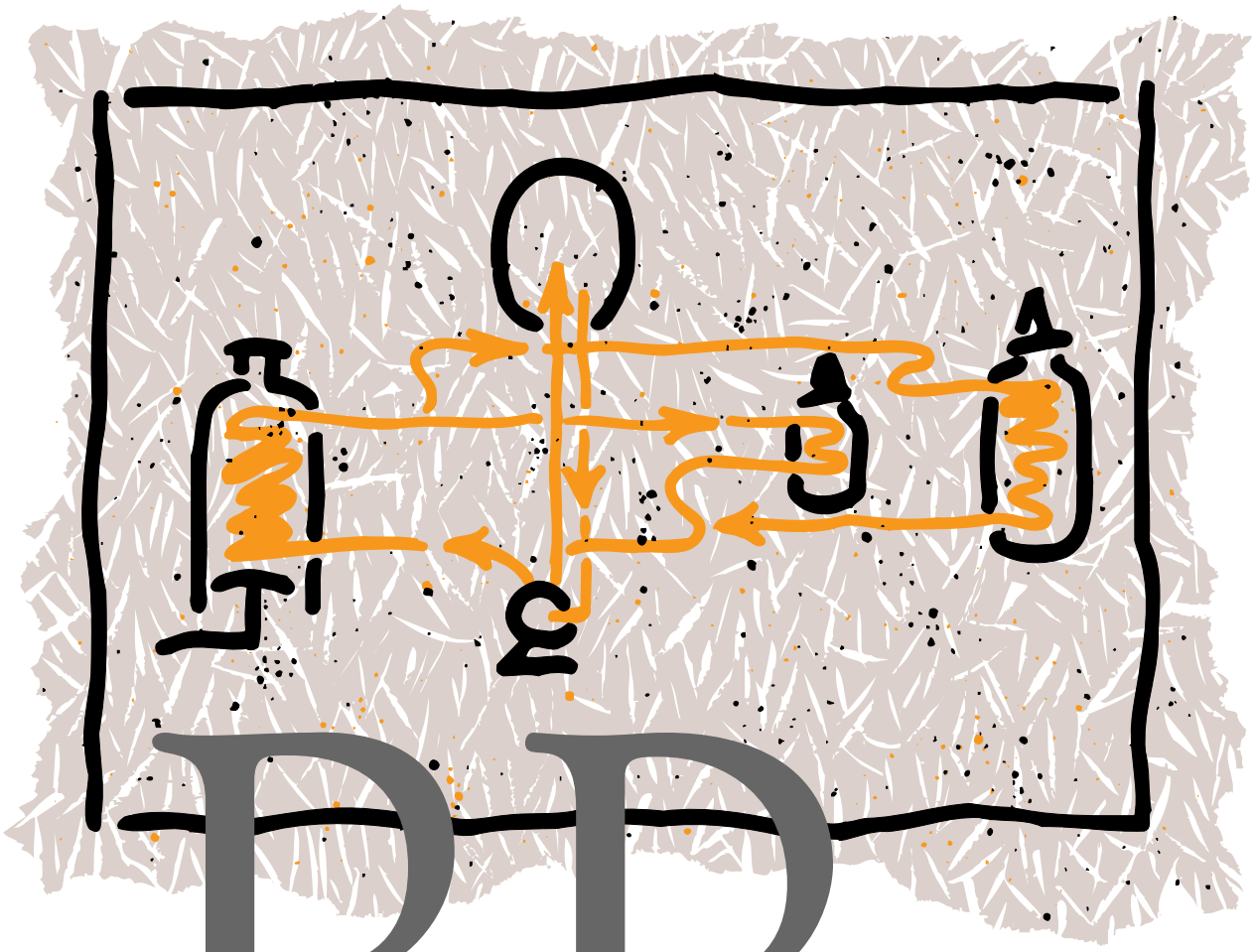
DOWTHERM RP Heat Transfer Fluid



RP

Product Technical Data

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DOWTHERM RP HEAT TRANSFER FLUID

DOWTHERM RP fluid provides high performance in non-pressurized systems

DOWTHERM* RP heat transfer fluid is a high purity diaryl alkyl that provides excellent performance in liquid phase heat transfer systems operating between -4°F and 660°F (-20°C to 350°C). It is the most thermally stable low-pressure liquid phase heat transfer fluid on the market today. This stability minimizes problems resulting from accidental overheating caused by flame impingement, improper heater firing, or inadequate circulation.

In addition, any degradation of DOWTHERM RP fluid that occurs under normal use conditions produces almost exclusively low boiling materials which vent from the system. As a result, high boiling sludges don't build up over time. This means that, under normal operating conditions, the fluid may never need to be changed out.

Start-up and shutdown problems are minimized by the fluid's excellent flow characteristics at low temperatures, reducing the need for heat tracing. DOWTHERM RP fluid has high flash, fire, and autoignition points and presents no fire hazard at ambient temperatures.

DOWTHERM RP fluid is backed by Dow's unequaled supporting services, including technical back-up in the design phase and during operation. Moreover, free analytical testing is provided to monitor fluid condition.

If, for some reason, your DOWTHERM RP fluid should ever need to be changed out, Dow's fluid return program allows you to return the old fluid and receive credit toward the purchase of your new fluid charge.

For Information About Our Full Line of Fluids…

To learn more about the full line of Dow Heat Transfer Fluids — 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.

*Trademark of The Dow Chemical Company
†Trademark of Dow Corning Corporation

Fluid Selection Criteria

Stability

DOWTHERM RP fluid offers excellent thermal stability at temperatures up to 660°F (350°C). The maximum recommended film temperature is 710°F (375°C).

Vapor Pressure

DOWTHERM RP fluid may be used as a liquid heat transfer medium up to 660°F (350°C) with a pressure of only 13 psia (96 kPa).

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 life for a fluid 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 per sec); a range of 6–12 feet per second (2–4 m per sec) 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.

Chemical Contamination

A primary concern regarding chemical contaminants in a heat transfer fluid system is their relatively poor thermal stability at elevated temperatures. The thermal degradation of chemical contaminants may be very rapid which may lead to fouling of heat transfer surfaces and corrosion of system components. The severity and nature of the corrosion will depend upon the amount and type of contaminant introduced into the system.

Air Oxidation

Organic heat transfer fluids operated at elevated temperatures are susceptible to air oxidation. The degree of oxidation and the rate of reaction is dependent upon the temperature and the amount of air mixing. Undesirable by-products of this reaction may include carboxylic acids which would likely result in system operating problems.

Preventive measures should be taken to ensure that air is eliminated from the system prior to bringing the heat transfer fluid up to operating temperatures. A positive pressure inert gas blanket should be maintained at all times on the expansion tank during system operation.

Units can be designed to operate at higher temperatures than those presently recommended in cases where the greater replacement costs of DOWTHERM RP fluid — resulting from its increased decomposition rate — can be economically justified. In such units, adequate provision must be made for good circulation, lower heat fluxes, and more frequent replacement of fluid.

Corrosivity

DOWTHERM RP heat transfer fluid is non-corrosive toward common metals and alloys. Even at the high temperatures involved, equipment usually exhibits excellent service life.

Steel is used predominantly, although low alloy steels, stainless steels, Monel alloy, 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 attack will depend upon the amounts and type of contamination involved.

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

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

Flammability

DOWTHERM RP heat transfer fluid is a combustible material. It has a closed cup flash point of 381°F (194°C), and an auto-ignition temperature of 725°F (385°C) (A.S.T.M. Method E 659).

Fluid leaks to the atmosphere are sometimes encountered. Such leaks, however small, should not be tolerated because of the cost of replacing lost fluid. Experience has shown that leaking fluids have usually cooled well below the fire point and fire has rarely resulted.

Leaks from pipelines into insulation are potentially hazardous as 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 DOWTHERM RP fluid do not pose a serious flammability hazard at room temperature because the saturation concentration is below the lower flammability limit making ignition unlikely. Flammable mists are, however, possible under unusual circumstances.

If used and maintained properly, installations employing DOWTHERM RP fluid should present no unusual flammability hazards.

Health, Safety, and Environmental Considerations

A Material Safety Data Sheet (MSDS) for DOWTHERM RP heat transfer fluid is available by calling the number listed on the back of this brochure. The MSDS contains complete health and safety information regarding the use of this product. Read and understand the MSDS before handling or otherwise using this product.

Provisions must be made to prevent significant discharge into public waters. The fluid is not recommended for use in food processing areas where potential leakage may occur.

Oral administration of DOWTHERM RP fluid to laboratory animals has revealed a low order of systemic toxicity. The single dose oral LD50 is >2000 m/kg for rats.

DOWTHERM RP fluid is slightly irritating to the skin and eyes. However, prolonged and repeated contact with the skin should be avoided, and suitable eye protection should be worn wherever there are opportunities or eye contamination.

The potential for DOWTHERM RP fluid to be absorbed through the skin in acutely toxic levels is low; its dermal LD50 is greater than 3160 mg/kg.

At room temperature, vapors are minimal due to physical properties of the fluid. At normal use temperatures, significant vapor concentrations or mists may be encountered due to leaks or spills. While vapors are not expected to be irritating to the upper respiratory tract, care should be taken to avoid exposure to high concentrations of vapor or mists.

When accidental or unusual conditions result in heavy concentrations of vapor or fume, workers should wear respiratory protection suitable for organic mists and vapors. Where there is a possibility of oxygen deficiency, workers should be equipped with air supplied masks or self-contained breathing apparatus. In normal operation, atmospheric contamination should be kept at levels where fluid odor is not discomforting to individuals.

Customer Service for Users of DOWTHERM RP Heat Transfer Fluid

Fluid Analysis

The Dow Chemical Company offers an analytical service for DOWTHERM RP 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
Syltherm and Dowtherm Testing Laboratory
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.

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.

Fluid Return Program for DOWTHERM Fluids

In the unlikely event that you need to change out DOWTHERM RP fluid, Dow offers a fluid return program. If analysis of a particular fluid sample reveals significant thermal degradation of the medium, the customer will be advised to return the fluid in his system to Dow. If the fluid is contaminated with organic materials of low thermal stability, it may not be acceptable for Dow processing and will not qualify for the return program. In this case, Dow will advise the customer that the fluid cannot be processed and therefore should not be returned to Dow. No material should be sent to Dow until the fluid analysis has been completed and the customer informed of the results.

If the analysis shows fluid change-out is necessary, the customer should order sufficient new material to recharge the system before sending the old fluid to Dow. Under the fluid return program, Dow will credit the customer for all usable material recovered.

The Dow fluid return program permits customers to minimize their heat transfer fluid investment, handling downtime and inventory, while assuring that replacement fluid is of the highest quality.

