Technical Information

Antifreeze and Anticorrosion Concentrate for Heating and Cooling Circuits in Food and Beverage Industry, for Thermal Solar and Heat Pump Systems

- based on Renewable Resources

TYFOCOR® L *eco*

Characteristics of Tyfocor® L-*eco* Concentrate

Appearance	clear, colourless liquid	
Boiling point	> 150 °C	ASTM D 1120
Pour point	< -50 °C	DIN ISO 3016
Density (20 °C)	1.044–1.048 g/cm^3	DIN 51757
Viscosity (20 °C)	70–80 mm^2/s	DIN 51562
Refraction nD20	1.410–1.450	DIN 51423
pH value (20 °C)		
- concentrate	8.0–9.0	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	> 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® L-*eco* is a virtually odourless, hygroscopic liquid. It is based on toxicologically unobjectionable propylene glycol, which has been obtained from renewable resources.

Tyfocor® L-*eco* thus may be used as a coolant or heat-transfer fluid in food processing and water purification applications.

The corrosion inhibitors of Tyfocor® L-*eco* reliably protect the metals normally used in heating and cooling systems as well as in solar technology against corrosion, ageing and deposits over long periods. Tyfocor® L-*eco* maintains the surfaces of heat exchangers clean, and ensures consistently high thermal efficiency of the system.

Tyfocor® L-*eco* is miscible with water in all proportions. It's mixtures with water protect against frost at temperatures down to -51 °C, depending on their concentration. Water hardness constituents do not affect the performance of the product, and do not lead to precipitation from aqueous solutions of Tyfocor® L-*eco*. Mixtures of Tyfocor® L-*eco* and water do not separate. The product neither contains borax nor nitrites, phosphates, nor amines.

Miscibility

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

Application

Tyfocor® L-*eco* / water mixtures are used as brines for cooling and heating circuits in the food and beverage industry, as heat transfer fluids for solar thermal systems and heat pump installations, and as antifreeze for sprinkler systems. Neutral water (potable water quality with a maximum chloride content of 100 mg/kg) or demineralised water must be used for aqueous solutions of Tyfocor® L-*eco*.

In order to prevent the systems from corrosion, the following minimum and maximum concentrations of Tyfocor® L-*eco* must be observed:

in solar installations: 40-75 vol. % Tyfocor® L-*eco*
in other installations: 25-75 vol. % Tyfocor® L-*eco*

Temperature Stability in Solar Installations

Sustained temperatures higher than 170 °C cause premature ageing of Tyfocor® L-*eco*. For solar thermal systems with stagnation temperatures above 170 °C it is therefore recommended to choose expansion vessels of sufficient size to ensure that the solar medium will be taken up completely in case of stagnation. The heat-transfer fluid begins to undergo irreversible chemical changes at temperatures higher than 200 °C, with the result that the reliability of the system may be endangered.

Antifreeze Effect, Density, Refractive index

Tyfocor® L-*eco* Concentrate	Anti-freeze*	Density (at 20 °C)	Refractive index nD20
25 Vol. %	-10.7 °C	1020 kg/m^3	1.3618
30 Vol. %	-14.5 °C	1026 kg/m^3	1.3679
35 Vol. %	-18.9 °C	1031 kg/m^3	1.3738
40 Vol. %	-24.0 °C	1035 kg/m^3	1.3795
45 Vol. %	-29.4 °C	1038 kg/m^3	1.3836
50 Vol. %	-36.6 °C	1042 kg/m^3	1.3898
55 Vol. %	-49.5 °C	1045 kg/m^3	1.3954
60 Vol. %	-51.0 °C	1047 kg/m^3	1.4000

*Antifreeze = Freezing point, see also page 7.

Anticorrosion Effect

The following table demonstrates the anticorrosion effect of a 33 vol. % Tyfocor® L-*eco* / water mixture after 14 days 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)	– 0.28 g/m^2
Soft solder (L Sn 30)	– 0.30 g/m^2
Brass (MS 63)	– 0.20 g/m^2
Cast Iron (GG 26)	± 0.00 g/m^2
Steel (HI)	± 0.00 g/m^2
Cast Aluminium (GAlSi6Cu4)	– 0.10 g/m^2

Compatibility with Sealing Materials

Tyfocor® L-*eco* / water mixtures do not attack the sealants that are normally used in heating and cooling systems as well as in solar technology. The following table of sealants, elastomers and plastics that are resistant to Tyfocor® L-*eco* / water mixtures has been compiled from experimental results, experience, and literature data:

Examples of sealants are Fermit®, Fermitol® (registered trademarks of Nissen & Volk GmbH, Hamburg, Germany), and 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 Tyfocor® L-*eco* / 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.

