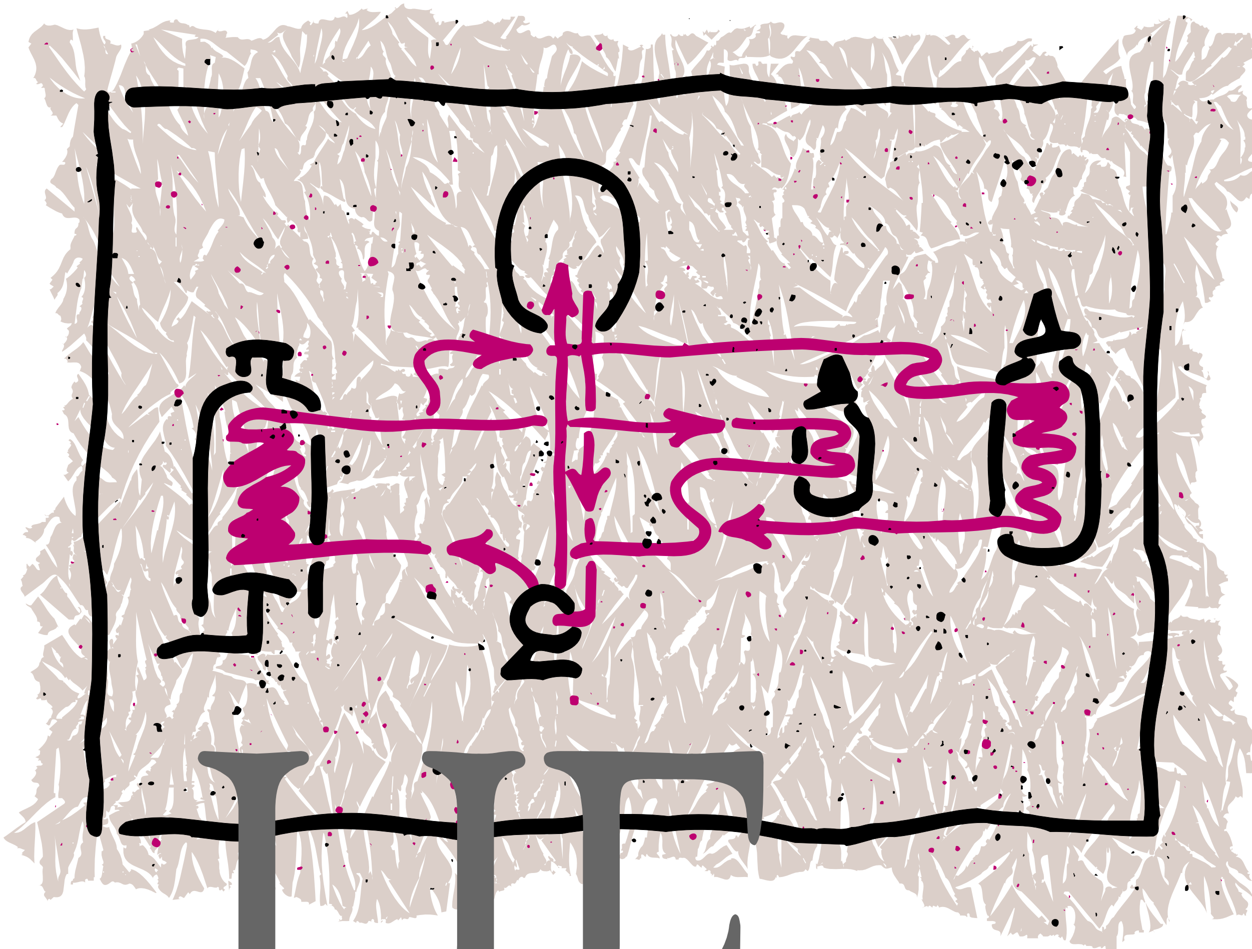
SYLTHERM HF
Heat Transfer Fluid



HF

Product Technical Data

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For Information About Our Full Line of Fluids…

To learn more about the full line of heat transfer fluids manufactured or distributed by Dow—including DOWTHERM* synthetic organic, SYLTHERM† silicone and DOWTHERM, DOWFROST*, and DOWCAL* glycol-based fluids—request our product line guide. Call the number for your area listed on the back of this brochure.

SYLTHERM HF Heat Transfer Fluid

A Very Low Odor, Long-lasting Heat Transfer Fluid with a High Flash Point and Excellent Low Temperature Properties

SYLTHERM† HF heat transfer fluid is a specially formulated, high performance silicone polymer designed for use as a low temperature, liquid phase heat transfer medium. With a recommended use temperature range of -100°F to 500°F (-73°C to 260°C), SYLTHERM HF fluid offers outstanding low temperature heat transfer and pumpability, plus excellent thermal stability. With a closed cup flash point above 145°F (63°C), SYLTHERM HF fluid provides an extra margin of safety and can reduce system and engineering costs. Like other SYLTHERM fluids, SYLTHERM HF has essentially no odor, is low in acute oral toxicity, and is not listed in the U.S.A. as reportable under SARA Title III, Section 313.[1] These features make SYLTHERM HF fluid a viable alternative to many organic heat transfer fluids, chlorinated solvents, and CFC's that are presently used for low temperature, liquid phase service.

At -100°F (-73°C), the viscosity of SYLTHERM HF heat transfer fluid is only 16.7 centipoise (16.7 mPa•s). A low viscosity at low operating temperatures is a critical property because it allows high heat transfer coefficients with low pressure drops and pumping horsepower.

The -100°F to 500°F (-73°C to 260°C) operating range of SYLTHERM HF fluid makes it ideal for single fluid process heating and cooling applications (batch processing). Single fluid processing with SYLTHERM HF fluid eliminates process interruption and the loss of temperature control associated with multiple fluid systems. Batch processing with SYLTHERM HF fluid also eliminates system flush requirements associated with steam/brine and steam/glycol systems. SYLTHERM HF fluid is noncorrosive toward metals and alloys commonly found in heat transfer systems.

In addition to the performance advantages of SYLTHERM HF fluid, Dow's supporting services are unequaled. They include technical backup in the design phase, during operation, and after shutdown. Moreover, free analytical testing is provided to monitor fluid condition.

†Trademark of Dow Corning Corporation

[1]You may need to comply with similar or additional laws in other countries.

Fluid Selection Criteria

When evaluating thermal fluids for specific applications, a variety of characteristics should be considered. Four of the most important are thermal stability, human health and environmental regulatory status, freeze point, and viscosity.

Stability

SYLTHERM HF fluid offers excellent thermal stability at temperatures between -100°F and 500°F (-73°C and 260°C). The maximum recommended film temperature is 550°F (288°C).

Within its recommended use range, SYLTHERM HF heat transfer fluid will not degrade to form solids or volatile compounds having substantially higher vapor pressures. As a result, system downtime for periodic fluid reprocessing and replacement is eliminated. SYLTHERM HF fluid can tolerate occasional high-temperature upsets with only minimal change to the physical properties of the fluid. However, extended use at bulk temperatures above 500°F (260°C), or film temperatures greater than 550°F (288°C), has the potential to generate higher system pressures and cause polymer cross-linking to occur. This will eventually cause the viscosity of the fluid to increase to a point where replacement will be required to restore system performance.

Low Odor, Non-reportable

SYLTHERM HF fluid is virtually odorless and is low in acute oral toxicity. In addition, it is not listed in the U.S.A. as reportable under SARA Title III, Section 313.[1] SYLTHERM HF fluid is well suited for use in pharmaceutical, fine chemical, and other processes where these properties are desired.

[1]*You may need to comply with similar or additional laws in other countries.*

SYLTHERM HF fluid is composed primarily of volatile methylsiloxanes (VMS's). Until recently, VMS fluids were classified as volatile organic compounds (VOC's) by the U.S. Environmental Protection Agency (EPA). Their status changed with the agency's ruling of Oct. 5, 1994, which declared VMS fluids to be exempt from that classification. The rule became final December 5, 1994. Basically, the EPA said that VMS fluids do not contribute to declining air quality; i.e., smog.

Freeze Point

SYLTHERM HF fluid remains liquid below -100°F (-73°C). This eliminates many of the problems associated with cold weather start-ups and shutdowns. Steam or electrical tracing, which is costly to install and operate, is not needed.

Viscosity

The excellent viscosity characteristics of SYLTHERM HF fluid at low temperatures make it an efficient choice for very low temperature applications. The low viscosity of SYLTHERM HF fluid at low temperatures (only 16.7 cps at -100°F, 16.7 mPa•s at -73°C) minimizes pressure drop and reduces pumping horsepower requirements. In addition, high heat transfer coefficients can be obtained over the fluid's entire temperature range. This can cut process heat exchanger surface area requirements.

Thermal Stability

The thermal stability of a heat transfer fluid is dependent not only on its chemical structure, but also on the design and operating temperature profile of the system in which it is used. Maximum fluid life can be obtained by following sound engineering practices in the design of the heat transfer system. Three key areas of focus are: designing and operating the heater and/or energy recovery unit, preventing chemical contamination, and eliminating contact of the fluid with air.

Heater Design and Operation

Poor design and/or operation of the fired heater can cause overheating resulting in excessive thermal degradation of the fluid.

When heaters are operated at high temperatures, they are designed for minimum liquid velocities of 6 feet per second (2 m/s); a range of 6–12 feet per second (2–4 m/s) should cover most cases. The actual velocity selected will depend on an economic balance between the cost of circulation and heat transfer surface. Operating limitations are usually placed on heat flux by the equipment manufacturer. This heat flux is determined for a maximum film temperature by the operating conditions of the particular unit. Some problem areas to be avoided include:

1. Flame impingement.
2. Operating the heater above its rated capacity.
3. Modifying the fuel-to-air mixing procedure to change the flame height and pattern. This can yield higher flame and gas temperatures together with higher heat flux.
4. Low fluid velocity—This can cause high heat flux areas resulting in excessive heat transfer fluid film temperatures.

The manufacturer of the fired heater should be the primary contact in supplying you with the proper equipment for your heat transfer system needs.

Contamination Effects

SYLTHERM HF heat transfer fluid is not sensitive to contamination by common piping contaminants, including water (during start-up and dry-out operations), rust, mill scale, lubricants, pipe dope, and small amounts of solvent and organic heat transfer fluid residue. SYLTHERM HF fluid is somewhat more sensitive to contamination by acids or bases at elevated temperatures. As a result, lower molecular weight cyclic siloxanes can form and can raise the freeze point of the fluid. Similarly, contamination by water, oxygen, or other oxidants when the fluid is at an elevated temperature can result in cross-linking of polymer molecules and, if not corrected, can cause a gradual increase in viscosity. In order to minimize the likelihood of oxygen contamination, the system expansion tank should have an inert gas (such as nitrogen) blanket.

Expansion Tank

Figure 1 (page 6) is a simplified schematic of a recommended system loop design for SYLTHERM HF heat transfer fluid. The expansion tank has the capability for full flow of the heat transfer fluid through the tank. The constant flow of heat transfer fluid through the tank ensures that vapors form only in the expansion tank. Once the system is heated up to the appropriate temperature and operating normally, system pressure will slowly increase until either the pressure in the expansion tank reaches the setting on the back pressure regulator valve, or the system reaches the vapor pressure for the temperature of the fluid in the expansion tank. When the back pressure regulator is set at a pressure lower than the equilibrium vapor pressure of the fluid for a given temperature, periodic venting of the volatile materials will take place. The fluid will suffer no deleterious effect; however, periodic additions of fluid will be needed to maintain system volume.

An inert gas (such as nitrogen) blanket on the expansion tank is required to prevent the fluid from coming into contact with the outside air. Without this inert gas blanket, humid, outside air is likely to be drawn into the tank whenever the system cools below its normal operating temperature. This moisture contamination can result in increased pressure in the system due to steam formation on the next heat-up cycle or form ice in refrigeration equipment during low temperature operation.

