Dynalene LC Series

engineering guide

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Contents

Product Overview

This engineering guide provides operating guidelines, product information, and engineering data for the Dynalene LC series of heat transfer fluids. Dynalene LC products are specially designed for cooling PEM fuel cells, electronics, computers, batteries, charging stations, data centers and other applications requiring low electrical conductivity coolants. They provide efficient heat transfer that prevents your system from overheating while simultaneously protecting against electric shocks, fires, and thermal runaway reactions as a result of spills. Low conductivity also protects against electrolysis in systems where active electrodes are exposed to fluid. LC products use a non-ionic corrosion inhibitor package that protects aluminum, copper, brass, and stainless steel components in your system.

Dynalene offers different LC products, each with its own specific advantages depending on the process it is used in and which materials the fluid will be contacting. These products are Dynalene LC-PG (made from propylene glycol), Dynalene LC-EG (made from ethylene glycol). These fluids are non-flammable and are all safer to handle than hydrocarbon-based low-conductivity fluids. Dynalene LC-PG is non-toxic. All Dynalene LC fluids can be blended to any concentration or sold as a concentrate. LC fluids are available in 1, 2.5, 5-gallon pails, 30 or 55-gallon drums, 265-gallon totes, or in bulk tankers.

To maintain low electrical conductivity as the fluid ages, Dynalene strongly recommends using an ion-exchange resin cartridge with all LC products. Dynalene's IC-093 Series cartridges are designed and tested extensively for greater ion removal on our low conductivity heat transfer fluid products. These cartridges can be easily installed in systems operating up to 200°F (93°C).

Table 1: Typical properties of Dynalene LC solutions

Composition	Glycol, water and non-ionic inhibitors
Color	Clear and colorless
Odor	Little or none
Operating Range	-58 to 200°F (-50 to 93°C)
Electrical Conductivity	<5.0 μS/cm
Flash Point	None (for glycol concentrations ≤80%)

**pH is not applicable for low-conductivity LC fluid*

Ethylene vs Propylene Glycol

Dynalene offers several different glycol-based coolants. When choosing which glycol to use, there are a few important factors to consider. Ethylene glycol-based coolants are less viscous at low temperatures than propylene glycol coolants, so ethylene glycol will provide better heat transfer across the entire temperature range, as depicted in Figure 1 below.

When toxicity is a concern, such as food applications, where contact with drinking water is possible or if leaks or spills could result in environmental contamination, ethylene glycol should not be used. Propylene glycol would be the suitable choice for these applications, as it is generally recognized as safe for food contact. It is important to identify any toxicity concerns that could be associated with your system prior to installing ethylene glycol.

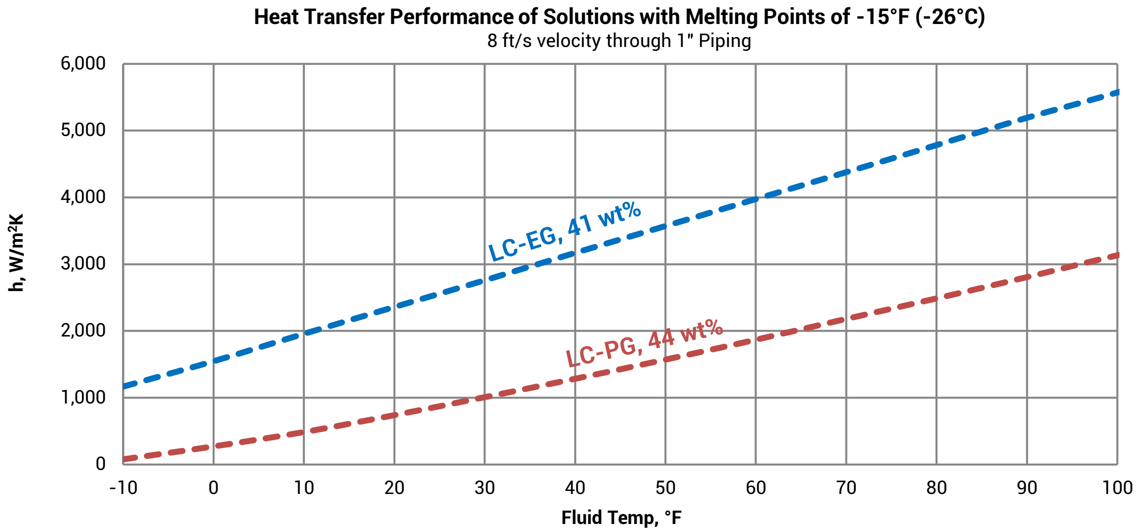

Figure 1. Heat transfer performance comparison of different glycol solutions.

Freeze and Burst Protection

The concentration of glycol required in the heat transfer fluid depends on the lowest operating temperature of your system and the coldest environmental conditions the fluid will experience. As the temperature of the glycol solution drops below its freezing point, ice crystals begin to form and precipitate out into the fluid. The liquid glycol solution becomes further concentrated with glycol and remains fluid. Ice occupies a larger specific volume than water, and as more slush forms the glycol slurry expands in the system provided there is an expansion reservoir where the slurry can flow into. If an adequate amount of glycol is included in the heat transfer fluid, damage should not occur to system exponents during this expansion. This is important for systems that remain dormant during winter shutdown where there is potential for the temperature to drop below the glycol solution's freezing point. This is known as "burst protection." Tables 2 and 3 give recommendations for sufficient burst protection using Dynalene LC products.

Freeze protection is required in closed systems where there is inadequate expansion volume available to accommodate slush formation. With freeze protection, no ice crystals are able to form, and the fluid can be pumped at the lowest operating temperature. Systems that shut down during the winter but need to start up again while the weather is still cold may require freeze protection. For optimal freeze protection, Dynalene recommends a glycol solution that can maintain a freezing point of at least 10°F below the lowest anticipated temperature. See Tables 2 and 3 for Dynalene LC freezing points at various concentrations.