Application Guidelines

In view of the specific properties of Tyfocor® L-*eco,* 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. The systems must not be equipped with internally galvanised heat exchangers, tanks or pipes, because zinc can be detached by propylene glycol / water mixtures.

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

4. 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 to pitting corrosion on e. g. stainless steel.

5. Chemically speaking, Tyfocor® L-*eco* / water mixtures are largely inert. It is important, however, to ensure that the manufacturer's recommendations state that all the sealants and connector materials used in solar thermal systems are resistant to temperatures up to the maximum stagnation temperature.

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

7. It must be ensured that no external voltages are applied between parts of the system that will come into contact with the Tyfocor® L-*eco* solution. At most, an external voltage of no more than 1.5 volts may be applied to components made of copper or copper alloys.

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

9. 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.

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

11. Scaling on copper surfaces must be removed from the system before filling. Otherwise, these particles will be removed from the hot heat-transfer fluid and transported into other areas of the system, which may subsequently lead to formation of deposits and obstruction of the fluid flow rate.

12. 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 according to DIN 18380, the circuit should be completely drained and filled immediately with the Tyfocor® L-*eco* / water mixture, even if the plant is put into operation at a later date, in order to protect the circuit from corrosion.

13. 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.

14. 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.

15. The concentration of the Tyfocor® L-*eco* / water mixture can be checked by measuring the fluid density with a hydrometer or an antifreeze tester suitable for propylene glycol / water mixtures. An equally convenient and accurate way to determine

the content of Tyfocor® L-*eco* is to measure the refractive index by a hand-held refractometer. A summary of the freezing points, densities and refractive indices of Tyfocor® L-*eco* / water mixtures can be found on page 1 of this leaflet.

16. If losses occur due to evaporation, the system can be topped up with neutral potable or demineralised water. Losses caused by leakage or removal from the system must be replaced by a mixture of Tyfocor® L-*eco* and potable or demineralised water of equal content. In cases of doubt, the content of Tyfocor® L-*eco* must be determined via density or refractive index as described under **15**.

Storage Stability

Tyfocor® L-*eco* 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® L-*eco* 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 60, 30, 20 and 10 litre non-returnable plastic cans.

Disposal

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

Ecology

Tyfocor® L-*eco* 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.

Handling

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

Safety Data Sheet

A Safety Data Sheet has been compiled for Tyfocor® L-*eco* in accordance with EC Directive 1907/2006/EC [REACH].

Density of TYFOCOR® L-*eco* / water mixtures [kg/m^3]
as a function of temperature and concentration

T [°C]	25 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
120	958	963	962	965	966	971	969	971
110	965	969	970	973	974	978	976	979
100	972	976	977	981	982	985	984	987
90	979	983	986	989	990	993	992	995
80	986	990	994	996	997	1000	1000	1003
70	993	997	1001	1003	1005	1008	1008	1011
60	1000	1004	1007	1010	1012	1015	1016	1019
50	1006	1010	1014	1017	1019	1022	1024	1026
40	1011	1016	1020	1023	1025	1029	1031	1033
30	1016	1021	1026	1029	1032	1036	1038	1040
20	1020	1026	1031	1035	1038	1042	1045	1047
10	1024	1030	1036	1040	1044	1048	1051	1054
0	1027	1034	1040	1045	1049	1054	1057	1061
-10	1029	1037	1044	1050	1054	1060	1064	1067
-20	-	-	-	1054	1059	1065	1070	1074
-30	-	-	-	-	-	1070	1075	1080
-40	-	-	-	-	-	-	1080	1087
-50	-	-	-	-	-	-	-	1094

Specific heat capacity of TYFOCOR® L-*eco* / water mixtures [kJ/kg·K]
as a function of temperature and concentration

T [°C]	25 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
120	4.152	4.138	4.085	4.022	3.949	3.866	3.753	3.641
110	4.132	4.108	4.055	3.982	3.909	3.816	3.714	3.601
100	4.112	4.078	4.015	3.952	3.869	3.776	3.674	3.562
90	4.082	4.048	3.985	3.912	3.830	3.737	3.634	3.522
80	4.062	4.019	3.955	3.883	3.790	3.697	3.595	3.483
70	4.032	3.989	3.916	3.843	3.750	3.658	3.555	3.443
60	4.012	3.959	3.886	3.803	3.710	3.608	3.506	3.403
50	3.982	3.919	3.846	3.763	3.671	3.568	3.466	3.364
40	3.962	3.889	3.816	3.734	3.631	3.529	3.426	3.324
30	3.933	3.859	3.776	3.694	3.591	3.489	3.387	3.285
20	3.913	3.830	3.747	3.654	3.552	3.449	3.347	3.245
10	3.883	3.790	3.707	3.615	3.512	3.400	3.308	3.206
0	3.863	3.760	3.677	3.585	3.472	3.360	3.268	3.166
-10	3.833	3.730	3.637	3.545	3.433	3.321	3.219	3.126
-20	-	-	-	3.505	3.393	3.281	3.179	3.087
-30	-	-	-	-	-	3.241	3.139	3.048
-40	-	-	-	-	-	-	3.100	3.008
-50	-	-	-	-	-	-	-	2.966