Before returning material for credit, contact Dow at the number for your area listed on the back of this bulletin for details.

For further information, please contact your nearest Dow representative or call the number for your area listed on the back of this brochure. Ask for DOWTHERM RP Fluid.

Table 1 — Physical Properties of DOWTHERM RP Fluid†

Composition: Diaryl Alkyl

Color: Clear colorless liquid

Property	English Units	SI Units
Crystal Point	Below 30°F	Below 0°C
Boiling Point	667°F	353°C
Flash Point[1]	381°F	194°C
Autoignition Temperature[2]	725°F	385°C
LFL, vol %[3]	0.33% @ 392°F	0.33% @ 200°C
UFL, vol %[3]	4.66% @ 464°F	4.66% @ 240°C
Estimated Critical Constants:		
T_c	1066°F	575°C
P_c	20.4 atm.	20.7 bar
V_c	0.0552 ft^3/lb	3.446 l/kg
Average Molecular Weight	236.4	
Density at 75°F	8.56 lb/gal	1026.6 kg/m^3
Density at 25°C	8.55 lb/gal	1025.8 kg/m^3

† Not to be construed as specifications.

[1] Closed cup

[2] ASTM E 659-78

[3] ASTM E 681-85

Table 2 — Select Saturated Vapor Properties of DOWTHERM RP (English Units), Values are estimated

Temp. °F	ΔH_{lv} *Btu/lb*	Z_{vapor}	*Cp/Cv*
400	123.396	0.99695	1.0198
420	121.580	0.99580	1.0195
440	119.807	0.99433	1.0193
460	118.078	0.99248	1.0191
480	116.392	0.99020	1.0190
500	114.749	0.98742	1.0190
520	113.146	0.98408	1.0190
540	111.580	0.98013	1.0191
560	110.046	0.97550	1.0193
580	108.539	0.97013	1.0196
600	107.052	0.96398	1.0200
620	105.578	0.95698	1.0204
640	104.108	0.94910	1.0210
660	102.631	0.94027	1.0218
680	101.135	0.93045	1.0227
700	99.6063	0.91960	1.0237

Table 3 — Select Saturated Vapor Properties of DOWTHERM RP (SI Units), Values are estimated

Temp. °C	ΔH_{lv} *kJ/kg*	Z_{vapor}	*Cp/Cv*
200	288.544	0.99733	1.0199
210	284.704	0.99641	1.0196
220	280.944	0.99526	1.0194
230	277.267	0.99382	1.0192
240	273.673	0.99206	1.0191
250	270.161	0.98994	1.0190
260	266.728	0.98742	1.0190
270	263.370	0.98444	1.0190
280	260.082	0.98097	1.0191
290	256.857	0.97696	1.0192
300	253.687	0.97237	1.0195
310	250.560	0.96716	1.0198
320	247.464	0.96128	1.0201
330	244.386	0.95471	1.0206
340	241.310	0.94741	1.0212
350	238.216	0.93933	1.0219
360	235.084	0.93045	1.0227
370	231.889	0.92073	1.0236

Table 4 — Saturated Liquid Properties of DOWTHERM RP Fluid (English Units)

Temp. °F	*Specific Heat Btu/(lb)(°F)*	*Density lb/ft³*	*Therm. Cond. Btu/(hr)(ft²)(°F/ft)*	*Viscosity cP*	*Vapor Pressure psia*
30	0.372	65.25	0.0775	248.68	
40	0.376	65.00	0.0771	142.76	
50	0.380	64.76	0.0766	88.17	
60	0.384	64.52	0.0762	57.84	
70	0.388	64.28	0.0758	39.90	
80	0.392	64.04	0.0754	28.71	
90	0.396	63.79	0.0750	21.41	
100	0.400	63.55	0.0746	16.46	
110	0.404	63.31	0.0741	12.98	
120	0.408	63.07	0.0737	10.47	
130	0.412	62.82	0.0733	8.60	
140	0.416	62.58	0.0729	7.19	
150	0.420	62.33	0.0725	6.10	
160	0.424	62.09	0.0721	5.24	
170	0.428	61.85	0.0717	4.55	
180	0.432	61.60	0.0712	3.99	
190	0.435	61.36	0.0708	3.53	
200	0.439	61.11	0.0704	3.15	
210	0.443	60.86	0.0700	2.83	
220	0.447	60.62	0.0696	2.55	
230	0.451	60.37	0.0692	2.32	
240	0.455	60.12	0.0687	2.12	
250	0.459	59.88	0.0683	1.94	
260	0.463	59.63	0.0679	1.79	
270	0.467	59.38	0.0675	1.66	
280	0.471	59.13	0.0671	1.54	
290	0.475	58.88	0.0667	1.43	0.02
300	0.479	58.63	0.0662	1.34	0.02
310	0.483	58.38	0.0658	1.25	0.03
320	0.487	58.13	0.0654	1.18	0.04
330	0.491	57.88	0.0650	1.11	0.05
340	0.495	57.63	0.0646	1.05	0.07
350	0.499	57.38	0.0642	0.99	0.09
360	0.503	57.13	0.0637	0.94	0.11
370	0.507	56.87	0.0633	0.89	0.14
380	0.511	56.62	0.0629	0.85	0.17
390	0.515	56.36	0.0625	0.80	0.22
400	0.518	56.11	0.0621	0.77	0.27
410	0.522	55.85	0.0617	0.73	0.33
420	0.526	55.60	0.0612	0.70	0.40
430	0.530	55.34	0.0608	0.67	0.49
440	0.534	55.08	0.0604	0.64	0.59
450	0.538	54.82	0.0600	0.62	0.71
460	0.542	54.56	0.0596	0.59	0.85
470	0.546	54.30	0.0592	0.57	1.01
480	0.550	54.04	0.0588	0.55	1.20
490	0.554	53.78	0.0583	0.53	1.41
500	0.558	53.51	0.0579	0.51	1.66
510	0.562	53.25	0.0575	0.49	1.94
520	0.566	52.98	0.0571	0.48	2.26
530	0.570	52.72	0.0567	0.46	2.62
540	0.574	52.45	0.0563	0.45	3.03
550	0.578	52.18	0.0558	0.43	3.49
560	0.582	51.91	0.0554	0.42	4.01
570	0.586	51.64	0.0550	0.40	4.59
580	0.590	51.37	0.0546	0.39	5.24
590	0.594	51.09	0.0542	0.38	5.96
600	0.598	50.81	0.0538	0.37	6.77
610	0.601	50.54	0.0533	0.36	7.65
620	0.605	50.26	0.0529	0.35	8.63
630	0.609	49.97	0.0525	0.34	9.71
640	0.613	49.69	0.0521	0.33	10.90
650	0.617	49.41	0.0517	0.32	12.20
660	0.621	49.12	0.0513	0.32	13.63
670	0.625	48.83	0.0508	0.31	15.18
680	0.629	48.54	0.0504	0.30	16.88
690	0.633	48.24	0.0500	0.29	18.72
700	0.637	47.94	0.0496	0.29	20.72

Table 5 — Saturated Liquid Properties of DOWTHERM RP Fluid (SI Units)

Temp. °C	*Specific Heat kJ/(kg)(K)*	*Density kg/m³*	*Therm. Cond. W/(m)(K)*	*Viscosity (mPa)(s)*	*Vapor Press. bar*
0	1.561	1043.2	0.1340	221.10	
10	1.591	1036.2	0.1327	88.17	
20	1.620	1029.2	0.1314	42.82	
30	1.650	1022.3	0.1301	23.99	
40	1.680	1015.3	0.1288	14.92	
50	1.710	1008.3	0.1275	10.05	
60	1.739	1001.3	0.1262	7.19	
70	1.769	994.2	0.1249	5.39	
80	1.799	987.2	0.1236	4.20	
90	1.829	980.1	0.1223	3.37	
100	1.858	973.0	0.1210	2.77	
110	1.888	965.9	0.1197	2.32	
120	1.918	958.8	0.1184	1.98	
130	1.948	951.7	0.1171	1.71	
140	1.978	944.5	0.1158	1.49	
150	2.007	937.3	0.1145	1.32	
160	2.037	930.1	0.1132	1.18	
170	2.067	922.9	0.1119	1.06	
180	2.097	915.6	0.1106	0.96	0.01
190	2.126	908.3	0.1093	0.87	0.01
200	2.156	901.0	0.1080	0.80	0.02
210	2.186	893.7	0.1067	0.73	0.02
220	2.216	886.3	0.1054	0.68	0.03
230	2.245	878.8	0.1041	0.63	0.05
240	2.275	871.3	0.1029	0.58	0.06
250	2.305	863.8	0.1016	0.54	0.09
260	2.335	856.2	0.1003	0.51	0.11
270	2.364	848.6	0.0990	0.48	0.15
280	2.394	840.9	0.0977	0.45	0.20
290	2.424	833.2	0.0964	0.43	0.25
300	2.454	825.3	0.0951	0.40	0.33
310	2.483	817.4	0.0938	0.38	0.41
320	2.513	809.5	0.0925	0.36	0.52
330	2.543	801.4	0.0912	0.34	0.64
340	2.573	793.2	0.0899	0.33	0.79
350	2.602	785.0	0.0886	0.31	0.96
360	2.632	776.6	0.0873	0.30	1.16
370	2.662	768.1	0.0860	0.29	1.40

Figure 1 — Thermal Conductivity of DOWTHERM RP Fluid (English Units)

