Technical Information

TYFOCOR®

Concentrate

Antifreeze and Anticorrosion Concentrate
for Heating and Cooling Circuits.
Medium for Ground Source Heat Pump Systems

TYFOROP Chemie GmbH

Applications for TYFO products

Renewable energy

Thermal solar systems place high demands on the properties of heat transfer fluids. Both during cold winter nights and under the hot midday sun — you need your solar system to work reliably, year in and year out. Our products make sure your solar thermal fluid remains liquid and pumpable all the way down to –30 °C while resisting breakdown up to 200 °C. Since there is always a possibility of leakage causing contamination of the hot water supply, solar thermal fluids must not present a health risk. That's why they are formulated with non-toxic propylene glycol. Heat transfer fluids for geothermal systems have it easier in comparison. Here, the main objective is to ensure that heat is transferred from the earth to the heat pump even when temperatures are below freezing, all the while protecting the system's components against corrosion. We also provide specialized products for drinking water protection zones and other areas that fall under special regulations.

Products:
TYFOCOR®, L, LS®, L-eco®, GE, Spezial, HTL, G-LS, LG

HVAC

Central air-conditioning systems in large buildings provide heat in the winter and cooling in the summer. To accomplish this, the heat transfer fluid in the central air-conditioning system is either heated or cooled and then transported to the heat exchangers in the individual rooms through piping. The heat transfer fluid used has to live up to all the demands placed on it regarding heat transfer and corrosion protection over an extended period of time and under both high and low temperatures. Even in buildings at remote locations which are not heated the entire winter through, our products prevent the heating system from freezing and thus ensure a long, trouble-free service life.

Products: TYFOCOR®, L, GE

Refrigeration

A number of technical processes require rapidly cooling equipment or components to very low temperatures. To achieve this, products are required which not only have good thermal transfer and corrosion inhibiting properties, but which also possess very low viscosities across the entire temperature range. This is the only way to ensure sufficient flow with rapid and efficient heat transfer.

Products: TYFOCOR®, L, **TYFO**XIT®

Food & Beverage

Wherever you look — refrigerated cases in the supermarket or steps during food and beverage processing: Excess heat has to be removed quickly and products need to be kept at consistently low temperatures to maintain shelf life. For use in the food and beverage industry, our products need to possess an additional quality beyond their technical specifications: they must be absolutely non-toxic. This is an important prerequisite to ensure that spills and even small leaks cannot lead to foods being contaminated with potentially hazardous substances.

Products: TYFOCOR®, L, **TYFO**XIT®

Characteristics of TYFOCOR® Concentrate

Appearance	clear, colourless liquid	
Boiling point	> 165 °C	ASTM D 1120
Pour point	< –15 °C	DIN ISO 3016
Density (20 °C)	1.120–1.125 g/cm³	DIN 51757
Viscosity (20 °C)	24–28 mm²/s	DIN 51562
Refraction nD20	1.432–1.434	DIN 51423
pH value (20 °C)		
- concentrate	8.0–8.5	ASTM D 1287
- 33 vol. %	7.5–8.5	ASTM D 1287
Water content	max. 4 %	DIN 51777
Flash point	> 100 °C	DIN 51758
Reserve alkalinity	> 10 ml 0.1 m HCl	ASTM D 1121

The above data represent average values that were valid when this Technical Information Bulletin went into print. They do not have the status of a product specification. Specified values are the subject of a special leaflet.

Properties

TYFOCOR® is a clear, colourless, and virtually odourless liquid based on ethylene glycol. The product is used as antifreeze/corrosion protection fluid and heat transfer medium for heating, air conditioning and cooling circuits, as well as brine for heat pump systems.

TYFOCOR® iis miscible with water in all proportions. **TYFO**COR®/water mixtures protect against frost at temperatures down to –50 °C, depending on their concentration, and lengthen the life of the installations that they protect. Water hardness constituents do not affect the performance of the product, and do not lead to precipitations from the heat transfer fluid. Mixtures of **TYFO**COR® and water do not separate.