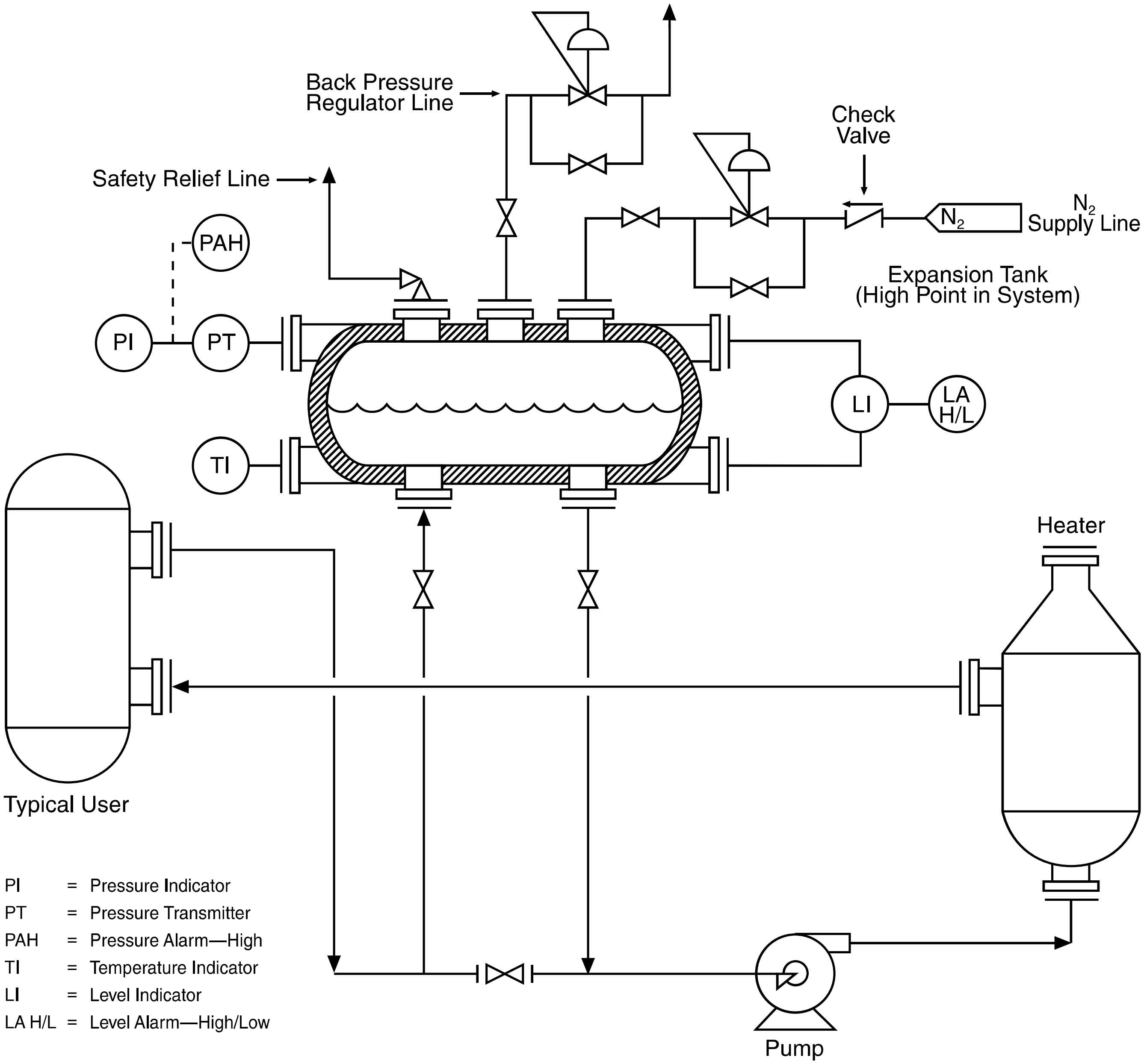
To prevent pump cavitation, the fluid pressure at the entrance to the pump must be above its vapor pressure, and there must be sufficient head in addition to the vapor pressure to satisfy the Net Positive Suction Head (NPSH) requirements of the pump. If the expansion tank is designed as shown in Figure 1, the back pressure regulator setting on the expansion tank will control the pressure at the entrance to the pump. The regulator set point should be 10 to 15 psi (0.7 to 1 bar) above the vapor pressure corresponding to the fluid temperature in the expansion tank.

NPSH requirements are primarily satisfied by the elevation of the expansion tank. The elevation is determined by calculating the total head necessary to overcome frictional line losses and specific NPSH requirements of the pump. In systems where such tank elevation is not practical, NPSH requirements can be met by increasing the amount of the blanket gas (usually nitrogen) in the vapor space of the expansion tank, thereby increasing the overall pressure in the tank. However, the additional system pressure created by the nitrogen should be accounted for during the system design.

The expansion tank design must satisfy two necessary requirements for proper start-up and operation of the system. First, the system piping to the expansion tank should be designed to permit full flow of fluid through the tank. A double drop leg design (see Figure 1) is the most effective arrangement to remove air, water vapors, and other noncondensibles during system start-up. For on-going operation, flow of fluid through the tank can often be reduced as long as sufficient flow is maintained to prevent pump cavitation. The tank and connecting piping should also be insulated to prevent the condensation of any vapors that may accumulate in this portion of the system.

Second, the inert gas blanket on the expansion tank should allow for a continuous flow of inert gas to be purged through the vapor space during the initial start-up. Separate inert gas supply and discharge nozzles, spaced as far apart as possible, will help ensure that any volatile contaminants (such as water or solvents) will be swept from the system during initial start-up.

Figure 1—Simplified System Schematic for SYLTHERM HF Heat Transfer Fluid



PI = Pressure Indicator
PT = Pressure Transmitter
PAH = Pressure Alarm—High
TI = Temperature Indicator
LI = Level Indicator
LA H/L = Level Alarm—High/Low

The vent lines from the safety relief valve and back pressure regulator should be discharged to a safe area away from open flame and other potential sources of ignition. An appropriate outside container located well away from building air-intake fans is recommended. The vented volatile materials will be typically classified as flammable.

The expansion tank should be sized so that it is approximately 1/4 full when the system is at ambient temperature, and 3/4 full when the system is at its maximum operating temperature. Expansion tank instrumentation and fittings must meet the design requirements of the anticipated operating temperatures and pressures of the system and should include (refer to Figure 1):

1. Electronic level gauge covering the full fluid level range.
2. Fluid temperature indicator.
3. Level alarm (high/low) with low level shutdown to protect pump.
4. Pressure indicator with high pressure alarm.

Corrosivity

SYLTHERM HF heat transfer fluid is noncorrosive toward common metals and alloys used in heat transfer systems, as long as it remains uncontaminated. Even at the high temperatures involved, equipment usually exhibits excellent service life.

Carbon steel is used predominantly in heat transfer systems utilizing SYLTHERM HF fluid, although low alloy steels, stainless steels, Monel alloys, etc., are also used in miscellaneous pieces of equipment and instruments.

Most corrosion problems are caused by chemicals introduced into the system during cleaning or from process leaks. The severity and nature of the corrosivity will depend upon the amounts and type of contamination involved.

When special materials of construction are used, extra precaution should be taken to avoid contaminating materials containing the following:

Construction Material	***Contaminant***
Austenitic Stainless Steel	*Chlorides*
Nickel	*Sulfur*
Copper Alloys	*Ammonia*

Flammability and Fire Hazards

SYLTHERM HF heat transfer fluid is a combustible material with a flash point of 145°F (63°C) (CC), and an autoignition temperature of 671°F (355°C) by ASTM method E-659.

Vapor leaks to the atmosphere are sometimes encountered. Such leaks, however small, should not be tolerated because of the cost of replacing lost medium. Experience has shown that leaking vapors have usually cooled below the fire point.

Leaks from flanges or valves into insulation are also potentially hazardous because they can lead to fires in the insulation. It has been found, for example, that leakage of organic materials into some types of insulation at elevated temperatures may result in spontaneous ignition due to auto-oxidation.

Vapors of SYLTHERM HF fluid do not pose a serious flammability hazard at room temperature because the saturation concentration is so far below the lower flammability limit that ignition is extremely unlikely. Flammable mists are, however, possible under unusual circumstances where the time of exposure to an ignition source, the temperature of the source and the atmosphere, the volume of mixture, the fuel-air ratio, and the mist particle size all fall within a somewhat narrow range.

Static Spark Hazard

Heat transfer fluids like SYLTHERM HF heat transfer fluid are generally poor electrical conductors, which means they can build up static charges and discharge static electricity within vessels or while being drained out of vessels. Therefore, safe engineering practice dictates that oxygen must be excluded from the headspace of the expansion tank. Similar precautions concerning static sparks should be taken when loading and unloading used fluid and volatiles.

Flammable-gas Detectors

Silicone vapors can deactivate many brands of flammable-gas detectors. However, several manufacturers offer detectors for silicone environments and report the operating life of these detectors is not affected by the presence of silicone materials.

New System Start-up

The following information is a brief summary of the general recommendations and procedures for starting up a system with SYLTHERM HF heat transfer fluid.

Prior to start-up, the system must be cleaned of dirt, welding slag, and other miscellaneous debris. Extra care taken to keep the system clean during construction can eliminate extensive cleaning prior to start-up. As mentioned previously, it is also very important to remove any residual water from the system prior to the installation of SYLTHERM HF heat transfer fluid.

Because the design of all heat transfer systems differs to some extent, a detailed set of start-up procedures covering all possible systems is not practical. Users should develop procedures based on their own internal standards and recommendations from heat transfer equipment suppliers. The following procedures are presented as general guidelines only.

1. If the system is flushed with water or a suitable solvent, be sure that the fluid is circulated sufficiently through the system to pick up any remaining oils and debris. The pump and suction strainer should be checked periodically during this time to ensure that any collected debris is not severely restricting fluid flow to the pump inlet. If a filter is installed, filter the fluid for as long as practical through a 10-micron filter.
2. Completely drain the flush fluid by pressurizing the system with nitrogen or dry air, and opening all low-point drains. Alternately open and close all drain valves to increase the velocity of the gas flow. This will help to remove residual water/solvent and loose foreign particles.
3. Fill the system with SYLTHERM HF heat transfer fluid. Circulate the fluid cold. Check for and repair any leaks. If a flush fluid was not used, check the pump suction strainers for any collected solids. If a filter is installed, continue circulating the fluid through the filter until the upper temperature limit of the filter is approached.
4. For the initial stages of start-up, the inert gas blanket system on the expansion tank should be arranged to allow a steady purge (1–2 scfm) of gas to sweep through the vapor space of the tank. At the same time, the valves controlling fluid flow should be set so that the maximum amount of fluid flows through the expansion tank.
5. Increase the fluid temperature to 250°F (120°C) as measured at the heater outlet. The rate of increase should be held to 100°F (40°C) per hour or the maximum recommended for the various pieces of equipment in the system, whichever is lower. This will allow the equipment to be brought up to temperature safely and enable start-up personnel to check for leaks and ensure that all instrumentation is operating properly. Maintain the 250°F (120°C) temperature until the amount of steam or solvent vapors exiting the vent line from the expansion tank has subsided. This may require several hours.

   It is essential that sufficient flow of fluid be maintained through the expansion tank during these steps so that the temperature in the tank is high enough to boil out any residual moisture or solvents from the system.
6. Set the nitrogen supply regulator and the back pressure regulator to their design set points. No further venting will occur unless the pressure in the expansion tank exceeds the specified pressure. Any further pressure increase in the tank should only result from compression of the inert gas by the expanding fluid. Any additional inert gas should enter the tank only when the tank pressure falls below the design setpoint (e.g., as it would if the system were to be shut down).

   For systems which operate primarily at low temperatures and do not have the capability of heating the fluid to the temperatures outlined above, other methods of water removal may be required. The use of molecular sieves or ion exchange resins to remove the water from the fluid may be necessary.

Health and Safety Considerations

A Material Safety Data Sheet (MSDS) for SYLTHERM HF heat transfer fluid is available by contacting your nearest Dow sales representative, or by calling the number for your area listed on the back of this brochure. The MSDS contains health and safety information regarding the use of this product. Read and understand the MSDS before handling or otherwise using this product.

SYLTHERM HF heat transfer fluid has been studied for acute toxicological properties under the U.S. Federal Hazardous Substance Act (FHSA) guidelines. As a result of the FHSA study, SYLTHERM HF heat transfer fluid has been classified as:

- Nontoxic, with regard to acute oral ingestion or dermal absorption to quantities typically contacted during normal use
- Having minimal potential for eye or skin irritation

Additionally, studies indicate that repeated, prolonged skin contact should not result in irritation. Normal industrial handling procedures are adequate to handle this product.

Unlike many low temperature heat transfer fluids, SYLTHERM HF fluid has minimal odor and no airborne exposure limits. However, vapors of SYLTHERM HF heat transfer fluid released into the air at temperatures above 300°F (150°C) may cause some temporary eye and/or respiratory irritation due to the partial oxidation of the fluid. In areas with adequate ventilation, no special breathing apparatus is required. Prolonged exposures or exposures in poorly ventilated areas with high vapor concentrations should be avoided. The predominant by-products in these vapors are low-molecular-weight dimethylsiloxanes. Linear siloxanes are commonly used in such personal care products as cosmetics and deodorants.

Leaks or spills of SYLTHERM HF heat transfer fluid into soil typically result in the gradual breakdown of the polymer to form naturally occurring materials like silica, water, and carbon dioxide.

