Temper®

The Intelligent Solution

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Thermal Properties

Temper Version/ Freezing point °C	Temperature, °C	Density kg/m³	Specific heat, kJ/kg·K	Thermal conductivity W/m·K	Dynamic viscosity mPa·s	Kinematic viscosity, mm²/s
Temper -10	90	1062	3,628	0,648	0,63	0,59
Temper -10	80	1066	3,626	0,634	0,65	0,61
Temper -10	70	1070	3,622	0,619	0,70	0,66
Temper -10	60	1074	3,617	0,604	0,77	0,72
Temper -10	50	1077	3,610	0,588	0,87	0,81
Temper -10	40	1082	3,601	0,574	1,00	0,93
Temper -10	30	1084	3,590	0,559	1,20	1,10
Temper -10	20	1086	3,577	0,544	1,48	1,37
Temper -10	10	1088	3,561	0,529	1,95	1,79
Temper -10	0	1090	3,542	0,514	2,81	2,58
Temper -10	-10	1092	3,520	0,499	4,78	4,38
Temper -15	90	1098	3,511	0,623	0,74	0,67
Temper -15	80	1101	3,509	0,609	0,77	0,70
Temper -15	70	1103	3,504	0,595	0,82	0,75
Temper -15	60	1105	3,498	0,581	0,90	0,81
Temper -15	50	1107	3,489	0,567	1,00	0,90
Temper -15	40	1110	3,477	0,553	1,14	1,02
Temper -15	30	1112	3,464	0,539	1,33	1,20
Temper -15	20	1114	3,447	0,525	1,62	1,45
Temper -15	10	1117	3,427	0,511	2,07	1,86
Temper -15	0	1119	3,403	0,497	2,88	2,57
Temper -15	-10	1121	3,375	0,483	4,55	4,06
Temper -15	-14	1122	3,362	0,478	5,78	5,15
Temper -20	90	1114	3,392	0,602	0,79	0,71
Temper -20	80	1119	3,387	0,588	0,84	0,75
Temper -20	70	1125	3,382	0,574	0,90	0,80
Temper -20	60	1129	3,375	0,561	0,99	0,87
Temper -20	50	1133	3,365	0,548	1,10	0,97
Temper -20	40	1136	3,357	0,534	1,26	1,11
Temper -20	30	1139	3,337	0,521	1,48	1,30
Temper -20	20	1142	3,315	0,508	1,79	1,57
Temper -20	10	1145	3,290	0,494	2,30	2,01
Temper -20	0	1147	3,263	0,481	3,17	2,77
Temper -20	-10	1149	3,233	0,467	4,97	4,32
Temper -20	-20	1151	3,200	0,454	9,58	8,32
Temper -30	90	1147	3,194	0,575	0,91	0,78
Temper -30	80	1152	3,186	0,562	0,98	0,84
Temper -30	70	1157	3,178	0,549	1,07	0,92
Temper -30	60	1161	3,170	0,536	1,18	1,01
Temper -30	50	1166	3,162	0,523	1,33	1,14
Temper -30	40	1170	3,151	0,511	1,52	1,30
Temper -30	30	1174	3,140	0,498	1,79	1,52
Temper -30	20	1177	3,124	0,486	2,17	1,84
Temper -30	10	1181	3,102	0,473	2,76	2,34
Temper -30	0	1184	3,075	0,460	3,77	3,18
Temper -30	-10	1187	3,042	0,448	5,69	4,80
Temper -30	-20	1190	3,004	0,435	10,1	8,51
Temper -30	-30	1192	2,961	0,423	23,4	19,6

