Product Sheet
HEAT TRANSFER FLUIDS

ANTIFROGEN® N

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ISSUE
June 2014

THE UNIVERSAL HEAT TRANSFER FLUID, ANTIFREEZE AND CORROSION INHIBITOR FOR REFRIGERATION, HEAT PUMP, HOT WATER HEATING SYSTEMS, CLIMATE SYSTEMS, HEAT RECOVERY, RAIL VEHICLES, LEAK DETECTION FLUID, WIND POWER MASCHINES, ETC.

Product description

Antifrogen® N is a liquid, tinted pale yellow, for use as a heat transfer medium in closed hot water heating systems, heat pumps and as cooling brine in industrial refrigeration equipment. Antifrogen® N is not suitable for the use in food or pharmaceutical applications. Alternatively, the use of Antifrogen® L is recommended. The product is inhibited without the use of nitrites-, amines-, borates-, silicates- and phosphates. The optimization of the corrosion inhibition system was performed without the use of CMR-substances (cancerogenic, mutagenic, reprotoxic).

According to the formulation Antifrogen® N doesn't contain any restricted substances as described in the EG-guideline 2011/65/EU (**RoHS** = Restriction of Hazardous Substances, Artikel 4 §1): Lead, mercury, hexavalent chromium, polybrominated biphenyl (PBB) respectively polybrominated diphenyl ether (PBDE).

Declaration of Reach-Conformity

Clariant declares that all of its products marketed in the EU, i.e. substances, preparations or sarticles within meaning the Article 3, Section 1-3 of Regulation (EC) 1907/2006 of the European Parliament and the Council of 18.12.2006 (REACH), hereinafter referred to as „substances" are delivered in accordance with all applicable chemical laws, with special references to the Reach Regulations (EC).

- Based on monoethylene glycol
- Including anticorrosion additives
- Minimal usage concentration: 20 % v/v (frost protection : -9 to -10 °C)
- Permanent usage temperatures*: approx -50 to +150 °C
- All-purpose heat transfer fluid

* Considering increased kinematic viscosity even lower permanent usage temperatures are possible

You can find further information regarding the products on our homepage www.antifrogen.com.

Technical data:

Density at 20 °C (DIN 51757)	g/cm³	approx. 1.11
Refractive index at 20 °C (DIN 51423, Teil 2)	-	approx. 1.434
pH-value (Antifrogen® N : Wasser = 1:2, DIN 51369)	-	approx. 8.5
Reserve alcalinity (ASTM D 1121)	ml c (HCl) 0.1 m	min. 4
Boiling point at 1013 mbar (ASTM D 1120)	°C	approx. 166
Pour point (DIN 51583)	°C	approx. -32
Kinematic viscosity at 20 °C (DIN 51562)	mm²/s	approx. 20
Surface tension at 20 °C (Antifrogen® N : water = 1:2, ASTM D 1331)	mN/m	approx. 34
Spec. el. conductivity at 25 °C (Antifrogen® N : water = 1:2)	µS/cm	approx. 2,800
Specific heat at 20 °C	kJ/kg · K	approx. 2.4
Thermal conductivity at 20 °C	W/m · K	approx. 0.29

Product properties

The certified quality system in accordance with DIN EN ISO 9001 is used in production and quality control. This ensures consistently high product quality.

The technical data below are used to describe the product and is taken from our own measurements or from literature. It does not constitute part of the delivery specification. The actual product specification may be obtained upon request.

Application properties and general application indications

Antifrogen® N was developed for use as a heat transfer and refrigerating medium. Its antifreeze action is based on monoethylene glycol, which with its high boiling point of about 198 °C prevents loss by evaporation.

Some information on the individual fields of application is given below:

Hot water heating systems

The advantage of using Antifrogen® N in closed hot water heating systems is that the entire system or parts of it can be turned off even at subzero temperatures but is ready to be started up at any time. This results in a considerable saving in fuel costs in building which do not have to be heated all the time, e. g. weekend houses, churches and schools.

Protection from freezing down to -20 °C should be adequate in our climate even if parts of the heating pipe work are installed in the external walls of the building. Antifrogen® N has also proved successful as an antifreeze and corrosion inhibitor in under floor hot water heating systems in combination with pipes made of plastic. In plastic pipes without an oxygen diffusion barrier the minimum concentration of Antifrogen® N should be 25 % v/v.

After the entire system has been completely drained of the previous heat transfer medium, it should be thoroughly rinsed through with water to flush out loose rust particles. Rinsing affords an opportunity to ascertain the contents of the system by reading the water meter.

Minor leaks – possible corrosion damage – in heating systems may become apparent after changing over to Antifrogen® N/water mixtures. These have a lower surface tension than water. If tightening the connections does not cure the problem in such cases, the part of the system in question must be drained and the Antifrogen® N/water mixture collected. Besides renewing the sealing material the heating engineer should also ensure that the pipe connections are technically satisfactory.

Heat pump systems

In heat pumps Antifrogen® N is used as the heat transfer medium in external circuits. The Antifrogen® N/water mixture transfers heat to the internal circuit of the heat pump. To prevent corrosion, the Antifrogen® N concentration should not be less than 20 % v/v.

Heat recovery systems

Antifrogen® N/water mixtures are also used in circulating heat recovery systems if the possibility of exposure to frost cannot be ruled out.

Refrigeration circuits

Antifrogen® N has a dual function as a refrigerating medium. The aqueous solution must remain liquid at the specified brine temperature and protect any metal components in the refrigeration system from corrosion.

Refrigeration systems previously operated with salt based cooling brine must be thoroughly flushed with water to remove traces of salt and rust particles. If chloride-rich brines have been used, flushing must be carried out with particular care because any residues in the system tend to impair the corrosion-inhibiting effect of Antifrogen® N.

If only one of several secondary circuits is converted to Antifrogen® N, while the others continue to be operated with the previous brine, both coolants must be kept completely separate. Installation of a blanking-off disc is not an adequate guarantee of this in the long term.

Gravity systems

For pure gravity systems, Antifrogen® N must be mixed with water before. This is recommended even if immediate frost protection is required.

