THERMINOL®
from Eastman

THERMINOL® VP-1

heat transfer fluid

Ultrahigh-temperature, vapor/liquid phase fluid

12° to 400°C
(54° to 750°F)

THERMINOL® VP-1
heat transfer fluid

Physical and chemical characteristics

Therminol VP-1 heat transfer fluid is usable as a liquid or as a boiling-condensing heat transfer medium up to 400°C (750°F). It is miscible and interchangeable (for top-up or design purposes) with other similarly constituted diphenyl oxide/biphenyl fluids.

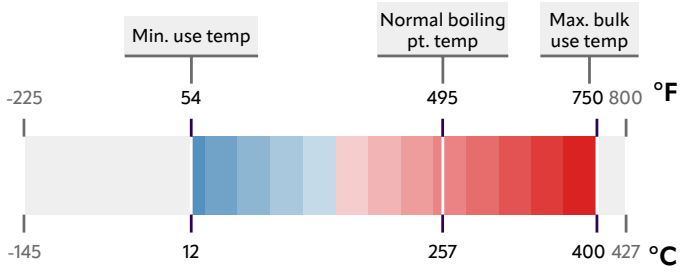
Therminol VP-1 has a low viscosity between its melting point (12°C/54°F) and the temperature at which it vaporizes (257°C/495°F). In geographic areas where the system may be exposed to temperatures below this level, all piping that may contain the fluid in its liquid state should be heat traced.

The recommended maximum bulk and film temperatures for Therminol VP-1 are based on industry-standard thermal studies. Operation at or below these temperature maximums can provide long service life under most operating conditions.

Actual fluid life is dependent on the total system design and operation and can vary by heat transfer fluid chemistry. As fluid ages under normal operating conditions, a vapor phase fluid will accumulate low-boiling contaminants such as air, water and degradation products. These noncondensables should be vented from the system as necessary to a safe location away from personnel and sources of ignition and in compliance with applicable regulations and laws. Venting noncondensables is also necessary to avoid aberrations in temperature control. Each user or group of users, if arranged in series that operate after the same control valve, should have at least one vapor accumulator (VA) installed for detecting and venting noncondensables. This is especially true if close temperature control is needed.

Therminol VP-1 is exceptionally heat stable. However, care must be taken to avoid overheating, which could lead to deposition of solids on the heating surfaces of the vaporizer. Circulation rates in the heater should be selected to limit skin temperatures to reasonable values, with due consideration to the cost of replacing damaged fluid and the cost of maintaining an adequate heat flux. This is normally accomplished by the vaporizer or heater manufacturer in the course of recommending a particular unit and stipulating its operating parameters.

Eastman Therminol VP-1 heat transfer fluid is specifically designed to meet the demanding requirements of vapor phase systems. It combines exceptional heat stability and low viscosity for efficient, dependable, uniform performance in a wide optimum use range.



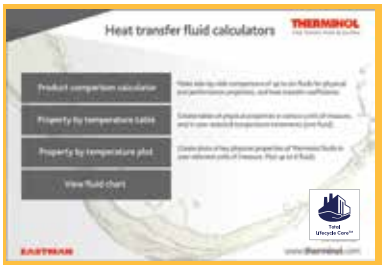
Therminol VP-1 is available globally. Contact your local Eastman Therminol sales representative for more information.

For more information about vapor phase system design, operation, and safety, refer to the *Vapor phase design guide* or the Therminol VP-1 safety data sheet (SDS).

Typical properties[a]

Appearance	Clear, water-white liquid
Composition	Biphenyl/diphenyl oxide (DPO) eutectic mixture
Maximum bulk temperature	400°C (750°F)
Maximum film temperature	430°C (800°F)
Normal boiling point	257°C (495°F)
Crystallizing point	12°C (54°F)
Flash point, COC (ASTM D92)	124°C (255°F)
Flash point, PMCC (ASTM D93)	110°C (230°F)
Autoignition temperature (ASTM E659)	601°C (1,114°F)
Autoignition temperature (DIN 51794)	621°C (1,150°F)
Coefficient of thermal expansion at 200°C	0.000979/°C (0.000544/°F)
Heat of vaporization at maximum use temperature	206 kJ/kg (88.7 Btu/lb)
Total acidity (ASTM D664)	<0.2 mg KOH/g
Average molecular weight	166
Pseudocritical temperature	499°C (930°F)
Pseudocritical pressure	33.1 bar (480 psia)
Pseudocritical density	327 kg/m^3 (20.4 lb/ft^3)
Sulfur content (ASTM D7691)	<10 ppm
Copper corrosion (ASTM D130)	<<1a
Moisture content, maximum (ASTM E203)	300 ppm
Volume contraction on freezing	6.27%
Volume expansion on melting	6.69%
Surface tension in air at 25°C	36.6 dynes/cm
Dielectric constant @ 23°C (ASTM D924)	3.35

