Technical Information

Antifreeze and Anticorrosion Concentrate for Ground Source Heat Pump Systems

TYFOCOR® GE

Characteristics of Tyfocor® GE Concentrate

Appearance	Clear, blue green liquid	
Boiling point	>175 °C	ASTM D 1120
Pour point	-18 °C	DIN ISO 3016
Density (20 °C)	1.10-1.13 g/cm^3	DIN 51757
Refraction nD20	1.430-1.439	DIN 51423
pH value (20 °C)		
-Concentrate	8.4-8.7	ASTM D 1287
-33 Vol. %	7.7-8.5	ASTM D 1287
Viscosity (20 °C)	24-28 mm^2/s	DIN 51562
Reserve alkalinity	>5.5 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® GE is a clear, blue green liquid with a faint odour and is based on ethylene glycol. It is miscible with water in all proportions. It's mixtures with water protect against frost at temperatures down to -52 °C, depending on their concentration. Tyfocor® GE / water mixtures do not separate.

The corrosion inhibitors of Tyfocor® GE reliably protect all metals and alloys normally used for Ground Source Heat Pumps even in mixed installations for long periods against corrosion, ageing and fouling. The inhibitor system of Tyfocor® GE neither contains borax nor nitrites, phosphates, nor amines.

Miscibility

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

Application

The concentration of Tyfocor® GE must be at least 20 volume percent in water (drinking water quality with a maximum chloride content of 100 mg/kg, or distilled water). The protection against frost deteriorates if the Tyfocor® GE concentration exceeds 60 percent by volume.

Antifreeze Effect

Tyfocor® GE Concentrate	Freeze point	Density (20°C)	Refraction nD20
10 Vol. %	-3 °C	1.015 g/cm^3	1.3451
20 Vol. %	-8 °C	1.028 g/cm^3	1.3545
23 Vol. %	-10 °C	1.032 g/cm^3	1.3575
30 Vol. %	-15 °C	1.041 g/cm^3	1.3645
35 Vol. %	-19 °C	1.048 g/cm^3	1.3670
40 Vol. %	-24 °C	1.056 g/cm^3	1.3754
50 Vol. %	-37 °C	1.069 g/cm^3	1.3862
60 Vol. %	-52 °C	1.080 g/cm^3	1.3951

In order to maintain effective protection from corrosion, the concentration of Tyfocor® GE must not be allowed to fall below 20 volume percent. Lower concentrations are insufficient and incur the risk of corrosion.

Anticorrosion Effect

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

Material	Average change of weight
Copper (SF Cu)	- 0.27 g/m^2
Soft Solder (L Sn 30)	- 0.28 g/m^2
Brass (MS 63)	- 0.20 g/m^2
Cast Iron (GG26)	± 0.00 g/m^2
Steel (HI)	± 0.00 g/m^2
Cast Aluminium (G AlSi6Cu4)	- 0.07 g/m^2

Compatibilities with Sealing Materials

Mixtures of Tyfocor® GE and water do not attack the sealants normally used for Ground Source Heat Pump Systems. The following list of sealants, elastomers and plastics that are resistant to Tyfocor® GE / water mixtures has been compiled from experimental results, experience, and the literature.

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

Butyl rubber	IIR
Chloroprene	CR
Ethylene-propylene-dien-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
Silcone 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 Tyfocor® GE / water mixtures is checked by performance tests before these

elastomers are taken into use for the first time. This applies particularly to elastomers intended as membranes for expansion tanks as described in DIN EN 12828 and DIN 4807 Part 2, respectively.

In some cases, the low surface tension of Tyfocor® GE / water mixtures may be responsible for leakage if the sealing strips have been produced from polytetrafluoroethylene (PTFE).

Application Guidelines

In view of the specific properties of Tyfocor® GE, the following application guidelines must be observed to achieve long-term protection for the installations.

1. Brine circuits must be designed as closed systems, 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 to be utilised preferably on joints. Fluxes used in combination with soft solder usually contain chlorides. Their residues must be removed from the brine circuit by thorough flushing. Otherwise an increased content of chlorides in the fluid may lead to pitting corrosion on e. g. 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 layout of the piping must ensure that circulation cannot be disturbed by gas pockets or deposits.