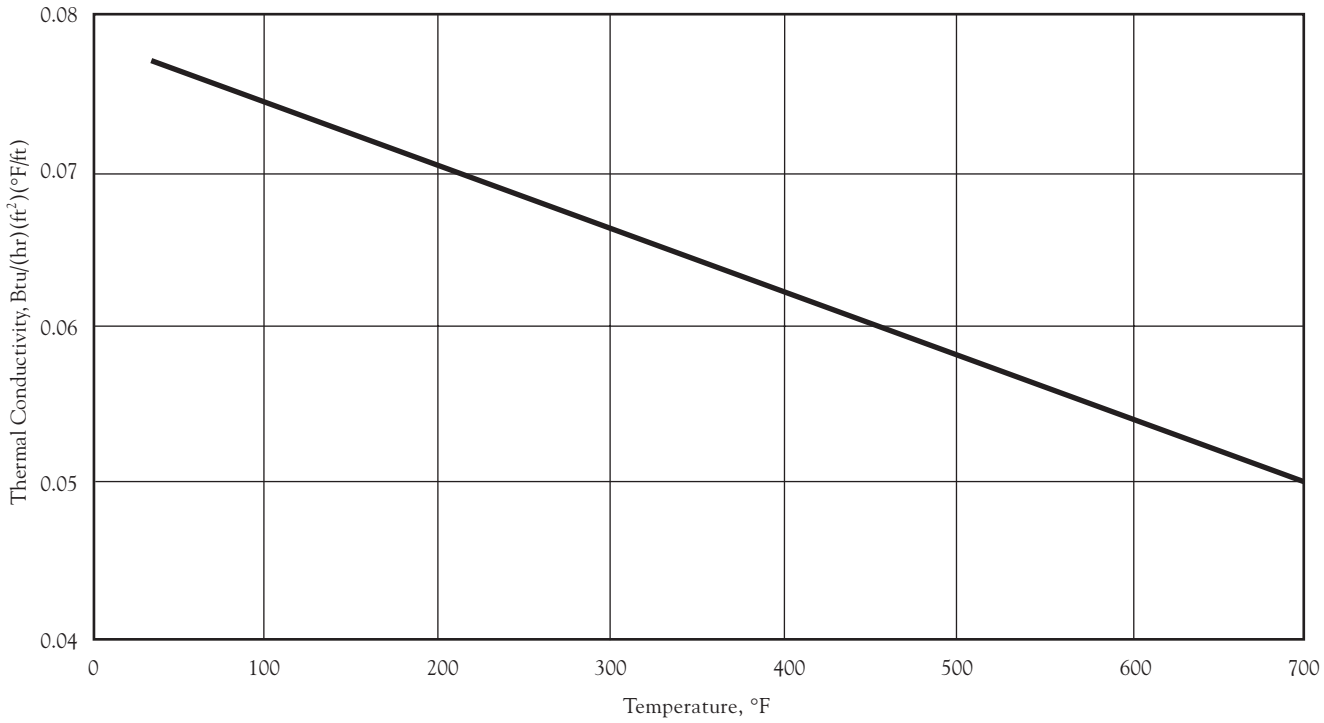


Figure 2 — Thermal Conductivity of DOWTHERM RP Fluid (SI Units)

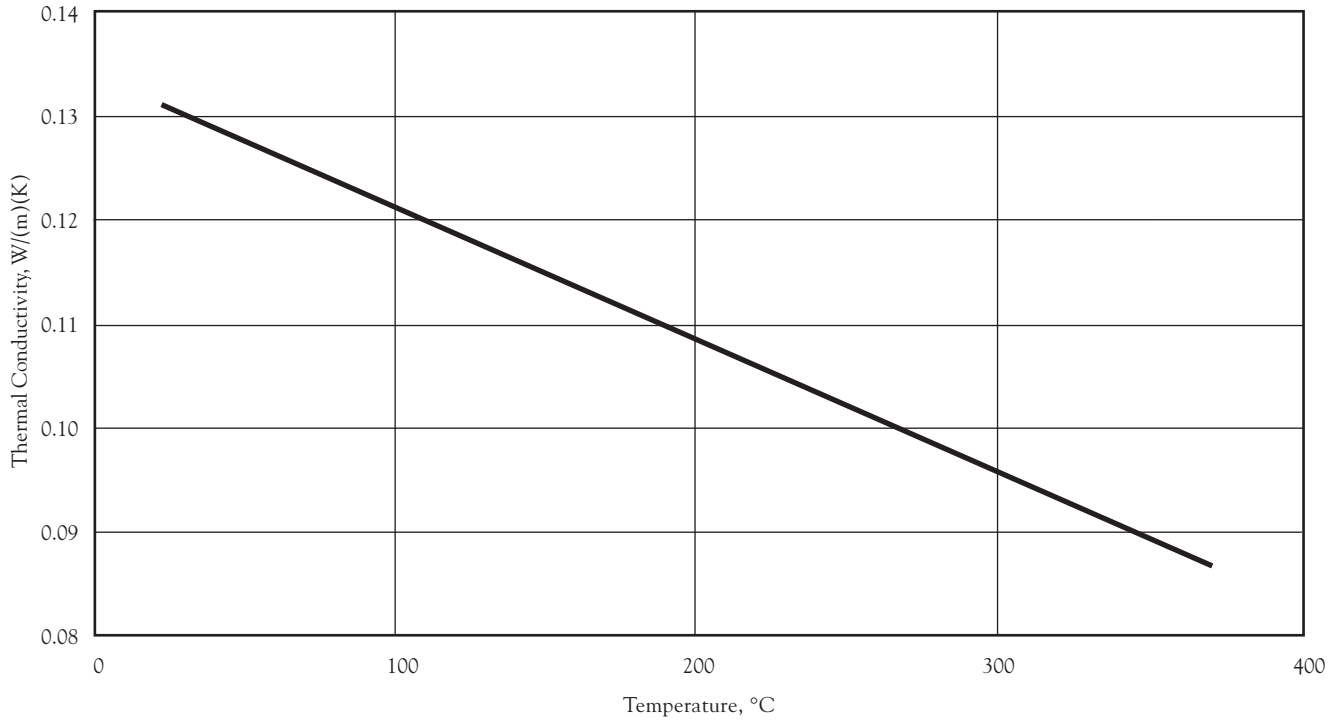


Figure 3 — Calculated Heat of Vaporization of DOWTHERM RP Fluid (English Units)

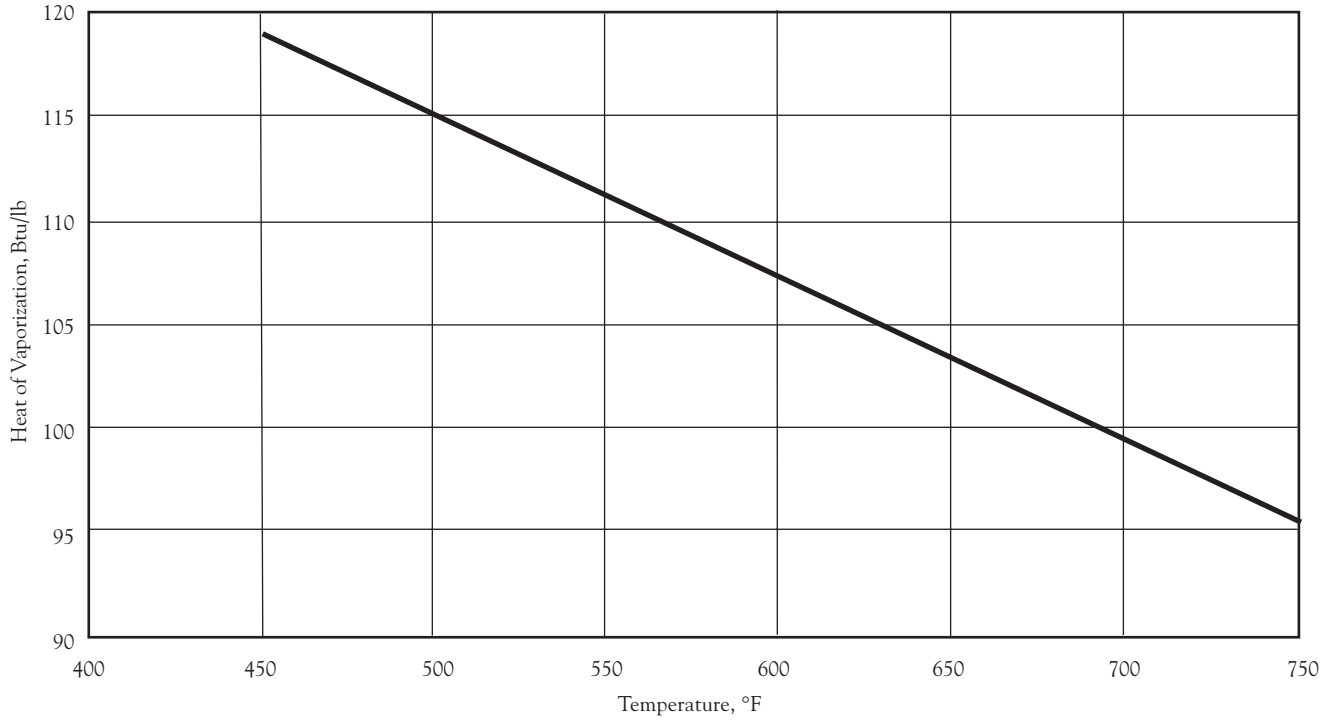


Figure 4 — Calculated Heat of Vaporization of DOWTHERM RP Fluid (SI Units)

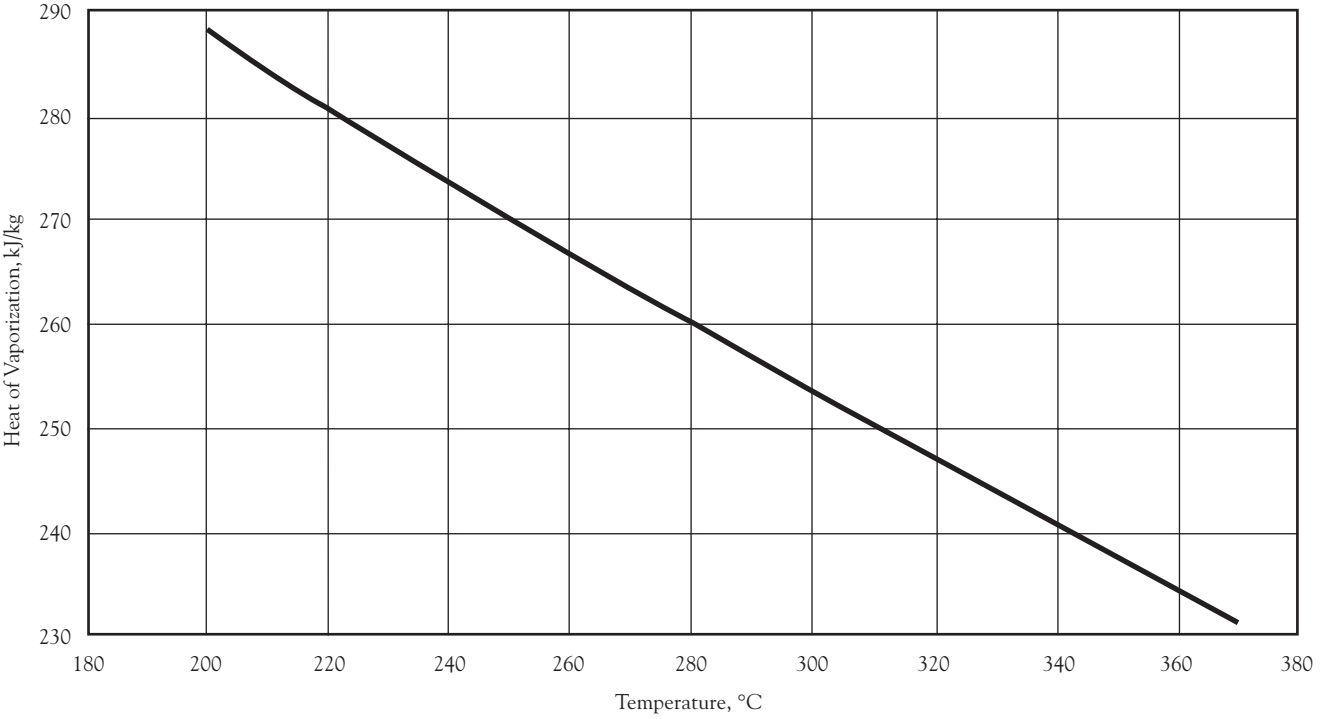


Figure 5 — Vapor Pressure of DOWTHERM RP Fluid (English Units)