[a]These data are based on samples tested in the laboratory and are not guaranteed for all samples. Contact us for complete sales specifications for Therminol VP-1 fluid. Does not constitute an express warranty. See disclaimer on the back page of this brochure.



To create your own customized table
with preferred properties, units of measure,
and temperature intervals, visit
Therminol.com/resources
and download the Therminol heat transfer fluid calculator.

For technical service, visit the contact page of our website, **Therminol.com.**

Liquid properties of Therminol VP-1 heat transfer fluid by temperature[a] (SI units)

Temperature		Liquid density	Liquid heat capacity	Heat of vaporization	Liquid enthalpy[b]	Liquid thermal conductivity	Liquid viscosity[c]		Vapor pressure[d]
°C	°F	kg/m³	kJ/(kg·K)	kJ/kg	kJ/kg	W/(m·K)	cP (mPa·s)	cSt (mm²/s)	kPa
12	54	1,070	1.523	419.0	0.0	0.1370	5.48	5.12	—
20	68	1,064	1.546	414.7	12.3	0.1363	4.29	4.03	0.001
30	86	1,056	1.575	409.3	27.9	0.1353	3.28	3.11	0.004
40	104	1,048	1.604	403.9	43.8	0.1344	2.60	2.48	0.009
50	122	1,040	1.633	398.6	60.0	0.1333	2.12	2.03	0.019
60	140	1,032	1.662	393.3	76.4	0.1323	1.76	1.71	0.041
70	158	1,024	1.690	388.1	93.2	0.1312	1.49	1.46	0.081
80	176	1,015	1.719	382.9	110.2	0.1300	1.28	1.26	0.153
90	194	1,007	1.747	377.8	127.6	0.1289	1.12	1.11	0.276
100	212	999	1.775	372.7	145.2	0.1277	0.985	0.986	0.477
110	230	991	1.803	367.6	163.1	0.1264	0.875	0.884	0.795
120	248	982	1.831	362.6	181.2	0.1252	0.784	0.798	1.28
130	266	974	1.858	357.5	199.7	0.1239	0.707	0.726	2.00
140	284	965	1.886	352.6	218.4	0.1225	0.642	0.665	3.05
150	302	957	1.913	347.6	237.4	0.1212	0.585	0.612	4.52
160	320	948	1.941	342.7	256.7	0.1197	0.537	0.566	6.56
170	338	940	1.968	337.7	276.2	0.1183	0.494	0.526	9.31
180	356	931	1.995	332.8	296.0	0.1168	0.457	0.491	13.0
190	374	922	2.021	327.9	316.1	0.1153	0.424	0.460	17.8
200	392	913	2.048	323.0	336.5	0.1138	0.395	0.432	23.9
210	410	904	2.075	318.0	357.1	0.1122	0.368	0.407	31.7
220	428	895	2.101	313.0	378.0	0.1106	0.345	0.385	41.5
230	446	886	2.128	308.0	399.1	0.1089	0.324	0.366	53.6
240	464	877	2.154	303.0	420.5	0.1072	0.305	0.348	68.4
250	482	867	2.181	297.9	442.2	0.1055	0.288	0.332	86.3
260	500	857	2.207	292.7	464.1	0.1038	0.272	0.317	108
270	518	848	2.234	287.5	486.3	0.1020	0.258	0.304	133
280	536	838	2.260	282.2	508.8	0.1002	0.244	0.292	163
290	554	827	2.287	276.8	531.6	0.0983	0.232	0.281	198
300	572	817	2.314	271.2	554.6	0.0964	0.221	0.271	239
310	590	806	2.341	265.6	577.8	0.0945	0.211	0.262	286
320	608	796	2.369	259.7	601.4	0.0925	0.202	0.254	340
330	626	784	2.397	253.8	625.2	0.0905	0.193	0.246	401
340	644	773	2.425	247.6	649.3	0.0885	0.185	0.239	470
350	662	761	2.454	241.3	673.7	0.0864	0.177	0.233	548
360	680	749	2.485	234.7	698.4	0.0843	0.170	0.227	635
370	698	736	2.517	227.8	723.4	0.0822	0.164	0.222	732
380	716	723	2.551	220.7	748.7	0.0800	0.158	0.218	840
390	734	709	2.588	213.2	774.4	0.0778	0.152	0.214	959
400	752	694	2.628	205.3	800.5	0.0756	0.146	0.211	1090
410	770	679	2.674	197.0	827.0	0.0733	0.141	0.208	1230
420	788	662	2.729	188.0	854.0	0.0710	0.137	0.206	1390