Antifrogen® N as leak detection fluid

We supply Antifrogen® N as a leak detection fluid for double-walled tanks in combination with leak detection equipment. Before use 35 % v/v Antifrogen® N is diluted with 65 % v/v tap water in accordance with official regulations. Antifrogen® N has been officially approved in accordance with the „Technical regulations for flammable liquids“ (TRbF 501 and 502).

Prospective users are asked to send for the approval and test certificates issued by the Federal Institute for Materials Testing (BAM) Az. 1.3/9790 and 5.1/3436. This documents can be downloaded from our website (www.antifrogen.com).

General application indications:

- In installing the system, only chloride-free soldering agents should be used.
- Systems which have been operated only temporarily with Antifrogen® N (e.g. for frost proofing during winter construction) must be flushed thoroughly with water several times before being refilled, since product residues may attack metals more severely because of the inadequate inhibitor concentration.
- After pressure testing with water or an Antifrogen® N/water mixture, systems should be left filled to avoid corrosion at the liquid/air phase boundary.
- Emptied systems should be refilled within a few days. Before filling with an Antifrogen® N/water mixture, the operator must carefully inspect the state of corrosion of the system. If necessary, measures must be taken to ensure perfectly clean metal surfaces. Corroded systems in which slight rust formation is already present cannot subsequently be operated corrosion-free with Antifrogen®, since the metal may be unevenly inhibited and the inhibitor consumed prematurely.
- When a refrigeration or heating system previously operated with a salt-based cooling brine or water is charged with Antifrogen® N, the lower surface tension and associated rust-removing action of this product may cause any existing corrosion damage to show up as leaks. **Older systems should therefore be thoroughly inspected and rinsed to ensure they are rust-free before the change is made. Good seals are the only way to ensure perfect functioning of the system and prevent costly leaks.**

- After leakage, systems with Antifrogen® N/water mixtures should only be filled up with Antifrogen® N of the same concentration. Mixing with different products should be avoided, as it can lead to incompatibilities. In exceptional cases, the expert opinion of the manufacturer should be contacted. Mixing with other Antifrogen products should be avoided too (e.g. Frost resistance is only partially testable).
- According the requirements of "Wasserhaushaltsgesetz und Anlagenverordnung" a safety collection pan to retain leaking water pollutants such as glycol has to be installed. This equipment has to discharge rainwater in the outdoor area but retain fluids draining off the facility. Ready made solutions are affered e.g. by Gewässer-Umwelt-Schutz GmbH in Nordhorn (www.glykolprotektor.de).
- Although Antifrogen® N is miscible in all proportions with water, it is advisable to fill systems with circulating pumps with about two-thirds of the required amount of water. Antifrogen® N is then added and the system is filled up with water. Complete mixing is achieved by starting up the system. Depending on the system, this may take up to several days.
- The critical heat transfer coefficients of the Antifrogen® N/water mixtures commonly used are only slightly different from the coefficient of tap water alone when heat is transferred to the atmosphere via radiators. In such cases, the quantity of heat that can be transferred with an Antifrogen® N/water mixture is practically the same as for water alone and so the heat exchange surfaces do not need to be modified. In liquid/liquid heat transfer, on the other hand, the quantity of heat that can be transferred decreases as the content of Antifrogen® N increases, so that the heat exchange surface has to be increased according to the altered k values.

  Since Antifrogen® N/water mixtures have a higher viscosity and density than pure water, a higher pressure drop must be expected in pipelines etc; graphs of the relative heat transfer coefficient and relative pressure drop – in comparison with pure water – are particularly useful for calculation purposes. These graphs and other physical data are to be found in the appendix.

Frost resistance and usage concentration

The frost resistance is determined by the mixing ratio with water. **The minimum usage concentration of Antifrogen® N is 20 % v/v.**

The frost resistance of the mixture does not change even after many years' use, provided the Antifrogen® N concentration remains constant. Furthermore phase separation of Antifrogen® N/water mixtures does not occur.

As shown in the freezing point diagram (see on page 21) an Antifrogen® N concentration of 38% and more exhibits no bursting effect at any temperature.

Antifrogen® N should always be diluted with water.

The water used to dilute Antifrogen® N shall contain no more than 100 mg/kg (ppm) chlorides. This should be kept in mind particularly if systems contain components made of aluminum or aluminum alloys. A wide range of water hardness is acceptable (between 0 and 25° GH). This means that, in addition to fully deionized water, distilled and ordinary tap water may be used.

The good corrosion-inhibiting properties of Antifrogen® N/water mixtures decrease as expected with increasing water content.

The Antifrogen® N concentration of a cooling brine or heat transfer medium should therefore be at least 20 % v/v. Such a solution is resistant to freezing down to -9 to -10 °C. Below this concentration in the brine exists the danger of bacterium, alga and fungi growth and microbial induced corrosion.

Practical experience has shown frost resistance over the following temperature ranges to be adequate:

Hot water heating systems	approx. -10 to -20 °C
External circuits combined with heat pumps	approx. -10 to -15 °C
Other external circuits	approx. -20 to -30 °C
Refrigeration systems	approx. -10 to -40 °C
Leak detection fluid	-20 °C

Special antifreeze testers are available for determining frost resistance. For further informations please apply to our Antifrogen® distributors (www.antifrogen.com).

Material compatibilities

Antifrogen® N contains corrosion inhibitors that protect the metals of the cooling and heating systems, even in combined systems, permanently against corrosion and prevent the formation of boiler scale.

The effectiveness of the inhibitor combinations is checked constantly by the manufacturer by means of the well-known corrosion test method:

ASTM D 1384 (American Society for Testing and Materials).

The following table shows the relatively low corrosion of common metals caused by an Antifrogen® N/water mixture (frost protection = -20 °C) compared with a monoethylene glycol/water mixture.

The values, determined by the above mentioned method (ASTM D 1384), show the weight loss of metals in g/m² due to corrosion after 336 h and 3000 h.