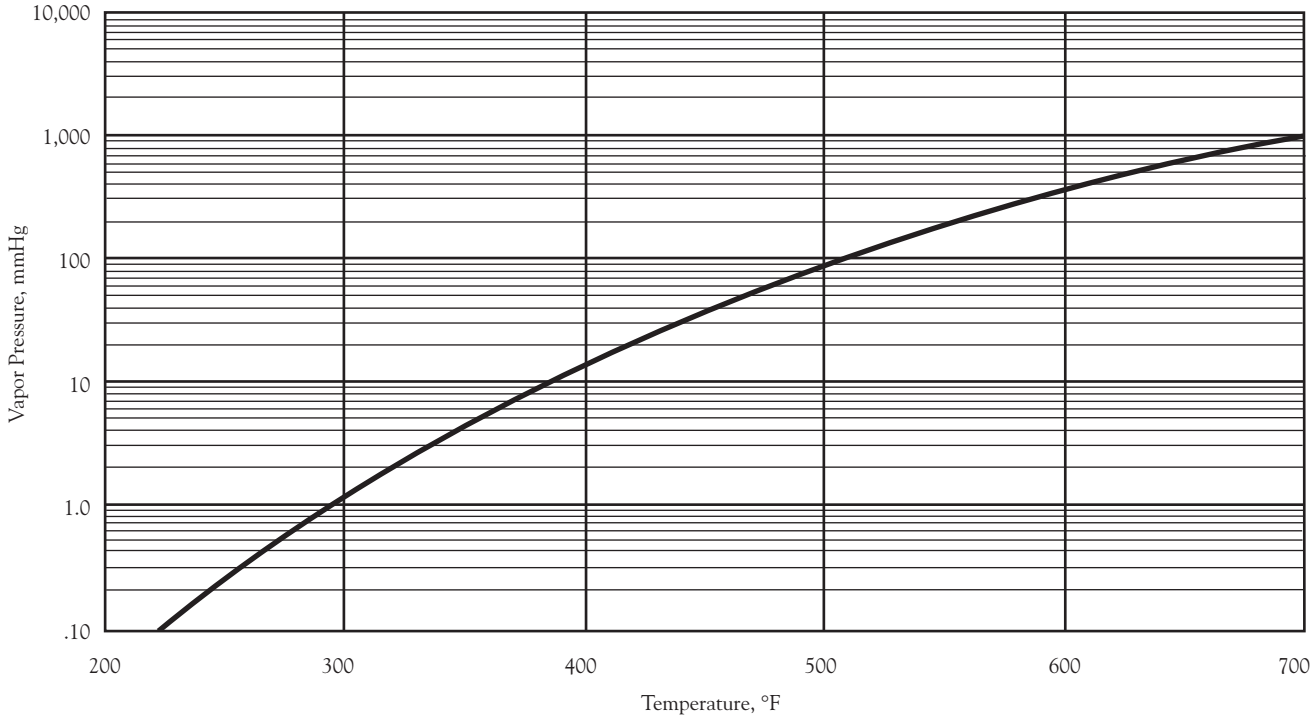


Figure 6 — Vapor Pressure of DOWTHERM RP Fluid (SI Units)

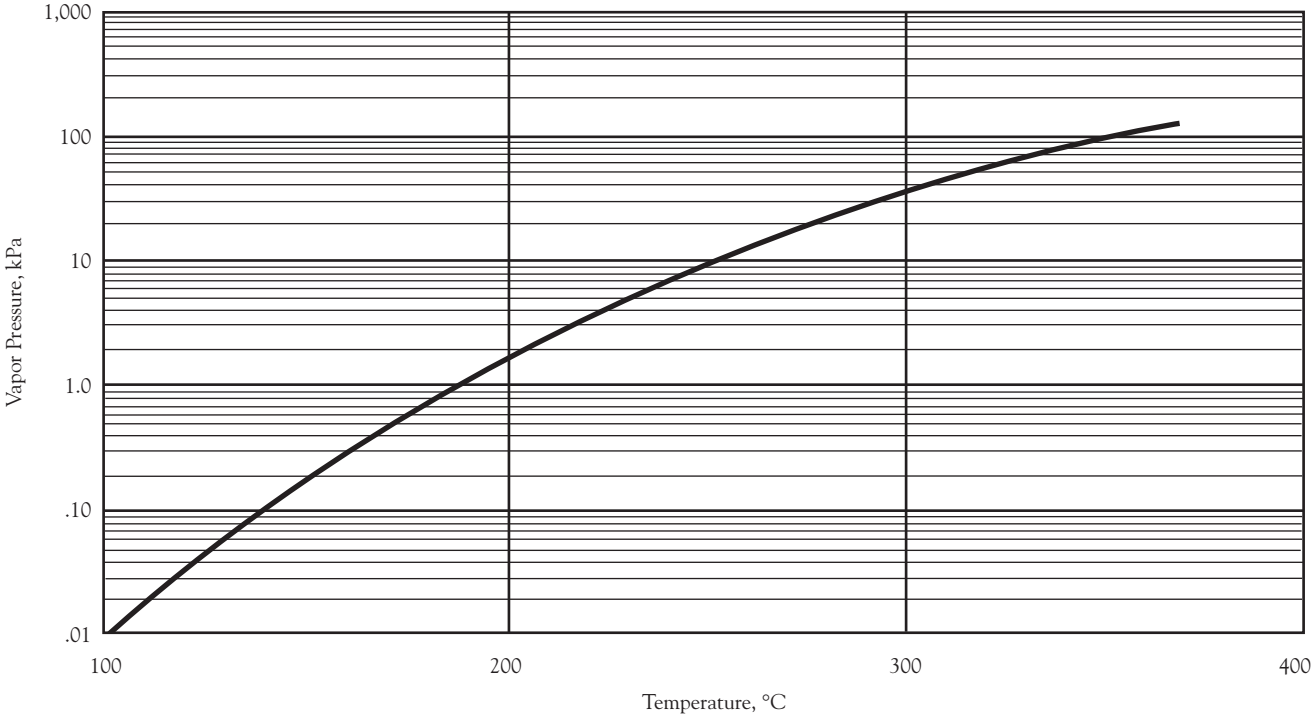


Figure 7 — Specific Heat of DOWTHERM RP Fluid (English Units)

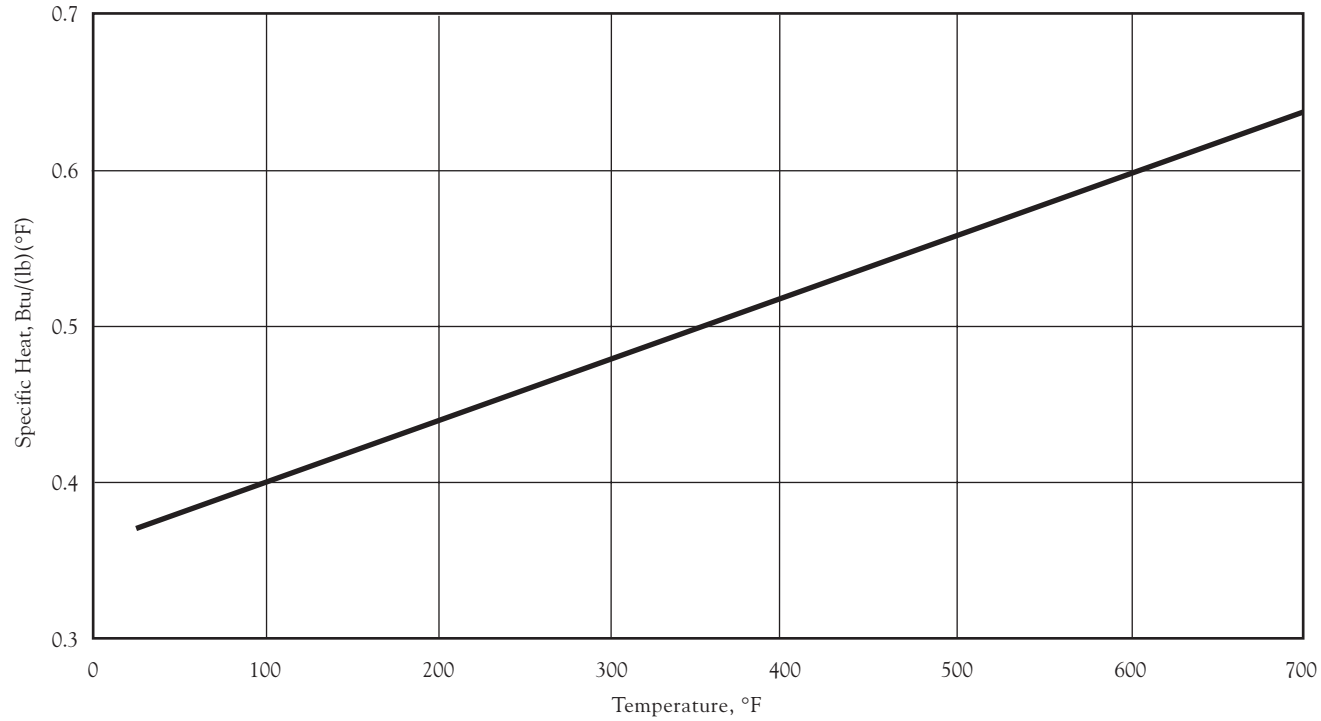


Figure 8 — Specific Heat of DOWTHERM RP Fluid (SI Units)