Temper Version/ Freezing point °C	Temperature, °C	Density kg/m³	Specific heat, kJ/kg·K	Thermal conductivity W/m·K	Dynamic viscosity mPa·s	Kinematic viscosity, mm²/s
Temper -40	90	1172	3,074	0,542	0,95	0,80
Temper -40	80	1178	3,067	0,530	1,07	0,90
Temper -40	70	1183	3,060	0,519	1,21	1,01
Temper -40	60	1188	3,050	0,508	1,38	1,15
Temper -40	50	1194	3,040	0,497	1,59	1,33
Temper -40	40	1198	3,027	0,487	1,86	1,55
Temper -40	30	1203	3,021	0,476	2,23	1,86
Temper -40	20	1207	3,012	0,465	2,76	2,29
Temper -40	10	1211	2,997	0,454	3,56	2,94
Temper -40	0	1215	2,977	0,443	4,88	4,01
Temper -40	-10	1218	2,951	0,432	7,26	5,96
Temper -40	-20	1222	2,918	0,421	12,2	9,99
Temper -40	-30	1225	2,878	0,410	24,5	20,0
Temper -40	-40	1227	2,830	0,399	63,8	52,0
Temper -55	90	1212	2,957	0,504	1,22	1,00
Temper -55	80	1215	2,952	0,495	1,40	1,15
Temper -55	70	1218	2,946	0,486	1,61	1,32
Temper -55	60	1222	2,932	0,477	1,88	1,54
Temper -55	50	1226	2,911	0,468	2,21	1,80
Temper -55	40	1230	2,883	0,459	2,65	2,15
Temper -55	30	1235	2,852	0,450	3,24	2,62
Temper -55	20	1240	2,817	0,441	4,06	3,27
Temper -55	10	1245	2,781	0,432	5,26	4,23
Temper -55	0	1250	2,745	0,423	7,11	5,69
Temper -55	-10	1254	2,710	0,414	10,11	8,06
Temper -55	-20	1259	2,679	0,405	15,33	12,18
Temper -55	-30	1262	2,651	0,396	25,18	19,95
Temper -55	-40	1265	2,630	0,387	45,72	36,13
Temper -55	-50	1268	2,615	0,378	94,11	74,23
Temper -55	-55	1269	2,611	0,373	142,95	112,67
Temper -60	90	1232	2,931	0,496	1,28	1,04
Temper -60	80	1234	2,927	0,488	1,47	1,19
Temper -60	70	1238	2,920	0,480	1,69	1,37
Temper -60	60	1241	2,912	0,472	1,97	1,59
Temper -60	50	1246	2,890	0,464	2,32	1,86
Temper -60	40	1250	2,867	0,456	2,78	2,23
Temper -60	30	1255	2,853	0,448	3,40	2,71
Temper -60	20	1260	2,820	0,440	4,28	3,40
Temper -60	10	1265	2,781	0,432	5,56	4,40
Temper -60	0	1270	2,742	0,424	7,55	5,95
Temper -60	-10	1274	2,708	0,416	10,81	8,48
Temper -60	-20	1279	2,679	0,408	16,53	12,93
Temper -60	-30	1282	2,655	0,400	27,50	21,45
Temper -60	-40	1286	2,629	0,392	50,86	39,56
Temper -60	-50	1288	2,593	0,384	107,50	83,46
Temper -60	-55	1289	2,569	0,380	166,14	128,89
Temper -60	-60	1290	2,537	0,376	269,36	208,86

Thermal Expansion of Temper

There are many different ways of calculating thermal expansion.

In some cases the concept of coefficient of expansion is used. Instead of just one unambiguous way, unfortunately there are several of ways, different reference temperatures among other things, to calculate the coefficient of expansion.

Usually you want to know how much a certain fluid expands in volume with increased temperature. Fluids always expand with higher temperatures and consequently decrease in density.

Below is a method described for calculating the relation between temperature and volume for a certain temperature interval.

Note! Chose the density for the correct Temper version.

The density values may be read out of the table ”Thermal properties or from our web page www.temper.se

D(T0) = The density of the fluid at the lower temperature, T0.

D(T1) = The density of the fluid at the higher temperature, T1.

V = The total volume of the system.

ΔV = The expansion of the fluid, in volume.

ΔV = V × [D(T0)- D(T1)] / D(T1) Litres or

ΔV = 100 × [D(T0)- D(T1)] / D(T1) %

Example:

How much will a fluid expand if the volume of the system is 600 litres of Temper-40 and the temperatures increases from –30°C to +20°C?

D(T0) = D(-30) = 1225 kg/m3

D(T1) = D(+20) = 1207 kg/m3

V = 600 Litres

ΔV = 600 × [1225-1207] / 1207 litres = 8,95 Litres or 1,49%.