Corrosion of metals in g/m², tested with ASTM D 1384 (88 °C / 6 l air/h):

	MEG [a]	Antifrogen® N [b] 336 h	Antifrogen® N [b] 3000 h	weight-change limits
Copper	-2.8	-0.9	-1.9	10
Soft solder (WL 30)	-135	-0.9	-2.3	30
Brass (MS 63)	-7.6	-0.8	-1.1	10
Steel (C15)	-152	-0.1	-0.5	10
Cast iron (GG 22)	-273	±0	-1.4	10
Cast aluminium (AlSi6Cu3)	-16	-0.3	-1.0	30

[a] Monoethylene glycol/water mixture without inhibitors (1:2), [b] Antifrogen® N/water mixture (1:2)

Glycol/water mixtures without inhibitors should not be used as this combination shows more corrosiveness than pure water.

Do not use the product in galvanized pipelines as all glycol/water mixtures can dissolve zinc and precipitate as zinc glycolate. If despite our recommendation galvanized pipelines were used and the formation of zinc glycolate were observed we suggest to install a microfilter (approx. 100 to 150 µm). In case the zinc is dissolved the subjacent steel is protected against corrosion due to the corrosion additive package of Antifrogen® N.

According to data published in literature and the results of our own tests and trials, the following plastics and elastomers are suitable for the manufacture of components coming into contact with Antifrogen® N/water mixtures*:

Polyethylene low density, high density	(LDPE, HDPE)
Polyethylene crosslinked, e.g. Rautherm® (Rehau), Polytherm® (Hewing)	(CPE)
Polypropylene, e.g. Hostalen® PPH 2222	(PP)
Polybutene, e.g. Rhiatherm® (Simona)	(PB)
Polyvinylchloride unplasticied	(uPVC)
Polytetrafluorethylene, e.g. Hostaflon® (Dyneon)	(PTFE)
Polyamide	(PA)
Polyester resins	(UP)
Polyacetal, e.g. Hostaform®	(POM)
Acrylonitrile-butadiene-styrene, e.g. COOL-FIT (Georg Fischer)	(ABS)
Nature rubber up to 80 °C	(NR)
Styrene butadien rubber up to 100 °C	(SBR)
Butyl rubber	(IIR)
Olefin rubber, e.g. Buna® AP (Bayer)	(EPDM)
Fluorocarbon elastomers, e.g. Viton® (Du Pont)	(FPM)
Silicone rubber, e.g. Elastosil® (Wacker)	(Si)
Nitril rubber, e.g. Perbunan® (Bayer)	(NBR)
Polychlorbutadiene elastomers, z. B.Neopren® (Du Pont)	(CR)

* The materials have been tested at +80 °C in specific conditions. Please consider the specifications and material compatibilities given by the manufacturer of the elastomers and plastics. We will check not listed materials on compatibility with Antifrogen® N.

Polyurethane elastomers, plasticized PVC and phenolformaldehyde resins are not resistant.

Graphite cords can be used as gland seals and for threaded pipe connections hemp. For threaded pipe connections in which hemp is used as a seal, coating with Fermit® or Fermitol® (Nissen & Volk) has proved successful. Leaks may occasionally occur when polytetrafluoro-ethylene (PTFE) sealing tapes are used.

Material for surge tanks like e.g. Flexcon® (Flamco) shows no impact after testing and after usage of Antifrogen® water mixtures for years.

Using circulation pumps it has to be considered that they are compatible with anti-freeze agents. Pump elements made out of e.g. phenolic resins normally don't meet the requirements.

Service and monitoring

According to our experience Antifrogen® N can be used in installations for many years. However, the Antifrogen® N concentration in the installation should be checked annually. This check is also advisable when the installation is topped up with liquid. Distributors have Antifrogen® N antifreeze testers for this purpose.

The performance of the Antifrogen® N/water mixture should also be checked at intervals of one to two years. If a 250 ml sample is provided, the distributors can also perform this service.

For major industrial installations these tests can also be undertaken directly by Clariant Produkte (Deutschland) GmbH, Werk Gendorf, BU ICS / TA, D-84508 Burgkirchen, Germany, phone +49(0) 86 79/7-22 72, (www.antifrogen.com, see Technical service).

The data in our service report relate solely to the sample sent to us. Guidance on further use for the product tested assumes that the system is in proper condition and properly operated. We would expressly point out that, particularly where corrosion or scale is already present in the system, interactions with the product may occur with unpredictable consequences. We accept no liability whatsoever for any damage resulting from the improper condition or operation of the system.

Safety and Handling:

Flash point (DIN 51758)	°C	119
Ignition temperature (DIN 51794)	°C	410
Temperature class (DIN/VDE 0165)		T2

Antifrogen® N/water mixtures have neither a flash point nor a fire point.

Spent Antifrogen® N/water mixtures can be disposed off in accordance with local regulations. According to the 2nd general administrative regulation relating to the German waste management act of 10.04.1990, reuse is preferable to disposal. The product is recyclable.

Antifrogen® N contains more than 90 % ethylene glycol together with some water and organic and inorganic additives, which are present in a well balanced combination and act as corrosion inhibitors with a long-lasting effect.

Antifrogen® N is harmful to humans and animals if swallowed. Consult a doctor immediately if the product is swallowed inadvertently.

The lethal dose for humans can be assumed to be 100 ml taken at once. In the majority of reported cases of poisoning cerebral damage and pulmonary edemas in particular have been observed besides renal damage.

Ethylene glycol, the product on which Antifrogen® N is based, is classified in water hazard class **WGK 1 (slightly water-polluting)** according to the list of water-polluting substances (VwVwS from 17.05.1999). **This also applies to mixtures of Antifrogen® N with water.**

In concentrations up to 1000 mg/l, Antifrogen® N/water mixtures show no acute harmful effects on fish and bacteria. They are readily biodegradable.

Further information will be found in the current EG safety data sheet.

Transport and storage:

VbF	-
GGVE/RID	non-regulated
GGVS/ADR	non-regulated
ADNR	non-regulated
IMDG-Code	non-regulated
UN Nummer	-
IATA-DGR	non-regulated

Antifrogen® N is supplied by our Antifrogen® distributors in road tankers, intermediate bulk containers (IBC, 1100 kg), non-returnable corrugated drums (230 kg) and diverse small containers. Further informations about our Antifrogen® distributors you can find on our homepage www.antifrogen.com.