Customer Service for Users of SYLTHERM HF Heat Transfer Fluid

Fluid Analysis

The Dow Chemical Company, and its affiliates, offer an analytical service for SYLTHERM HF heat transfer fluid. It is recommended that users send a one-pint (0.5 liter) representative sample at least annually to:

North America & Pacific
The Dow Chemical Company
Larkin Lab/Thermal Fluids
1691 North Swede Road
Midland, Michigan 48674
United States of America

Europe
Dow Benelux NV
Testing Laboratory for SYLTHERM and DOWTHERM Fluids
Oude Maasweg 4
3197 KJ Rotterdam – Botlek
The Netherlands

Latin America
Dow Quimica S.A.
Fluid Analysis Service
1671, Alexandre Dumas
Santo Amaro – Sao Paulo – Brazil 04717-903

This analysis gives a profile of fluid changes to help identify trouble from product contamination or thermal decomposition.

Fluid Sampling Procedures

When a sample is taken from a hot system it should be cooled to below 100°F (40°C) before it is put into the shipping container. Cooling the sample below 100°F (40°C) will prevent the possibility of thermal burns to personnel; also, the fluid is then below its flash point. In addition, any low boilers will not flash and be lost from the sample. Cooling can be done by either a batch or continuous process. The batch method consists of isolating the hot sample of fluid from the system in a properly designed sample collector and then cooling it to below 100°F (40°C). After it is cooled, it can be withdrawn from the sampling collector into a container for shipment.

The continuous method consists of controlling the fluid at a very low rate through a steel or stainless steel cooling coil so as to maintain it at 100°F (40°C) or lower as it comes out of the end of the cooler into the sample collector. Before a sample is taken, the sampler should be thoroughly flushed. This initial fluid should be returned to the system or disposed of in a safe manner in compliance with all laws and regulations.

It is important that samples sent for analysis be representative of the charge in the unit. Ordinarily, samples should be taken from the main circulating line of a liquid system. Occasionally, additional samples may have to be taken from other parts of the system where specific problems exist. A detailed method for analyzing the fluid to determine its quality is available upon request.

Used heat transfer fluid which has been stored in drums or tanks should be sampled in such a fashion as to ensure a representative sample.

Retrofill

SYLTHERM HF heat transfer fluid has successfully replaced organic fluids in existing heat transfer systems. However, there are engineering considerations that should be addressed due to the unique characteristics of SYLTHERM HF heat transfer fluid. It is suggested that The Dow Chemical Company be consulted in advance of fluid purchase and installation to discuss how best to optimize fluid performance in your system.

Storage and Shelf-life

SYLTHERM HF heat transfer fluid, when stored in its original container, will meet sales specification requirements for a period of 5 years from date of shipment.

Store fluid at ambient temperature.

NOTE: *If outside storage of drums is planned, it is suggested that some type of removable drum cover be used to prevent water from entering the drum through the bung seal.*

Packaging

SYLTHERM HF heat transfer fluid is routinely supplied in 375-lb (170-kg) containers (net weight) and in bulk quantities.

Table 1—Physical Properties of SYLTHERM HF Fluid †

Composition: Dimethyl polysiloxane
Color: Crystal Clear Liquid

Property	English Units	SI Units
Viscosity at 77°F (25°C)	1.9 cSt	1.9 cSt
Flash Point[1],		
Closed Cup, Typical	145°F	63°C
Flash Point[2],		
Open Cup, Typical	170°F	77°C
Autoignition Temperature,		
ASTM D-2155	671°F	355°C
Freeze Point	< -115°F	< -82°C
Density at 77°F (25°C)	7.2 lb/gal	864 kg/m^3
Heat of Combustion	13,670 Btu/lb	31,851 kJ/kg
Average Molecular Weight	361	
Estimated Critical Constants		
T_c	662°F	350°C
P_c	10.5 atm	10.6 bar
V_c	0.058 ft^3/lb	3.62 l/kg

†*Not to be construed as specifications.*
[1]*ASTM D92*
[2]*ASTM D93*

Table 2 — Saturated Vapor Properties of SYLTHERM HF Fluid (English Units), Values estimated

Temp. °F	ΔH_{lv} Btu/lb	Z_{vapor}	Cp/Cv	Molecular Weight
300	71.6	0.9776	1.019	302.2
320	69.5	0.9707	1.019	304.4
340	67.3	0.9624	1.019	306.6
360	65.2	0.9526	1.020	308.8
380	62.9	0.9410	1.020	311.0
400	60.7	0.9275	1.021	313.1
420	58.3	0.9120	1.023	315.2
440	55.9	0.8943	1.024	317.4
460	53.3	0.8743	1.027	319.6
480	50.6	0.8517	1.030	321.8
500	47.8	0.8263	1.034	324.1
520	44.7	0.7977	1.040	326.6
540	41.4	0.7657	1.048	329.2
560	37.8	0.7295	1.060	331.9
580	33.7	0.6884	1.080	335.0
600	29.1	0.6410	1.113	338.5
620	23.6	0.5844	1.179	342.6

Table 3 — Saturated Vapor Properties of SYLTHERM HF Fluid (SI Units), Values estimated

Temp. °C	ΔH_{lv} kJ/kg	Z_{vapor}	Cp/Cv	Molecular Weight
150	166.1	0.9770	1.019	302.4
160	161.6	0.9707	1.019	304.4
170	157.1	0.9633	1.019	306.4
180	152.6	0.9547	1.019	308.4
190	148.0	0.9446	1.020	310.3
200	143.3	0.9331	1.021	312.2
210	138.4	0.9200	1.022	314.2
220	133.4	0.9052	1.023	316.1
230	128.2	0.8886	1.025	318.0
240	122.8	0.8700	1.027	320.0
250	117.1	0.8493	1.030	322.0
260	111.1	0.8263	1.034	324.1
270	104.7	0.8007	1.039	326.3
280	97.9	0.7724	1.046	328.6
290	90.5	0.7409	1.056	331.1
300	82.3	0.7055	1.071	333.8
310	73.2	0.6656	1.094	336.7
320	62.9	0.6197	1.133	340.1

Table 4 — Saturated Liquid Properties of SYLTHERM HF Fluid (English Units)

Temp. °F	Specific Heat Btu/lb°F	Density lb/ft³	Thermal Conduc. Btu/hr ft²(°F/ft)	Viscosity cP	Vapor Pressure psia
-100	0.347	60.31	0.0752	16.65	0.00
-80	0.354	59.61	0.0736	11.57	0.00
-60	0.360	58.91	0.0720	8.34	0.00
-40	0.367	58.21	0.0704	6.20	0.00
-20	0.373	57.51	0.0688	4.73	0.00
0	0.380	56.81	0.0672	3.70	0.00
20	0.386	56.11	0.0656	2.95	0.00
40	0.393	55.41	0.0640	2.40	0.00
60	0.399	54.70	0.0625	1.98	0.00
80	0.406	54.00	0.0609	1.66	0.01
100	0.412	53.30	0.0593	1.41	0.02
120	0.419	52.60	0.0577	1.21	0.04
140	0.426	51.90	0.0561	1.05	0.07
160	0.432	51.20	0.0545	0.92	0.13
180	0.439	50.50	0.0529	0.81	0.23
200	0.445	49.80	0.0513	0.72	0.38
220	0.452	49.09	0.0497	0.64	0.61
240	0.458	48.39	0.0481	0.58	0.94
260	0.465	47.69	0.0465	0.52	1.41
280	0.471	46.99	0.0449	0.48	2.06
300	0.478	46.29	0.0433	0.44	2.93
320	0.484	45.59	0.0418	0.40	4.09
340	0.491	44.89	0.0402	0.37	5.60
360	0.497	44.18	0.0386	0.34	7.52
380	0.504	43.48	0.0370	0.32	9.93
400	0.511	42.78	0.0354	0.30	12.92
420	0.517	42.08	0.0338	0.28	16.57
440	0.524	41.38	0.0322	0.26	20.98
460	0.530	40.68	0.0306	0.25	26.24
480	0.537	39.98	0.0290	0.23	32.47
500	0.543	39.28	0.0274	0.22	39.76

Table 5 — Saturated Liquid Properties of SYLTHERM HF Fluid (SI Units)

Temp. °C	Specific Heat kJ/kg K	Density kg/m³	Thermal Conduc. W/mK	Viscosity mPa•s	Vapor Pressure bar
-73	1.453	965.78	0.1301	16.46	0.00
-70	1.460	962.75	0.1293	14.87	0.00
-60	1.485	952.64	0.1268	10.81	0.00
-50	1.509	942.53	0.1244	8.08	0.00
-40	1.534	932.42	0.1219	6.20	0.00
-30	1.559	922.31	0.1194	4.86	0.00
-20	1.583	912.20	0.1169	3.88	0.00
-10	1.608	902.09	0.1144	3.16	0.00
0	1.633	891.98	0.1120	2.60	0.00
10	1.657	881.87	0.1095	2.18	0.00
20	1.682	871.76	0.1070	1.84	0.00
30	1.707	861.65	0.1045	1.58	0.00
40	1.731	851.54	0.1020	1.37	0.00
50	1.756	841.43	0.0996	1.19	0.00
60	1.780	831.32	0.0971	1.05	0.01
70	1.805	821.21	0.0946	0.93	0.01
80	1.830	811.10	0.0921	0.83	0.01
90	1.854	800.99	0.0896	0.74	0.02
100	1.879	790.88	0.0872	0.67	0.03
110	1.904	780.77	0.0847	0.61	0.05
120	1.928	770.66	0.0822	0.56	0.08
130	1.953	760.55	0.0797	0.51	0.11
140	1.977	750.44	0.0772	0.47	0.15
150	2.002	740.33	0.0748	0.43	0.21
160	2.027	730.22	0.0723	0.40	0.28
170	2.051	720.11	0.0698	0.37	0.37
180	2.076	710.00	0.0673	0.35	0.49
190	2.101	699.89	0.0648	0.33	0.63
200	2.125	689.78	0.0624	0.31	0.80
210	2.150	679.67	0.0599	0.29	1.01
220	2.174	669.56	0.0574	0.27	1.26
230	2.199	659.45	0.0549	0.26	1.55
240	2.224	649.34	0.0524	0.24	1.89
250	2.248	639.23	0.0500	0.23	2.29
260	2.273	629.12	0.0475	0.22	2.74

Figure 2—Thermal Conductivity of SYLTHERM HF Fluid (English Units)

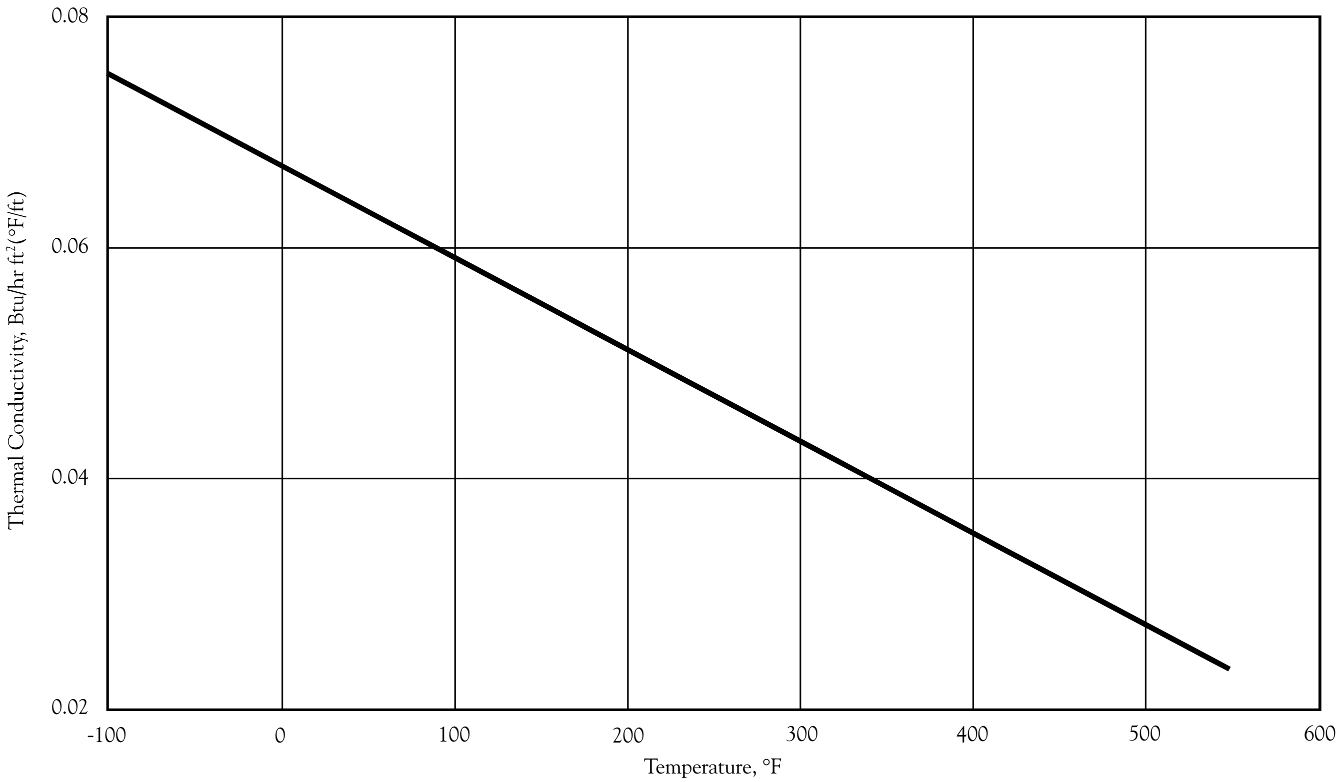


Figure 3 —Thermal Conductivity of SYLTHERM HF Fluid (SI Units)