Technical Specifications

Temper -10	
Appearance:	Colorless to pale yellowish liquid
Boiling point:	≈ +109 °C
Freezing point:	< -10 °C
Density (+20 °C):	1079 - 1092 kg/m3
pH (+20 °C):	8,5 ± 0,5
Dynamic viscosity (+20 °C):	Ca. 1,48 mPa.s (cP)
Kinematic viscosity (+20 °C):	Ca. 1,37 mm2/s (cSt)
Specific heat capacity (+20 °C)	Ca. 3,577 kJ/kg .K
Thermal conductivity (+20 °C)	Ca. 0,544 W/m .K

Temper -15	
Appearance:	Colorless to pale yellowish liquid
Boiling point:	≈ +109 °C
Freezing point:	< -15 °C
Density (+20 °C):	1110 – 1119 kg/m3
pH (+20 °C):	8,5 ± 0,5
Dynamic viscosity (+20 °C):	Ca. 1,62 mPa.s (cP)
Kinematic viscosity (+20 °C):	Ca. 1,45 mm2/s (cSt)
Specific heat capacity (+20 °C)	Ca. 3,447 kJ/kg .K
Thermal conductivity (+20 °C)	Ca. 0,525 W/m .K

Temper –20	
Appearance:	Colorless to pale yellowish liquid
Boiling point:	≈ +109 °C
Freezing point:	< -20 °C
Density (+20 °C):	1138-1146 kg/m3
pH (+20 °C):	8,5 ± 0,5
Dynamic viscosity (+20 °C):	ca. 1,79 mPa.s (cP)
Kinematic viscosity (+20 °C):	ca. 1,57 mm2/s (cSt)
Specific heat capacity (+20 °C)	ca. 3,315 kJ/kg .K
Thermal conductivity (+20 °C)	ca. 0,508 W/m .K

Temper –30	
Appearance:	Colorless to pale yellowish liquid
Boiling point:	≈ +109 °C
Freezing point:	< -30 °C
Density (+20 °C):	1173 - 1183 kg/m3
pH (+20 °C):	8,5 ± 0,5
Dynamic viscosity (+20 °C):	ca. 2,17 mPa.s (cP)
Kinematic viscosity (+20 °C):	ca. 1,84 mm2/s (cSt)
Specific heat capacity (+20 °C)	ca. 3,124 kJ/kg .K
Thermal conductivity (+20 °C)	ca. 0,486 W/m .K

Temper –40	
Appearance:	Colorless to pale yellowish liquid
Boiling point:	≈ +109 °C
Freezing point:	< -40 °C
Density (+20 °C):	1204 - 1213 kg/m3
pH (+20 °C):	8,5 ± 0,5
Dynamic viscosity (+20 °C):	ca. 2,76 mPa.s (cP)
Kinematic viscosity (+20 °C):	ca. 2,29 mm2/s (cSt)
Specific heat capacity (+20 °C)	ca. 3,012 kJ/kg .K
Thermal conductivity (+20 °C)	ca. 0,465 W/m .K

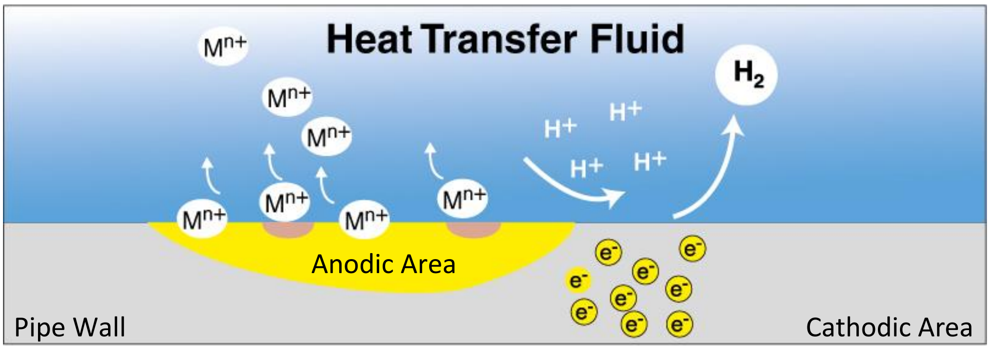
Temper –55	
Appearance:	Colorless to pale yellowish liquid
Boiling point:	≈ +109 °C
Freezing point:	< -55 °C
Density (+20 °C):	1239 - 1242 kg/m3
pH (+20 °C):	8,5 ± 0,5
Dynamic viscosity (+20 °C):	ca. 4,06 mPa.s (cP)
Kinematic viscosity (+20 °C):	ca. 3,27 mm2/s (cSt)
Specific heat capacity (+20 °C)	ca. 2,817 kJ/kg .K
Thermal conductivity (+20 °C)	ca. 0,441 W/m .K

Temper –60	
Appearance:	Colorless to pale yellowish liquid
Boiling point:	≈ +109 °C
Freezing point:	< -60 °C
Density (+20 °C):	1259 - 1262 kg/m3
pH (+20 °C):	8,5 ± 0,5
Dynamic viscosity (+20 °C):	ca. 4,28 mPa.s (cP)
Kinematic viscosity (+20 °C):	ca. 3,40 mm2/s (cSt)
Specific heat capacity (+20 °C)	ca. 2,820 kJ/kg .K
Thermal conductivity (+20 °C)	ca. 0,440 W/m .K

Corrosion inhibitor

Corrosion

Corrosion needs electrical potential differences in a metal or between two different metals and an electrolyte, i.e. a liquid that can distribute electrical charge (electrons). (see picture 1).