Selecting the Right Concentration

Glycols are generally mixed with water to form solutions to increase the heat transfer performance of the fluid. Water has a lower viscosity, higher thermal conductivity, and higher heat capacity than pure glycol, so solutions with lower glycol concentrations will have superior heat transfer performance than solutions with higher glycol concentrations. However, in situations where low-temperature freeze protection is necessary, higher glycol concentrations must be used. To determine what percentage of glycol your application requires for freeze protection, identify the lowest possible temperature the fluid will be exposed to and select a solution with a freezing point 10°F below your lowest anticipated temperature. Tables 2 and 3 provide freezing points, burst points, boiling points, and specific gravities for various concentrations of Dynalene LC fluids. You can also use our web-based glycol fluid calculator, which can be found at www.dynalene.com.

Table 2: Freezing point, burst point, boiling point, and specific gravity of Dynalene LC-EG solutions

Vol% Ethylene Glycol	Wt% Ethylene Glycol	Freezing Point		Burst Point		Boiling Point	Specific
		°F	°C	°F	°C	°F	Gravity (22°C)
0	0	32	0.0	32	0.0	212	1.000
5	5.6	29	-1.7	27	-2.7	213	1.008
10	11.2	26	-3.3	23	-4.9	214	1.020
15	16.6	22	-5.5	17	-8.6	215	1.026
20	22.0	16	-8.5	8	-13.2	216	1.033
25	27.3	10	-12.2	-2	-18.8	218	1.040
30	32.6	4	-15.6	-14	-25.4	220	1.047
35	37.7	-3	-19.4	-45	-42.8	221	1.053
40	42.9	-13	-25.0	<-60	<-51.1	223	1.060
45	48.0	-24	-31.1	<-60	<-51.1	224	1.066
50	53.0	-36	-37.8	<-60	<-51.1	226	1.073
55	57.9	-50	-45.6	<-60	<-51.1	228	1.081
60	62.8	< -60	< -51	<-60	<-51.1	232	1.086
65	67.9	< -60	< -51	<-60	<-51.1	237	1.093
70	72.4	< -60	< -51	<-60	<-51.1	244	1.100
75	77.2	< -60	< -51	<-60	<-51.1	251	1.106
80	81.8	-52	-46.7	<-60	<-51.1	263	1.110

Table 3: Freezing point, burst point, boiling point, and specific gravity of Dynalene LC-PG solutions

Vol% Propylene Glycol	Wt% Propylene Glycol	Freezing Point		Burst Point		Boiling Point	Specific
		°F	°C	°F	°C	°F	Gravity (22°C)
0	0	32	0.0	32	0.0	212	1.000
5	5.2	29	-1.7	27	-2.7	212	1.005
10	10.5	26	-3.3	22	-5.6	212	1.010
15	15.6	23	-5.0	18	-7.5	212	1.015
20	20.8	19	-7.2	11	-11.8	213	1.020
25	25.9	14	-10.1	-1	-18.4	214	1.025
30	31.1	8	-13.3	-18	-27.5	216	1.030
35	36.1	1	-17.2	-46	-43.3	217	1.034
40	41.2	-8	-22.2	<-60	<-51.1	219	1.039
45	46.2	-18	-27.8	<-60	<-51.1	220	1.044
50	51.2	-31	-35.0	<-60	<-51.1	222	1.049
55	56.2	-46	-43.3	<-60	<-51.1	223	1.052
60	61.2	<-60	<-51	<-60	<-51.1	225	1.055
65	66.1	<-60	<-51	<-60	<-51.1	227	1.057
70	71	<-60	<-51	<-60	<-51.1	230	1.057
75	75.9	<-60	<-51	<-60	<-51.1	238	1.058
80	80.8	<-60	<-51	<-60	<-51.1	246	1.059

Metals Compatibility

Caution: Do not use carbon steel or cast iron metals in a heat transfer loop containing Dynalene LC fluids. These metals are acceptable to use as support framing, electrical conduit, and structural components.

	LC-EG			LC-PG		
Metals	**R**	**NR**	**Temperature**	**R**	**NR**	**Temperature**
Stainless Steel	X		90°C	X		90°C
Aluminum	X		90°C	X		90°C
Brass	X		90°C	X		90°C
Copper	X		90°C	X		90°C
Greycast Iron		X			X	
Carbon Steel		X			X	

Gasket & Polymer Compatibility

For compatibility of Dynalene LC fluids with gasket and polymer materials, refer to the table below. These results are from Dynalene's own 5000-hour materials testing.

	LC-EG			LC-PG		
Polymers	**R**	**NR**	**Temperature**	**R**	**NR**	**Temperature**
Teflon™ (PTFE)	X		80°C	X		80°C
Buna Nitrile	X		50°C (fluid discoloration)	X		50°C (fluid discoloration)
Polyurethane	X		20°C (softening and swelling)	X		20°C (softening and swelling)
Viton™ (FKM)	X		80°C (Fair)	X		80°C (Fair)
Silicone	X		80°C (material leaching)	X		80°C (material leaching)
Ethylene propylene diene monomer (EPDM)	X		80°C	X		80°C
Neoprene	X		20°C (softening)	X		20°C (softening)
HDPE	X		80°C	X		80°C
LDPE	X		50°C	X		50°C
Polypropylene	X		80°C	X		80°C
Nylon (PA66)	X		50°C (surface cracking)	X		50°C (surface cracking)
Nylon (PA12)	X		50°C	X		50°C
Tygon®	X		20°C	X		20°C
Polyvinyl chloride (PVC)	X		50°C	X		80°C
Noryl™ PPO (polyphenylene oxide)	X		80°C	X		80°C
Polyphenylene sulfide (PPS)	X		80°C	X		80°C
Delrin® (homopolymer acetal)	X		80°C	X		80°C
Tecaflon PVDF (polyvinylidene fluoride)	X		80°C	X		80°C
Graphite	X		80°C	X		80°C
Acrylic/ Methyl methacrylate	X		50°C	X		50°C