The corrosion inhibitors of **TYFO**COR® reliably protect the metals normally used in heating and cooling systems against corrosion, ageing and deposits over long periods even in mixed installations. **TYFO**COR® neither contains borax nor nitrites, phosphates, nor amines.

TYFOCOR® posseses excellent stability at high temperatures and prevents the formation of harmful deposits on hot metal surfaces (at temperatures of up to 200 °C) at watt densities as high as about 40 W/cm². It thus helps to avoid overheating at heat transfer surfaces and the formation of deposits in the circuit, and thus ensures consistently high thermal efficiency of the system.

Miscibility

TYFOCOR® is miscible with all commercial antifreezes based on ethylene glycol. If mixing of **TYFO**COR® with other products is intended, we recommend, however, to contact our department of application technique beforehand.

Application

TYFOCOR® is added to water (potable water quality, with a maximum chloride content of 100 mg/kg, or demineralised water) in concentrations of at least 20 percent by volume. The protection against frost deteriorates if the content of **TYFO**COR® exceeds 58 percent by volume.

Temperature stability

Sustained temperatures higher than 140 °C cause premature ageing of the heat transfer fluid, but brief exposure to temperatures higher than 140 up to 200 °C can be tolerated if the liquid is subsequently cooled. At temperatures above 200 °C, the heat transfer fluid commences to undergo chemical change, with the result that the dependability of the installation may be endangered. A blanket of nitrogen is recommended to lengthen the life of the heat transfer fluid if the sustained operating temperature is higher than 110 °C.

Anticorrosion Effect

The following table demonstrates the anticorrosion effect of a 33 vol. % **TYFO**COR®/water mixture after a 14 days test at 88 °C under permanent aeration. Corrosion test accordingly ASTM D 1384 (American Society for Testing and Materials).

Material		Average change of weight
Copper	(SF Cu)	–0.1 g/m²
Soft solder	(L Sn 30)	–0.1 g/m²
Brass	(MS 63)	±0.0 g/m²
Steel	(HI)	±0.0 g/m²
Cast Iron	(GG 26)	±0.0 g/m²
Cast Aluminium	(G-AlSi6Cu4)	–0.4 g/m²

The outstanding anticorrosion properties of mixtures of **TYFO**COR® and water have also been demonstrated in high-temperature corrosion tests on cast iron GG 25 and cast aluminium G-AlSi10Mg subjected to the flow and heat transfer conditions relating to watt densities up to 40 W/cm².

In order to maintain effective protection from corrosion, the concentration of **TYFO**COR® must not be allowed to fall below 20 percent by volume. This content corresponds to a freezing point of –9 °C. Concentrations lower than 20 percent by volume are insufficient and increase the risk of corrosion.

If **TYFO**COR® is run to existing installations in which only water has previously been circulated, it should be noted that the rust in these systems greatly increases the effective area of contact with the heat transfer fluid.

It thus binds the corrosion inhibitors contained in **TYFO**COR®, with the consequence that their effective concentration may be reduced to such an extent that the protection against corrosion is impaired. For this reason, the rust in these installations should be flushed out to the utmost extent before the filling. In particularly severe cases, pickling with subsequent neutralisation of the acid is recommended.

After they have been emptied, installations that have been run temporarily with **TYFO**COR® must be thoroughly flushed several times to ensure that all residual traces of the product are removed, because any product residues may give rise to increased corrosion.

Compatibility with Sealing Materials

TYFOCOR®/water mixtures do not attack the sealings that are normally used in heating and cooling systems. The following table of sealants,

elastomers and plastics that are resistant to **TYFO**COR®/water mixtures has been compiled from experimental results, experience, and from literature data:

Examples of sealants are Fermit®, Fermitol® (registered trademarks of Nissen & Volk GmbH, Hamburg, Germany), hemp

Butyl rubber	IIR
Chloroprene	CR
Ethylene-propylene-diene-rubber	EPDM
Fluorocarbon elastomers	FPM
Natural rubber below 80 °C	NR
Nitrile rubber	NBR
Polyacetal	POM
Polyamides below 115 °C	PA
Polybutene	PB
Polyethylene, soft, hard	PE-LD/HD
Polyethylene, crosslinked	PE-X
Polypropylene	PP
Polytetrafluorethylene	PTFE
Polyvinylchloride, rigid	PVC h
Silicone rubber	Si
Styrene butadiene rubber below 100 °C	SBR
Unsaturated polyester resins	UP

Phenolic and urea resins, plasticized PVC, and polyurethane elastomers are not resistant.