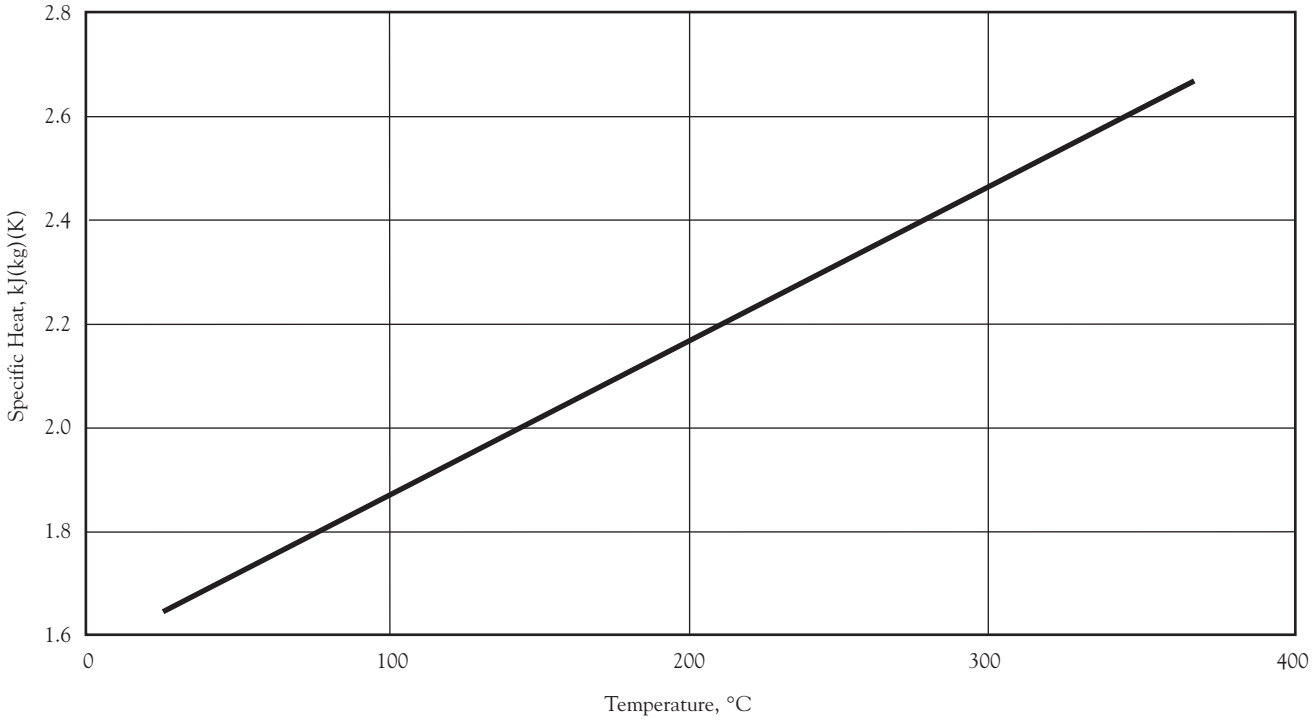


Figure 9 — Density of DOWTHERM RP Fluid (English Units)

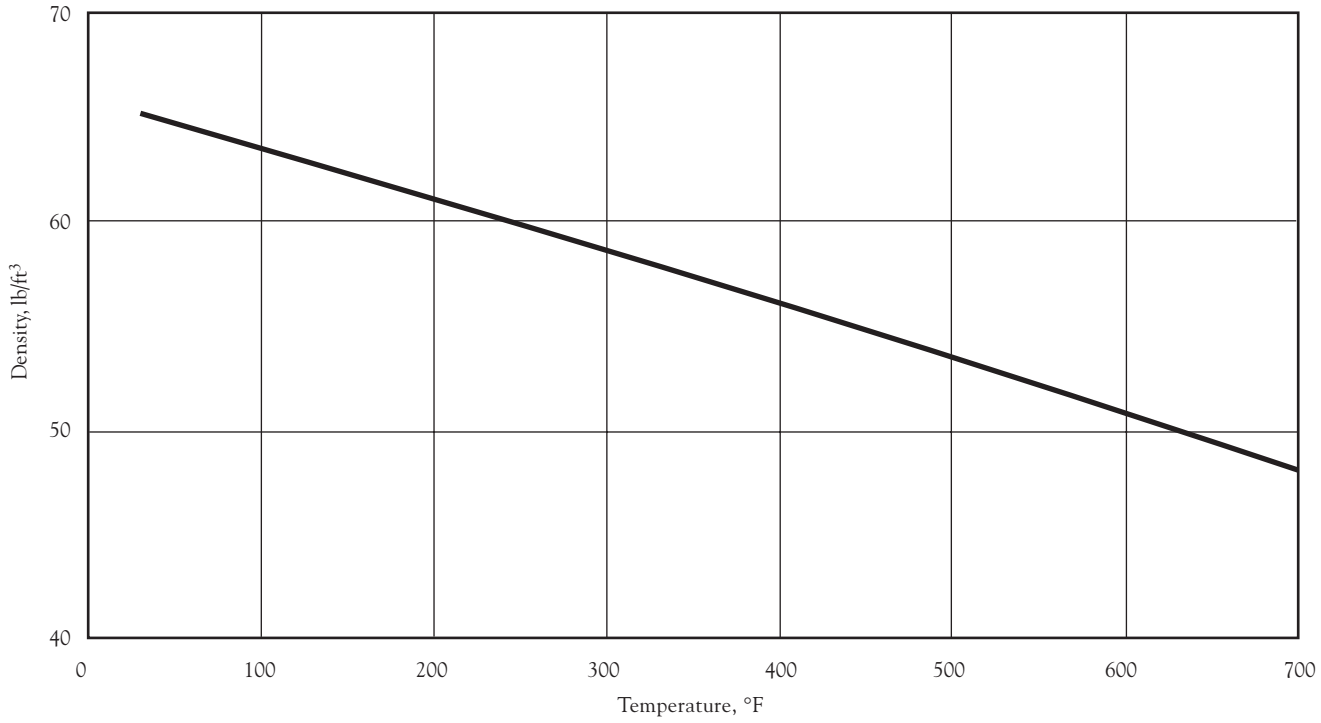


Figure 10 — Density of DOWTHERM RP Fluid (SI Units)

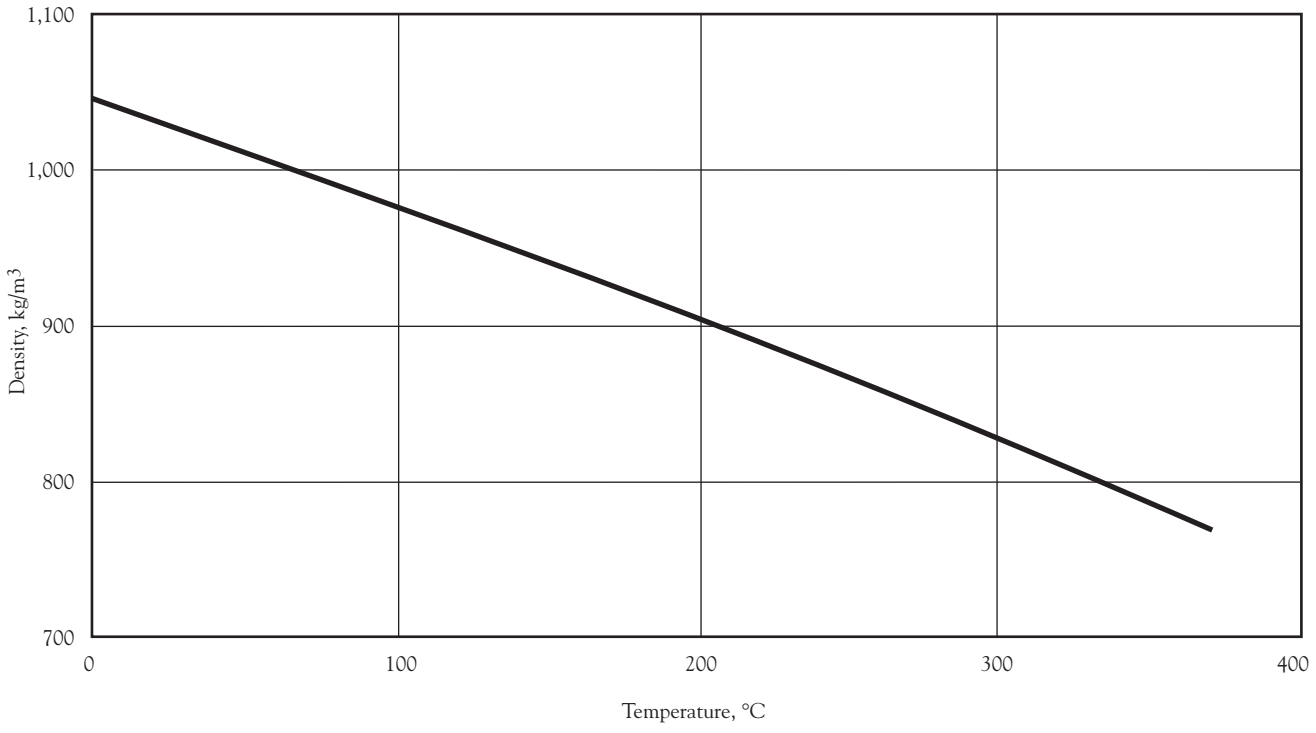


Figure 11 — Viscosity of DOWTHERM RP Fluid (English Units)