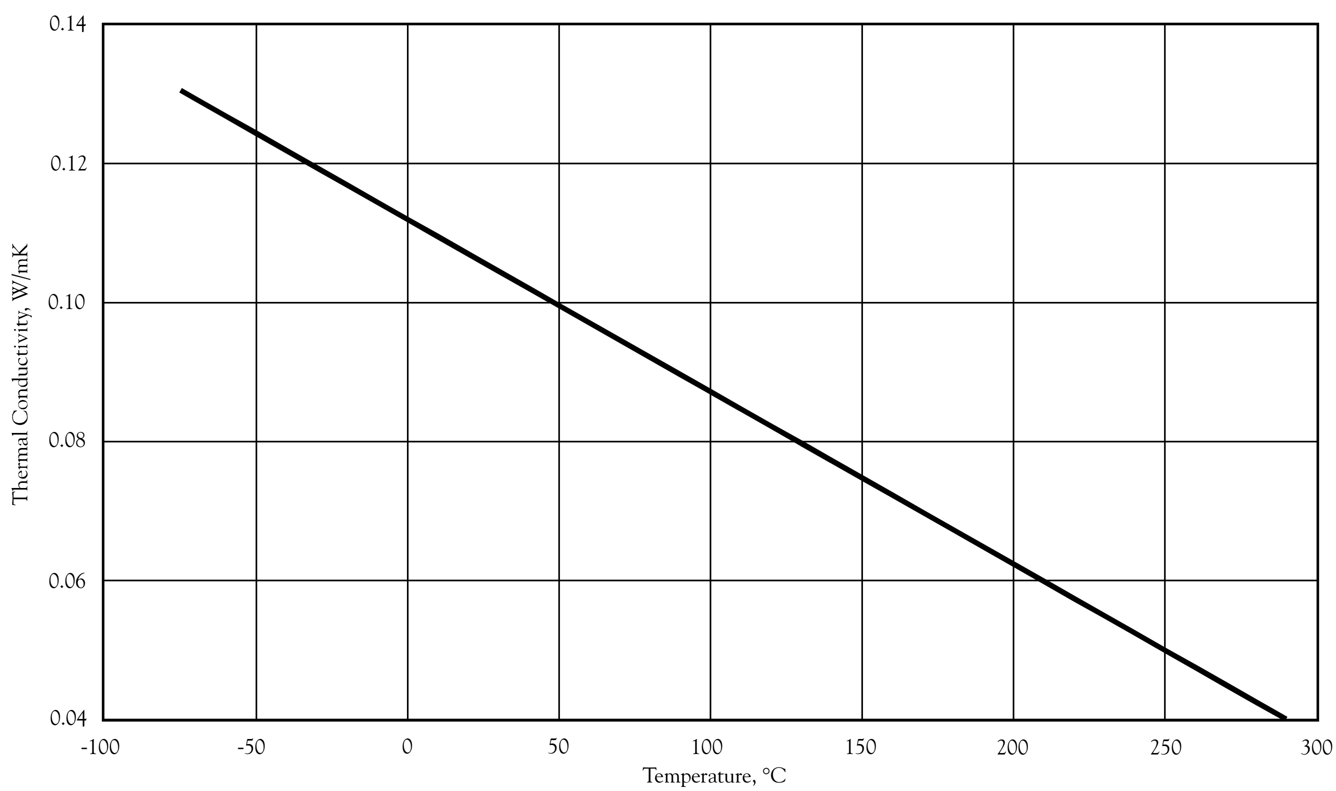


Figure 4 —Vapor Pressure of SYLTHERM HF Fluid (English Units)

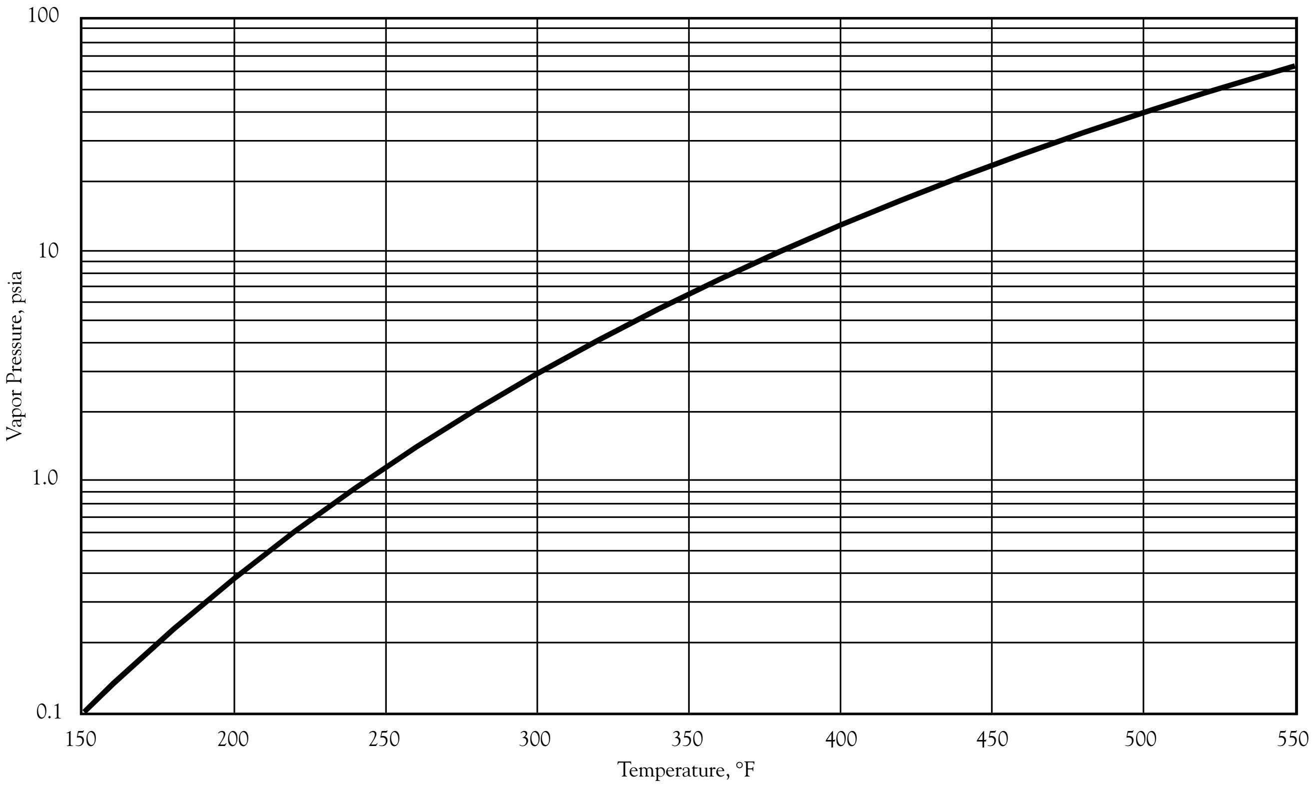


Figure 5 —Vapor Pressure of SYLTHERM HF Fluid (SI Units)

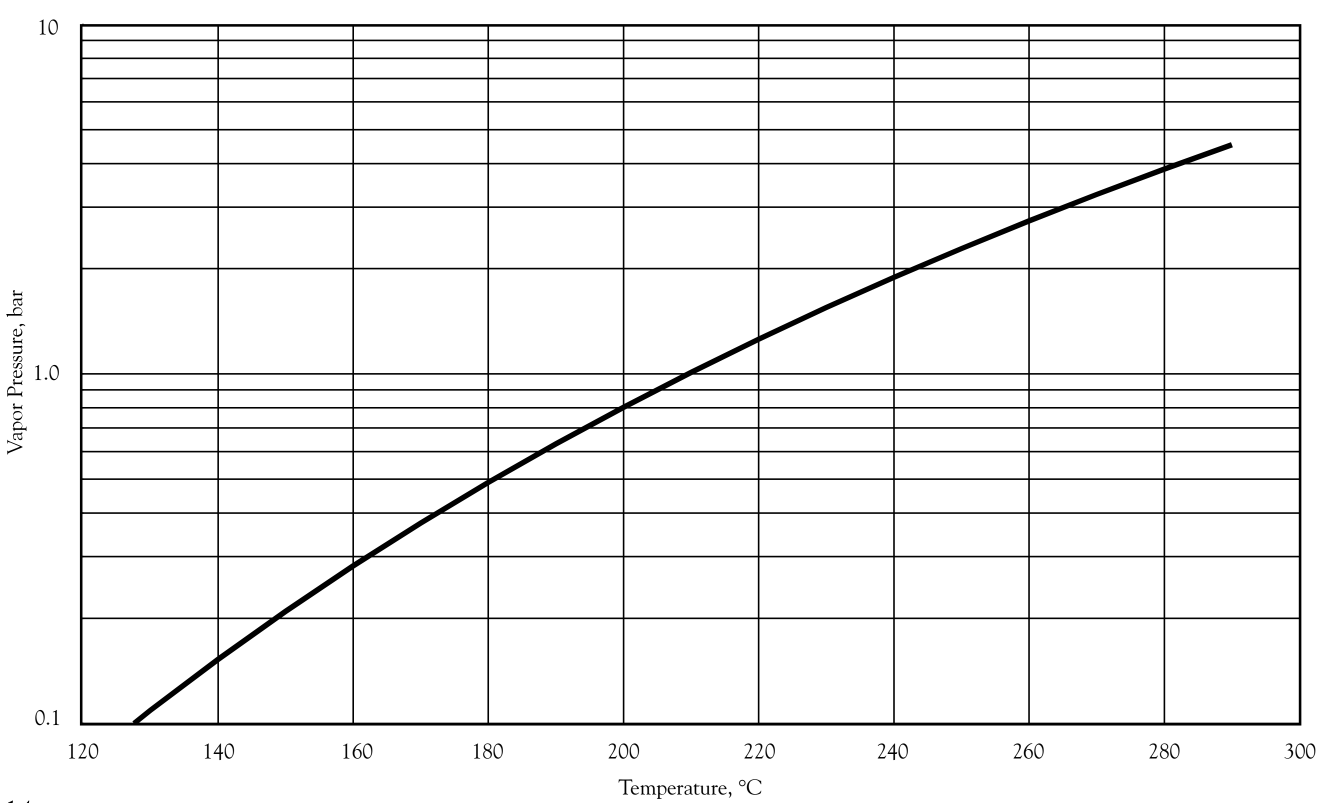


Figure 6— Specific Heat of SYLTHERM HF Fluid (English Units)