Polymers	LC-EG R	LC-EG NR	LC-EG Temperature	LC-PG R	LC-PG NR	LC-PG Temperature
Acrylonitrile butadiene styrene (ABS)	X		50°C	X		80°C
Chlorinated polyvinyl chloride (CPVC)	X		50°C	X		50°C
Polyether ether ketone (PEEK)	X		50°C	X		80°C
THV	X		20°C	X		20°C
Natural Rubber	X		50°C	X		50°C
Fluorinated ethylene propylene (FEP)	X		80°C	X		80°C
Polysulfone	X		80°C	X		80°C
Isobutylene-Isoprene Rubber (IIR)	X		50°C	X		50°C (hardening)
Styrene-Butadiene Rubber (SBR)	X		50°C (fluid discoloration)	X		50°C (fluid discoloration)
Hydrogenated Acrylonitrile Butadiene Rubber (HNBR)	X		80°C	X		80°C
EcoHydrin®	X		50°C (softening and swelling)	X		50°C (softening and swelling)
Polycarbonate	X		80°C	X		80°C
Fluorosilicone	X		80°C	X		80°C (hardening)

If you would like to use a material not listed in the above table, please contact Dynalene at 1-877-244-5525 or +1 610-262-9686, or email info@dynalene.com.

System Preparation

New Systems

Newly constructed systems typically contain residual amounts of metal debris, machine oil, lubricant, flux, solder, dirt, and other general pipe scale. It is important to remove films and particulates prior to installing Dynalene LC fluid. Unremoved contaminants can degrade the quality of the fluid and metal components over time. Systems should be thoroughly rinsed with either distilled water or deionized until the rinse fluid runs clear. It is strongly recommended to not use tap water.

An effective procedure for cleaning new systems is as follows:

1. Rinse with water for at least 1 hour, or until a sample of rinse water is free of debris. If significant amounts of particulates remain, drain water, charge with fresh water, and repeat until contaminants are removed.
2. Rinse with distilled or deionized water for at least 1 hour, then drain. Check the conductivity of the rinse water leaving the system. If the conductivity is above 5µS/cm, continue rinsing until the conductivity is below 5µS/cm.
3. (Optionally) Purge the existing system with compressed air or an inert gas such as nitrogen, until there is no more fluid leaving the system. Build up a small amount of pressure with the purging gas, then disrupt to zero pressure several times until all residual fluid is removed. This is also an ideal time to check for system leaks using a soapy solution applied to joints and fittings.
4. Install Dynalene LC fluid.

If the exact volume of the system is unknown, fresh water can be metered or measured into the system until it is full. In most cases, the cleaning and rinsing procedure can result in a hold-up of water in places like heat exchangers, reservoirs, pump housings, elbows, etc. Thus, after initially installing Dynalene LC fluid, the concentration may be slightly diluted. Concentration can be checked on-site using a handheld refractometer or hydrometer (see Tables 2 – 3 for specific gravity) and can be adjusted using Dynalene full-strength LC. After circulation it is recommended to send a fluid sample to Dynalene to check for concentration, inhibitor amount, and other chemical analysis if needed.

Retrofitting Systems

Existing systems may contain rust, scale, and debris which must be removed and cleaned before installing Dynalene LC. If the previous heat transfer fluid was either glycol or otherwise aqueous-based, several rinses with deionized water should remove almost all residual heat transfer fluid. Check the rinse fluid conductivity until it reaches below 5μS/cm. Dynalene recommends testing the previous heat transfer fluid used in the system in order to determine the best method of cleaning. Small amounts of clean, non-ionic flush water that remain in the system are acceptable if free from contaminants. Performing analytical tests on the flush water to detect traces of residual heat transfer fluid is the recommended method of determining the effectiveness of the procedure. Flush water that may be contaminated should be disposed of in accordance with local, state and federal regulations.

The following methods are useful for removing residual non-aqueous heat transfer fluids, such as fluorocarbons (including PFAS), silicones, and hydrocarbons:

1. **System Evacuation**
   System evacuation is usually performed for volatile heat transfer fluids. Residual fluid is removed by creating a vacuum, usually more than 28"Hg within the existing system. As the vacuum within the system increases, the boiling point of the residual liquid will decrease resulting in evaporation. The intent is to evaporate the residual liquid completely by lowering its boiling point to below the internal temperature of the system.

2. **Air and Inert Gas Evaporation**
   For volatile heat transfer fluids, evaporation using air or inert gas may be another method of removing residual fluid from an existing piping system. This is performed by allowing warm compressed air or nitrogen to enter the existing system and flow through the wetted areas, including low points. The intent is to evaporate the residual fluid and allow the effluent to exit the system at a point that is generally opposite to the inlet air or inert gas connection.

3. **Dilution**
   Dilution of residual fluid can be performed in conjunction with the system evacuation or evaporation methods. Dilution of the residual fluid can be performed by selecting a dilution solvent that is miscible with the residual fluid and has a high vapor pressure.

   After diluting the residual fluid with the solvent, drain and follow either step 1 or 2.

If corrosion is severe, consult a Dynalene representative regarding possible flushing procedures.

Ion Removal

To maintain low electrical conductivity, ions that leach from system components or form as a result of glycol degradation must be removed. This can be done by incorporating an ion-exchange filter into the system.