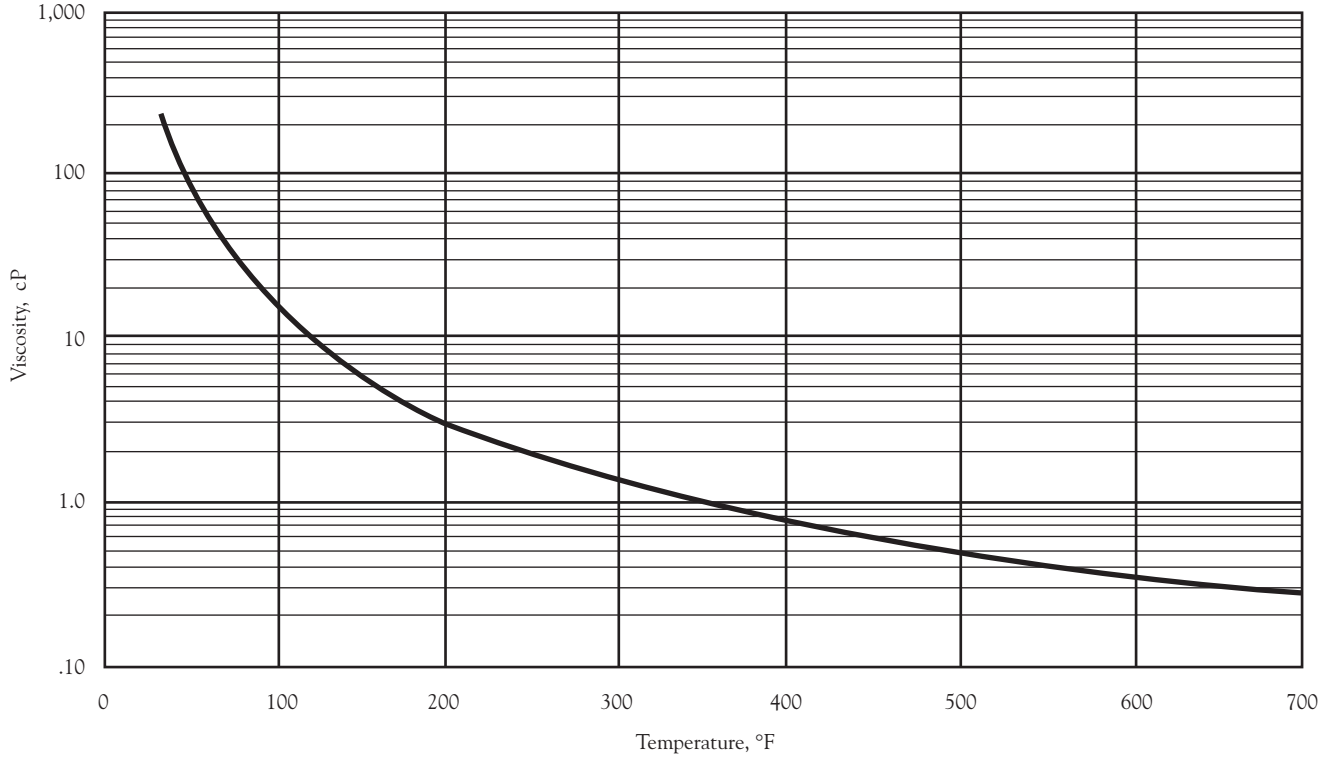


Figure 12 — Viscosity of DOWTHERM RP Fluid (SI Units)

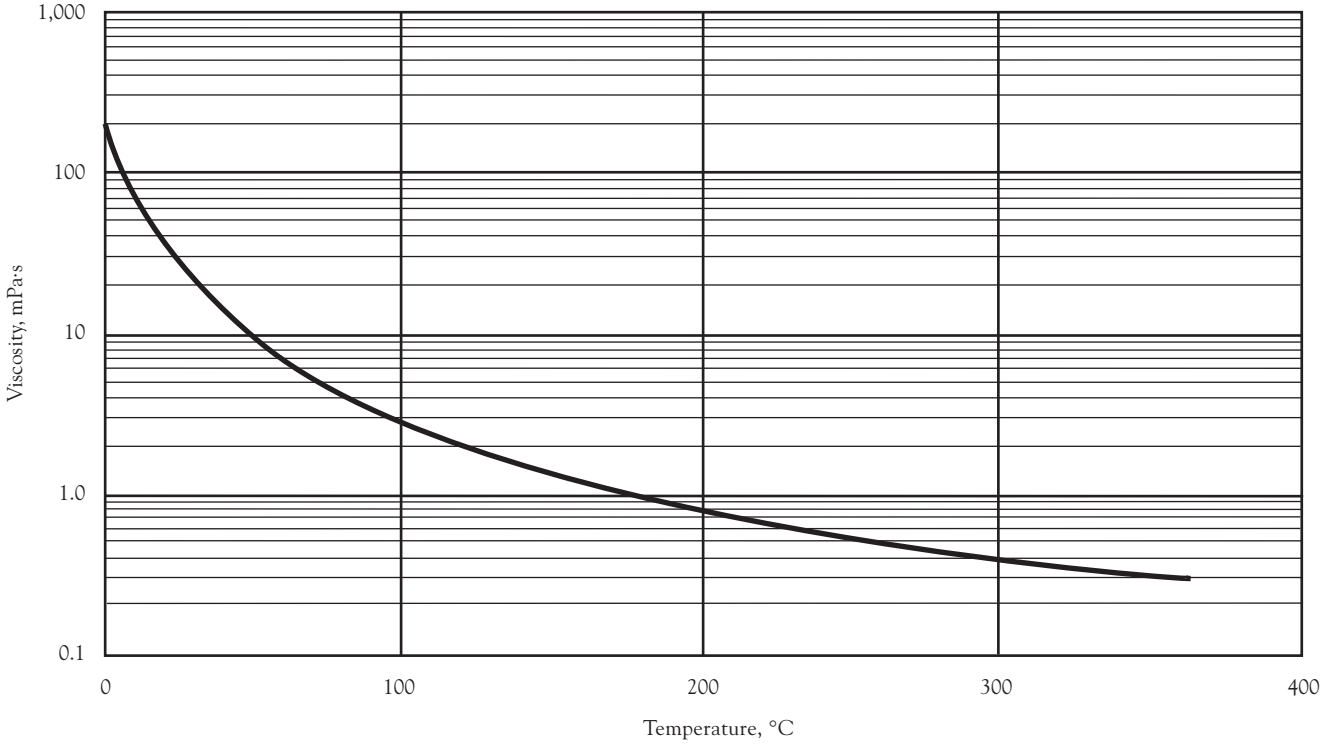
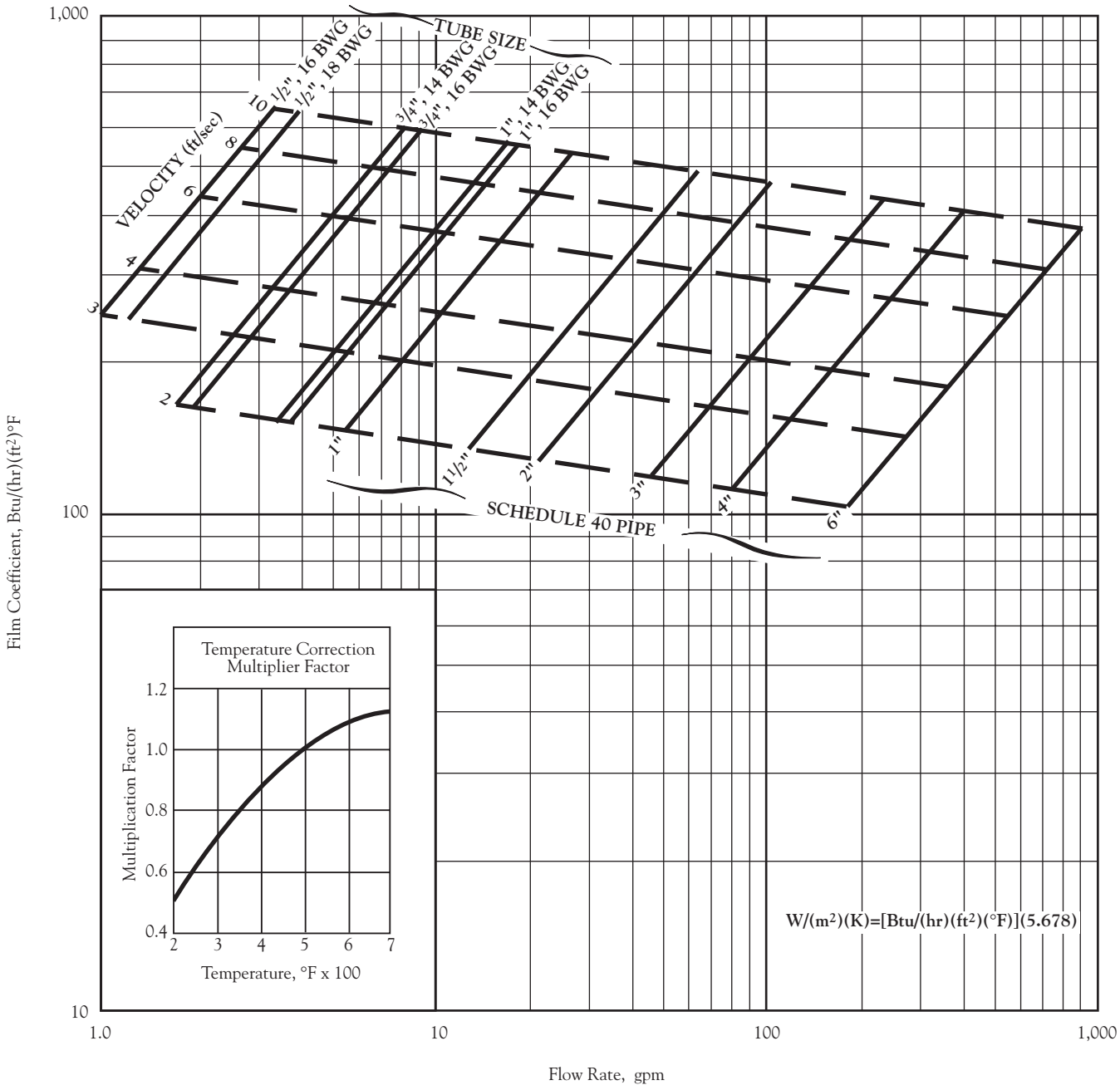


Figure 13 — Liquid Film Coefficient of DOWTHERM RP Fluid Inside Pipes and Tubes (English Units)



