitors level in the fluid. This may lead to corrosion or fouling issues. Reserve alkalinity, for in-use DOWFROST™ LC should be greater than 4.0 mL of 0.1 of N HCl when tested according to ASTM D1121. Dow’s Technical Service Team can advise on the proper course of action if the fluid is outside of the recommended range.

5.6 Degradation products

When exposed to heat and air during system operation, glycol-based heat transfer fluids will oxidize and degrade. These degradation compounds accumulate over time and deplete the corrosion inhibitors and stabilizers present in the fluid. This is natural and unavoidable. Every fluid reaches the end of its useful life when the level of degradation products is high enough to negate the effectiveness of the corrosion inhibitors. When this happens, fluid pH will decrease below 8.0 and may lead to corrosion or fouling of TCS components. Dow’s Technical Service Team can advise on the proper course of action if this happens.

5.7 Fluid lifetime and replacement

When DOWFROST™ LC has reached the end of its useful life, the system should be drained, flushed and filled with new fluid. There is no other practical way to remove the harmful impurities or degradation compounds that combine to cause corrosion, fouling or foaming problems for the system.

To assist with fluid maintenance, it is recommended that a system nameplate, encased in clear plastic and with the following information, be affixed to the system:

- Date of installation
- Description of the heat transfer fluid (DOWFROST™ LC 25 or DOWFROST™ LC 55)
- Volume of fluid installed
- Copy of the Safety Data Sheet (SDS)

Table 10. Expected quality characteristics for in-use DOWFROST™ LC Heat Transfer Fluids

Characteristic	Acceptable values	Test Method
Appearance	Yellow, clear, particulate free	Visual
Glycol Concentration	DOWFROST™ LC 25 - 24 to 29% PG, by volume DOWFROST™ LC 55 - 53 - 57% PG, by volume	ASTM D3321
Fluid pH	8.0-10.5	ASTM D1287
Reserve Alkalinity	>4 mL 0.1 of N HCl	ASTM D1121
Copper	< 5 ppm	ASTM D6130
Iron	< 5 ppm	ASTM D6130
Total Hardness	<25 ppm (as $CaCO_3$)	ASTM D6130
Chloride	< 25 ppm	ASTM D5827
Sulfate	< 25 ppm	ASTM D5827

6.0 Conditions to avoid

6.1 Excessive fluid temperature

The maximum recommended bulk fluid temperature for DOWFROST™ LC Heat Transfer Fluid is 90°C (194°F). Operation above the maximum recommended fluid temperature limits may accelerate fluid degradation, compromise the expected lifetime of the fluid and adversely affect the performance of the TCS.

DOWFROST™ LC 25 provides freeze protection down to -10°C (14°F). In the case of DOWFROST™ LC 55, the lowest operating temperature is normally considered -20°C (0°F) due to the viscosity increase at this temperature, however, freeze protection down to -40°C (-40°F) can be achieved.

6.2 Excessive aeration

Excessive turbulence in an expansion tank that is vented to the atmosphere, or other situations where the fluid is exposed to an extensive amount of air, should be avoided as this can lead to air entrainment, foaming and increased oxidation of the fluid which may reduce the expected life of the fluid and compromise the performance of the TCS.

7.0 Storage

DOWFROST™ LC Heat Transfer Fluid should be stored at ambient temperatures between -7°C to 50°C (19°F to 122°F) to avoid freezing conditions or excessive heat which may affect product performance. All packaged DOWFROST™ LC should be stored away from the elements, such as in a warehouse or a similar enclosed facility.

The storage area should be dry and well-ventilated and allow for storage away from dust and debris which can accumulate on containers and compromise cleanliness during opening. Indoor storage will also protect drums and tote labels from fading, peeling, or becoming illegible by avoiding exposure to sunlight, water, and harsh conditions. This is especially important as the labels contain important information needed for tracking, identification and compliance purposes (e.g. product name, production date, batch number). If short-term outdoor storage is unavoidable (e.g. less than 1 week), it is best practice to store containers under a protective covering.

Containers of DOWFROST™ LC should be kept away from direct sunlight. Prolonged UV exposure can cause fading of the dye used for leak detection, reducing its effectiveness. This is especially important for totes due to their translucent nature. Exposure to sunlight can also weaken plastic totes and fade labeling.

About Dow

Dow (NYSE: DOW) combines global breadth; asset integration and scale; focused innovation and materials science expertise; leading business positions; and environmental, social and governance leadership to achieve profitable growth and help deliver a sustainable future. The Company's ambition is to become the most innovative, customer centric, inclusive and sustainable materials science company in the world. Dow's portfolio of plastics, industrial intermediates, coatings and silicones businesses delivers a broad range of differentiated, science-based products and solutions for its customers in high-growth market segments, such as packaging, infrastructure, mobility and consumer applications. Dow operates manufacturing sites in 31 countries and employs approximately 35,800 people. Dow delivered sales of approximately $44.6 billion in 2023. References to Dow or the Company mean Dow Inc. and its subsidiaries. For more information, please visit www.dow.com or follow @DowNewsroom on Twitter.

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