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

7. Dirt, soil and water must not be allowed to enter the Ground Source Heat Pump system during the installation of the probes. After the assembly has been completed, the brine circuit must be thoroughly flushed to remove any foreign matter (swarf, fluxes, packaging residues, etc.) and assembly aids before the system is finally filled with the Tyfocor® GE / water mixture.

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

9. 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 low may occur due to deposits in any part of the installation.

10. After the system has been filled, the concentration of the Tyfocor® GE / water mixture should 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 Tyfocor® GE content is to measure the refractive index by using a hand-held refractometer. A summary of densities and refractive indices of Tyfocor® GE / water mixtures as a function of concentration can be found on page 1 of this leaflet.

11. If leakages or other losses occur, the heat transfer liquid in the system must be replenished with an aqueous Tyfocor® GE solution of the same concentration. In cases of doubt, the Tyfocor® GE content must be determined via density or refractive index as described in section 10.

Storage stability

Tyfocor® GE has a shelf life of at least three years in airtight containers. It should not be stored in galvanised containers, because zinc is detached by glycol / water mixtures.

Delivery Form and Packaging

Tyfocor® GE is available as a concentrate or ready-mix according to customer's specification. It is supplied in road tankers, in 1000 litre IBCs, in 200 litre drums, and in 30, 20 and 10 litre non-returnable plastic cans.

Disposal

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

Ecology

Tyfocor® GE 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). Tyfocor® GE is readily biodegradable.

Handling

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

Safety Data Sheet

A Safety Data Sheet has been drawn up for Tyfocor® GE in accordance with EC Directive 1907/2006/EC [REACH].

Density of TYFOCOR® GE / water mixtures [g/cm³]

as a function of temperature and concentration

T [°C]	20 Vol. %	23 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
100	0.984	0.987	0.994	1.001	1.009	1.016	1.018	1.021	1026
90	0.991	0.994	1.001	1.008	1.016	1.022	1.025	1.029	1034
80	0.998	1.001	1.008	1.015	1.022	1.029	1.032	1.036	1041
70	1.004	1.007	1.014	1.021	1.029	1.035	1.039	1.043	1048
60	1.010	1.013	1.021	1.024	1.035	1.041	1.046	1.050	1055
50	1.015	1.018	1.026	1.033	1.040	1.047	1.052	1.056	1062
40	1.020	1.024	1.032	1.038	1.046	1.052	1.058	1.062	1068
30	1.024	1.028	1.037	1.044	1.051	1.058	1.063	1.068	1074
20	1.028	1.032	1.041	1.048	1.056	1.063	1.069	1.074	1.080
10	1.031	1.036	1.045	1.053	1.061	1.066	1.074	1.080	1086
0	1.034	1.038	1.049	1.057	1.065	1.073	1.079	1.085	1092
-10	-8: 1.035	1.041	1.052	1.060	1.069	1.077	1.084	1.090	1097
-20	-	-	-15: 1.054	-19: 1.064	1.073	1.082	1.089	1.095	1103
-30	-	-	-	-	-24: 1.074	1.087	1.094	1.101	1108
-40	-	-	-	-	-	-	-37: 1.097	1.107	1114

Specific heat capacity of TYFOCOR® GE / water mixtures [J/g·K]