[a]Maximum recommended bulk temperature 400°C (750°F). These data are based on samples tested in the laboratory and are not guaranteed for all samples. Contact us for complete sales specifications for Therminol VP-1 fluid. *[b]The enthalpy basis is liquid at the crystallizing point 12°C (53.6°F).* *[c]1 cSt = 1 mm²/s and 1 mPa•s = 1 cP* *[d]100 kPa = 1 bar*

Liquid properties of Therminol VP-1 heat transfer fluid by temperature[a] (English units)

Temperature		Liquid density		Liquid heat capacity	Heat of vaporization	Liquid enthalpy[b]	Liquid thermal conductivity	Liquid viscosity[c]		Vapor pressure[d]
°F	°C	lb/gal	lb/ft³	Btu/(lb·°F)	Btu/lb	Btu/lb	Btu/(ft·h·°F)	lb/(ft·h)	cSt (mm²/s)	psia
54	12	8.93	66.8	0.364	180.2	0.1	0.0792	13.2	5.08	—
60	16	8.91	66.7	0.366	179.4	2.3	0.0790	11.8	4.58	—
80	27	8.84	66.1	0.374	176.8	9.7	0.0784	8.64	3.37	—
100	38	8.76	65.5	0.382	174.3	17.3	0.0778	6.60	2.60	0.001
120	49	8.69	65.0	0.390	171.7	25.0	0.0772	5.23	2.08	0.003
140	60	8.61	64.4	0.397	169.2	32.9	0.0765	4.26	1.71	0.006
160	71	8.53	63.8	0.405	166.7	40.9	0.0758	3.55	1.43	0.013
180	82	8.46	63.3	0.412	164.2	49.1	0.0750	3.01	1.23	0.025
200	93	8.38	62.7	0.420	161.8	57.4	0.0743	2.59	1.07	0.048
220	104	8.31	62.1	0.427	159.4	65.9	0.0735	2.26	0.938	0.087
240	116	8.23	61.5	0.435	156.9	74.5	0.0727	1.99	0.834	0.151
260	127	8.15	61.0	0.442	154.5	83.3	0.0719	1.77	0.749	0.251
280	138	8.07	60.4	0.449	152.2	92.2	0.0710	1.59	0.677	0.404
300	149	7.99	59.8	0.457	149.8	101.2	0.0701	1.43	0.617	0.629
320	160	7.91	59.2	0.464	147.4	110.4	0.0692	1.30	0.566	0.951
340	171	7.83	58.6	0.471	145.1	119.8	0.0683	1.18	0.522	1.40
360	182	7.75	58.0	0.478	142.7	129.3	0.0674	1.09	0.483	2.02
380	193	7.67	57.4	0.485	140.4	138.9	0.0664	1.00	0.450	2.85
400	204	7.59	56.8	0.492	138.0	148.7	0.0654	0.926	0.421	3.94
420	216	7.50	56.1	0.499	135.6	158.6	0.0644	0.859	0.395	5.35
440	227	7.42	55.5	0.506	133.2	168.7	0.0633	0.800	0.372	7.15
460	238	7.33	54.9	0.514	130.8	178.9	0.0622	0.747	0.352	9.41
480	249	7.25	54.2	0.521	128.4	189.2	0.0611	0.700	0.333	12.2
500	260	7.16	53.5	0.528	125.9	199.7	0.0600	0.658	0.317	15.6
520	271	7.06	52.8	0.535	123.4	210.3	0.0589	0.620	0.303	19.8
540	282	6.97	52.2	0.542	120.9	221.1	0.0577	0.585	0.289	24.8
560	293	6.88	51.4	0.549	118.3	232.0	0.0565	0.553	0.277	30.7
580	304	6.78	50.7	0.556	115.6	243.0	0.0553	0.524	0.267	37.6
600	316	6.68	50.0	0.563	112.9	254.2	0.0540	0.498	0.257	45.7
620	327	6.58	49.2	0.571	110.0	265.5	0.0527	0.474	0.248	55.1
640	338	6.47	48.4	0.578	107.1	277.0	0.0514	0.451	0.241	65.8
660	349	6.36	47.6	0.586	104.1	288.7	0.0501	0.431	0.234	78.1
680	360	6.25	46.7	0.594	101.0	300.5	0.0488	0.412	0.227	92.1
700	371	6.13	45.9	0.602	97.7	312.4	0.0474	0.394	0.222	108
720	382	6.01	44.9	0.612	94.2	324.6	0.0460	0.378	0.217	125
740	393	5.88	43.9	0.622	90.6	336.9	0.0446	0.363	0.213	145
760	404	5.74	42.9	0.633	86.8	349.4	0.0431	0.349	0.210	167
780	416	5.59	41.8	0.646	82.6	362.2	0.0417	0.335	0.207	191
800	427	5.43	40.6	0.662	78.1	375.3	0.0402	0.323	0.205	218