Antifrogen® N has a storage stability of two years, if stored in closed original packaging. Since zinc is not resistant to Antifrogen® N, this should be considered when the product is transferred to other containers.

Antifrogen® L

Antifrogen® L is a blue tinted, clear liquid, which is used as a heat transfer medium in heat recovery systems and in the food and pharmaceutical sector or where the possibility of the heat transfer medium entering process water or hot water cannot be excluded. For this applications a " Toxicological Risk Evaluation on Adverse Human Health Effects for Users from Oral Uptake of Foodstuff contaminated with Antifrogen® L" is available (www.antifrogen.com, see downloads/certificates)

Antifrogen® L contains as the base product the toxicologically harmless 1,2-propylene glycol, which is approved by the FDA (Food and Drug Administration, acc. § 184.1666 of the Federal Register from 1.4.1985), Propylene glycol is registered as a generally harmless food additive) in the USA. Additionally, the 1,2-Propylene glycol is approved as solvent and extracting agent according Lebensmittel-Zusatzstoffverkehrsordnung vom 10.7.1984 (BG B1.I S. 897), Anlage 2, Liste 9. Also, Antifrogen® L is approved as an officially fire extinguishing agent (VdS-Certificate, www.antifrogen.com, see downloads/certificates).

Antifrogen® KF

Antifrogen® KF is a non-toxic clear liquid, based on an aqueous formate solution which is used as a low-temperature brine down to -50 °C in industrial and food refrigeration systems. The brine has a low viscosity at low temperatures.

Antifrogen® SOL HT

Antifrogen® SOL HT is a physiologically harmless, yellowish, clear liquid based on an aqueous solution higher boiling glycols, which is used as a heat transfer medium in solar heating, especially those exposed to high thermal loads. The product is premixed with deionized water to give a frost resistance of about -23 °C.

Antifrogen® SOL Clean

Antifrogen® SOL Clean is a physiologically harmless, colorless, clear liquid based on glycol ethers with characteristic odor. Antifrogen® SOL Clean is used as a cleaning agent in solar systems.

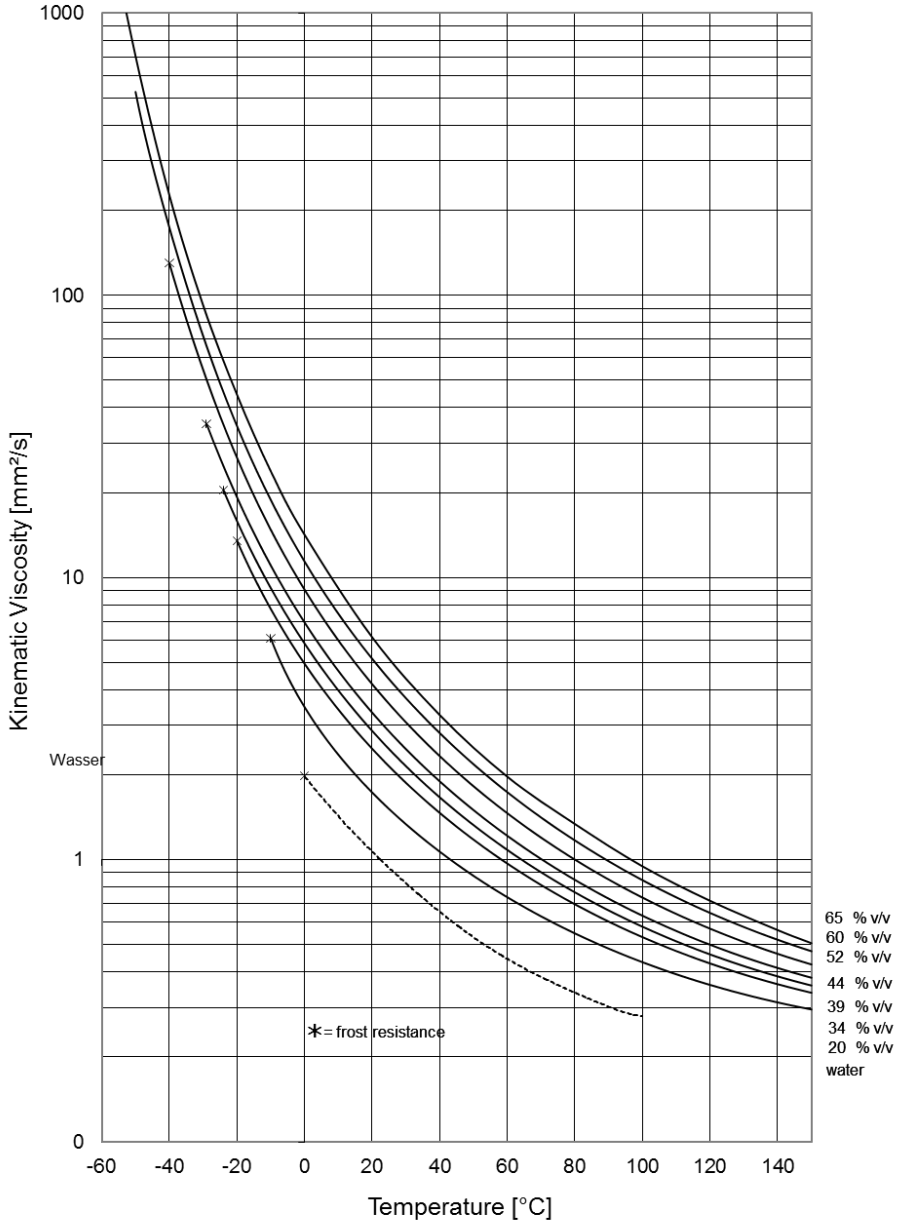
Antifrogen Homepage

Please visit us at www.antifrogen.com, where you can find newest informations on our product range. Additionally, a technical calculation program with all relevant physical data can be used and the technical leaflets can be downloaded there.