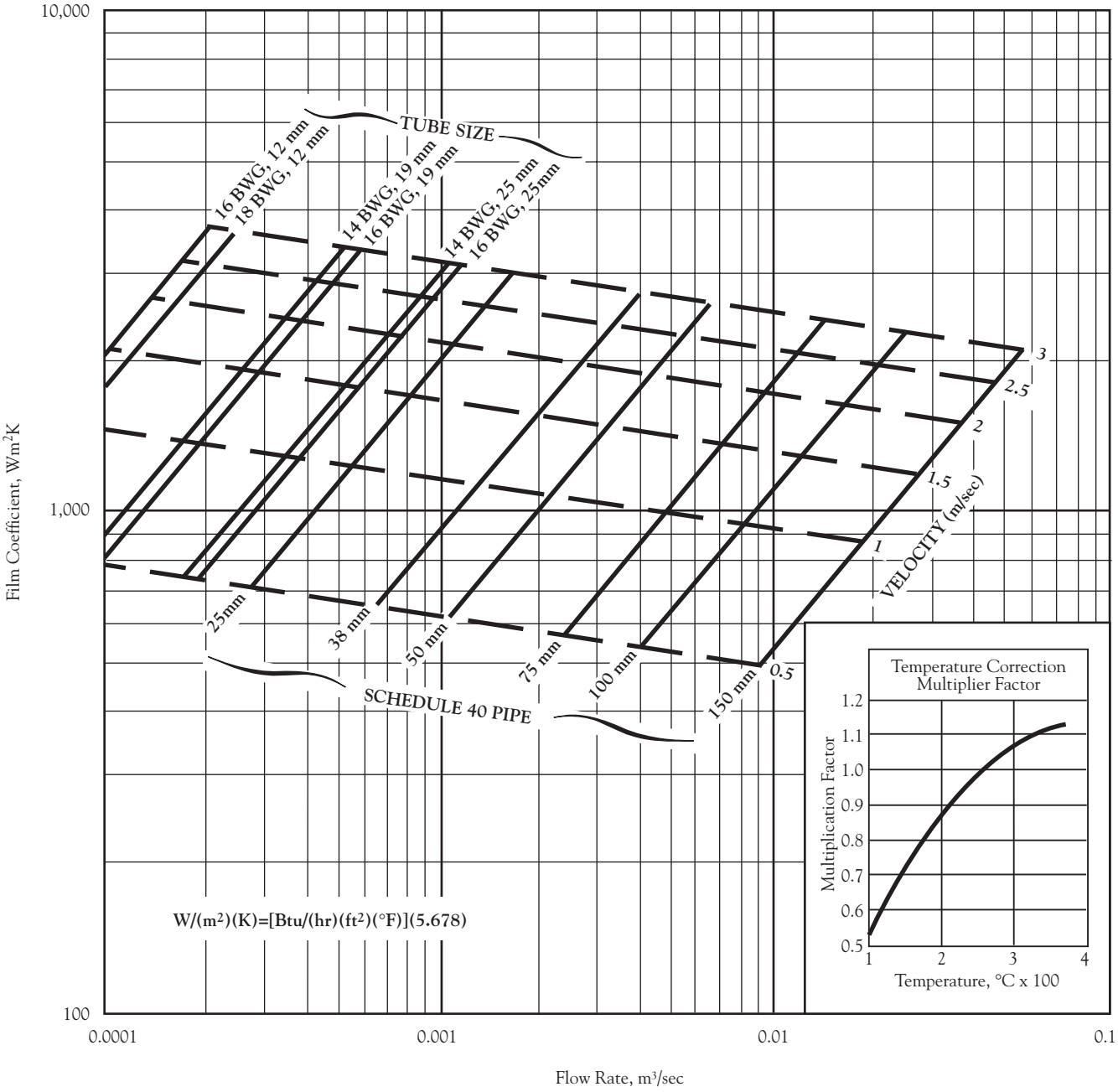
Sieder and Tate equation
Process Heat Transfer,
D.Q. Kern (1950) p. 103

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

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.

Figure 14 — Liquid Film Coefficient of DOWTHERM RP Fluid Inside Pipes and Tubes (SI Units)



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

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

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.

Figure 15 — Pressure Drop vs. Flow Rate for DOWTHERM RP Fluid in Schedule 40 Nominal Pipe and BWG Tube (English Units)

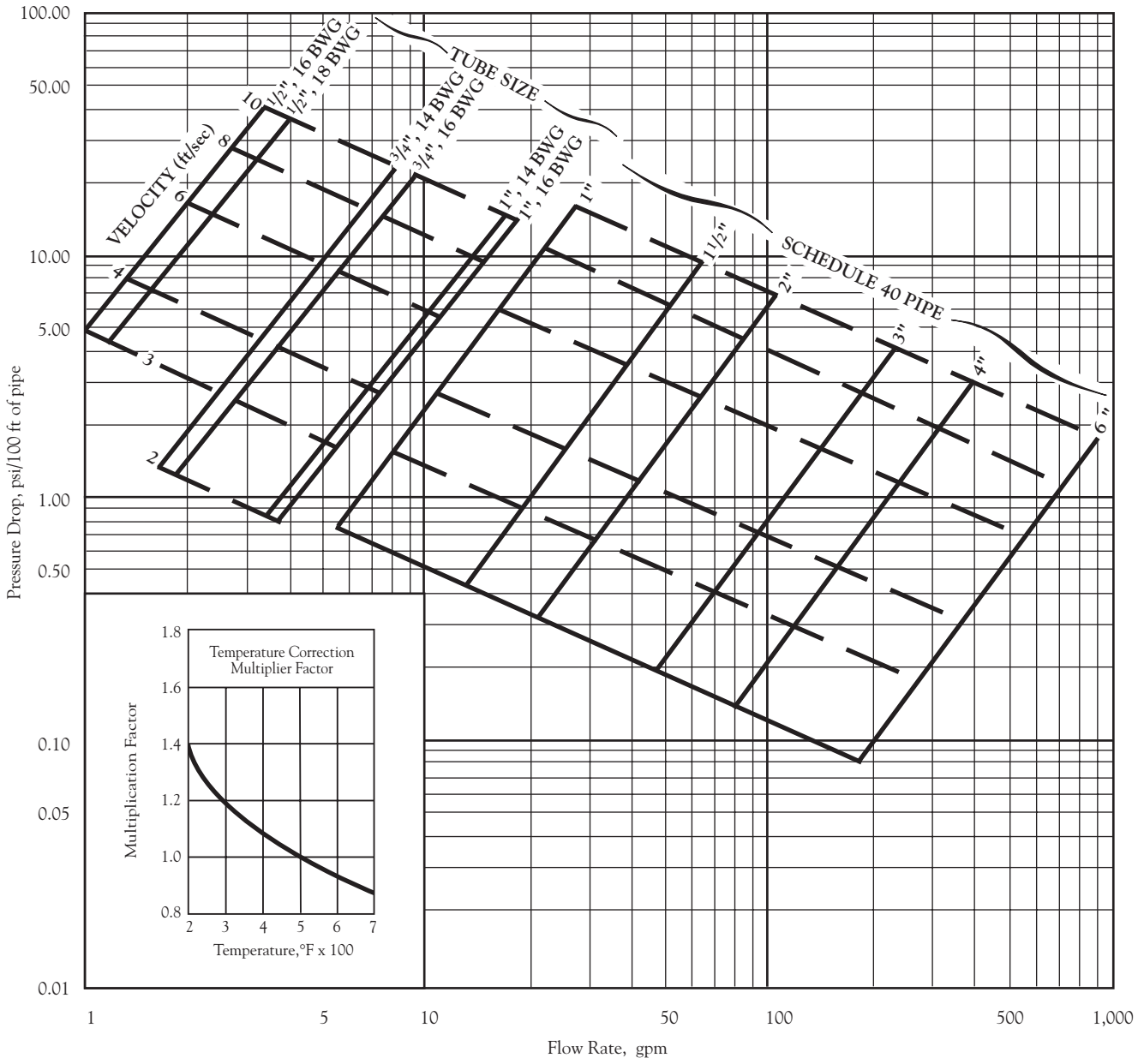


Figure 16 — Pressure Drop vs. Flow Rate for DOWTHERM RP Fluid in Schedule 40 Nominal Pipe and Tube (SI Units)

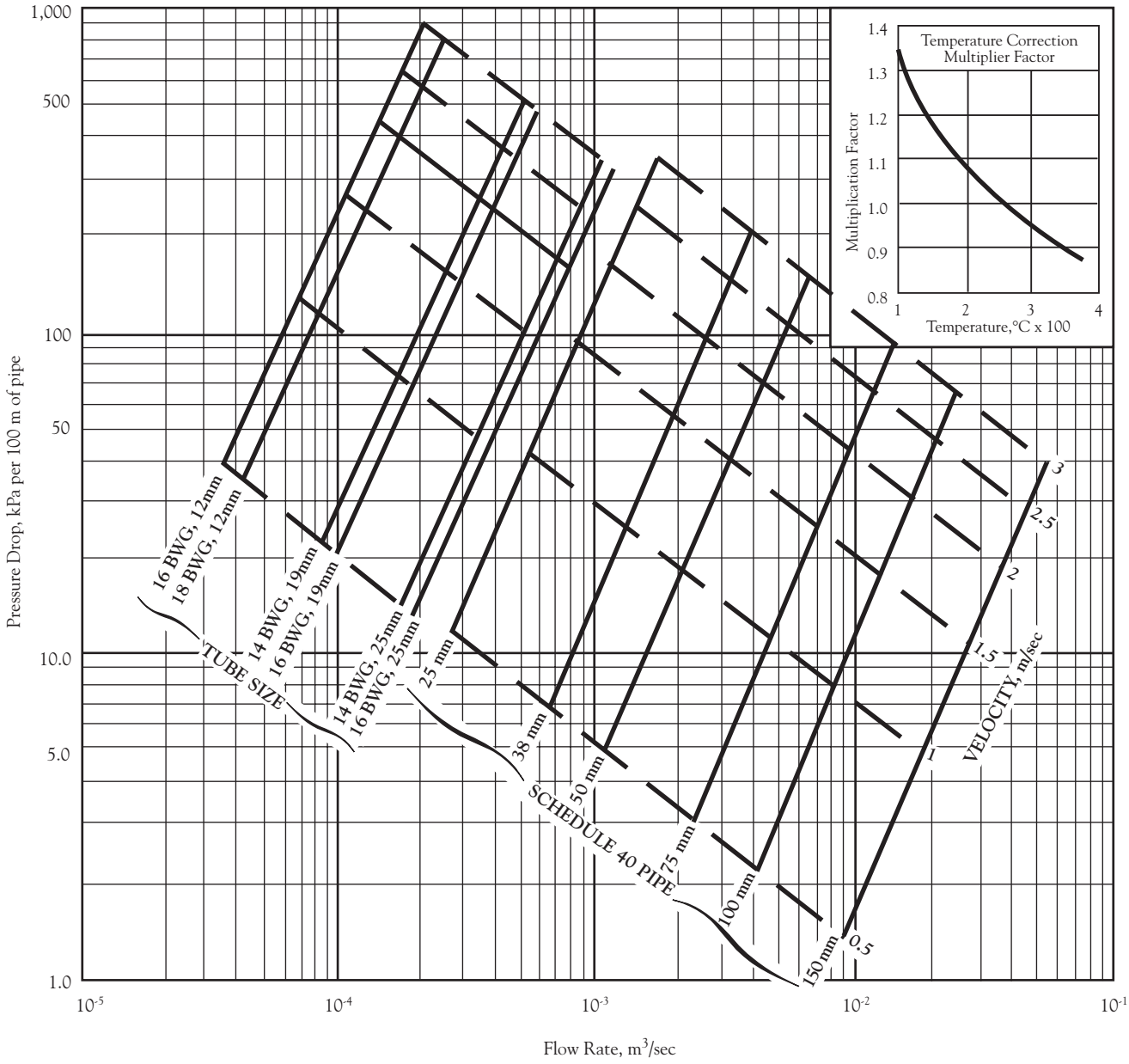


Figure 17 — Thermal Expansion of Liquid DOWTHERM RP Fluid (English Units)