An important point to note is that the performance of elastomers is not only governed by the properties of the rubber itself, e.g. EPDM, but also by the nature and amount of the constituent additives and the vulcanisation conditions. For this reason, it is recommended that their resistance to **TYFO**COR®/water mixtures is checked by performance tests before these elastomers are taken into use for the first time. This applies in particular to elastomers intended as membranes for expansion vessels as described in DIN EN 12828 and DIN 4807 Part 2, respectively.

Gaskets that have proved to be resistant to hot **TYFO**COR®/water mixtures are: up to 160 °C: gaskets made from 70 EPDM 281 (Carl Freudenberg GmbH, D-69465 Weinheim). Up to 200 °C: flat gaskets such as REINZ-AFM 34 (REINZ-Dichtungs-GmbH, D-89229 Neu-Ulm) or Centellen 3820 based on aramide/special-NBR. (Hecker Werke GmbH, D-71093 Weil im Schönbuch).

The low surface tension of **TYFO**COR®/water mixtures in some cases may be the reason for leakage if the sealing strips have been produced from polytetrafluoroethylene (PTFE). Likewise, the addition of **TYFO**COR® in heating systems may allow latent leaks to be detected, because the resulting **TYFO**COR®/water mixture possesses higher wetting power than neat water.

If the leakage cannot be prevented by tightening the connections, the system must be drained. The sealings must then be replaced, and the connection must be rechecked to ensure that there is no leakage.

It is important that all connections with renewed sealings are retightened after the system has been restarted and brought to the maximum operating temperature.

The procedure for filling installations with forced circulation is to run in about two-thirds of the requisite amount of water first of all. **TYFO**COR® should then be added and the system topped up with the remainder of the water. The fluids become completely mixed after the circulation pump has been run for several hours. **TYFO**COR® and water must be completely mixed together before they are filled into systems with natural circulation.

Application Guidelines

In view of the specific properties of **TYFO**COR®, the following instructions must be observed to ensure long-term protection for the installations.

1. Installations must be designed as closed circuits, as otherwise the contact with atmospheric oxygen will accelerate the consumption of inhibitors.

2. Flexible-membrane expansion tanks must conform to DIN EN 12828 and DIN 4807 Part 2, resp.

3. Silver or copper brazing solders are preferably to be used on joints. Fluxes used in combination with soft solder usually contain chlorides. Their residues must be removed from the system by thorough flushing. Otherwise, an increased content of chlorides in the heat transfer fluid may lead for example to pitting corrosion on stainless steel.

4. The only flexible connections that are permitted for use are hoses, preferably made of metal, that are resistant to oxygen diffusion.

5. The systems must not be equipped with internally galvanised heat exchangers, tanks or pipes, because zinc can be detached by ethylene glycol/water mixtures.

6. It must be ensured that no external voltages are applied between parts of the system that come into contact with **TYFO**COR®/water mixture, as otherwise corrosion may occur.

7. The layout of the piping must ensure that the circulation of the heat transfer fluid will not be disturbed by gas pockets or deposits.

8. The fluid level must never be allowed to fall below the highest point in the system. A closed vessel fitted with a bleed valve must be provided at the highest point in the circuit in order to bleed gases from the system.

9. If automatic bleed valves are used, they must not allow subsequent suction of air into the system.

10. Dirt and water must not be allowed to enter the installation or its components during assembly and before filling. After the assembly has been completed, the system should be flushed to remove e.g. swarf, fluxes, assembly aids and any other impurities. Following to the flushing process and the leak test, the circuit should be completely drained and then filled immediately with the **TYFO**COR®/water mixture, even if the plant is put into operation at a later date, in order to protect the circuit from corrosion.

11. It must be ensured that no air pockets remain in the circuit after it has been filled. It is essential to eliminate any existing gas pockets, because their collapse following a temperature drop would give rise to a vacuum and thus cause air to be sucked into the system. Insufficient deaeration furthermore affects the heat transfer efficiency of the system.