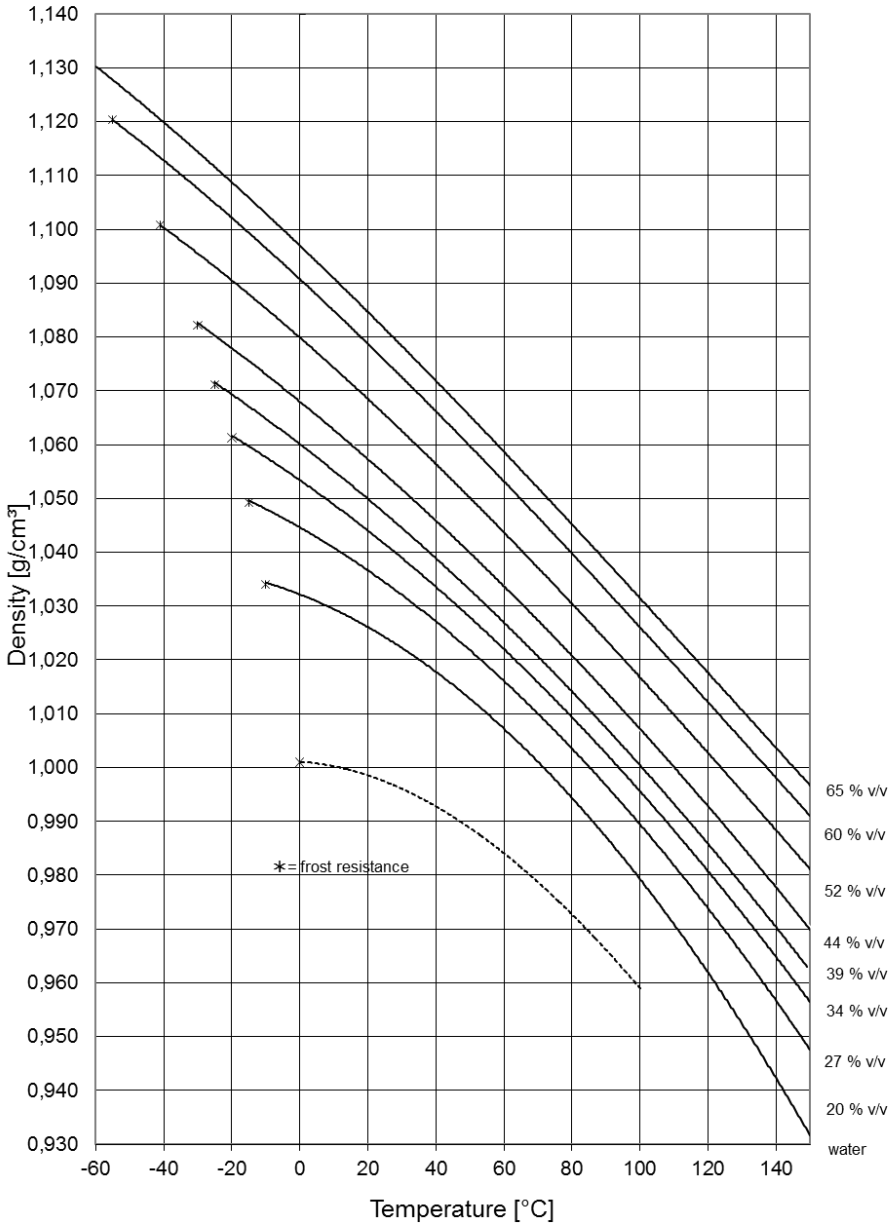
Appendix

The following graphs show the most important physical properties of Antifrogen® N/water mixtures. Due to the calculation software, which has been used to gain the related curves, small variances of the physical values are possible. With temperatures above 100°C – the boiling points of the respective Antifrogen® N – water mixtures have to be taken into consideration.

Kinematic Viscosity
of Antifrogen N - water mixtures of different concentrations



Density
of Antifrogen N-water mixtures of different concentrations



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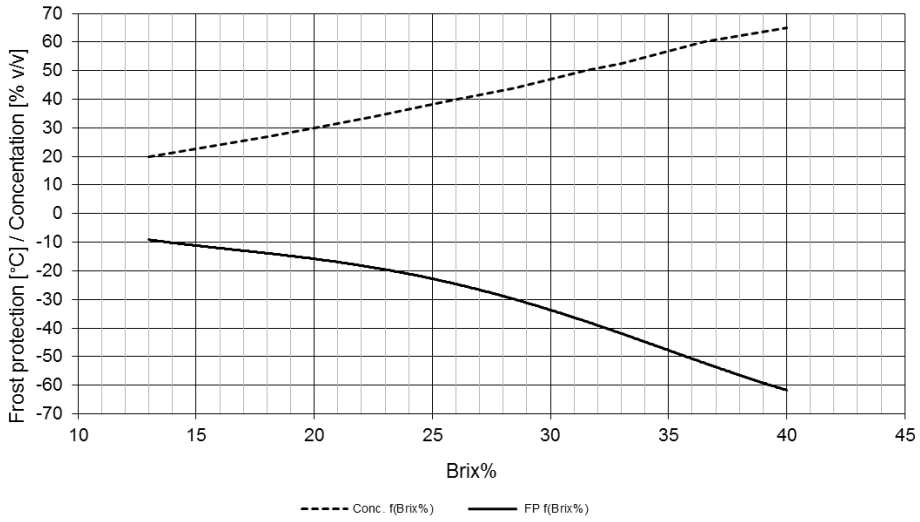
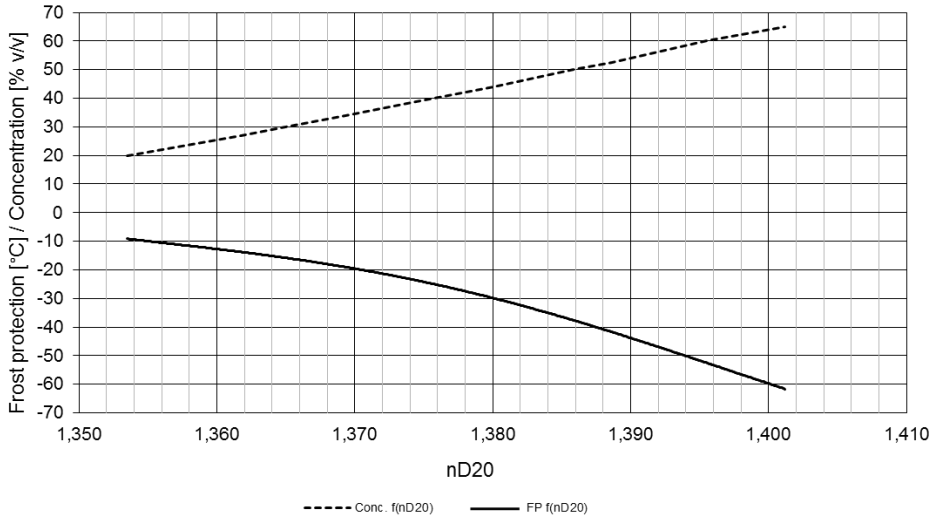
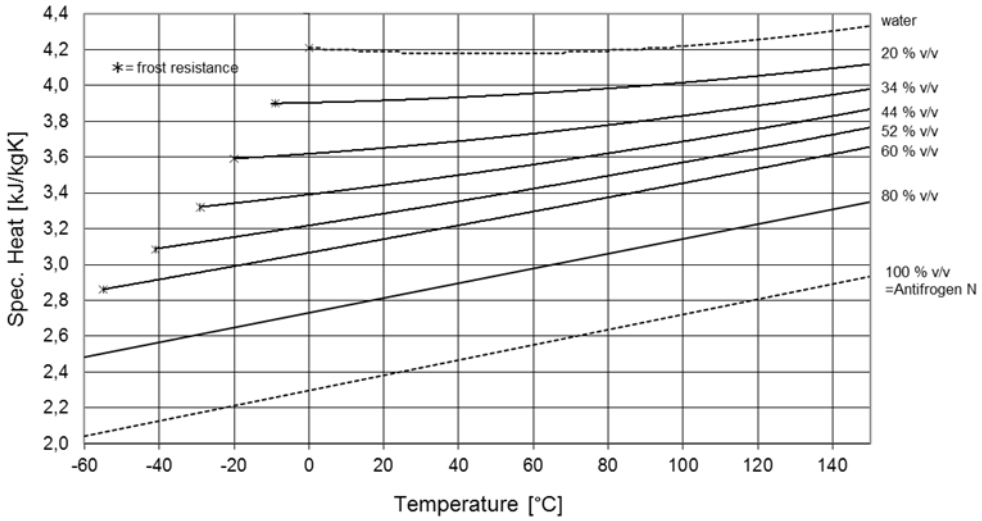
Frost protection / Concentration
of Antifrogen N - water mixtures in response of Brix%