Basis: 1 gallon at 77°F

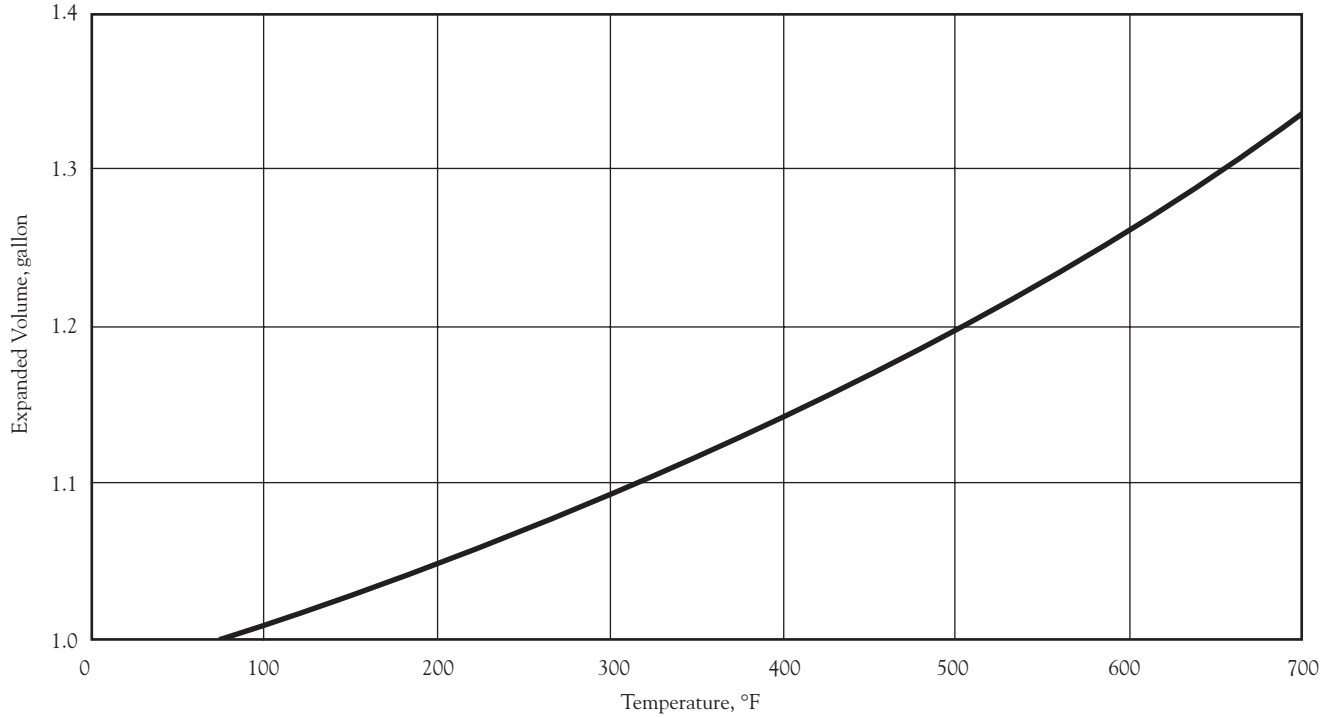
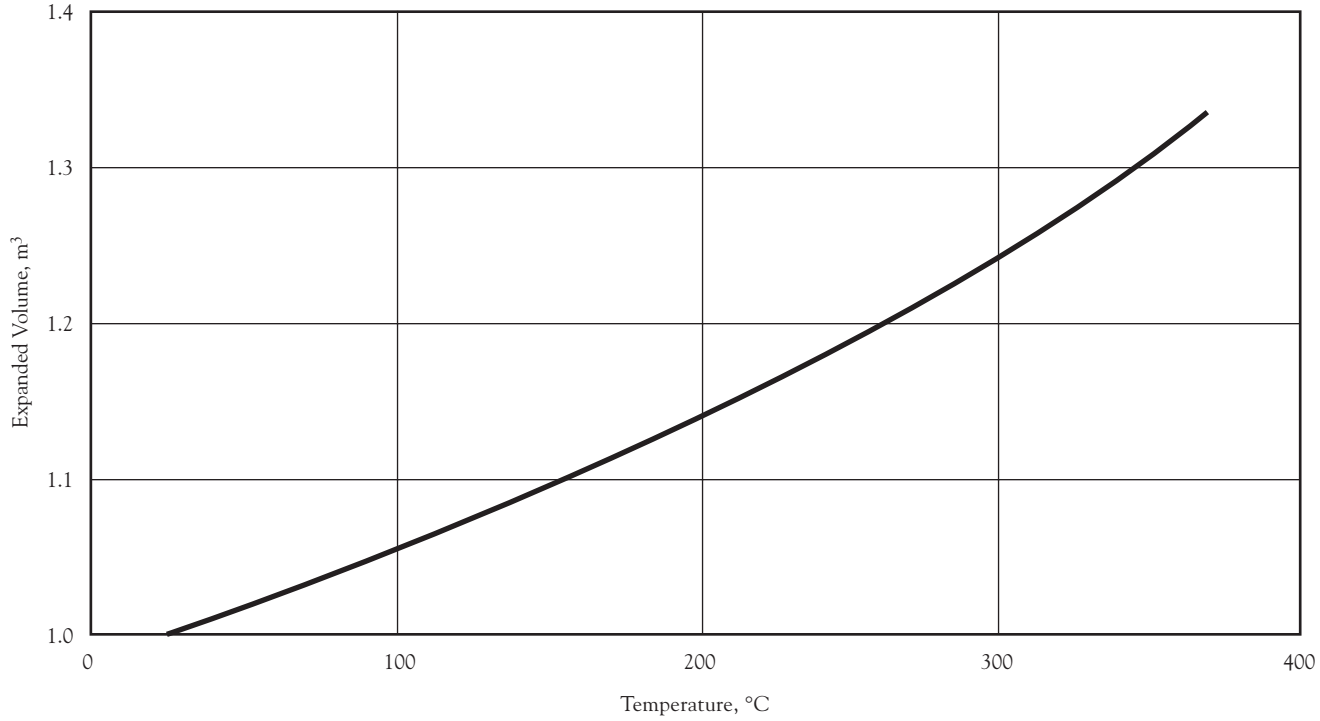


Figure 18 — Thermal Expansion of Liquid DOWTHERM RP Fluid (SI Units)

Basis: 1 m^3 at 25°C



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
$LA^{H}/_{L}$ – Level Alarm–High/Low
LI – Level Indicator
LC – Level Controller
LSL – Level Switch Low
PCV – 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 DOWTHERM Fluid
Electrical Lines
Instrument Air Lines

(A) – Vaporizers for DOWTHERM RP fluid utilize both natural and forced circulation.

(B) – A pump is required where there is insufficient elevation between vaporizer and heat user to return condensate by gravity.

(C) – Hand-throttled bypass required to prevent pump heat-up.

(D) – Process fluid freezes at 350°F (177°C).

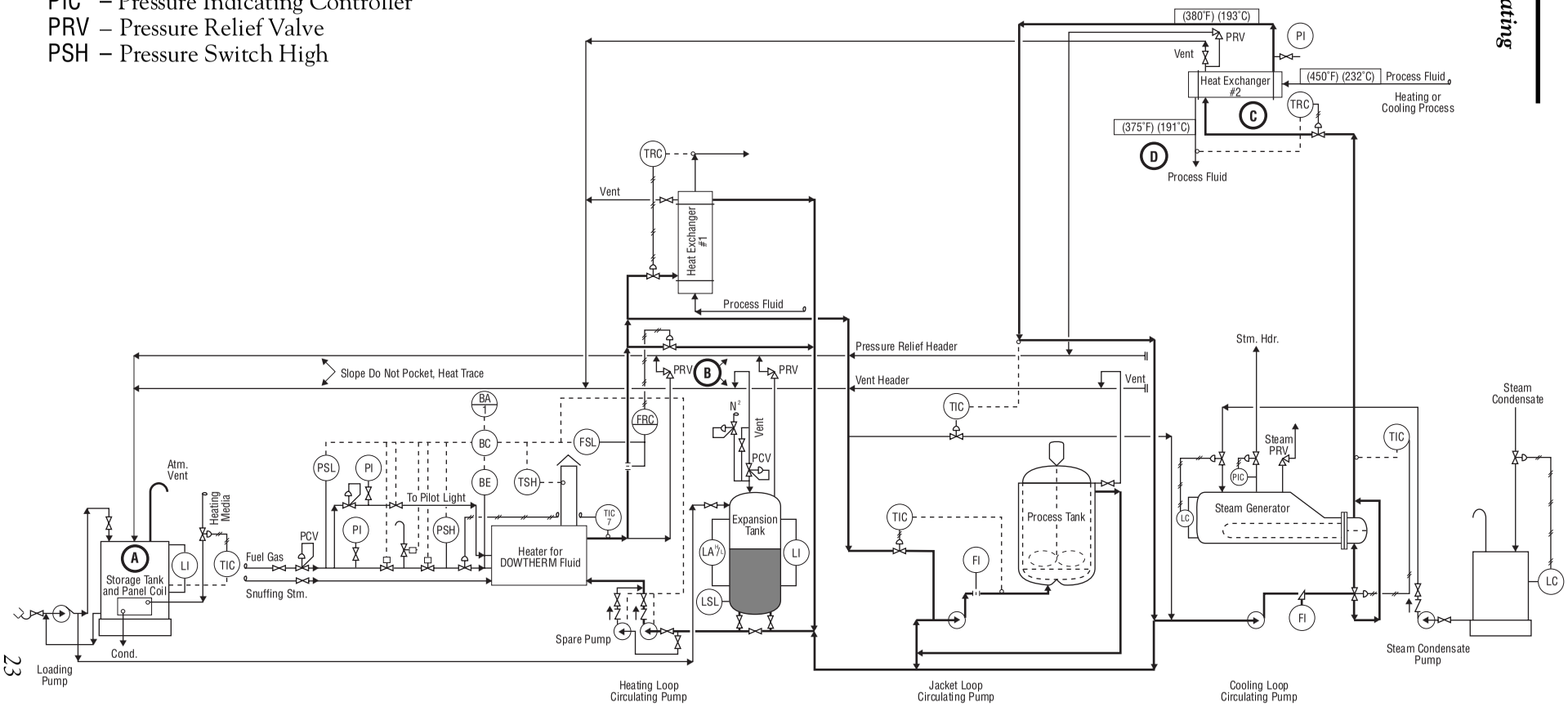


Figure 19 — Typical Liquid Phase Heating Scheme Using DOWTHERM Fluids

DOWTHERM* RP Heat Transfer Fluid

Product Technical Data

For further information, call...

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

http://www.dow.com/specialty/heat/heat.html

Published November 1996

NOTE: SYLTHERM heat transfer fluids are manufactured by Dow Corning Corporation and distributed by The Dow Chemical Company under an exclusive agreement.

Printed in U.S.A.

NA/LA/Pacific: Form No. 176-01474-1196 AMS
Europe: CH 153-035-E-1196