Dynalene's IC-093 series of ion exchange cartridges can be used to maintain low electrical conductivity in fuel cell cooling, battery cooling, electronic cooling and computer cooling applications. They are designed and tested for maximum performance with low conductivity heat transfer fluid products, including our Dynalene LC series products. More information, including connector options, can be found in the IC Series documentation available at www.dynalene.com.

Solution Preparation

Good quality water must be used if diluting Dynalene LC. Dynalene recommends using distilled or deionized water (conductivity <1μS/cm) to maximize the performance of the fluid and system. In addition to raising the conductivity, the minerals and salts in tap water can increase metal corrosion, cause formation of scale and deposits, interfere with inhibitor protection, and clog system components.

A handheld refractometer (glycol tester) or hydrometer can be used to check the Dynalene LC concentration after circulating in your system. Concentration can be adjusted by using undiluted Dynalene Raw Glycols to increase it, or distilled or deionized water to decrease it.

Pre-mixed Dynalene LC products are prepared using weight percent. Please refer to tables 2-3 to determine the weight percentage required for your application based on the desired freezing point, or use the glycol Fluid Calculator found at www.dynalene.com.

General Usage Guidelines

The following recommendations are provided to assist the Dynalene LC fluid installer in achieving simple and safe operation. Always refer to component manufacturer's installation guidelines when initially setting up your system.

1. **Consult with Dynalene**
   Every system is different. Dynalene recommends talking to one of our experts for specific system needs.

2. **The Manual**
   Prior to purchasing Dynalene LC glycols, review and understand all of the information contained in this manual.

3. **Presence of Air Bubbles in the Fluid**
   It is always recommended to eliminate the presence of air bubbles in your system to prevent foaming, corrosion, and pump cavitation. Bleeder valves and air separators can be used to remove air bubbles during circulation.

4. **Electrical Conductivity**
   Surface temperature of heat source components in systems using Dynalene LC fluids should not exceed 212°F (100°C) in systems where a mechanism is being used to keep the electrical conductivity low. Dynalene recommends using LC fluids with an ion removal system such as Dynalene IC series cartridges. Fluid velocity should be maintained between 4 to 8 ft/sec to reduce overheating of the heater walls and to minimize erosion of metal system components.

5. **Materials of Construction**
   Stainless steel, brass, copper, aluminum and some plastic piping materials are acceptable. Cast iron and carbon steel are not recommended. See the Materials Compatibility section on pages 5-6 for further details.

   As in all systems using different metals, galvanic corrosion can occur if dissimilar metals are near or contacting each other. To prevent galvanic corrosion it is important to maintain the low conductivity of the fluid with in-line ion-exchange devices.

6. **Pump Equipment**
   Centrifugal pumps are commonly used with Dynalene LC series fluids. Gear, reciprocating, and other positive displacement pumps are also acceptable. Check the Materials Compatibility section for pump components, seals, and packing. However it is always recommended to consult the seal, packing, and pump manufacturers regarding high (above 150°F) or low (below 32°F) operating temperatures.

7 Volumetric Expansion

Volumetric expansion and/or contraction of Dynalene LC fluids must be taken into consideration when calculating the overall fluid volume within the entire system. For systems with large temperature ranges, consider using an expansion tank. Refer to the volumetric expansion in Tables 4 – 5.

Table 4: Volumetric expansion, in %, of Dynalene LC-EG solutions vs temperature

Temp	% Volumetric Expansion								
°F	20%	25%	30%	35%	40%	45%	50%	55%	60%
-30									-2.53
-20							-2.20	-2.26	-2.33
-10							-1.99	-2.04	-2.10
0					-1.66	-1.71	-1.77	-1.82	-1.86
10			-1.35	-1.40	-1.45	-1.50	-1.55	-1.58	-1.63
20	-1.05	-1.10	-1.16	-1.19	-1.23	-1.26	-1.31	-1.33	-1.37
40	-0.65	-0.69	-0.73	-0.74	-0.76	-0.79	-0.81	-0.82	-0.84
60	-0.23	-0.25	-0.26	-0.26	-0.25	-0.27	-0.28	-0.28	-0.29
80	0.25	0.26	0.26	0.27	0.28	0.28	0.28	0.29	0.29
100	0.74	0.77	0.79	0.83	0.85	0.88	0.89	0.91	0.92
120	1.28	1.33	1.38	1.43	1.47	1.50	1.52	1.55	1.57
140	1.87	1.93	1.99	2.05	2.11	2.15	2.20	2.24	2.27
160	2.49	2.58	2.64	2.73	2.80	2.85	2.91	2.95	2.99
180	3.14	3.25	3.34	3.44	3.52	3.58	3.64	3.69	3.74
200	3.83	3.95	4.07	4.18	4.27	4.34	4.41	4.49	4.54
220	4.58	4.71	4.83	4.95	5.06	5.14	5.22	5.29	5.36

Table 5: Volumetric expansion, in %, of Dynalene LC-PG solutions vs temperature

Temp	% Volumetric Expansion								
°F	20%	25%	30%	35%	40%	45%	50%	55%	60%
-30									-2.41
-20							-2.03	-2.13	-2.23
-10							-1.86	-1.95	-2.05
0					-1.51	-1.59	-1.67	-1.76	-1.85
10			-1.18	-1.26	-1.34	-1.42	-1.49	-1.56	-1.63
20	-0.90	-0.96	-1.03	-1.09	-1.16	-1.22	-1.27	-1.33	-1.39
40	-0.58	-0.63	-0.67	-0.71	-0.74	-0.78	-0.81	-0.85	-0.89
60	-0.20	-0.22	-0.23	-0.25	-0.26	-0.28	-0.29	-0.31	-0.32
80	0.22	0.23	0.25	0.26	0.28	0.28	0.29	0.31	0.32
100	0.72	0.76	0.79	0.84	0.88	0.91	0.94	0.97	1.01
120	1.27	1.34	1.42	1.47	1.53	1.59	1.66	1.71	1.76
140	1.89	1.99	2.09	2.17	2.26	2.33	2.41	2.49	2.57