12. In-circuit filter elements must be cleaned within 14 days at the latest after the system was put into operation, in order to ensure that no obstruction to the fluid flow may occur due to deposits in any part of the installation.

13. The concentration of **TYFO**COR®/water mixtures can be checked by measuring the fluid density with a hydrometer or an antifreeze tester suitable for ethylene glycol/water mixtures. An equally convenient and accurate way to determine the content of **TYFO**COR® is to measure the refractive index by a hand-held refractometer. The following table displays a summary of the freezing points, densities and the refractive indices of **TYFO**COR®/water mixtures.

TYFOCOR® Concentrate	Freezing Point	Density at 20 °C	Refractive Index nD20
20 vol. %	–9.0 °C	1029 kg/m³	1.3545
25 vol. %	–12.3 °C	1037 kg/m³	1.3599
30 vol. %	–16.1 °C	1044 kg/m³	1.3653
35 vol. %	–20.4 °C	1052 kg/m³	1.3707
40 vol. %	–25.2 °C	1059 kg/m³	1.3762
45 vol. %	–30.8 °C	1066 kg/m³	1.3816
50 vol. %	–37.6 °C	1073 kg/m³	1.3868
55 vol. %	–45.4 °C	1079 kg/m³	1.3918
58 vol. %	–51.0 °C	1082 kg/m³	1.3947

14. If losses occur due to evaporation, the system can be topped up with neutral potable or demineralised water. Fluid losses caused by leakage or removal from the system must be replaced by a mixture of **TYFO**COR® Concentrate and potable or demineralised water of equal content. In cases of doubt, the content of **TYFO**COR® must be determined via measurement of density or refractive index as described in section **13**.

Storage Stability

TYFOCOR® has a shelf life of at least three years in airtight containers. It must not be stored in galvanised containers.

Delivery Form and Packaging

TYFOCOR® is available as a concentrate or ready-to-use according to customer's specification. It is supplied in road tankers, in 1,000 litre IBCs, in 200 litre drums, and in 60, 30, 20 and 10 litre non-returnable plastic cans.

Disposal

Spills of **TYFO**COR® must be taken up with an absorbent binder and disposed of in accordance with the regulations. For further information, please refer to the Safety Data Sheet.

Ecology

TYFOCOR® is classified in water hazard class 1, (low-rate endangering, Germany) according to german water hazard regulations (*Verwaltungsvorschrift für wassergefährdende Stoffe* of May 17, 1999). The product is readily biodegradable.

Safety

TYFOCOR® shall not be used for installations, where penetration of the heat transfer fluid into food processing or drinking water applications cannot be completely excluded. For such purposes it is recommended to use **TYFO**COR® L, which is based on toxicologically unobjectionable propylene glycol.

Handling

The usual safety and industrial hygiene measures relating to chemicals must be observed in handling **TYFO**COR®. The information and instructions given in our Safety Data Sheet must be strictly observed.

Safety Data Sheet

A current Safety Data Sheet in accordance with EU Directive 1907/2006/EC [REACH] is available on our website **www.tyfo.de**.

Density of TYFOCOR®**/water mixtures [kg/m³]**

as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
120	970	975	982	991	999	1002	1003	1008	1012
110	978	983	990	998	1006	1010	1012	1017	1020
100	985	990	997	1005	1013	1017	1020	1025	1028
90	992	998	1004	1012	1019	1024	1027	1033	1036
80	998	1004	1011	1018	1025	1030	1035	1040	1043
70	1005	1011	1017	1024	1031	1037	1042	1047	1050
60	1010	1017	1024	1030	1037	1043	1048	1054	1057
50	1016	1022	1029	1036	1043	1049	1055	1060	1064
40	1021	1028	1035	1042	1049	1055	1061	1067	1070
30	1025	1032	1040	1047	1054	1060	1067	1073	1076
20	1029	1037	1044	1052	1059	1066	1072	1079	1083
10	1032	1040	1049	1056	1064	1071	1078	1085	1089
0	1035	1044	1052	1061	1068	1076	1083	1090	1094
–10	-	1046	1056	1064	1073	1081	1088	1096	1100
–20	-	-	-	1068	1077	1085	1094	1101	1106
–30	-	-	-	-	-	1090	1099	1107	1111
–40	-	-	-	-	-	-	-	1112	1117
–50	-	-	-	-	-	-	-	-	1122