Picture 1 Galvanic Corrosion

Corrosion through electrical potential differences between various noble metals is normally called galvanic corrosion. Corrosion may also be seen in material with only one metal due to for instance concentration gradients in the electrolyte/fluid or impurities in the metal chemical structure etc.

The pre-state of corrosion

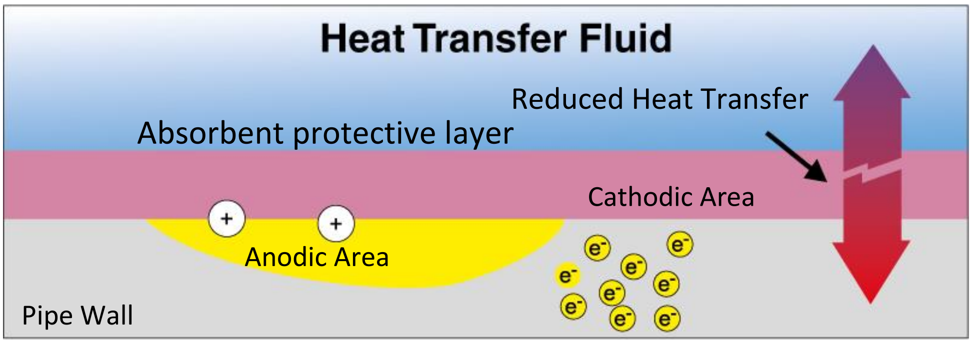
You may call a condition a pre-state of corrosion when the electrons in the cathodic area or the metal atoms that have become positively charged not yet have left the metal surface. This electrical potential diversion is occurring all the time in electrical conductors such as metals. The diversions are created all the time to be, most of the times, reduced without any corrosion.

Corrosion protection

Traditionally you protect metals using sacrificial anode metals, i.e. zinc, or by adding corrosion inhibitors.

Traditional corrosion inhibitors create a protective layer, that works mechanically, and prevent transport of electrons and metal ions to the electrolyte. This technology is good as long as the protective layer is intact. But through mechanical influence the layer can be damaged. The protective layer does not only prevent transport of electrons and metal ions but also it prevents heat transfer.

Some of the traditional components will also be consumed or degraded. You have to fill up with fresh fluid to get the corrosion protection, which build up new protective films not only at the damaged areas but in the whole system and consequently reducing the heat transfer even more just to maintain the corrosion protection (see picture 2).

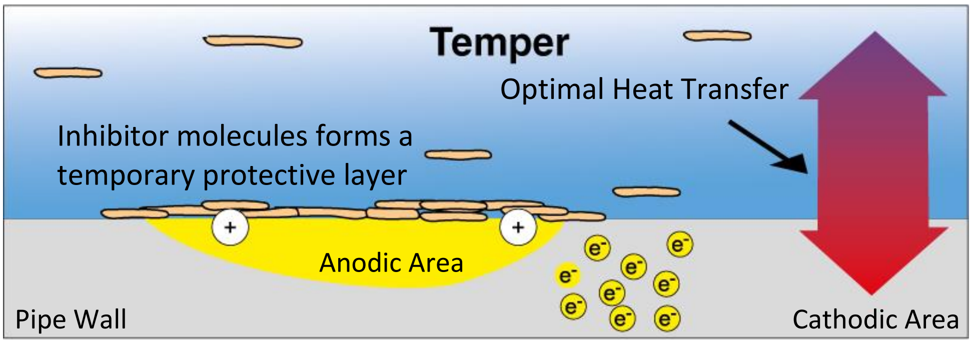


Picture 2 Protective Layer

To analyze the status of the system in terms of corrosion you have to inspect the entire parts of the system to be able to ensure that the protective layer is sufficient This is extremely difficult if not impossible, very time consuming and consequently very costly.

The Temper corrosion inhibitor package is pulled together on the metal surfaces by electrical coupling already at the pre-state of corrosion (see above ”The pre-state of corrosion”) creating a local temporary and very thin protective layer. Temper corrosion inhibitor creates locally, and only when necessary, protective films with a minimal (monomolecular) thickness, which still allows optimum heat transfer. (See picture 3).