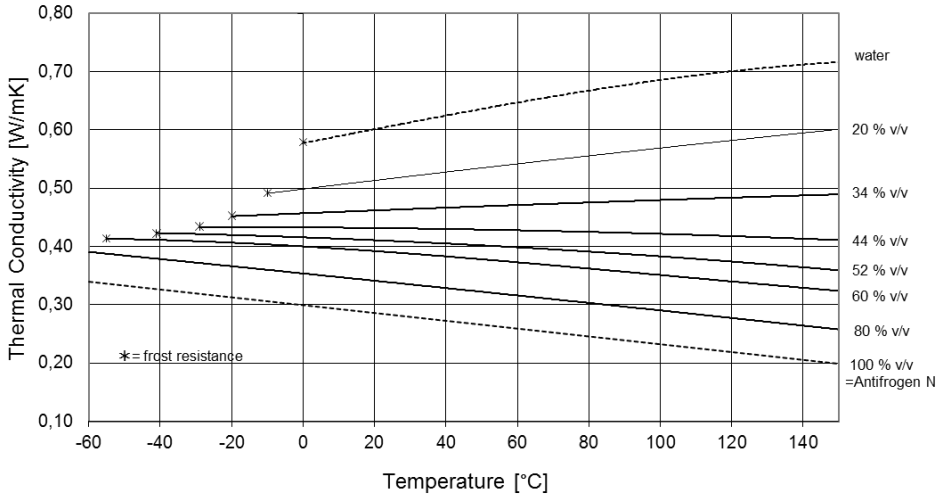
Frost protection / Concentration
of Antifrogen N - water mixtures in response of the nD20



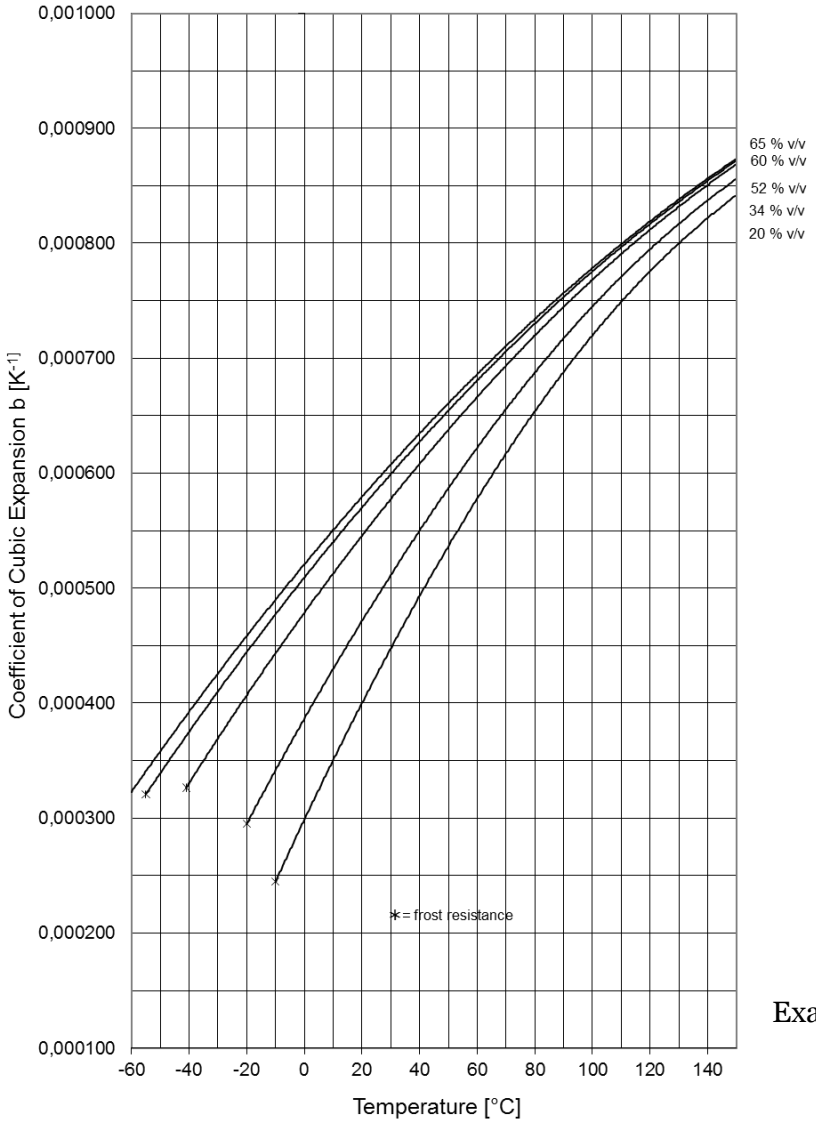
Specific Heat
of Antifrogen N - water mixtures of different concentrations