Specific heat capacity of TYFOCOR®**/water mixtures [kJ/kg·K]**

as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
120	4.05	4.01	3.96	3.89	3.81	3.76	3.68	3.61	3.57
110	4.06	4.03	3.97	3.89	3.81	3.75	3.67	3.59	3.56
100	4.07	4.03	3.97	3.90	3.80	3.73	3.65	3.57	3.53
90	4.08	4.03	3.97	3.89	3.79	3.71	3.62	3.54	3.51
80	4.07	4.03	3.97	3.88	3.78	3.69	3.59	3.51	3.47
70	4.07	4.03	3.96	3.87	3.76	3.66	3.56	3.48	3.44
60	4.06	4.01	3.95	3.85	3.73	3.63	3.52	3.44	3.40
50	4.05	4.00	3.93	3.83	3.70	3.59	3.47	3.39	3.35
40	4.03	3.98	3.91	3.80	3.66	3.54	3.42	3.34	3.30
30	4.01	3.95	3.88	3.75	3.62	3.49	3.37	3.29	3.25
20	3.98	3.92	3.85	3.72	3.57	3.44	3.31	3.23	3.19
10	3.95	3.89	3.81	3.68	3.52	3.38	3.25	3.17	3.13
0	3.91	3.85	3.77	3.63	3.46	3.31	3.18	3.10	3.06
–10	-	3.81	3.72	3.57	3.40	3.24	3.11	3.03	2.99
–20	-	-	-	3.51	3.33	3.17	3.03	2.95	2.92
–30	-	-	-	-	-	3.08	2.95	2.87	2.84
–40	-	-	-	-	-	-	-	2.79	2.75
–50	-	-	-	-	-	-	-	-	2.67

Thermal conductivity of TYFOCOR®**/water mixtures [W/m·K]**

as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
120	0.624	0.596	0.569	0.535	0.504	0.479	0.454	0.430	0.416
110	0.612	0.585	0.559	0.527	0.496	0.472	0.448	0.425	0.411
100	0.601	0.575	0.549	0.518	0.489	0.465	0.442	0.419	0.406
90	0.590	0.564	0.539	0.509	0.481	0.458	0.436	0.414	0.401
80	0.579	0.553	0.529	0.500	0.474	0.451	0.429	0.409	0.397
70	0.567	0.543	0.518	0.492	0.466	0.444	0.423	0.403	0.392
60	0.556	0.532	0.508	0.483	0.459	0.437	0.417	0.398	0.387
50	0.545	0.521	0.498	0.474	0.451	0.430	0.410	0.392	0.382
40	0.534	0.510	0.488	0.465	0.444	0.423	0.404	0.387	0.377
30	0.522	0.500	0.478	0.57	0.436	0.416	0.398	0.382	0.372
20	0.511	0.489	0.467	0.448	0.429	0.410	0.391	0.376	0.368
10	0.500	0.478	0.457	0.439	0.421	0.403	0.385	0.371	0.363
0	0.489	0.468	0.447	0.430	0.414	0.396	0.379	0.366	0.358
–10	-	0.457	0.437	0.422	0.406	0.389	0.373	0.360	0.353
–20	-	-	-	0.413	0.399	0.382	0.366	0.355	0.348
–30	-	-	-	-	-	0.375	0.360	0.349	0.344
–40	-	-	-	-	-	-	-	0.344	0.339
–50	-	-	-	-	-	-	-	-	0.334