as a function of temperature and concentration

T [°C]	20 Vol. %	23 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
100	4.0	4.06	4.00	3.94	3.84	3.76	3.70	3.62	3.56
90	4.08	4.07	4.00	3.94	3.83	3.75	3.67	3.60	3.53
80	4.08	4.06	3.99	3.93	3.82	3.73	3.65	3.57	3.50
70	4.07	4.06	3.99	3.92	3.80	3.70	3.61	3.53	3.46
60	4.06	4.05	3.97	3.90	3.78	3.67	3.58	3.49	3.42
50	4.05	4.03	3.96	3.88	3.75	3.54	3.53	3.45	3.38
40	4.03	4.01	3.94	3.86	3.71	3.59	3.49	3.40	3.33
30	4.01	3.99	3.91	3.83	3.67	3.55	3.43	3.35	3.28
20	3.99	3.96	3.88	3.79	3.63	3.49	3.38	3.29	3.22
10	3.96	3.93	3.85	3.75	3.58	3.44	3.31	3.22	3.16
0	3.92	3.89	3.81	3.70	3.52	3.37	3.25	3.16	3.09
-10	-8: 3.89	3.85	3.76	3.65	3.46	3.31	3.17	3.08	3.02
-20	-	-	-15: 3.74	-19: 3.60	3.40	3.23	3.10	3.01	2.94
-30	-	-	-	-	-24: 3.37	3.14	3.01	2.92	2.86
-40	-	-	-	-	-	-	-37: 2.94	2.83	2.77

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

as a function of temperature and concentration

T [°C]	20 Vol. %	23 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
100	0.605	0.590	0.560	0.533	0.500	0.475	0.454	0.437	0.415
90	0.593	0.579	0.550	0.524	0.492	0.468	0.447	0.430	0.410
80	0.582	0.568	0.539	0.514	0.484	0.461	0.441	0.424	0.404
70	0.571	0.557	0.529	0.505	0.476	0.453	0.434	0.418	0.399
60	0.559	0.546	0.518	0.495	0.468	0.446	0.427	0.412	0.394
50	0.548	0.535	0.508	0.486	0.460	0.439	0.421	0.406	0.389
40	0.536	0.524	0.497	0.476	0.452	0.432	0.414	0.400	0.384
30	0.525	0.513	0.487	0.467	0.444	0.425	0.407	0.394	0.378
20	0.514	0.502	0.476	0.457	0.436	0.418	0.401	0.388	0.373
10	0.502	0.491	0.466	0.448	0.429	0.411	0.394	0.382	0.368
0	0.491	0.487	0.455	0.438	0.421	0.404	0.387	0.376	0.363
-10	-8: 0.482	0.470	0.445	0.429	0.413	0.396	0.381	0.369	0.358
-20	-	-	-15: 0.440	-19: 0.420	0.405	0.389	0.374	0.363	0.353
-30	-	-	-	-	-24: 0.401	0.381	0.367	0.357	0.347
-40	-	-	-	-	-	-	-37: 0.362	0.351	0.342

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

as a function of temperature and concentration

T [°C]	20 Vol. %	23 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
100	0.47	0.50	0.55	0.60	0.63	0.72	0.74	0.78	0.82
90	0.51	0.54	0.59	0.65	0.68	0.77	0.83	0.88	0.92
80	0.57	0.60	0.65	0.71	0.76	0.86	0.95	1.08	1.05
70	0.64	0.68	0.75	0.81	0.87	0.99	1.12	1.22	1.25
60	0.75	0.79	0.88	0.96	1.04	1.18	1.36	1.49	1.53
50	0.90	0.95	1.06	1.17	1.28	1.46	1.68	1.85	1.96
40	1.10	1.17	1.32	1.46	1.64	1.88	2.14	2.37	2.60
30	1.39	1.48	1.68	1.89	2.18	2.50	2.81	3.13	3.59
20	1.80	1.93	2.22	2.52	3.00	3.44	3.82	4.28	5.17
10	2.40	2.59	3.00	3.46	4.27	4.95	5.42	6.13	7.78
0	3.29	3.56	4.19	4.92	6.31	7.43	8.13	9.32	12.30
-10	-8: 4.31	5.04	6.02	7.21	9.67	11.70	13.10	15.30	20.60
-20	-	-	-15: 7.40	-19: 10.5	15.30	19.40	23.10	27.90	36.80
-30	-	-	-	-	-24: 18.80	33.90	45.70	57.90	71.10
-40	-	-	-	-	-	-	-37: 83.81	140.42	150.0