[a]Maximum recommended bulk temperature 400°C (750°F). These data are based on samples tested in the laboratory and are not guaranteed for all samples. Contact us for complete sales specifications for Therminol VP-1 fluid. [b]The enthalpy basis is liquid at the crystallizing point 12°C (53.6°F). [c]1 cSt = 1 mm²/s and 1 mPa•s = 1 cP [d]100 kPa = 1 bar

Vapor properties of Therminol VP-1 heat transfer fluid by temperature[a] (SI units)

Temperature		Vapor density	Vapor heat capacity	Vapor enthalpy[b]	Vapor thermal conductivity	Vapor viscosity[c]	
°C	°F	kg/m³	kJ/(kg·K)	kJ/kg	W/(m·K)	mPa·s	cSt
12	54	—	0.976	419.0	0.0081	0.0057	—
20	68	—	1.00	427.0	0.0085	0.0059	—
30	86	0.00023	1.04	437.2	0.0090	0.0061	—
40	104	0.00055	1.07	447.7	0.0095	0.0063	—
50	122	0.00120	1.10	458.6	0.0100	0.0065	—
60	140	0.00245	1.14	469.8	0.0105	0.0067	2720
70	158	0.00473	1.17	481.3	0.0110	0.0069	1450
80	176	0.00866	1.20	493.2	0.0116	0.0071	817
90	194	0.0152	1.23	505.3	0.0121	0.0073	479
100	212	0.0256	1.27	517.8	0.0126	0.0075	293
110	230	0.0415	1.30	530.7	0.0132	0.0077	185
120	248	0.0651	1.33	543.8	0.0137	0.0079	121
130	266	0.0994	1.36	557.2	0.0143	0.0081	81.5
140	284	0.148	1.39	571.0	0.0148	0.0083	56.3
150	302	0.214	1.42	585.0	0.0154	0.0085	39.8
160	320	0.303	1.45	599.4	0.0160	0.0087	28.8
170	338	0.422	1.48	614.0	0.0166	0.0089	21.2
180	356	0.575	1.51	628.9	0.0171	0.0091	15.9
190	374	0.771	1.54	644.0	0.0177	0.0094	12.1
200	392	1.02	1.57	659.4	0.0183	0.0096	9.38
210	410	1.33	1.60	675.1	0.0189	0.0098	7.36
220	428	1.71	1.63	691.0	0.0195	0.0100	5.85
230	446	2.17	1.66	707.1	0.0201	0.0102	4.70
240	464	2.72	1.68	723.5	0.0207	0.0104	3.82
250	482	3.38	1.71	740.1	0.0213	0.0106	3.13
260	500	4.17	1.74	756.9	0.0219	0.0108	2.59
270	518	5.09	1.77	773.8	0.0226	0.0110	2.16
280	536	6.17	1.79	791.0	0.0232	0.0112	1.82
290	554	7.42	1.82	808.3	0.0238	0.0114	1.54
300	572	8.86	1.84	825.8	0.0245	0.0116	1.31
310	590	10.5	1.87	843.4	0.0251	0.0118	1.13
320	608	12.4	1.90	861.1	0.0258	0.0120	0.970
330	626	14.6	1.92	879.0	0.0264	0.0122	0.841
340	644	17.0	1.95	896.9	0.0271	0.0124	0.731
350	662	19.8	1.97	915.0	0.0277	0.0126	0.639
360	680	22.9	2.00	933.1	0.0284	0.0129	0.560
370	698	26.5	2.03	951.3	0.0291	0.0131	0.493
380	716	30.5	2.05	969.5	0.0298	0.0133	0.435
390	734	35.0	2.08	987.7	0.0304	0.0135	0.384
400	752	40.1	2.11	1,005.8	0.0311	0.0137	0.341
410	770	45.8	2.14	1,024.0	0.0318	0.0139	0.302
420	788	52.4	2.17	1,042.0	0.0325	0.0140	0.268