Kinematic viscosity of TYFOCOR®**/water mixtures [mm²/s]**

as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
120	0.42	0.45	0.49	0.52	0.57	0.61	0.62	0.67	0.71
110	0.45	0.49	0.53	0.57	0.63	0.67	0.68	0.73	0.77
100	0.48	0.52	0.57	0.61	0.67	0.73	0.76	0.81	0.84
90	0.52	0.57	0.62	0.66	0.72	0.80	0.87	0.91	0.93
80	0.58	0.63	0.68	0.73	0.79	0.91	1.01	1.05	1.06
70	0.65	0.71	0.78	0.84	0.91	1.05	1.20	1.25	1.26
60	0.76	0.83	0.91	0.99	1.08	1.26	1.45	1.53	1.55
50	0.91	1.00	1.11	1.21	1.34	1.56	1.81	1.94	2.00
40	1.12	1.24	1.38	1.54	1.73	2.00	2.30	2.55	2.70
30	1.41	1.58	1.77	2.01	2.31	2.64	3.02	3.49	3.79
20	1.83	2.07	2.34	2.72	3.19	3.62	4.11	4.96	5.57
10	2.45	2.39	3.18	3.80	4.58	5.16	5.85	7.37	8.54
0	3.35	3.87	4.46	5.49	6.85	7.75	8.84	11.6	13.7
–10	-	5.52	6.44	8.19	10.6	12.3	14.4	19.3	23.1
–20	-	-	-	12.5	17.1	21.1	26.2	34.7	41.0
–30	-	-	-	-	-	39.0	54.2	68.3	77.0
–40	-	-	-	-	-	-	-	150.0	153.0
–50	-	-	-	-	-	-	-	-	-

Prandtl numbers of TYFOCOR®**/water mixtures**

as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
120	2.65	2.98	3.35	3.72	4.30	4.81	5.01	5.63	6.13
110	2.91	3.30	3.75	4.20	4.84	5.39	5.63	6.30	6.81
100	3.20	3.63	4.12	4.62	5.27	5.96	6.40	7.07	7.51
90	3.57	4.04	4.57	5.10	5.77	6.68	7.41	8.04	8.41
80	4.05	4.59	5.18	5.97	6.49	7.64	8.73	9.37	9.70
70	4.71	5.35	6.05	6.73	7.56	9.00	10.5	11.2	11.6
60	5.61	6.41	7.27	8.13	9.14	10.9	12.9	13.9	14.4
50	6.86	7.88	8.99	10.2	11.5	13.7	16.1	17.8	18.7
40	8.61	10.0	11.4	13.1	15.0	17.6	20.7	23.5	25.3
30	11.1	12.9	14.9	17.4	20.2	23.5	27.3	32.3	35.6
20	14.7	17.2	20.1	23.8	28.1	32.3	37.3	45.9	52.4
10	19.4	23.6	27.8	33.6	40.7	46.4	53.2	68.3	80.2
0	27.8	33.2	39.6	49.0	61.2	69.8	80.4	106.9	128.5
–10	-	48.1	57.9	73.9	95.3	111.1	131.2	177.6	215.6
–20	-	-	-	114.0	153.4	189.6	236.7	317.7	380.2
–30	-	-	-	-	-	349.8	487.7	620.9	706.8
–40	-	-	-	-	-	-	-	1352	1389
–50	-	-	-	-	-	-	-	-	-

Vapour pressure of TYFOCOR®**/water mixtures [bar]**

as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
180	9.25	8.99	8.70	8.39	8.06	7.65	7.19	6.73	6.42
170	7.32	7.11	6.88	6.65	6.40	6.07	5.71	5.34	5.10
160	5.71	5.55	5.38	5.20	5.01	4.76	4.48	4.19	4.00
150	4.40	4.28	4.15	4.01	3.87	3.68	3.47	3.24	3.09
140	3.34	3.25	3.15	3.05	2.94	2.80	2.64	2.47	2.36
130	2.50	2.43	2.36	2.28	2.20	2.10	1.98	1.85	1.77
120	1.83	1.78	1.77	1.67	1.62	1.54	1.46	1.37	1.34
110	1.32	1.28	1.25	1.29	1.17	1.11	1.05	0.99	0.94
100	0.93	0.91	0.88	0.85	0.82	0.79	0.74	0.70	0.66
90	0.64	0.62	0.61	0.59	0.57	0.54	0.51	0.48	0.46
80	0.43	0.42	0.41	0.39	0.38	0.36	0.34	0.32	0.31
70	0.28	0.27	0.27	0.26	0.25	0.24	0.22	0.21	0.20
60	0.18	0.17	0.17	0.16	0.16	0.15	0.14	0.13	0.13
50	0.11	0.11	0.10	0.10	0.10	0.09	0.09	0.08	0.08
40	0.07	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05
30	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03

