WACKER

HELISOL®

HEAT TRANSFER FLUIDS

Frequently Asked Questions

Content

WACKER

1 What are HELISOL® Heat Transfer Fluids?

HELISOL® heat transfer fluids are highly stable silicone fluids especially designed for high-temperature and heating/cooling applications. They combine excellent high-temperature stability and low freezing points to enable best possible performance in a broad temperature range. The recommended use of HELISOL® heat transfer fluids are in liquid phase in inert, pressurized systems.

2 Which HELISOL Heat Transfer Fluids are available?

	HELISOL® 5A	HELISOL® 10A	HELISOL® XA	HELISOL® XLP
Pour point – in use	< − 55 °C	< − 55 °C	− 36 °C	− 45 °C
Boiling point/range (1013 hPa)	155 – 308 °C	> 370 °C	340 – 393 °C	> 380 °C
Boiling point/range (1013 hPa) – in use	84 – 274 °C	173 – 343 °C	120 – 283 °C	> 259 °C
Density at 25 °C	0.92 g/cm³	0.93 g/cm³	0.94 g/cm³	0.95 g/cm³
Vapor pressure at 425 °C – in use	20 bar	16.3 bar	15.9 bar	12.6 bar
Viscosity, kinematic at 25 °C	~ 5 mPa·s	~ 10 mPa·s	~ 20 mPa·s	~ 35 mPa·s
Viscosity, kinematic at 25 °C – in use	~ 3.5 mPa·s	~ 6.5 mPa·s	~ 9 mPa·s	~ 12 mPa·s
Viscosity, kinematic at − 40 °C	~ 23 mPa·s	~ 40 mPa·s	~ 90 mPa·s	~ 220 mPa·s
Viscosity, kinematic at − 40 °C – in use	~ 16 mPa·s	~ 27 mPa·s	~ 38 mPa·s	~ 58 mPa·s
Flash point (ISO 2719)	120 °C	175 °C	225 °C	222 °C
Flash point – in use	51 °C	61 °C	60 °C	67 °C
Ignition temperature (EN 14522)	359 °C	365 °C	369 °C	376 °C

These data are based upon samples tested in the laboratory and are not guaranteed for all samples. Contact your WACKER representative for further information or complete sales specifications of HELISOL®

in use = 720 hours at 425 °C

3 What is the maximum and minimum temperature for HELISOL® Heat Transfer Fluids?

HELISOL® Heat Transfer Fluids cover a very broad temperature range from −40 to +425 °C (−40 °F to 797 °F). The maximum recommended working temperature is +425 °C, the maximum recommended film temperature is +450 °C.

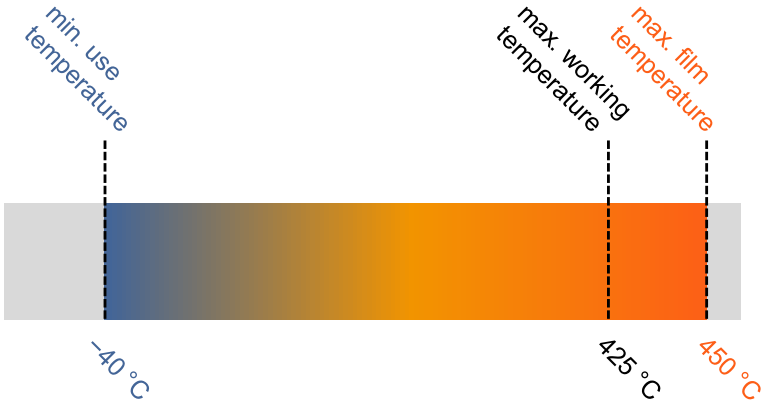

Figure 1: Recommended temperature range of the HELISOL® heat transfer fluids.

4 What are the advantages of HELISOL® Heat Transfer Fluids compared to other thermal fluids?

HELISOL® heat transfer fluids are linear, clear, odorless and non-reactive polydimethylsiloxanes with a viscosity range of approx. 5 to 35 mm²/s at room temperature.

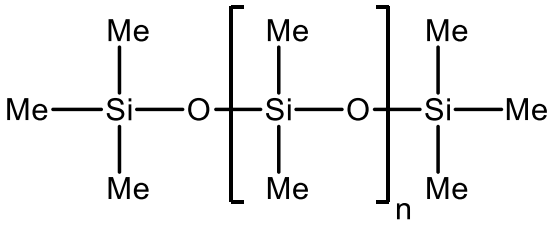

Figure 2: Molecular structure of the polydimethylsiloxane − HELISOL® heat transfer fluids.