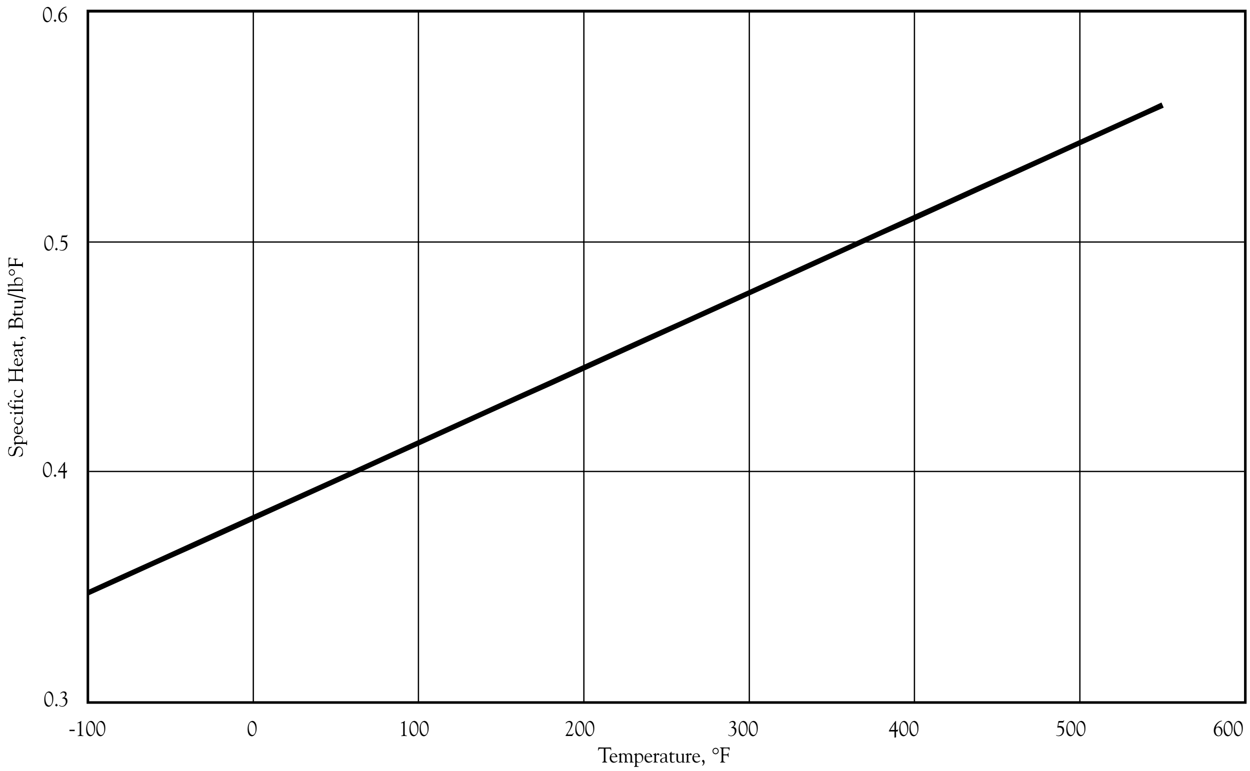


Figure 7 — Specific Heat of SYLTHERM HF Fluid (SI Units)

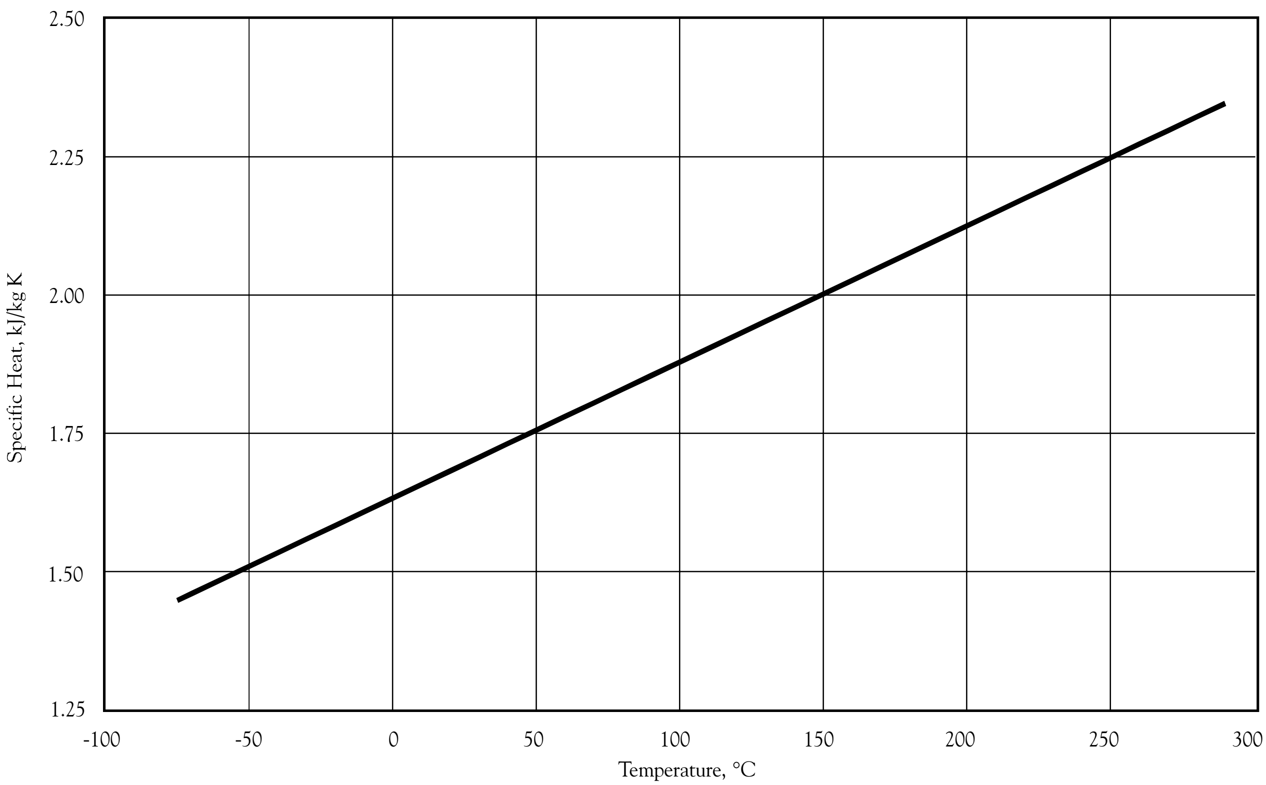


Figure 8 — Density of SYLTHERM HF Fluid (English Units)

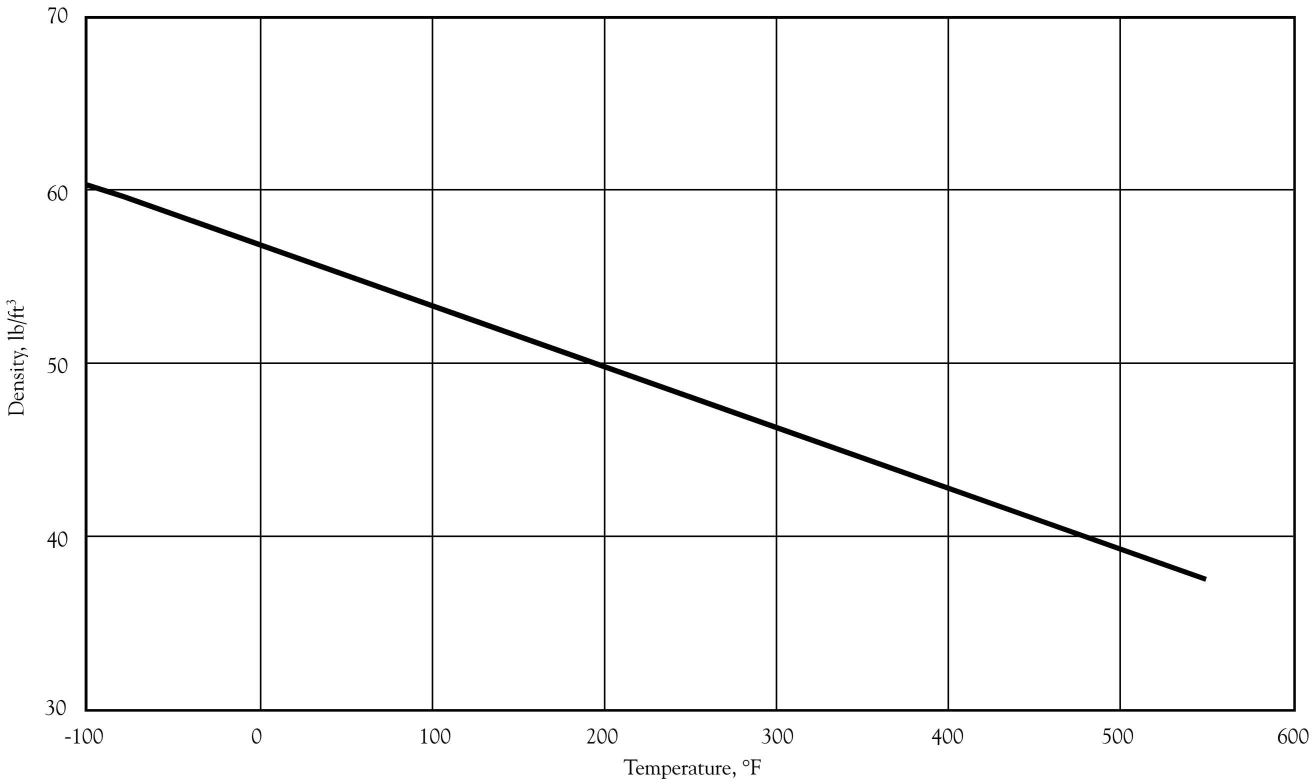


Figure 9 — Density of SYLTHERM HF Fluid (SI Units)

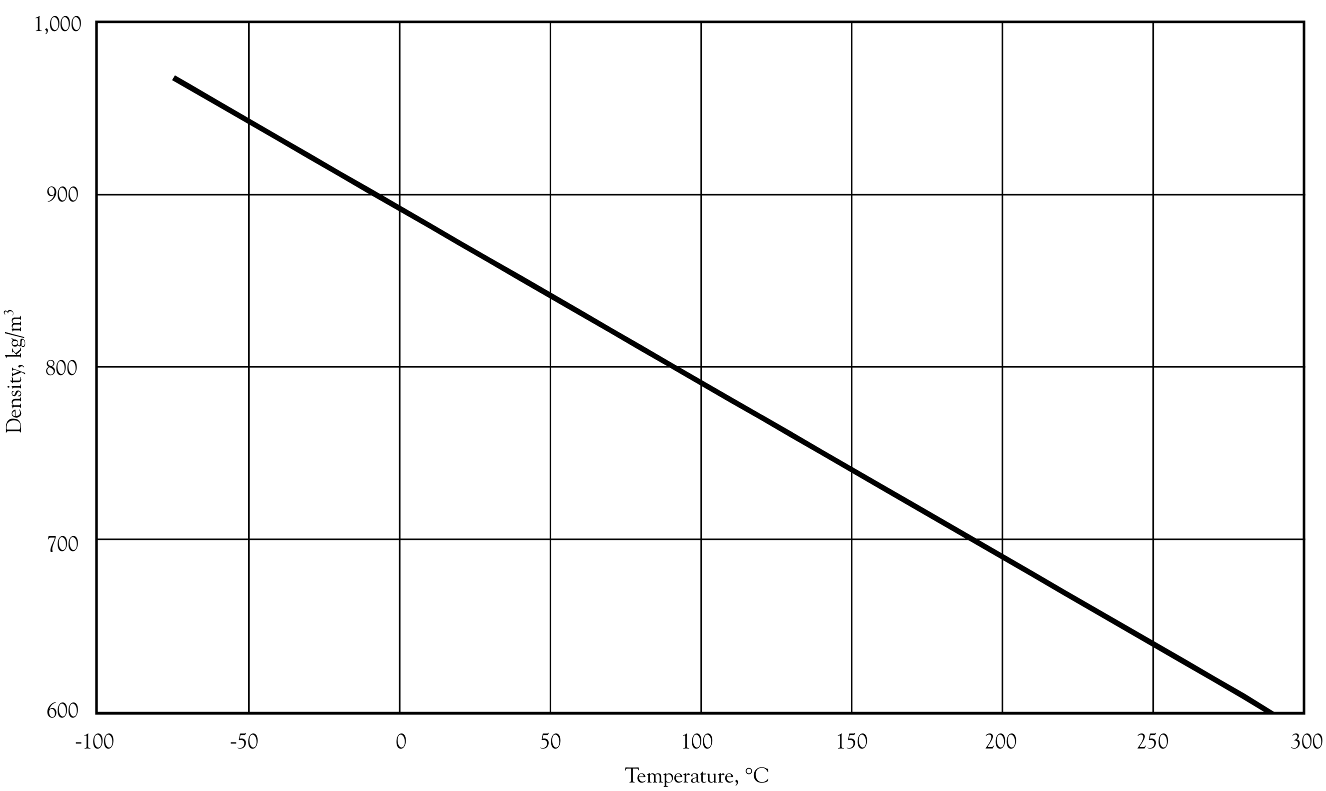


Figure 10 — Liquid Viscosity of SYLTHERM HF Fluid (English Units)