[a]Maximum recommended bulk temperature 400°C (750°F). Vapor properties given for saturated vapor. These data are based on samples tested in the laboratory and are not guaranteed for all samples. Contact us for complete sales specifications for Therminol VP-1 fluid. *[b]The enthalpy basis is liquid at the crystallizing point 12°C (53.6°F).* *[c]1 cSt = 1 mm²/s and 1 mPa•s = 1 cP*

Vapor properties of Therminol VP-1 heat transfer fluid by temperature[a] (English units)

Temperature		Vapor density	Vapor heat capacity	Vapor enthalpy[b]	Vapor thermal conductivity	Vapor viscosity[c]	
°F	°C	lb/ft³	Btu/(lb·°F)	Btu/lb	Btu/(ft·h·°F)	lb/(ft·h)	mPa·s
54	12	—	0.233	180.3	0.0047	0.0138	0.0057
60	16	—	0.236	181.8	0.0048	0.0140	0.0058
80	27	—	0.246	186.6	0.0051	0.0145	0.0060
100	38	—	0.253	191.6	0.0054	0.0150	0.0062
120	49	0.00007	0.263	196.8	0.0057	0.0156	0.0064
140	60	0.00015	0.272	202.1	0.0061	0.0161	0.0067
160	71	0.00032	0.280	207.6	0.0064	0.0167	0.0069
180	82	0.00061	0.289	213.3	0.0068	0.0172	0.0071
200	93	0.00113	0.299	219.2	0.0071	0.0178	0.0073
220	104	0.00199	0.306	225.2	0.0074	0.0183	0.0076
240	116	0.00334	0.315	231.4	0.0078	0.0189	0.0078
260	127	0.00541	0.323	237.8	0.0082	0.0194	0.0080
280	138	0.00846	0.332	244.3	0.0085	0.0200	0.0083
300	149	0.0128	0.339	251.0	0.0089	0.0205	0.0085
320	160	0.0189	0.347	257.8	0.0092	0.0211	0.0087
340	171	0.0273	0.356	264.8	0.0096	0.0217	0.0090
360	182	0.0384	0.363	272.0	0.0100	0.0222	0.0092
380	193	0.0529	0.370	279.3	0.0104	0.0228	0.0094
400	204	0.0717	0.378	286.7	0.0107	0.0233	0.0097
420	216	0.0954	0.387	294.2	0.0111	0.0239	0.0099
440	227	0.125	0.394	301.9	0.0115	0.0245	0.0101
460	238	0.162	0.402	309.7	0.0119	0.0250	0.0103
480	249	0.206	0.409	317.6	0.0123	0.0256	0.0106
500	260	0.260	0.416	325.6	0.0127	0.0261	0.0108
520	271	0.325	0.423	333.7	0.0131	0.0267	0.0110
540	282	0.401	0.430	341.9	0.0135	0.0272	0.0113
560	293	0.492	0.437	350.2	0.0139	0.0278	0.0115
580	304	0.597	0.445	358.6	0.0143	0.0284	0.0117
600	316	0.720	0.452	367.1	0.0147	0.0289	0.0119
620	327	0.862	0.457	375.6	0.0151	0.0295	0.0122
640	338	1.03	0.464	384.2	0.0156	0.0300	0.0124
660	349	1.22	0.471	392.8	0.0160	0.0305	0.0126
680	360	1.43	0.478	401.4	0.0164	0.0311	0.0129
700	371	1.68	0.485	410.1	0.0169	0.0316	0.0131
720	382	1.96	0.492	418.8	0.0173	0.0322	0.0133
740	393	2.29	0.500	427.5	0.0177	0.0327	0.0135
760	404	2.66	0.507	436.2	0.0182	0.0332	0.0137
780	416	3.08	0.516	444.8	0.0186	0.0338	0.0140
800	427	3.57	0.526	453.4	0.0191	0.0343	0.0142