Due to their chemical structures, HELISOL® heat transfer fluids have an outstanding property profile, which sets them apart from organic materials such as mineral oils and aromatic heat transfer fluids. They are especially characterized by a very high thermal stability. Properly handled and maintained HELISOL® heat transfer fluids can be operated at 425 °C for many years before they need replacement. Operation below these temperature maximums may provide even longer service life under most operating conditions.

5 How are HELISOL® heat transfer fluids different from other heat transfer fluids I may have used in the past?

HELISOL® heat transfer fluids are polydimethylsiloxanes - mixtures of linear siloxane compounds. Due to their chemical structure, they undergo rearrangement reactions (equilibration) of their silicone-oxygen bonds when operated at temperatures above 220 °C. The rate of this molecular rearrangement is directly related to the temperature applied. As a result, low molecular-weight linear and cyclic siloxanes are formed until an equilibrium fluid composition is reached that remains stable. This rearrangement reaction of HELISOL® heat transfer fluids is not a degradation reaction and does not affect fluid lifetime. The newly formed low molecular-weight linear and cyclic siloxanes are part of the heat transfer fluid itself and therefore require operation in closed heating systems. There is no need to separate these low-boiling components from the fluid.

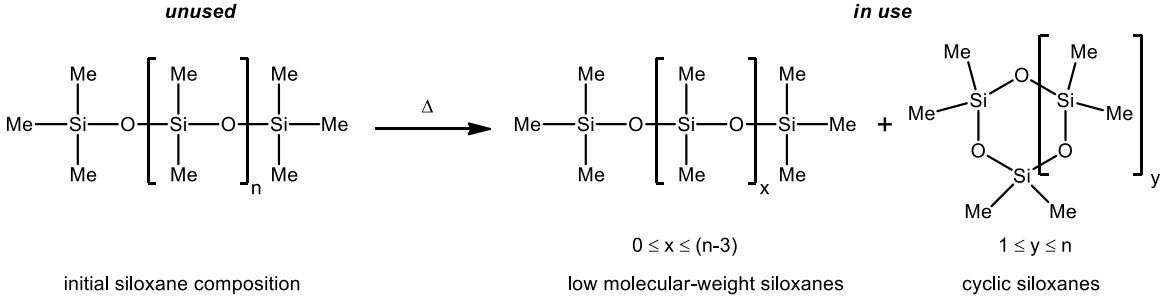

Figure 3: Representation of the equilibrium reaction of polydimethylsiloxanes at high temperatures.

6 How do the physical properties of HELISOL® heat transfer fluids change during operation?

Because of the rearrangement reaction some physical properties of the fluids will change throughout operation. Especially, viscosity and flashpoint decrease, while the equilibrium vapor pressure increases. Once the equilibrium fluid composition is reached the physical properties remain stable. For comparison reasons and for the layout of boiler systems, the typical product

data and the physical property tables (i.e. phase diagrams, enthalpy and density) are provided in the technical relevant pressure/temperature range (*p*,T) both, for the unused (HELISOL® *unused*) and used fluid (HELISOL® *in use*).

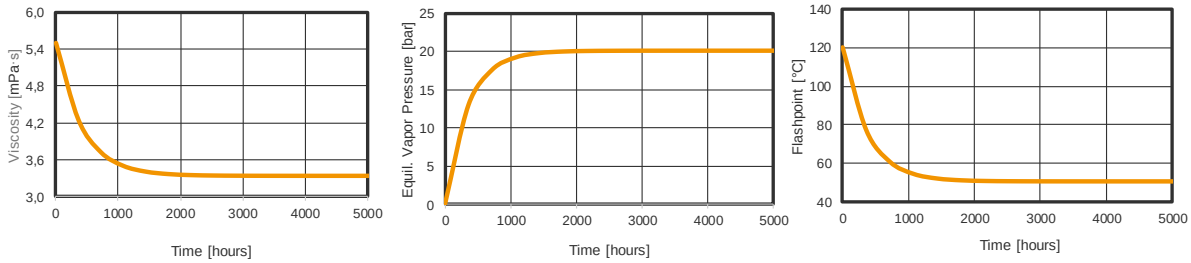

Figure 4: Representation of the temperature-induced change of important physical properties during equilibration in the case of HELISOL® 5A (working temperature = 425 °C).

For further information about the fluid properties in the full temperature and pressure range please consider the HELISOL® heat transfer fluid **Extended Technical Datasheet**.