Thermal Conductivity
of Antifrogen N - water mixtures of different concentrations



Coefficient of Cubic Expansion
of Antifrogen N - water mixtures of different concentrations



Example:

By how much does V_o = 100 L of a 35 % v/v Antifrogen® N/ water mixture expand on heating from t_o = -10 °C to t_1 =80 °C?

$\Delta_t = t_1 - t_0 = +80 - (-10) = 90°C$

$t_{average} = t_0 + \frac{\Delta t}{2} = -10 + \frac{90}{2} = 35°C$

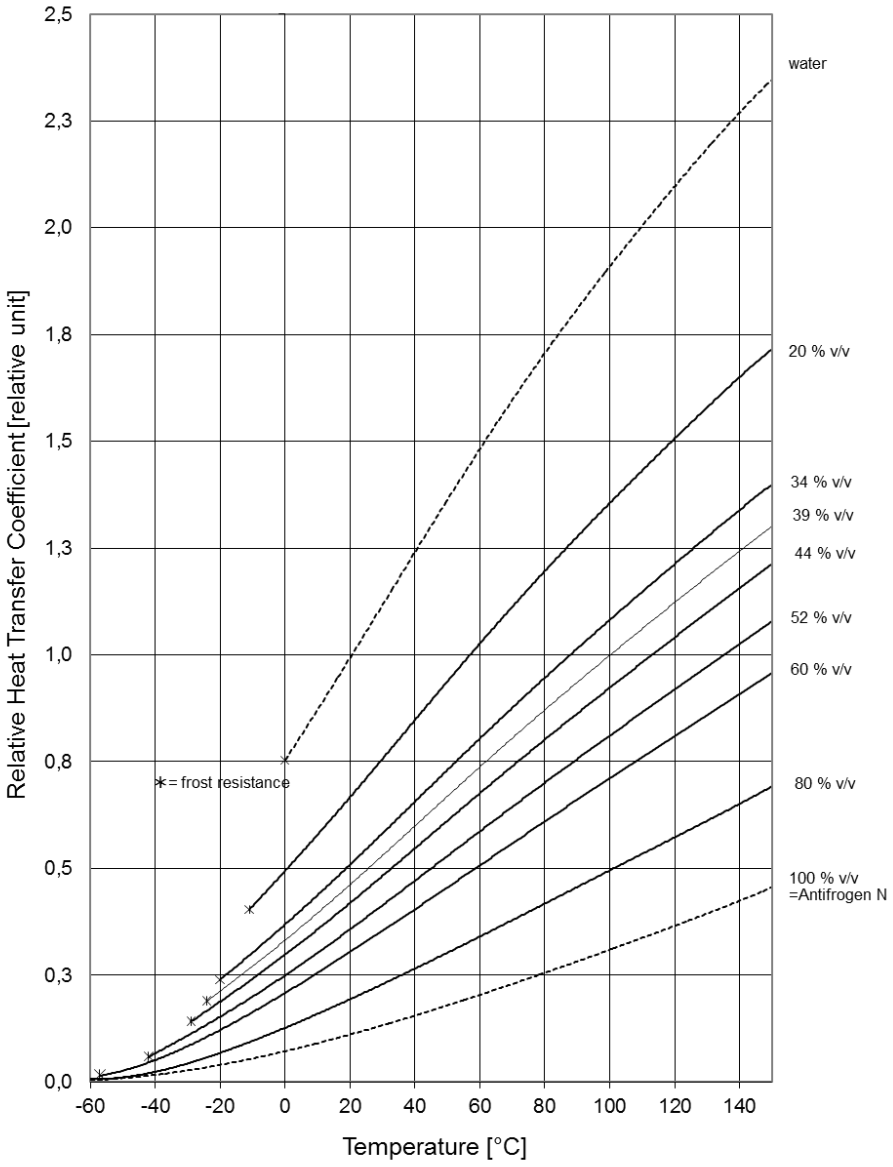
$\beta\ t_{average} (from\ the\ curve\ for\ 35\ \%\ v/v = 0{,}00051$