[a]Maximum recommended bulk temperature 400°C (750°F). Vapor properties given for saturated vapor. These data are based on samples tested in the laboratory and are not guaranteed for all samples. Contact us for complete sales specifications for Therminol VP-1 fluid. *[b]The enthalpy basis is liquid at the crystallizing point 12°C (53.6°F).*
[c]1 cSt = 1 mm²/s and 1 mPa•s = 1 cP

Total Lifecycle Care™

Total Lifecycle Care is a comprehensive service that uses analytics, sampling and training to prevent heat transfer system failures, ensuring safe, efficient and uninterrupted operations.

- Offers industry-leading technical support
- Provides data through Fluid Genius™ for informed decision-making
- Helps minimize unexpected downtime and maintenance costs
- Assists in maximizing fluid life
- Enables safe working environments through tailored safety training
- Helps keep systems running smoothly

Comprehensive support services

- **In-service heat transfer fluid sample analysis**
  Eastman provides comprehensive testing services to extend heat transfer fluid life and ensure system performance by detecting contamination, moisture and degradation through key tests like acid number, viscosity, insoluble solids and moisture content.

- **Fluid Genius™**
  Fluid Genius is a web-based portal and sampling service that simplifies fluid sample management by providing expert analysis, fluid condition monitoring, lifespan prediction, early maintenance alerts, technical support and access to a comprehensive knowledge base. Learn more at fluidgenius.net.

Operational efficiency

- **System design support**
  Eastman collaborates with leading manufacturers to provide expert support in heat transfer system design, performance, fluid selection, and compliance, offering seminars, technical visits, and on-site audits to improve system reliability and efficiency.

- **Start-up assistance**
  Eastman offers start-up assistance by reviewing procedures and recommending improvements to streamline systems and reduce common issues, with support available from local technical specialists or on-site visits.

- **Flush and refill guidance**
  Therminol FF is specially formulated to clean liquid-phase heat transfer systems. After flushing with Therminol FF, refill the system with the appropriate Eastman heat transfer fluid to ensure optimal performance. Contact your local Eastman technical specialist to learn more and get expert guidance.

- **Compliance support**
  Our team provides guidance to help you achieve and maintain regulatory compliance related to safety, health and environmental standards, ensuring your operations meet the necessary requirements.

- **Environmental impact**
  Eastman supports your sustainability goals by advising on waste heat recovery and water-lean utility deployments using Therminol products to reduce CO_2 emissions and water consumption.

Operational and safety awareness training

- **Operational training**
  Eastman's customized training programs improve expertise in fluid selection and heat transfer system operation for technicians, supervisors, maintenance staff and engineers through core and specialized sessions to enhance design, improve safety and reduce costs.

- **Safety awareness training**
  At Eastman, we approach safety with a zero-incident mindset. We offer our customers safety awareness training that focuses on the design start-up, operation and maintenance of heat transfer fluid systems to help ensure safe, efficient operations.

- **Expert global assistance**
  Get direct access to experienced technical service specialists who can help answer questions regarding heat transfer fluid selection, system start-ups, system design and operational issues.

For more information, visit **therminol.com.**

EASTMAN

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