7 Are HELISOL® heat transfer fluids environmentally friendly?

HELISOL® heat transfer fluids are not classified as hazardous. For more information please consider the **Material Safety Data Sheet (MSDS)** of the respective product. The MSDS of all HELISOL® heat transfer fluids are related to the *unused* condition.

However, when HELISOL® heat transfer fluids are used as intended above 220 °C the products of the typical equilibration are D-cyclic siloxanes (including octamethylcyclotetrasiloxane D4 (CAS 556-67-2), decamethylcyclopentasiloxane D5 (CAS 541-02-6) and dodecamethyl-cyclohexasiloxane D6 (540-97-6). These volatiles will have different toxicological and flammability ratings as the unused fluid. Therefore, appropriate handling precautions must be taken. HELISOL® *in use* contains substances ≥ 0.1% that have been subjected to the SVHC process according to REACH regulation (EC) No 1907/2006 Art. 57 as fulfilling the PBT and/or vPvB criteria according to REACH regulation (EC) No 1907/2006 Annex XIII.

This must be considered when handling (sampling, leakages, filling, emptying) HELISOL® heat transfer fluids. For further information regarding the hazard identification and classification of HELISOL® heat transfer fluids "*In Use*" please contact your WACKER representative.

Table 1: Hazardous ingredients of HELISOL® heat transfer fluids *in use*

EC-No.	CAS No.	Substance	Content [%]
209-136-7	556-67-2	Octamethylcyclotetrasiloxane	>0.1
203-492-7	107-46-0	Hexamethyldisiloxane	>0.1

Table 2: The product contains the following substances of very high concern (Regulation (EC) No. 1907/2006 (REACH), Article 57) in amounts ≥0.1%

CAS No.	Substance	Content [%]
556-67-2	Octamethylcyclotetrasiloxane	>0.1
541-02-6	Decamethylcyclopentasiloxane	>0.1
540-97-6	Dodecamethylcyclohexasiloxane	>0.1

Please also consider the HELISOL® heat transfer fluid **Safety Guidance** where all relevant information regarding fluid properties and safe handling are summarized.

8 How to determine thermal degradation of HELISOL® heat transfer fluids?

In general, there are standardized methods for measuring the thermal stability of organic heat transfer fluids in Europe and the Americas (DIN 51528/51435 and ASTM D6743/7213 respectively). In these tests the thermal degradation is analyzed via the quantification of low-boiling and high-boiling degradation products, which have boiling points below and above the initial and final boiling points of the unstressed heat transfer fluid.

Because of the omnipresent equilibration reaction these test methods cannot be applied to silicone fluids. But, HELISOL® heat transfer fluids have been lab and field tested to measure the rate of formation of degradation products in the whole temperature range.

WACKER will inspect your used HELISOL® heat transfer fluid with regard to the general fluid appearance, viscosity, acid value, water content, flash point and the content of insoluble solids. Together with a detailed molecular fluid analysis WACKER will give the customer a specific recommendation how to properly handle the fluid. If for example specific test results fall within the limits of action, you should consider taking measures to return the heat transfer medium to a more normal state, either by proper fluid maintenance or by emptying and refilling the heat transfer system.

9 How do I know when to change or replace the HELISOL® heat transfer fluid in my system? How often should HELISOL® heat transfer fluids be changed? And how can WACKER help me?

Fluid service life in general varies with the quality of the fluid and the type and quality of the heat transfer system equipment and can vary from system to system. Significant overheating and fluid contamination will also affect the performance of a heat transfer fluid system. Properly handled and maintained, HELISOL® heat transfer fluids can be operated at 425 °C for many years before they need replacement. Operation below this temperature maximum may provide even longer service life under most operating conditions.

According to DIN 4754 HELISOL® heat transfer fluids must be checked to its serviceability limit state once a year or on demand. Therefore, WACKER recommends regular sampling and inspection of your heat transfer fluids.

Possible cases of demand are:

- After the initial start-up
- Three months after the initial start-up period
- Irregularities of the process which could harm the heat transfer fluid e.g. impurities, water contamination, overheating etc.
- Three months after a change-over from a different heat transfer fluid

WACKER provides a complete in-depth analysis of your used HELISOL® heat transfer fluids. Please get in contact with your WACKER representative for further information about analytical services. In the case that no continued reliable operation with your used fluid is possible or in any other case of need to exchange your used heat transfer fluid, please also contact your WACKER representative for details on assistance in the proper disposal. With regard to environmental sustainability WACKER in general takes back sold heat transfer fluids to ensure proper recycling and disposal under common regulations.

The most common reasons for suggesting fluid replacement are:

- The test results of viscosity are outside the limits of action resulting for example in impaired low-temperature fluid performance (pumpability).