Cubic expansion coefficient of TYFOCOR®**/water mixtures [•10^{-5}/K]**

as a function of temperature and concentration

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
120	79	80	79	73	67	75	86	85	83
110	76	77	76	71	66	72	81	81	80
100	72	73	72	68	64	69	77	79	76
90	68	70	69	66	62	66	73	73	73
80	64	66	65	63	60	64	69	70	70
70	60	62	62	60	58	61	65	67	67
60	56	57	58	57	56	59	62	64	64
50	51	53	54	54	54	56	59	61	62
40	46	48	50	51	52	54	57	59	60
30	40	44	46	48	49	51	54	56	58
20	35	39	42	45	47	49	52	55	56
10	29	34	38	42	45	47	50	53	54
0	22	28	34	38	42	45	49	51	53
–10	-	23	29	35	39	44	47	50	52
–20	-	-	-	31	37	42	46	49	51
–30	-	-	-	-	-	40	46	49	50
–40	-	-	-	-	-	-	-	48	50
–50	-	-	-	-	-	-	-	-	49

Example for calculating the volume expansion:

What would be the increase in volume (in litres) if V_0 = 80 litres of a 30 vol. % **TYFO**COR®/water mixture will be heated from t_0 = –10 °C to t_1 = +90 °C?

$\Delta t = t_1 - t_0 = +90 - (-10) = 100$ °C, $t_{average} = t_0 + \Delta t/2 = -10 + 100/2 = +40$ °C

$ß_{average}$ (from table for 30 vol. %) = $50 \cdot 10^{-5}$

$\Delta V = ß_{average} \cdot \Delta t \cdot V_0 = 50 \cdot 10^{-5} \cdot 100 \cdot 80 = 4.0$ litres increase in volume

Relative pressure drop factor of TYFOCOR®**/water mixtures**

in comparison with water at 10 °C, turbulent pipe flow (approximate values)

T [°C]	20 vol. %	25 vol. %	30 vol. %	35 vol. %	40 vol. %	45 vol. %	50 vol. %	55 vol. %	58 vol. %
100	0.77	0.78	0.80	0.81	0.83	0.85	0.87	0.88	0.90
90	0.79	0.81	0.83	0.84	0.86	0.89	0.91	0.93	0.94
80	0.82	0.84	0.86	0.88	0.90	0.93	0.95	0.97	0.99
70	0.85	0.88	0.90	0.92	0.94	0.97	1.00	1.02	1.04
60	0.88	0.91	0.94	0.96	0.99	1.02	1.05	1.08	1.10
50	0.91	0.95	0.99	1.01	1.04	1.07	1.10	1.14	1.18
40	0.96	1.01	1.05	1.07	1.10	1.14	1.17	1.22	1.27
30	1.01	1.06	1.11	1.14	1.18	1.22	1.26	1.32	1.37
20	1.08	1.14	1.19	1.23	1.28	1.32	1.35	1.42	1.49
10	1.17	1.23	1.29	1.33	1.38	1.42	1.46	1.55	1.64
0	1.29	1.35	1.40	1.45	1.50	1.56	1.61	1.71	1.80
–10	-	1.50	1.59	1.63	1.68	1.74	1.80	1.93	2.05
–20	-	-	-	1.85	1.92	1.99	2.06	2.21	2.35

Antifreeze effect of TYFOCOR®/water mixtures

The **freezing point**, colloquially called 'antifreeze', is a measure for the freezing point depression effect of antifreeze fluids. When a given **TYFO**COR®/water mixture is cooled down, the freezing point is the temperature at which initial ice crystals begin to form. The resulting ice slurry does not possess any expansive force. Further reduction in temperature causes further thickening of the ice slurry until it solidifies at the **pour point**. Only below this temperature, there is danger of bursting for the installation. The arithmetic mean from freezing point and pour point is referred to as **frost protection**.