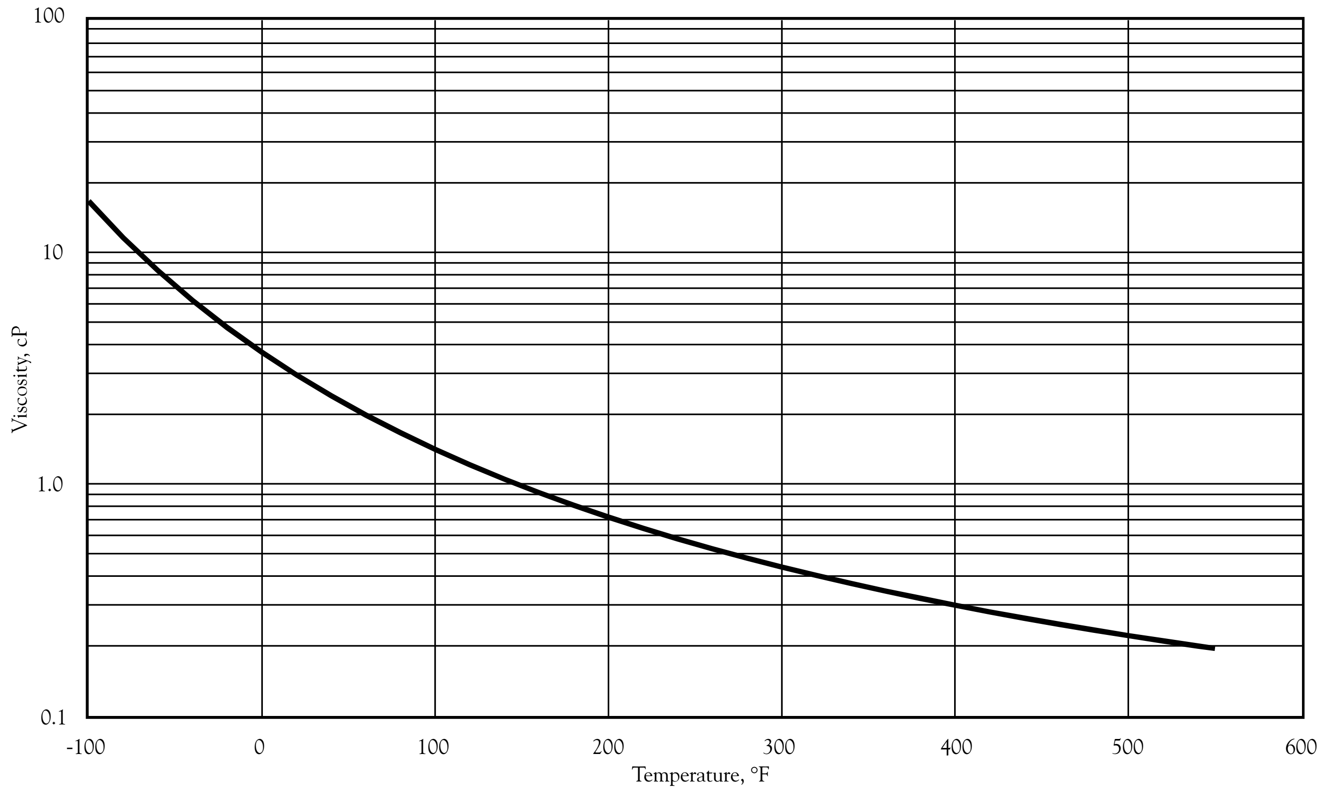


Figure 11 — Liquid Viscosity of SYLTHERM HF Fluid (SI Units)

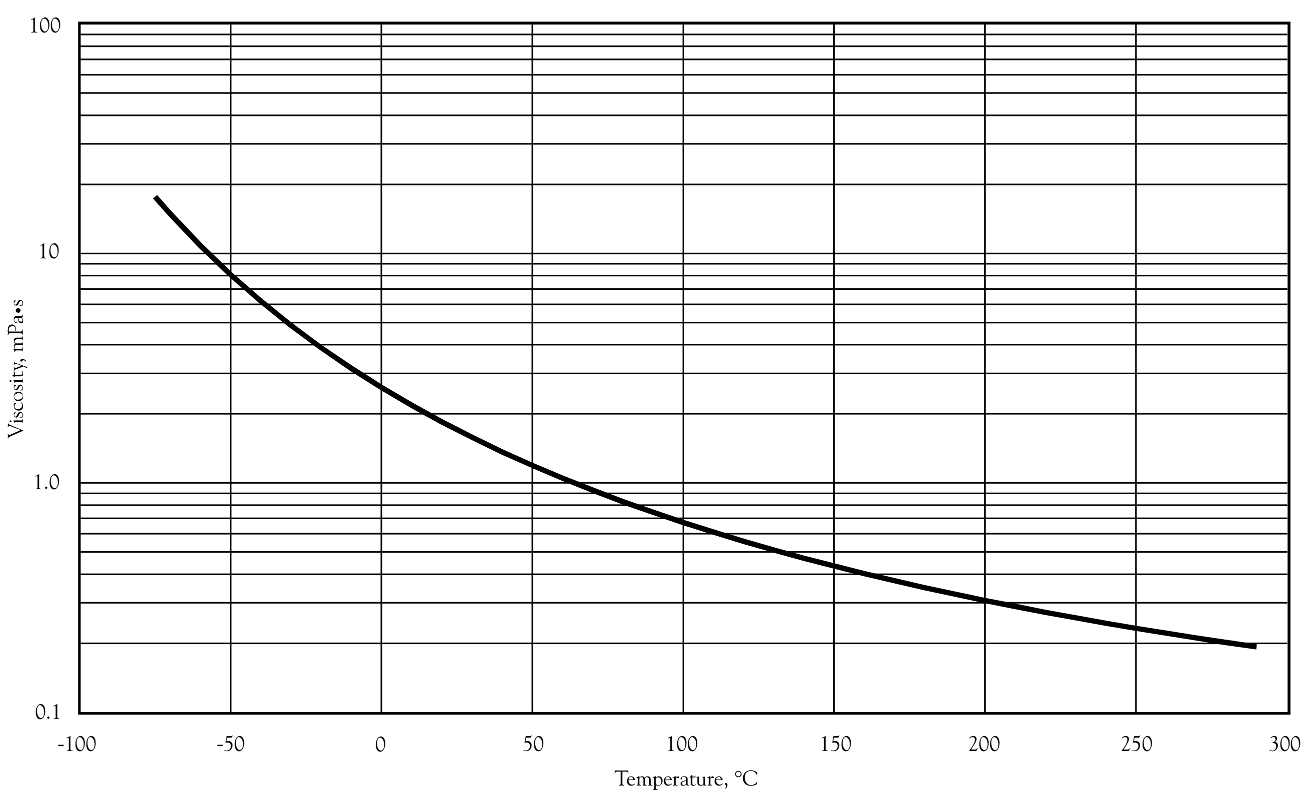
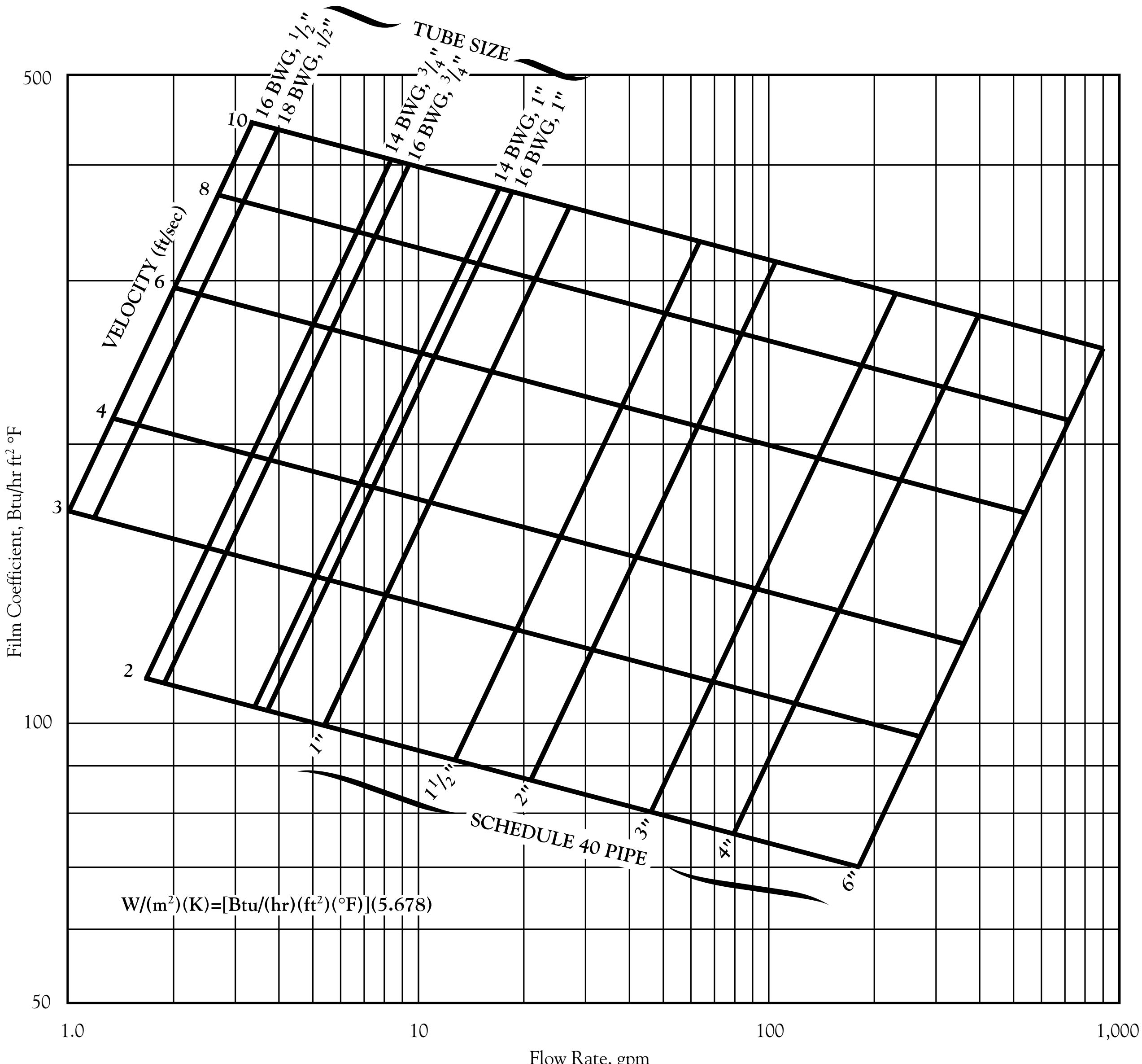
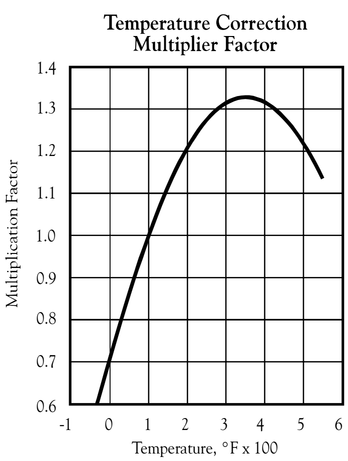


Figure 12 — Liquid Film Coefficient of SYLTHERM HF Fluid Inside Pipes and Tubes (Turbulent Flow Only) (English Units)

Valid for Reynold's Numbers >10,000



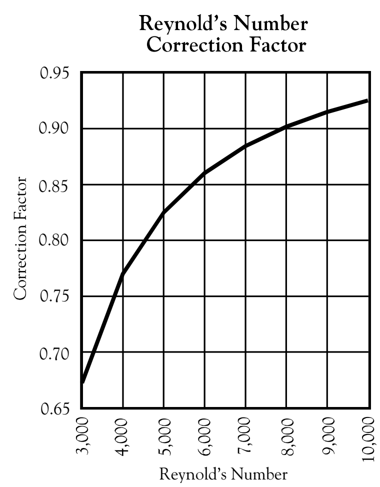


Sieder and Tate equation
Process Heat Transfer,
D.Q. Kern (1950) p.103

$$Nu = 0.027Re^{0.8}Pr^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14}$$