- Contamination of the heat transfer fluid with extensive quantities of water or other foreign materials (insoluble solids).

Please also consider the HELISOL® heat transfer fluid **Sampling Guide** where all relevant information regarding proper sampling techniques and cases of demand are summarized.

10 Are HELISOL ® Heat Transfer Fluids compatible with organic or mineral oil-based heat transfer fluids?

This has to be evaluated in detail because there is a variety of different heat transfer fluid technologies available and depends on the exact chemical composition. Always consult your supplier's technical service department for recommendations. In general, petroleum-based, aromatic chemical or synthetic fluids may not be compatible with HELISOL® heat transfer fluids at high temperatures. Deposits from oxidized, thermally degraded, or contaminated organic fluids can foul interior surfaces. These fouling products are not soluble in HELISOL® heat transfer fluids, making it necessary to clean the system prior to charging with the new fluid.

11 How do I deal with water in my heat transfer system?

Water can cause a variety of problems in a heat transfer system. For instance:

- Water in heat transfer systems operated below 0 °C can form ice crystals that may clog valves and form a coating on heat exchanger surfaces.
- In high-temperature applications, any moisture could turn to steam, which may increase internal pressure.
- HELISOL® heat transfer fluids in contact with water/moisture can degrade over time at high temperatures, thereby adversely affecting fluid performance and fluid lifetime.
- Water promotes rust and corrosion of metal parts, resulting in greater maintenance costs and downtime.

In general, HELISOL® heat transfer fluids do only contain very small quantities of water (max. 130 ppm) but to ensure proper fluid-lifetime always avoid any kind of contact between the hot fluid with air and moisture. Therefore, the heat transfer system must be constructed to ensure a safe inertisation with inert gas (e.g. nitrogen) or if possible, a propriate instrumentation to control the oxygen concentration in the expansion vessel is recommended.

The proper way to deal with small quantities of water inside your heat transfer system (e.g. after initial clean-up of your system) is to boil-out the water in gradual steps. Therefore, increase the heat transfer fluid temperature to about 100 °C (measured at the heater outlet). Maintain this specific temperature level so that water vapors, which develop during the heat-up process, can escape through the expansion tank vent. This process could take several hours. During the heating process check again whether the system remains technically tight (e.g. flanges, seals, joints, etc.). Stepwise increase the fluid temperature to higher temperatures and repeat the procedure. During those “boiling-steps” the fluid flow through the expansion tank must be sufficient so that the temperature in the expansion tank is high enough to get rid of any moisture from the entire system. When increasing the temperature, the system pressure must be adjusted so that the evaporation of the fluid is taken into account (consider equilibrium vapor pressure as described in the **Extended Material Datasheets** for further information).

12 How did WACKER assess the safety of HELISOL® heat transfer fluids?

WACKER prepared an in-depth risk analysis in order to consider material related properties in terms of safety relevant aspects which should help customers to consider that information in terms of the facility design but also in terms of operating, fluid handling and maintenance.

Additional detailed test reports are available on request:

- Determination of safety related parameters: Flash point (ISO 2719, closed cup), Autoignition temperature (DIN 14522), Heat of Combustion (DIN 51900), Flammability characteristics in contact with hot surfaces (ISO 20823), Determination of the wick flame persistence (ISO 14935), Determination of spray ignition characteristics (ISO 15029), Limiting oxygen concentration (LOC, DIN EN 1839-B), Detailed analysis of combustion products, Material compatibility tests.

- Risk assessment of pipe/system failures and accidents, small leakages (leaky valves, flanges etc.), severe leakages (e.g. pipe ruptures), leakages into thermal insulation, leakages inside HTF/steam heat exchanger (reaction with water), leakages inside HTF/thermal energy storage unit heat exchanger (reaction with molten salt).

Please also consider the HELISOL® heat transfer fluid **Safety Guidance** where all relevant information regarding safe handling and personnel protection are summarized. This document should help customers to consider specific properties of HELISOL® heat transfer fluids in terms of safety aspects. Safety relevant parameters therefore are compared with the parameters of commercially available organic heat carriers. Also, the impact of the special equilibration and aging of HELISOL® heat transfer fluids are described regarding safety relevant parameters.

13 Which conditions are harmful to HELISOL® heat transfer fluids and must be avoided?

At high temperatures, HELISOL® heat transfer fluids may be sensitive to various contamination. Therefore, it must be ensured to guarantee the exclusion of water, oxygen, oxidizing agents, alcohols, acids and bases or any contamination at operating temperature. Acids, bases or alcohols may accelerate the formation of volatile by-products, while water or oxygen/oxidizing agents (e.g. solar salt $NaNO_3/KNO_3$) can result in crosslinking of siloxane molecules and may cause a faster increase in viscosity.