Temp	% Volumetric Expansion (LC-PG continued)								
°F	20%	25%	30%	35%	40%	45%	50%	55%	60%
160	2.56	2.69	2.82	2.93	3.04	3.14	3.24	3.34	3.44
180	3.30	3.46	3.61	3.75	3.88	4.00	4.13	4.25	4.37
200	4.10	4.28	4.47	4.63	4.79	4.94	5.08	5.21	5.35
220	4.96	5.18	5.39	5.57	5.76	5.93	6.09	6.25	6.40

8 Reservoir Tank

Purging and eliminating air from the headspace above the Dynalene LC in the reservoir tank is recommended. Return fluid piping should enter a storage tank below the Dynalene LC fluid surface to prevent foaming, air entrapment, and bubbles. Air bubbles can contribute to damaging effects such as corrosion and loss of heat transfer.

9 Pressure Relief Valve Considerations

Pressure relief valves should be cleaned of residue to prevent clogging or sticking if Dynalene LC fluid is released through the valve.

Valve Sizing: Relief valve sizing depends on whether the valve is intended to relieve liquid or vapor from the system. For liquid, the relief valves should be sized using Dynalene LC liquid properties to permit sufficient liquid volumetric flow to match or exceed the maximum possible pressure building volume rate increase in the system. If the relief temperature is above the fluid saturated vapor temperature for the discharge pressure, flashing will occur and the relief valve must be sized for two-phase flow. For vapor, consult Dynalene for the latent heat of vaporization.

10 Dynalene LC Quality Check

Dynalene recommends a sample to be sent for a quality inspection immediately after system startup. Often, residual flushing water left in the system can dilute the fluid concentration at installation, in which case Dynalene will recommend how to bring it to the desired level. Further sampling intervals will be based on the results of that inspection and the customer's needs.

Sample kits are available from Dynalene which contain a sample bottle and label, plus sampling instructions describing how to return the sample to Dynalene for testing, or samples may be sent using any clean container made from compatible material. Representative samples of Dynalene LC fluid should ideally be obtained from an active liquid stream at room temperature. If this is not possible, obtain a sample from an area within the active system.

Customers can easily check fluid concentration and electrical conductivity on-site with simple, readily available field instruments such as glycol testers and conductivity meters.

Vapor Pressure

Vapor pressure is a critical property to be considered when calculating Net Positive Suction Head (NPSH). It is important to provide sufficient head pressure above the pump to prevent local boiling and cavitation in the pump when operating at higher temperatures. Refer to the pump specifications and determine the necessary head pressure your pump requires. Glycols have higher boiling points and lower vapor pressures than those of pure water, and higher glycol concentrations will result in lower vapor pressures. The vapor pressures for Dynalene LC fluids are given in Tables 7 and 8. It is recommended to be used in airtight systems when operating at elevated temperatures to maintain liquid phase.

Table 7. Vapor pressures of Dynalene LC-EG solutions.

Temp °F	Vapor Pressure, psia 20%	25%	30%	35%	40%	45%	50%	55%	60%
100	0.9	0.9	0.8						
110	1.2	1.2	1.1	1.1	1.0				
120	1.6	1.6	1.5	1.5	1.4	1.4	1.3	1.2	1.1
130	2.0	2.0	2.0	1.9	1.8	1.8	1.7	1.6	1.5
140	2.7	2.6	2.5	2.5	2.4	2.3	2.2	2.1	2.0
150	3.5	3.4	3.3	3.2	3.1	3.1	2.8	2.6	2.6
160	4.4	4.3	4.2	4.1	3.9	3.8	3.6	3.5	3.3
170	5.6	5.5	5.3	5.2	5.0	4.8	4.6	4.4	4.2
180	7.0	6.6	6.2	6.3	6.3	6.1	5.8	5.6	5.3
190	8.7	8.5	8.3	8.1	7.8	7.5	7.2	6.9	6.6
200	10.8	10.6	10.3	10.0	9.7	9.7	9.0	8.2	8.2
210	13.2	12.9	12.6	12.2	11.8	11.4	11.0	10.5	10.0
220	16.4	15.9	15.3	14.9	14.4	13.9	13.4	12.9	12.3
230	19.4	19.0	18.5	18.0	17.5	16.9	16.2	15.6	14.9
240	23.3	22.8	22.3	21.7	21.0	20.3	19.5	18.7	17.9
250	27.9	26.6	26.6	25.9	25.1	25.1	23.3	21.4	21.4

Table 8. Vapor pressures of Dynalene LC-PG solutions.

Temp °F	Vapor Pressure, psia 20%	25%	30%	35%	40%	45%	50%	55%	60%
100	0.9	0.9	0.9	0.9	0.9				
110	1.9	1.6	1.2	1.2	1.2	1.2	1.1	1.1	1.0
120	1.7	1.7	1.6	1.5	1.5	1.5	1.5	1.5	1.4
130	2.2	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.8
140	2.8	2.8	2.7	2.7	2.6	2.6	2.5	2.4	2.3
150	3.6	3.6	3.5	3.5	3.4	3.4	3.2	3.0	3.0
160	4.6	4.5	4.4	4.4	4.3	4.2	4.1	4.0	3.8
170	5.8	5.8	5.6	5.4	5.4	5.3	5.2	5.0	4.8
180	7.2	7.1	7.0	6.9	6.7	6.6	6.5	6.2	5.9
190	9.0	8.9	8.7	8.5	8.3	8.2	8.1	7.8	7.4
200	11.0	10.9	10.7	10.5	10.2	10.1	9.9	9.5	9.1
210	13.5	13.5	13.1	12.8	12.5	12.3	12.1	11.6	11.1
220	16.4	16.4	15.9	15.6	15.2	15.0	14.8	14.2	13.6
230	19.8	19.5	19.2	18.8	18.4	17.8	17.8	17.1	16.4
240	23.8	23.4	23.0	22.5	22.0	21.7	21.4	20.6	19.7
250	28.4	27.9	27.4	26.9	26.3	26.0	25.6	24.6	23.5

Packing & Shipping

Dynalene LC fluids are available in 1, 2½, 5-gallon pails, 30 or 55-gallon drums, 265-gallon totes, or in bulk tankers.