The following table displays the freezing points, frost protection and pour points of **TYFO**COR®/water mixtures as a function of the concentration:

TYFOCOR® **Concentrate**	**Freezing point (acc. ASTM D 1177)**	**Frost protection (calculated)**	**Pour point (acc. DIN 51583)**
20 vol. %	–9.0 °C	–11.0 °C	–13.0 °C
25 vol. %	–12.3 °C	–14.8 °C	–17.3 °C
30 vol. %	–16.1 °C	–19.1 °C	–22.0 °C
35 vol. %	–20.4 °C	–23.7 °C	–26.9 °C
40 vol. %	–25.2 °C	–28.6 °C	–32.0 °C
45 vol. %	–30.8 °C	–33.4 °C	–37.2 °C
50 vol. %	–37.6 °C	–40.7 °C	–45.2 °C
55 vol. %	–45.4 °C	< –50 °C	< –50 °C
58 vol. %	< –50 °C	< –50 °C	< –50 °C

Further data can be determined by a calculation program available on our website **www.tyfo.de**.

Note

The information submitted in this publication is based on our current knowledge and experience. In view of the many factors that may affect processing and application these data do not relieve processors of the responsibility of carrying out their own tests and experiments, neither do they imply any legally binding assurance of certain properties or of suitability for a specific purpose. It is the responsibility of those to whom we supply our products to ensure that any proprietary rights and existing laws and legislations are observed.

The TYFO product range

TYFOCOR® is a long-life, corrosion-inhibiting antifreeze based on ethylene glycol for cooling and heating, air-conditioning, heat pump, and under-soil heating systems. It can be supplied as a concentrate or a pre-mixed, ready-to-use product as desired.

TYFOCOR® LS® is a special, ready-to-use, almost completely vaporizable, propylene-glycol-based heat transfer fluid for use in solar systems that are subject to extreme thermal conditions.

TYFOCOR® L is a long-life corrosion-inhibiting antifreeze based on propylene glycol for heating and air-conditioning, solar thermal, and heat pump systems. It is also used as a special food-grade brine by food and beverage manufacturers and is supplied both as a concentrate and a pre-mixed, ready-to-use product.

TYFOCOR® L-eco® is a long-life corrosion-inhibiting antifreeze based on propylene glycol that covers the same applications as **TYFO**COR® L. Practically all of the substances contained in the product are derived from 100% renewable resources.

TYFOCOR® HTL is a special, ready-to-use heat transfer fluid based on non-toxic glycols for use in solar systems that are subject to extreme thermal conditions.

TYFOCOR® GE is a long-life, corrosion-inhibiting antifreeze based on ethylene glycol specially formulated for use in geothermal heat pump systems, air conditioning units, and under-soil heating. It can be supplied as desired in the form of a concentrate or a pre-mixed, ready-to-use product.

TYFOCOR® G-LS is a special, ready-to-use, almost completely vaporizable, propylene-glycol-based heat transfer fluid for use in solar systems that are subject to extreme thermal conditions. It contains a glass protection additive that makes it suitable for use in all-glass solar collectors.

TYFO-SPEZIAL is a special, high-performance brine formulated for geothermal heat pumps located in water protection zones and areas subject to special government regulations. Due to its lack of glycols, it does not cause any underground biological oxygen depletion in the event of a leak.

TYFOXIT® 1.15–1.25 are non-toxic, high-performance, glycol-free refrigerants based on potassium acetate with very low viscosities for chiller systems with secondary cooling. They are available as concentrates (**TYFO**XIT® 1.25) and ready-to-use mixtures ranging from –20 °C (**TYFO**XIT® 1.15) to –55 °C (**TYFO**XIT® 1.25).

TYFOXIT® F15–50 are non-toxic, high-performance, glycol-free, potassium-formate-based heat transfer fluids with very low viscosities for chiller systems with secondary cooling. They are available as ready-to-use mixtures ranging from –15 °C (**TYFO**XIT® F15) to –50 °C (**TYFO**XIT® F50).

To learn more about our products, visit **www.tyfo.de**

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