Prandtl number of TYFOCOR® GE / water mixtures

as a function of temperature and concentration

T [°C]	20 Vol. %	23 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
100	3.14	3.40	3.87	4.42	4.92	5.77	6.13	6.57	7.21
90	3.50	3.79	4.30	4.89	5.41	6.35	6.99	7.60	8.16
80	3.97	4.30	4.89	5.54	6.11	7.17	8.15	8.95	9.47
70	4.62	4.99	5.71	6.45	7.14	8.36	9.72	10.77	11.34
60	5.50	5.96	6.86	7.76	8.67	10.11	11.86	13.23	14.07
50	6.72	7.29	8.48	9.63	10.87	12.67	14.85	16.63	18.19
40	8.44	9.18	10.76	12.30	14.12	16.42	19.06	21.42	24.13
30	10.87	11.85	14.03	16.17	18.97	22.03	25.17	28.40	33.43
20	14.38	15.72	18.80	21.88	26.33	30.62	34.37	38.98	48.17
10	19.51	21.90	25.40	30.52	37.83	44.22	48.94	55.92	77.45
0	27.16	29.92	36.7	43.93	56.32	66.63	73.52	85.01	114.3
-10	-8: 36.07	42.99	53.55	65.12	86.79	105.20	118.4	139.4	190.8
-20	-	-	-15: 66.30	-19: 95.76	137.6	174.30	208.3	252.7	333.8
-30	-	-	-	-	-24: 169.7	303.69	410.1	521.3	649.0
-40	-	-	-	-	-	-	-37:746.7	1253.3	1356.0

Cubic Expansion Coefficient of TYFOCOR® GE / water mixtures [x 10-5/K]

as a function of temperature and concentration

T [°C]	20 Vol. %	23 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
100	72	73	72	70	65	66	74	77	76
90	68	69	70	67	63	63	70	73	73
80	64	65	66	64	61	61	67	69	70
70	60	61	62	61	59	59	64	66	67
60	55	56	58	58	56	57	61	63	64
50	50	52	54	54	54	55	58	60	61
40	45	47	50	51	52	53	55	57	59
30	40	42	45	47	49	50	53	55	57
20	34	36	41	44	46	48	51	53	55
10	28	31	36	40	43	46	49	51	53
0	22	25	31	36	41	44	47	49	52
-10	-8: 16	19	27	32	38	42	45	48	51
-20	-	-	-15: 25	-15: 28	35	40	44	47	50
-30	-	-	-	-	-24: 33	38	43	46	49
-40	-	-	-	-	-	-	-37:43	45	49

Vapour pressure of TYFOCOR® GE / water mixtures [bar]
as a function of temperature and concentration

T [°C]	20 Vol. %	23 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
180	9.28	9.13	8.82	8.54	8.20	7.84	7.44	7.09	6.62
170	7.34	7.24	6.98	6.76	6.50	6.22	5.91	5.63	5.26
160	5.73	5.65	5.45	5.29	5.08	4.87	4.63	4.42	4.12
150	4.42	4.35	4.20	4.08	3.92	3.77	3.58	3.42	3.19
140	3.35	3.31	3.19	3.10	2.98	2.87	2.93	2.60	2.43
130	2.50	2.47	2.39	2.32	2.23	2.15	2.04	1.95	1.82
120	1.84	1.81	1.75	1.70	1.64	1.58	1.50	1.44	1.34
110	1.32	1.31	1.26	1.23	1.18	1.14	1.08	1.04	0.970
100	0.935	0.922	0.890	0.864	0.834	0.803	0.765	0.733	0.686
90	0.645	0.635	0.613	0.595	0.574	0.553	0.527	0.505	0.473
80	0.434	0.427	0.412	0.400	0.385	0.371	0.354	0.340	0.318
70	0.284	0.279	0.269	0.261	0.251	0.242	0.231	0.221	0.208
60	0.180	0.177	0.170	0.165	0.158	0.152	0.146	0.140	0.131
50	0.110	0.108	0.104	0.100	0.096	00.93	0.089	0.085	0.080
40	0.065	0.064	0.061	0.054	0.056	00.54	0.052	0.050	0.047
30	0.037	0.036	0.034	0.033	0.031	0.030	0.029	0.028	0.026

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.

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