Chart based on $\left(\frac{\mu}{\mu_w}\right)^{0.14} = 1$

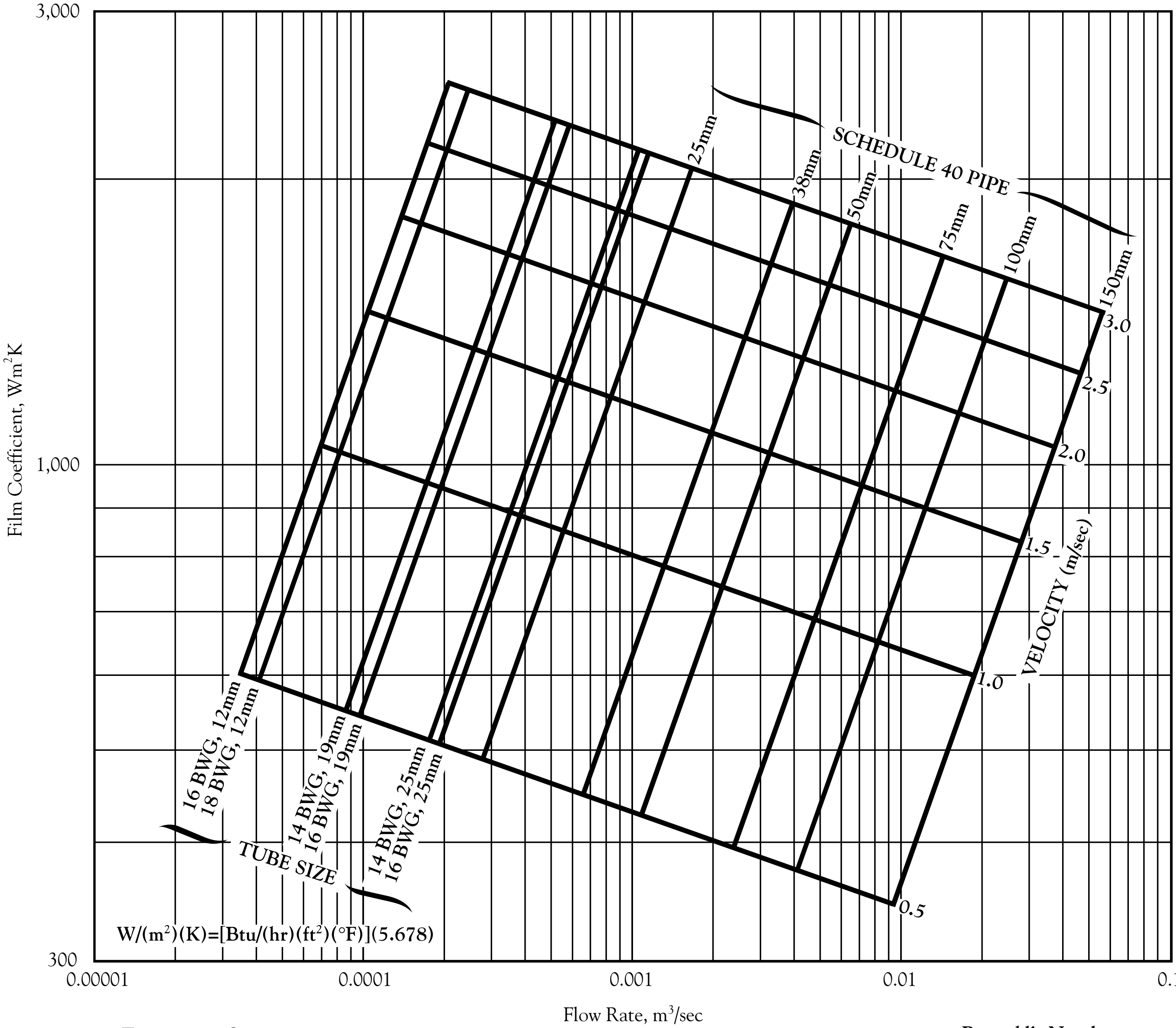
Note: The values in this graph are based on the viscosity of fluid as supplied.



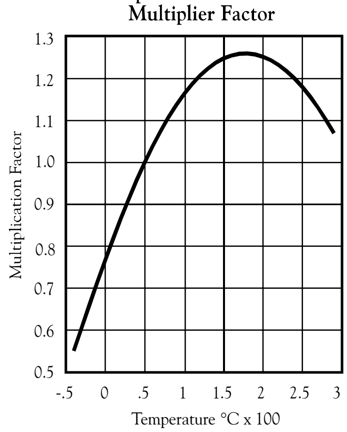
For 3,000< Re <10,000, correct h_i from chart for temperature, then choose a correction factor for Reynold's Number.

Figure 13 — Liquid Film Coefficient of SYLTHERM HF Fluid Inside Pipes and Tubes (Turbulent Flow Only) (SI Units)

Valid for Reynold's Numbers >10,000



Temperature Correction Multiplier Factor



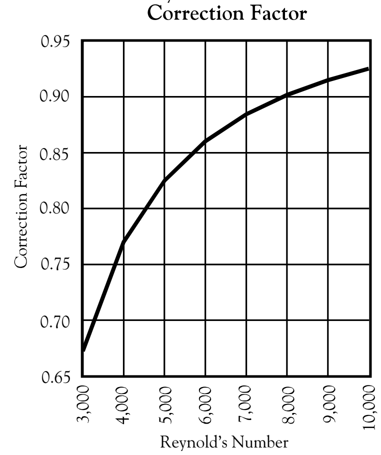
Sieder and Tate equation
Process Heat Transfer,
D.Q. Kern (1950) p.103

$$Nu = 0.027Re^{0.8}P_R^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14}$$

Chart based on $\left(\frac{\mu}{\mu_w}\right)^{0.14} = 1$

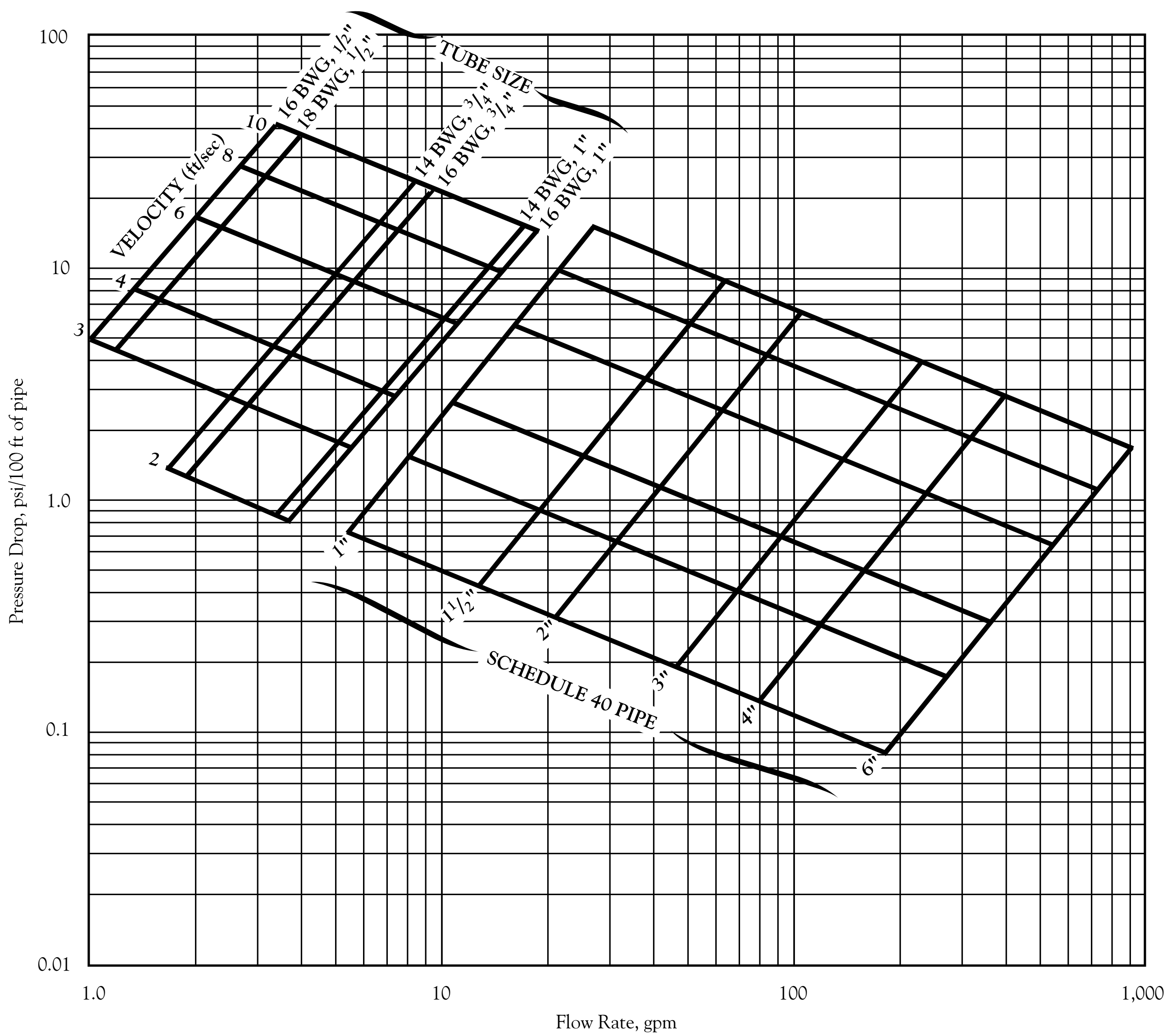
Note: The values in this graph are based on the viscosity of fluid as supplied.

Reynold's Number Correction Factor



For 3,000< Re <10,000, correct h_i from chart for temperature, then choose a correction factor for Reynold's Number.

Figure 14—Pressure Drop vs. Flow Rate of SYLTHERM HF Fluid in Schedule 40 Nominal Pipe and BWG Tube (English Units)



Temperature Correction Multiplier Factor

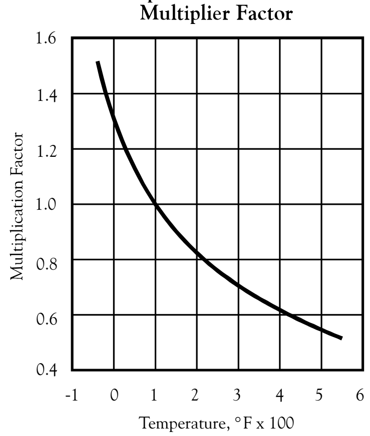
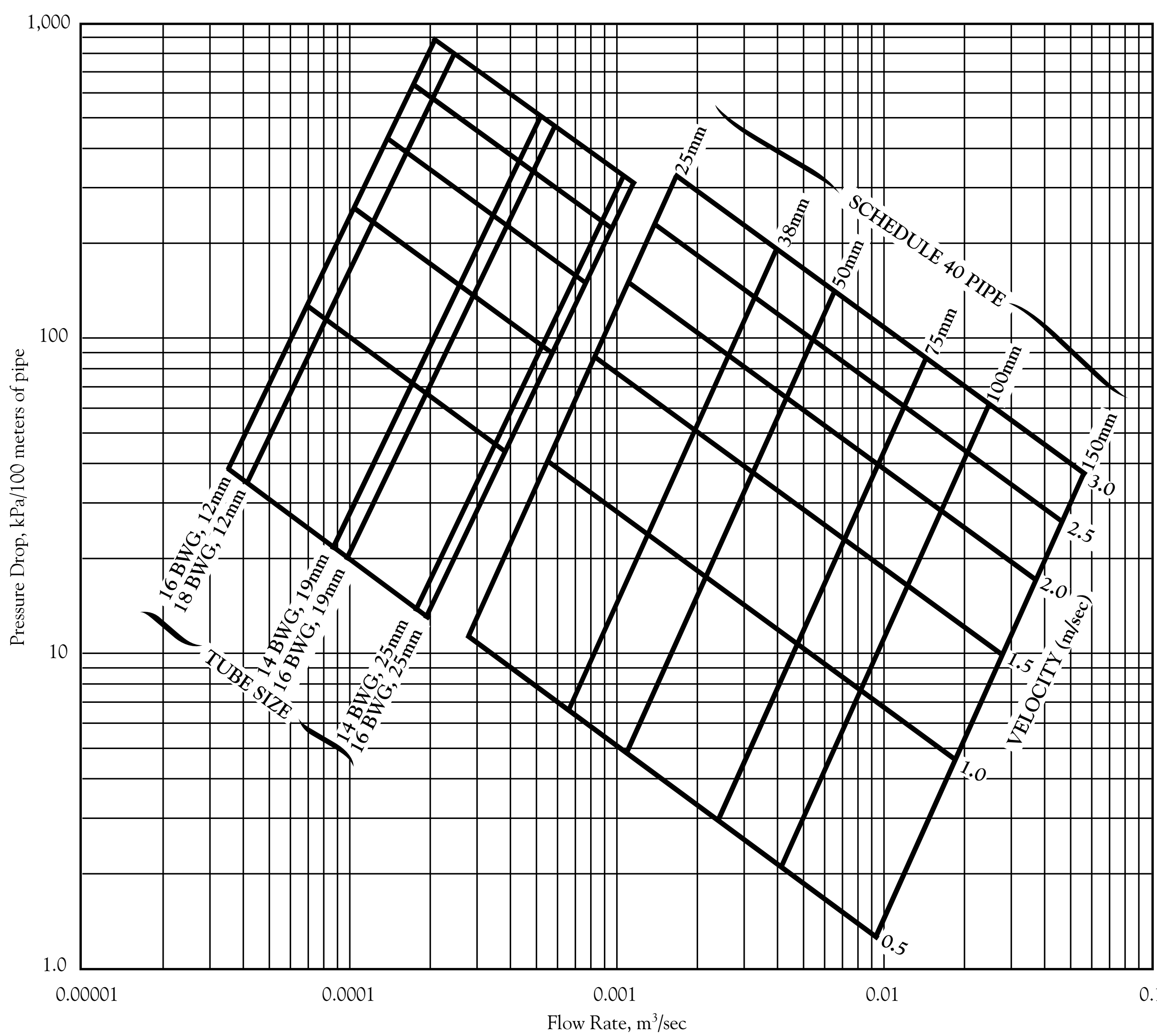