Please refer to the SDS for each product for shipping information.

Shelf Life

Dynalene LC fluids will remain stable for a period of at least three years if:

1. It is stored in the original unopened container
2. It is stored indoors or is otherwise completely protected from sunlight exposure
3. The storage area temperature does not exceed 100°F (37°C)

Toxicological Information

For complete toxicological information regarding Dynalene LC products, consult the relevant SDS. The SDS for any Dynalene LC fluid should be understood prior to use.

Dynalene LC properties

Tables 9-16 contain information on the thermophysical properties of Dynalene LC-EG and LC-PG.

Dynalene LC Properties: Viscosity

Table 9. Viscosities of Dynalene LC-EG solutions.

Temp	Viscosity, cP								
	Dynalene LC-EG concentration =								
°F	20%	25%	30%	35%	40%	45%	50%	55%	60%
-30									89.7
-20							40.4	50.5	60.5
-10							27.3	34.7	42.1
0					13.8	16.6	19.3	24.7	30.1
10			6.83	8.47	10.1	12.2	14.3	18.2	22.1
20	3.90	4.64	5.38	6.56	7.74	9.32	10.9	13.8	16.6
30	3.14	3.74	4.33	5.21	6.09	7.29	8.48	10.6	12.7
40	2.59	3.07	3.54	4.23	4.91	5.84	6.77	8.34	9.90
50	2.18	2.57	2.95	3.50	4.04	4.77	5.50	6.68	7.85
60	1.86	2.18	2.49	2.94	3.38	3.97	4.55	5.44	6.33
70	1.61	1.87	2.13	2.50	2.87	3.34	3.81	4.49	5.17
80	1.41	1.63	1.84	2.15	2.46	2.85	3.23	3.76	4.28
90	1.24	1.42	1.60	1.87	2.13	2.45	2.76	3.17	3.58
100	1.11	1.26	1.41	1.64	1.87	2.13	2.39	2.71	3.03
120	0.90	1.01	1.11	1.29	1.46	1.64	1.82	2.03	2.23
140	0.74	0.82	0.90	1.04	1.17	1.30	1.43	1.56	1.69
160	0.63	0.69	0.75	0.85	0.95	1.05	1.15	1.24	1.32
180	0.54	0.59	0.63	0.71	0.79	0.87	0.94	1.00	1.06
200	0.47	0.51	0.54	0.61	0.67	0.73	0.78	0.82	0.86
220	0.41	0.44	0.46	0.52	0.57	0.62	0.66	0.69	0.72

1 cP= 0.001 Pa·s

Dynalene LC Properties: Viscosity

Table 10. Viscosities of Dynalene LC-PG solutions.

Temp	Viscosity, cP								
	Dynalene LC-PG concentration =								
°F	20%	25%	30%	35%	40%	45%	50%	55%	60%
-30									498
-20									299
-10							96.0	140	183
0					40.9	51.1	61.3	88.2	115
10			13.4	20.2	27.0	33.8	40.6	57.4	74.2
20	5.36	7.63	9.89	14.2	18.5	23.2	27.8	38.6	49.3
30	4.23	5.85	7.46	10.3	13.1	16.4	19.7	26.7	33.7
40	3.41	4.58	5.75	7.68	9.60	12.0	14.3	19.0	23.7
50	2.79	3.66	4.52	5.87	7.21	8.96	10.7	13.9	17.1
60	2.32	2.97	3.62	4.59	5.56	6.85	8.13	10.4	12.6
70	1.95	2.45	2.94	3.66	4.38	5.36	6.34	7.93	9.51
80	1.66	2.05	2.43	2.98	3.52	4.28	5.04	6.19	7.34
90	1.43	1.74	2.04	2.46	2.88	3.48	4.08	4.93	5.77
100	1.25	1.49	1.73	2.07	2.4	2.88	3.35	3.99	4.62
120	0.97	1.14	1.30	1.52	1.73	2.05	2.36	2.74	3.11
140	0.78	0.90	1.01	1.16	1.31	1.53	1.75	1.99	2.22
160	0.64	0.73	0.82	0.93	1.04	1.20	1.35	1.51	1.66
180	0.54	0.61	0.68	0.77	0.85	0.97	1.08	1.19	1.29
200	0.46	0.52	0.58	0.65	0.71	0.80	0.88	0.96	1.04
220	0.40	0.45	0.50	0.56	0.61	0.68	0.74	0.80	0.86

1 cP= 0.001 Pa·s

Dynalene LC Glycol Properties: Thermal Conductivity

Table 11. Thermal conductivities of Dynalene LC-EG solutions.