$\Delta V = \beta\ t_{average} * \Delta t * V_0 = 0{,}00051 * 90 * 100$

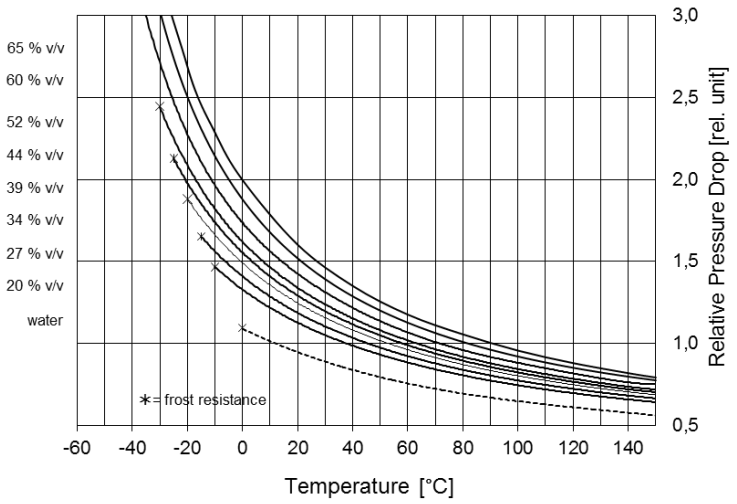
= 4,6 L increase in volume

$$\textbf{Prandtl-Zahl} = \frac{\rho \times \upsilon \times C_p}{\lambda}$$

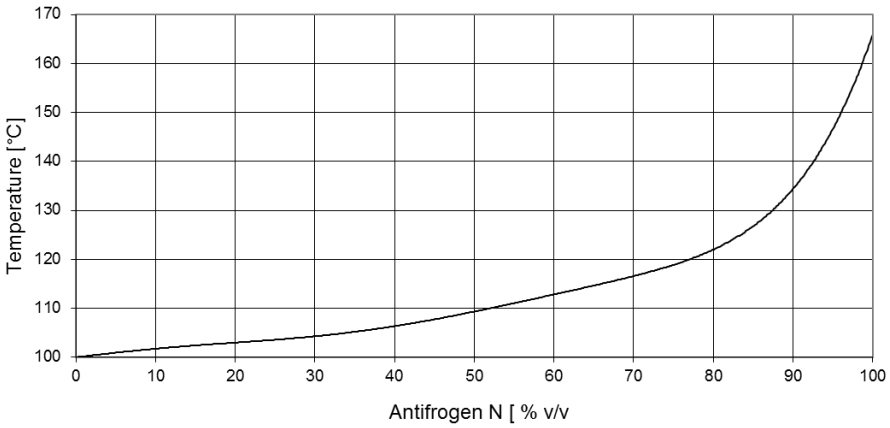
Relative Heat Transfer Coefficient
of Antifrogen N - water mixtures in comparison with water (+20°C) in turbulent flow



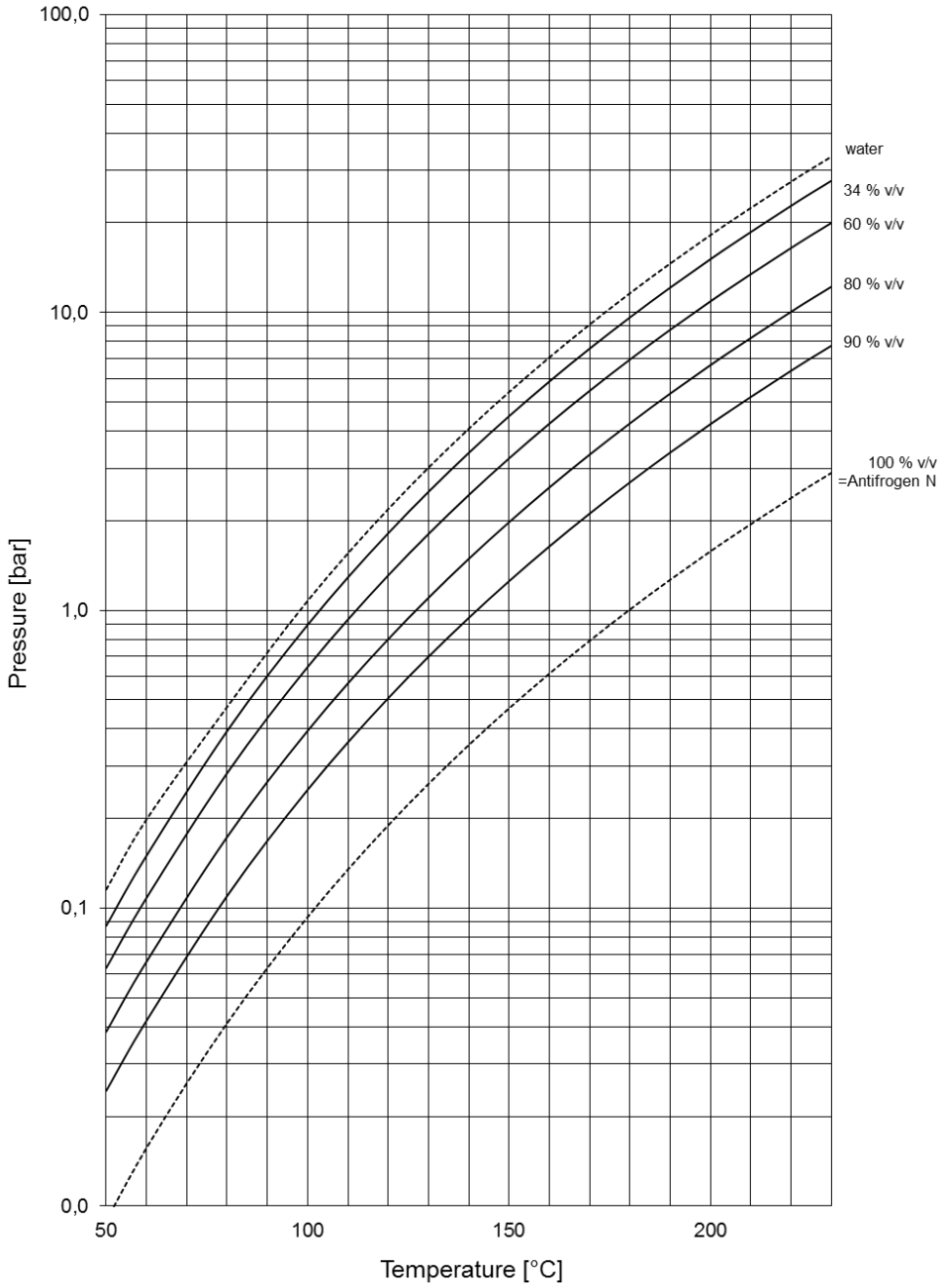
Relative Pressure Drop
of Antifrogen N-water mixtures in comparison with water (+10°C) in turbulent flow



Boiling Points
of Antifrogen N - water mixtures of different concentrations
in accordance with ASTM D 1120 at 1013 hPa (mbar)



Vapor Pressure
for Antifrogen N-water mixtures as a function of temperature



Frost Resistance
of Antifrogen N - water mixtures (crystallization point in accordance with ASTM D 1177)