Figure 15 — Pressure Drop vs. Flow Rate of SYLTHERM HF Fluid in Schedule 40 Nominal Pipe and BWG Tube (SI Units)



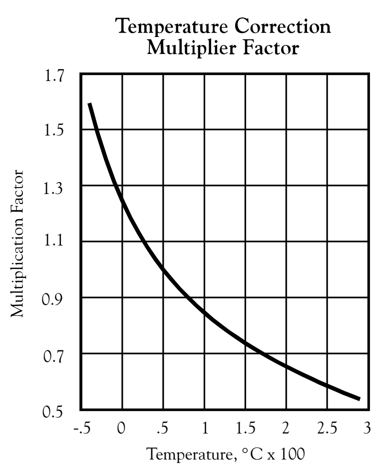


Figure 16—Thermal Expansion of Liquid SYLTHERM HF Fluid (English Units)

Basis: 1 gallon at 75°F

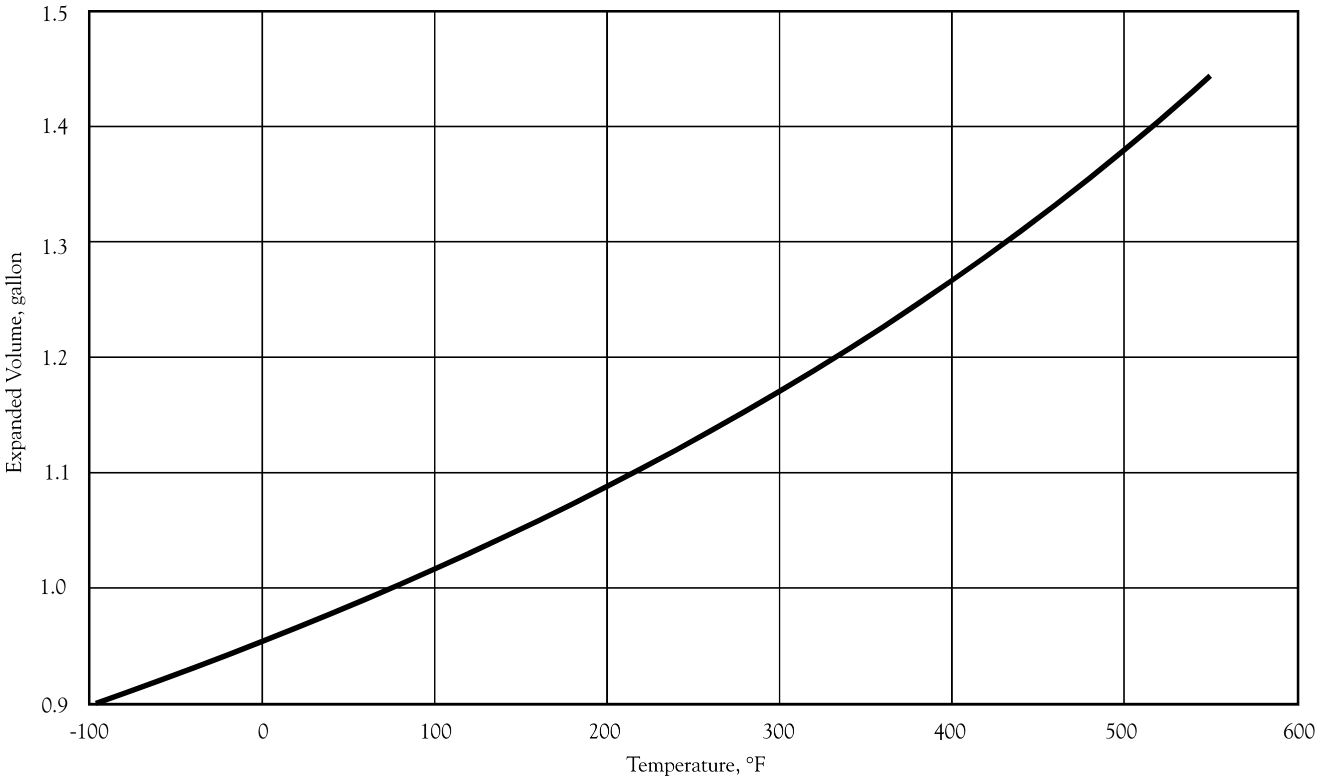


Figure 17—Thermal Expansion of Liquid SYLTHERM HF Fluid (SI Units)

Basis: 1 cubic meter at 25°C

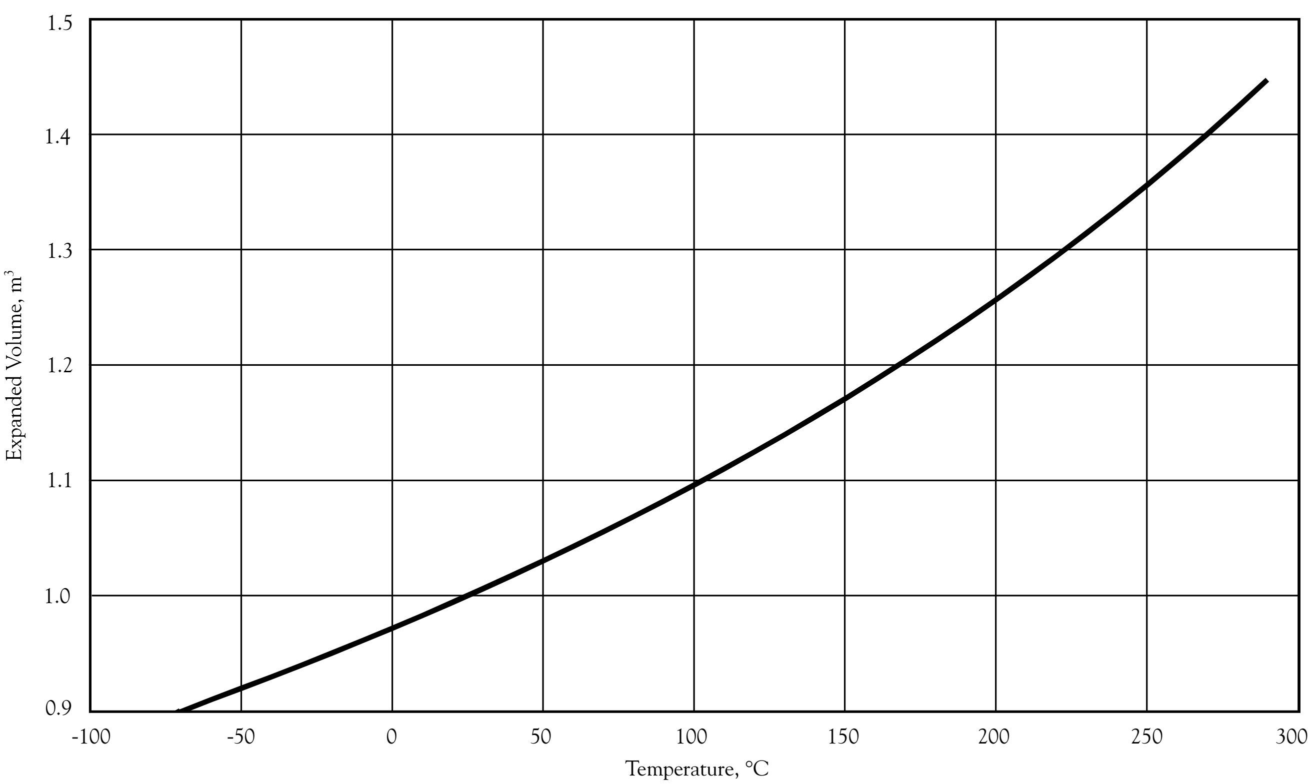


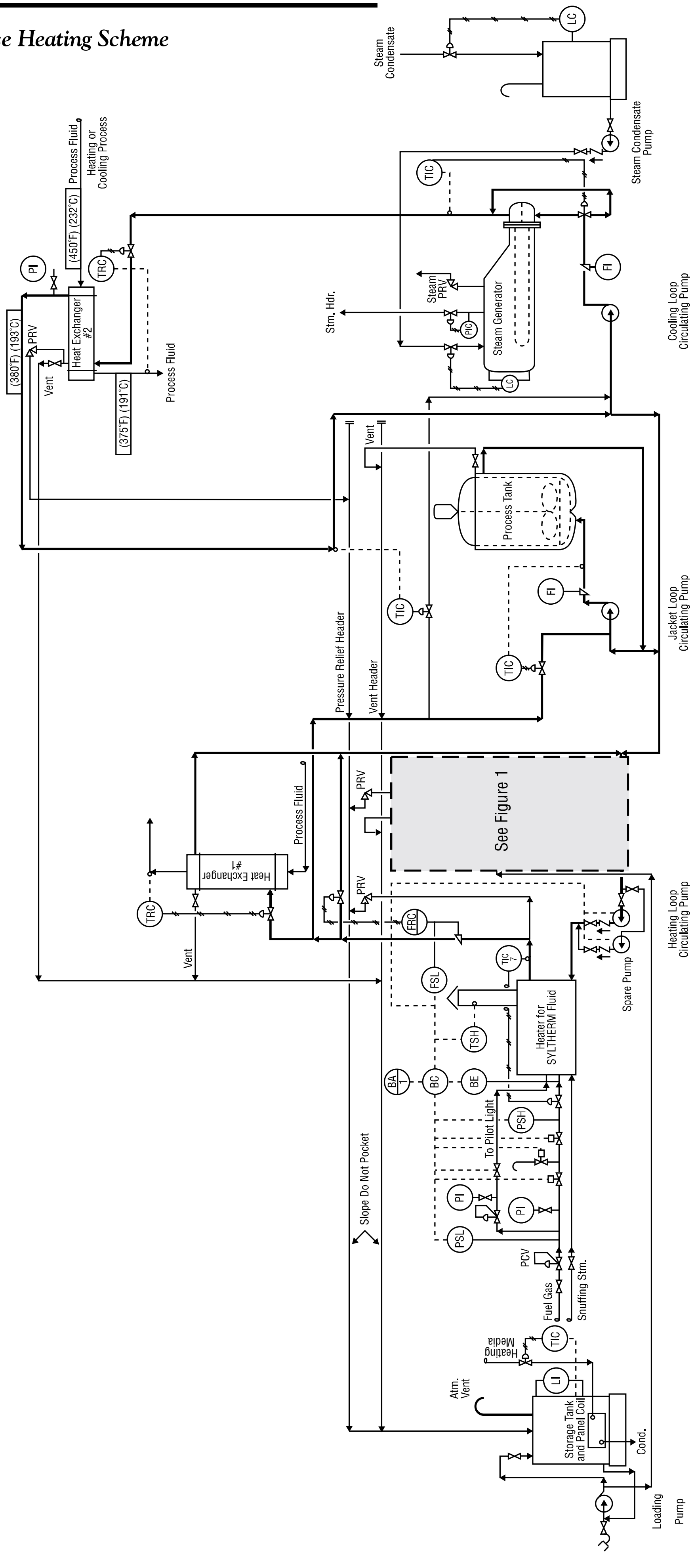
Figure 18—Typical Liquid Phase Heating Scheme Using SYLTHERM Fluids

Instrument Legend

BA – Burner Alarm
BC – Burner Control
BE – Burner Element (Fire-Eye)
FI – Flow Indicator (Orifice)
FRC – Flow Recording Controller
FSL – Flow Switch Low
LC – Level Controller
PVC – Pressure Control Valve

PI – Pressure Indicator
PIC – Pressure Indicating Controller
PRV – Pressure Relief Valve
PSH – Pressure Switch High
PSL – Pressure Switch Low
TIC – Temperature Indicating Controller
TRC – Temperature Recorder Controller
TSH – Temperature Switch High

——— Principal Circuits with SYLTHERM Fluid
- - - - Electrical Lines
-//-//- Instrument Air Lines



SYLTHERM† HF
Heat Transfer Fluid

Product Technical Data

For further information, call...

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In Europe: +31 20691 6268 • FAX: +31 20691 6418

In The Pacific: +886 2 715 3388 • FAX: +886 2 717 4115

In Other Global Areas: 1-517-832-1556 • FAX: 1-517-832-1465

http://www.dow.com/heattrans

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†**NOTE:** SYLTHERM heat transfer fluids are manufactured by Dow Corning Corporation and distributed by The Dow Chemical Company.

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