Later when the electrical diversion is reduced, the Temper corrosion inhibitors return to the fluid without being consumed but ready to protect at the next diversion (pre-state) that will occur. The Temper corrosion inhibitors are chemically selective to construction metals and are not interfered by other ions or non-construction metals such as for instance potassium. Temper corrosion inhibitor contains of course no environmentally hazardous components.



Picture 3 Temper Corrosion Inhibitor

To analyze the status of the system in terms of corrosion is very easy when using Temper. Since the Temper corrosion inhibitors are dissolved in the fluid, you may easily through analyzing the inhibitor concentration decide whether the system is OK or not.

If the inhibitor level is above the nominated minimal level, the amount to protect the system is enough. Since the inhibitor is chemically-electrically selective no pre-state may "escape" but are detected and protected by the inhibitors.

Electrical dissimilarities are very fast to detect and also the fastest chemical reactions (protection).

If the inhibitor level decreases, which after all may happen initially if the system was not carefully cleaned, or if the system contained corrosion elements from the beginning or by outer influence through in-leakage of foreign particles, you may very well top up with concentrated inhibitor solution to proper level.

Ecological Information

Temper is an environmentally adapted heat transfer fluid. It passes great ecological requirements. The product is biodegradable, not toxic, not reactive and not inflammable.

Biodegradability

Aerobic biodegradability of Temper has been investigated at test laboratory Cenox AB in Sweden. Temper is biodegradable, according to method OECD 301A.

Biodegradability	OECD 301 A	97 % degradation after 7 days 99 % degradation after 28 days	Biological easy degradable

The test involves continually estimations of amount remaining DOC (Dissolved Organic Carbon). According to EOCD guidelines for testing chemicals a test compound is regarded as easily biodegradable if the loss of DOC is greater than 70% within 28 days. The pass value has to be reached in a 10-day window within the 28-day period of the test. For test compound Temper as much as 97% DOC is consumed after 7 days. Thus the criterion is reached and Temper can be regarded as readily biodegradable.

Toxicity, marine bacteria

Toxic effects on marine bacteria have been tested at test laboratory Toxicon AB in Sweden. Temper is not acute toxic for the bacteria Vibro fisheri, according to Microtox method.

Acute toxicity, marine bacteria	Microtox Method	Slightly toxic day 0 No toxic effects after 28 days	Not acute toxic

The Microtox method involves an analysis of the light emitting ability of bioluminescent bacteria in solution of the test compound. Two test solutions with the same start concentration are tested. One solution is tested day 0 and the other is tested after 28 days of aerobic biodegradability. The light emitting ability from exposed bacteria is estimated in series at exposure times of 5, 15 and 30 minutes. The relationship between concentration of test compound and response are calculated. Then the concentrations at a 20%-reduction of light emission (EC20) respectively 50%-reduction (EC50) are calculated. According to test results Temper (0,7 % v/v) is slightly toxic for the bacteria Vibro fisheri day 0. After 28 days of biodegradability no toxic effects are shown.

Toxicity, rainbow trout

Toxic effects on rainbow trout has been analysed at test laboratory Toxicon AB. Temper is not regarded as acute toxic, according to method OECD TG no 203, ”Fish, Acute Test”

Acute toxicity, rainbow trout	OECD TG no 203	$LC_{50/96h}$ 13900 mg/l	Not acute toxic

The method involves exposure of rainbow trout in a solution of Temper in various concentrations. LC50 occurred at the concentration 1,2% v/v after 24 h respectively 1,1 % v/v after 96 h. (1,1% v/v=13900 mg /l).

Accumulation in living organisms

Temper does not contain components with the ability to accumulate in living organisms.

Fertilizing effect

Temper contains potassium, that works as a naturally fertiliser.

Life cycle assessment of Temper

Life cycle assessment (LCA) is an international method to evaluate the environmental burdens associated with the life cycle of a product. A project has been performed to systematic describe and quantify the total environmental impact under different phases in the life cycle of Temper. The result from the analysis shows that Temper has very low environmental impact.

Stability

Temper is stable, not flammable and not explosive.

Handling and safety

Temper is regarded as not dangerous to the environment and can if diluted be poured in sewage system, after consulting local authorities. Temper is stable, non-combustible and non-explosive. Thus the product is easy and safe to handle. Temper can, as well as any other salt solution, irritate in contact with the eyes, therefore use eye protection. Long skin contact may irritate, protective gloves are recommended.