To minimize these adverse effects HELISOL® heat transfer fluids must be operated under inert conditions in technical tight systems. For example, an inert gas blanket (e.g. nitrogen gas) on the expansion tank is required to prevent the fluid from coming into contact with the outer atmosphere. Especially, when filling or refilling the system, care should therefore be taken to prevent oxygen and moisture from entering the system with the cold fluid.

14 Do I need to clean my heat transfer system?

After setting up a new heat transfer system it is required to clean the entire system before filling in HELISOL® heat transfer fluids due to contaminants like iron oxide, mill scale or greases. These contaminants could not only lead to initial degradation of the fluid but also the system can require moderate to extensive cleaning to remove carbon and sludge.
A proper way to clean the heat transfer system should always be discussed with your equipment supplier. If afterwards, the system is operated and maintained properly, including regular oil inspections it is not required to clean the entire system. However, if a system is improperly started or shut down, or allowed to overheat, it may require some degree of cleaning.

Please also consider the HELISOL® heat transfer fluid **Technical Brochure** where all relevant information regarding technical details and proper system start-up are summarized.

15 Do HELISOL® heat transfer fluids form sludge?

HELISOL® heat transfer fluids are silicone fluids and are non-fouling by nature. In systems which are properly designed and operated, they generally do not form coke or insoluble tars and sludges. They are much more resistant to solids formation caused by oxidation than other types of heat transfer fluids, such as organic fluids. However, in systems, in which HELISOL® heat transfer fluids are used it must be always ensured that the system is properly inertized. Due to the presence of oxygen, non-soluble degradation products may be formed.

16 Are HELISOL® heat transfer fluids corrosive or reactive?

HELISOL® heat transfer fluids are silicone fluids and are in general non-reactive. Due to their chemical nature they are only reactive towards concentrated acids and bases as well as hydrofluoric acid. Silicone fluids are also non-corrosive towards most steel qualities which are commonly used in heat transfer systems. Other materials (e.g. sealings, fittings) probably must be evaluated separately. For further information please contact your regional WACKE representative.

17 Does the color of the fluid effect its performance?

In general, the fluid color is the least reliable indicator and does not imply any degradation. Although HELISOL® heat transfer fluids are colorless and clear when supplied, it is normal for them to darken in color when heated and exposed to minor contaminants in the heat transfer system such as iron oxide or mill scale. This change in color has no adverse effect on the fluid operational performance or overall fluid life.

18 How long can HELISOL® heat transfer fluids be stored?

The recommended maximum temperature allowed during storage and transportation is 40 °C. Always keep the storage container tightly closed to avoid any contaminations. To avoid any moisture in the storage container ideally store in a dry, cool place and not under direct sunlight. The 'Best use before end' date of each batch is shown on the product label. Storage beyond the date specified on the label does not necessarily mean that the product is no longer usable. In this case, however, the properties required for the intended use must be checked for quality assurance reasons. For further information please contact your local WACKER representative.

19 Which documents does WACKER provide to support the customer?

WACKER does provide additional documents to further support the customer:

Safety Guidance

- Detailed comparison of HELISOL® fluids with organic HTFs
- Safety Instructions for safe handling HELISOL® fluids

- Determination of safety related parameters and additional material compatibility tests
- Risk assessment of possible pipe/system failures and accidents
- Recommendations: e.g. exposure controls and personal protection, First aid measures, fluid sampling procedure, transport and regulation information, accidental release measures and recommended precautions.

Technical Brochure

- General fluid properties and characteristics, Conditions to Avoid, safety data, technical information (e.g. system start-up, sampling etc.)

Extended Material Datasheets

- Temperature- and pressure-dependent physical property data of liquid and gas phase (equilibrium vapor pressure, viscosity, density etc.), thermodynamic property formulae

Sampling Guide

- Guideline for proper fluid sampling and maintenance

This document is property of the Wacker Chemie AG and describes technical details of the HELISOL® heat transfer fluids. Enclosed information raises no claim of completeness and shall not be distributed to commercial purposes by third parties. The user is firmly bound to examine the technical aptitude by itself or a related technical expert.

Please note that the data provided is not intended to be used to create specifications. The measurements were carried out to the best of our knowledge, but WACKER assumes no liability for the accuracy of the measurement results. They only serve to inform the customer and there is no recommendation for action on the part of WACKER.

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