Thermal conductivity of TYFOCOR® L-*eco* / water mixtures [W/m·K]
as a function of temperature and concentration

T [°C]	25 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
120	0.686	0.648	0.604	0.560	0,529	0.503	0.478	0.453
110	0.662	0.625	0.584	0.542	0.511	0.486	0.463	0.438
100	0.637	0.602	0.563	0.524	0.494	0.469	0.447	0.424
90	0.613	0.580	0.544	0.507	0.478	0.453	0.432	0.410
80	0.589	0.557	0.524	0.490	0.461	0.437	0.417	0.396
70	0.566	0.535	0.504	0.472	0.445	0.422	0.403	0.382
60	0,542	0.512	0.484	0.455	0.430	0.408	0.388	0.369
50	0,517	0.490	0.463	0.437	0.414	0.393	0.374	0.355
40	0,493	0.468	0.443	0.419	0.398	0.379	0.360	0.342
30	0.469	0.445	0.423	0.402	0.382	0.365	0.347	0.329
20	0.445	0.423	0.403	0.385	0.367	0.350	0.333	0.316
10	0.421	0.400	0.384	0.367	0.351	0.336	0.319	0.302
0	0.397	0.378	0.364	0.350	0.335	0.321	0.304	0.288
-10	0.372	0.355	0.343	0.332	0.319	0.306	0.289	0.275
-20	-	-	-	0.314	0.303	0.291	0.275	0.261
-30	-	-	-	-	-	0.276	0.261	0.247
-40	-	-	-	-	-	-	0.246	0.233
-50	-	-	-	-	-	-	-	0.219

Kinematic viscosity of TYFOCOR® L-*eco* / water mixtures [mm²/s]
as a function of temperature and concentration

T [°C]	25 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
120	0.43	0.48	0.50	0.51	0.52	0.56	0.61	0.64
110	0.48	0.54	0.58	0.61	0.66	0.73	0.81	0.88
100	0.54	0.60	0.66	0.74	0.80	0.92	1.04	1.15
90	0.61	0.68	0.77	0.87	1.02	1.12	1.29	1.44
80	0.69	0.77	0.88	1.01	1.15	1.34	1.55	1.76
70	0.79	0.90	1.04	1.20	1.36	1.61	1.88	2.14
60	0.93	1.07	1.25	1.44	1.65	1.95	2.29	2.64
50	1.13	1.31	1.54	1.79	2.04	2.45	2.89	3.33
40	1.42	1.68	1.96	2.30	2.66	3.19	3.79	4.42
30	1.86	2.23	2.65	3.13	3.64	4.42	5.28	6.22
20	2.56	3.12	3.78	4.52	5.34	6.56	7.94	9.46
10	3.71	4.61	5.74	7.07	8.48	10.61	13.07	15.86
0	5.73	7.27	9.41	12.04	14.80	18.99	23.92	29.60
-10	9.49	12.20	16.72	22.60	28.68	37.98	49.50	62.55
-20	-	-	-	47.21	62.79	86.53	117.4	154.1
-30	-	-	-	-	-	227.7	324.5	446.8
-40	-	-	-	-	-	-	1065	1545
-50	-	-	-	-	-	-	-	6330

Prandtl number of TYFOCOR® L-*eco* / water mixtures
as a function of temperature and concentration

T [°C]	25 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
120	2.49	2.95	3.25	3.53	3.75	4.33	4.64	5.17
110	2.89	3.44	3.91	4.36	4.92	5.72	6.34	7.08
100	3.39	3.97	4.60	5.48	6.15	7.30	8.41	9.54
90	3.98	4.67	5.56	6.64	8.09	9.17	10.76	12.31
80	4.69	5.50	6.60	7.97	9.43	11.34	13.36	15.53
70	5.59	6.69	8.09	9.80	11.52	14.07	16.72	19.50
60	6.88	8.31	10.11	12.16	14.41	17.51	21.02	24.81
50	8.76	10.58	12.97	15.68	18.43	22.73	27.43	32.38
40	11.54	14.18	17.22	20.97	24.87	30.56	37.19	44.38
30	15.85	19.74	24.27	29.60	36.07	43.77	53.50	64.59
20	22.96	28.98	36.24	44.40	50.75	67.36	83.40	101.7
10	35.04	44.99	57.41	72.43	88.58	112.5	142.5	177.5
0	57.26	74.18	98.86	128.9	154.0	209.5	271.8	345.2
-10	100.6	132.9	185.1	253.4	325.3	436.9	586.6	758.7
-20	-	-	-	555.4	744.6	1039	1452	1958
-30	-	-	-	-	-	2861	4195	5955
-40	-	-	-	-	-	-	14494	21681
-50	-	-	-	-	-	-	-	93788