Temp	Thermal Conductivity, BTU/hr·ft·°F								
	Dynalene LC-EG concentration =								
°F	20%	25%	30%	35%	40%	45%	50%	55%	60%
-30									0.178
-20							0.193	0.187	0.181
-10							0.197	0.191	0.184
0					0.216	0.208	0.200	0.193	0.186
10			0.238	0.229	0.220	0.212	0.204	0.197	0.189
20	0.264	0.254	0.243	0.234	0.224	0.216	0.207	0.199	0.191
30	0.269	0.258	0.247	0.237	0.227	0.219	0.210	0.202	0.194
40	0.274	0.263	0.251	0.241	0.231	0.222	0.212	0.204	0.196
50	0.279	0.267	0.255	0.245	0.234	0.225	0.215	0.207	0.198
60	0.284	0.272	0.259	0.248	0.237	0.228	0.218	0.209	0.200
70	0.288	0.276	0.263	0.252	0.240	0.230	0.220	0.211	0.202
80	0.292	0.279	0.266	0.255	0.243	0.233	0.223	0.214	0.204
90	0.296	0.283	0.269	0.258	0.246	0.236	0.225	0.216	0.206
100	0.299	0.286	0.272	0.260	0.248	0.238	0.227	0.218	0.208
120	0.305	0.291	0.277	0.265	0.253	0.242	0.230	0.220	0.210
140	0.311	0.297	0.282	0.269	0.256	0.245	0.233	0.223	0.213
160	0.315	0.300	0.285	0.272	0.259	0.248	0.236	0.226	0.215
180	0.318	0.303	0.288	0.275	0.262	0.250	0.238	0.228	0.217
200	0.320	0.305	0.290	0.277	0.263	0.252	0.240	0.229	0.218
220	0.321	0.306	0.291	0.278	0.265	0.253	0.240	0.230	0.219

1 Btu/hr·ft·°F = 1.73 W/mK

Dynalene LC Glycol Properties: Thermal Conductivity

Table 12. Thermal conductivities of Dynalene LC-PG solutions.

Temp	Thermal Conductivity, BTU/hr·ft·°F								
	Dynalene LC-PG concentration =								
°F	20%	25%	30%	35%	40%	45%	50%	55%	60%
-30									0.171
-20							0.188	0.181	0.174
-10							0.191	0.184	0.176
0					0.211	0.203	0.194	0.186	0.178
10			0.235	0.225	0.215	0.206	0.196	0.188	0.179
20	0.262	0.251	0.239	0.229	0.218	0.209	0.199	0.190	0.181
30	0.267	0.255	0.243	0.233	0.222	0.212	0.201	0.192	0.183
40	0.272	0.260	0.247	0.236	0.225	0.215	0.204	0.194	0.184
50	0.277	0.264	0.251	0.239	0.227	0.217	0.206	0.196	0.186
60	0.281	0.268	0.254	0.242	0.230	0.219	0.208	0.198	0.187
70	0.285	0.272	0.258	0.246	0.233	0.222	0.210	0.199	0.188
80	0.289	0.275	0.261	0.248	0.235	0.223	0.211	0.200	0.189
90	0.292	0.278	0.263	0.250	0.237	0.225	0.213	0.202	0.190
100	0.295	0.281	0.266	0.253	0.239	0.227	0.214	0.203	0.191
120	0.298	0.283	0.268	0.255	0.241	0.228	0.215	0.204	0.192
140	0.306	0.290	0.274	0.260	0.245	0.232	0.218	0.206	0.194
160	0.309	0.293	0.277	0.262	0.247	0.234	0.220	0.207	0.194
180	0.312	0.296	0.279	0.264	0.249	0.235	0.221	0.208	0.195
200	0.314	0.297	0.280	0.265	0.249	0.235	0.221	0.208	0.194
220	0.314	0.297	0.280	0.265	0.249	0.235	0.220	0.207	0.194

1 Btu/hr·ft·°F = 1.73 W/mK

Dynalene LC Glycol Properties: Specific Heat

Table 13. Specific heats of Dynalene LC-EG solutions.

Temp	Specific Heat, BTU/lb·°F								
	Dynalene LC-EG concentration =								
°F	20%	25%	30%	35%	40%	45%	50%	55%	60%
-30									0.669
-20							0.730	0.702	0.674
-10							0.735	0.708	0.680
0					0.792	0.766	0.740	0.713	0.686
10			0.845	0.821	0.796	0.771	0.745	0.719	0.692
20	0.894	0.871	0.848	0.825	0.801	0.776	0.751	0.725	0.698
30	0.897	0.875	0.852	0.829	0.805	0.781	0.756	0.730	0.704
40	0.900	0.878	0.856	0.833	0.810	0.786	0.761	0.736	0.710
50	0.903	0.882	0.860	0.837	0.814	0.790	0.766	0.741	0.716
60	0.907	0.886	0.864	0.842	0.819	0.796	0.772	0.747	0.722
70	0.910	0.889	0.868	0.846	0.824	0.801	0.777	0.753	0.728
80	0.913	0.892	0.871	0.850	0.828	0.805	0.782	0.758	0.734
90	0.916	0.896	0.875	0.854	0.833	0.807	0.781	0.761	0.740
100	0.919	0.899	0.879	0.858	0.837	0.815	0.793	0.770	0.746
120	0.925	0.906	0.887	0.867	0.846	0.825	0.803	0.780	0.757
140	0.931	0.913	0.895	0.875	0.855	0.835	0.814	0.792	0.769
160	0.938	0.920	0.902	0.884	0.865	0.845	0.824	0.803	0.781
180	0.944	0.927	0.910	0.892	0.874	0.855	0.835	0.814	0.793
200	0.950	0.934	0.918	0.901	0.883	0.864	0.845	0.825	0.805
220	0.956	0.941	0.925	0.909	0.892	0.874	0.856	0.837	0.817

1 Btu/lb·°F = 4,186 J/kg°C

Dynalene LC Glycol Properties: Specific Heat

Table 14. Specific heats of Dynalene LC-PG solutions.