Cubic expansion coefficient of TYFOCOR® L-*eco* / water mixtures [●10^{-5}/K]
as a function of temperature and concentration

T [°C]	25 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
120	73	74	77	87	87	87	92	94
110	72	73	76	84	85	84	89	90
100	71	72	75	81	82	82	85	87
90	70	71	73	78	79	79	82	83
80	68	69	71	75	76	77	79	80
70	65	67	68	71	73	74	76	77
60	61	64	65	67	70	71	74	74
50	57	60	62	63	67	69	71	72
40	51	56	58	60	63	66	69	70
30	46	51	54	56	60	63	66	68
20	39	45	49	53	57	61	64	66
10	32	38	44	49	53	58	62	64
0	24	31	38	45	50	54	60	63
-10	15	23	32	41	47	52	58	62
-20	-	-	-	38	44	49	56	61
-30	-	-	-	-	-	46	55	61
-40	-	-	-	-	-	-	53	60
-50	-	-	-	-	-	-	-	59

Example for calculating the volume expansion:

What would be the increase in volume (in litres) if V_0 = 80 l of a 30 % vol. TYFOCOR® L-*eco* / 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.) = $56 \cdot 10^{-5}$

$\Delta V = ß_{average} \cdot \Delta t \cdot V_0 = 56 \cdot 10^{-5} \cdot 100 \cdot 80 = 4.48$ litres increase in volume.

Vapour pressure of TYFOCOR® L-*eco* / water mixtures [bar]
as a function of temperature and concentration

T [°C]	25 Vol. %	30 Vol. %	35 Vol. %	40 Vol. %	45 Vol. %	50 Vol. %	55 Vol. %	60 Vol. %
180	9.720	9.590	9.440	9.280	9.060	8.740	8.400	8.060
170	7.650	7.540	7.410	7.280	7.100	6.860	6.590	6.330
160	5.940	5.850	5.750	5.650	5.51	5.320	5.110	4.910
150	4.560	4.490	4.410	4.330	4.220	4.070	3.910	3.760
140	3.450	3.390	3.340	3.280	3.200	3.080	2.960	2.850
130	2.580	2.540	2.490	2.440	2.380	2.300	2.210	2.130
120	1.890	1.860	1.830	1.790	1.750	1.690	1.620	1.560
110	1.360	1.340	1.310	1.290	1,.260	1.220	1.170	1.130
100	0,966	0,949	0.932	0.916	0.890	0.864	0.833	0.804
90	0.669	0.659	0.648	0.635	0.621	0.602	0.580	0.561
80	0.454	0.447	0.440	0.432	0.422	0.410	0.396	0.384
70	0.300	0.296	0.292	0.287	0.281	0.274	0.264	0.257
60	0.193	0.191	0.189	0.186	0.182	0.177	0.172	0.167
50	0.121	0.119	0.118	0.117	0.115	0.112	0.109	0.107
40	0.073	0.073	0.072	0.072	0.070	0.069	0.067	0.066
30	0.043	0.043	0.043	0.042	0.042	0.041	0.041	0.040

Antifreeze effect of TYFOCOR® L-*eco* / water mixtures

The **freezing point**, colloquially called “antifreeze”, is a measure for the freezing-point depression of antifreeze fluids. When a given TYFOCOR® L-*eco* / water mixture will be 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 TYFOCOR® L-*eco* / water mixtures as a function of the concentration:

TYFOCOR® L-*eco* Concentrate	Freezing point (acc. ASTM D 1177)	Frost protection (calculated)	Pour point (acc. DIN 51583)
25 Vol. %	-10.7 °C	-11.5 °C	-12.3 °C
30 Vol. %	-14.5 °C	-15.5 °C	-16.5 °C
35 Vol. %	-18.9 °C	-20.3 °C	-21.7 °C
40 Vol. %	-24.0 °C	-26.2 °C	-28.5 °C
45 Vol. %	-29.4 °C	-33.0 °C	-36.7 °C
50 Vol. %	-36.6 °C	-42.4 °C	-48.2 °C
55 Vol. %	-49.5 °C	< -50 °C	< -50 °C
60 Vol. %	-51.0 °C	< -50 °C	< -50 °C

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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Edition 2012

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