Temp	Specific Heat, BTU/lb·°F								
	Dynalene LC-PG concentration =								
°F	20%	25%	30%	35%	40%	45%	50%	55%	60%
-30									0.741
-20							0.799	0.773	0.746
-10							0.804	0.778	0.752
0					0.855	0.832	0.809	0.784	0.758
10			0.898	0.879	0.859	0.837	0.814	0.789	0.764
20	0.936	0.919	0.902	0.883	0.864	0.842	0.820	0.795	0.77
30	0.938	0.922	0.906	0.887	0.868	0.847	0.825	0.801	0.776
40	0.941	0.925	0.909	0.891	0.872	0.851	0.830	0.806	0.782
50	0.944	0.929	0.913	0.895	0.877	0.856	0.835	0.811	0.787
60	0.947	0.932	0.917	0.899	0.881	0.861	0.840	0.817	0.793
70	0.950	0.935	0.920	0.903	0.886	0.866	0.845	0.822	0.799
80	0.953	0.939	0.924	0.907	0.890	0.870	0.850	0.828	0.805
90	0.956	0.942	0.928	0.911	0.894	0.875	0.855	0.833	0.811
100	0.959	0.945	0.931	0.915	0.899	0.880	0.861	0.839	0.817
120	0.965	0.952	0.939	0.924	0.908	0.890	0.871	0.850	0.828
140	0.970	0.958	0.946	0.931	0.916	0.899	0.881	0.861	0.840
160	0.976	0.965	0.953	0.939	0.925	0.908	0.891	0.872	0.852
180	0.982	0.972	0.961	0.948	0.934	0.918	0.902	0.883	0.864
200	0.988	0.978	0.968	0.956	0.943	0.928	0.912	0.894	0.875
220	0.994	0.985	0.975	0.963	0.951	0.937	0.922	0.905	0.887

1 Btu/lb·°F = 4,186 J/kg°C

Dynalene LC Glycol Properties: Density

Table 15. Densities of Dynalene LC-EG solutions.

Temp	Density, lb/ft³								
	Dynalene LC-EG concentration =								
°F	20%	25%	30%	35%	40%	45%	50%	55%	60%
-30									70.40
-20							69.26	69.76	70.26
-10							69.12	69.61	70.10
0					67.93	68.45	68.97	69.46	69.94
10			66.68	67.24	67.79	68.31	68.82	69.30	69.78
20	65.36	65.96	66.55	67.10	67.64	68.15	68.66	69.13	69.60
30	65.23	65.82	66.41	66.95	67.49	67.99	68.49	68.96	69.43
40	65.10	65.69	66.27	66.80	67.33	67.83	68.32	68.78	69.24
50	64.97	65.54	66.11	66.64	67.17	67.66	68.14	68.61	69.08
60	64.83	65.40	65.96	66.48	66.99	67.48	67.96	68.41	68.86
70	64.68	65.24	65.79	66.31	66.82	67.30	67.77	68.22	68.66
80	64.52	65.07	65.62	66.13	66.63	67.11	67.58	68.02	68.46
90	64.36	64.91	65.45	65.95	66.44	66.91	67.38	67.82	68.25
100	64.20	64.74	65.27	65.76	66.25	66.71	67.17	67.60	68.03
120	63.85	64.37	64.88	65.36	65.84	66.29	66.74	67.16	67.58
140	63.47	63.98	64.48	64.95	65.41	65.85	66.28	66.69	67.10
160	63.07	63.56	64.05	64.50	64.95	65.38	65.80	66.21	66.61
180	62.65	63.12	63.59	64.03	64.47	64.89	65.30	65.70	66.09
200	62.20	62.66	63.11	63.54	63.97	64.38	64.78	65.16	65.54
220	61.72	62.17	62.61	63.03	63.44	63.84	64.23	64.61	64.98

1 lb/ft^3= 16 kg/m^3

Dynalene LC Glycol Properties: Density

Table 16. Densities of Dynalene LC-PG solutions.

Temp	Density, lb/ft³								
	Dynalene LC-PG concentration =								
°F	20%	25%	30%	35%	40%	45%	50%	55%	60%
-30									67.05
-20							66.46	66.70	66.93
-10							66.35	66.58	66.81
0					65.71	65.97	66.23	66.46	66.68
10			65.00	65.30	65.60	65.86	66.11	66.33	66.54
20	64.23	64.57	64.90	65.19	65.48	65.73	65.97	66.18	66.38
30	64.14	64.47	64.79	65.07	65.35	65.59	65.82	66.02	66.22
40	64.03	64.35	64.67	64.94	65.21	65.44	65.67	65.86	66.05
50	63.92	64.23	64.53	64.80	65.06	65.28	65.50	65.69	65.87
60	63.79	64.09	64.39	64.65	64.90	65.12	65.33	65.51	65.68
70	63.66	63.95	64.24	64.49	64.73	64.94	65.14	65.31	65.47
80	63.52	63.80	64.08	64.32	64.55	64.75	64.95	65.11	65.26
90	63.37	63.64	63.91	64.14	64.36	64.55	64.74	64.89	65.04
100	63.20	63.47	63.73	63.95	64.16	64.35	64.53	64.67	64.81
120	62.85	63.09	63.33	63.54	63.74	63.90	64.06	64.19	64.32
140	62.46	62.68	62.90	63.09	63.27	63.42	63.57	63.68	63.79
160	62.03	62.23	62.43	62.60	62.76	62.90	63.03	63.13	63.22
180	61.56	61.74	61.92	62.07	62.22	62.34	62.45	62.53	62.61
200	61.05	61.21	61.37	61.50	61.63	61.73	61.83	61.90	61.97
220	60.50	60.64	60.78	60.89	61.00	61.09	61.17	61.23	61.28

1 lb/ft^3= 16 kg/m^3

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