FUCHS Industrial Lubricants

The right solution for every application

Refrigeration oils
2014/2015
For more than 80 years, we have been concentrating all our activities and research efforts on the development of innovative lubricants. This specialization means that we are enjoying continuous growth – geographically, technically and in the number of application areas.

Today, FUCHS is a German company that offers powerful lubricants and related specialties worldwide in practically all areas of application and industries.

What makes our products more valuable.
We develop lubricants on an application-specific basis and tailored to our partners’ processes. Together, we look for the best lubricant for our customers. This type of collaboration is unique in its form, scope and intensity. We call it a development partnership. This ability is based on one key feature: As a German company with its headquarters in Mannheim, we are the largest independent lubricant specialist, and this independence makes all the difference. We are open to new methods and visionary approaches – a prerequisite for innovations. And innovations are a FUCHS trademark.

Together, we can move more.
Refrigeration oils play an important role in the area of lubricants and lubrication technology. The expected long life of refrigerant compressors largely depends on the quality of the used refrigeration oil. The interaction with other substances, in particular the refrigerant, at fluctuating high and low temperatures makes very specific demands on the lubricant in the circuit. The principal function of a refrigeration oil is to adequately lubricate all moving parts in the refrigerant compressor. Depending on the type of compressor, heat must also be dissipated and compression chambers and valves have to be sealed.

The compressor type, the efficiency of the oil separator, the design of the refrigeration system, the operating parameters, the refrigeration oil selection etc. are responsible for varying amounts of oil present in the refrigerant circuit. Oil content in the system usually can reach ranges from 1 to 5% and in special cases also higher values. To ensure reliable oil circulation and to ensure that the oil returns from the “cold” part of the circuit, refrigeration oils ensure reliable oil circulation and to ensure that the oil from 1 to 5% and in special cases also higher values. To ensure sufficient oil circulation in the system, the necessary low-temperature flowing properties needed to ensure sufficient oil circulation in the circuit. Apart from favourable solubility characteristics with the refrigerant, good low-temperature flowability, high thermal stability, good ageing resistance and high chemical stability in the presence of refrigerant are additional important parameters.

Particularly during start-ups, oil enrichment due to pronounced oil foaming as a result of dissolved refrigerant can occur. The oil then cools down when the refrigerant evaporates. If the flowability of the remaining oil is not sufficient (as a result of dissolved refrigerant), reliable return to the compressor is not possible. The compressor, on the other hand, requires a certain viscosity of the oil-refrigerant mixture. The optimum operating viscosity of the lubricant – subject to the influence of the refrigerant (pressure- and temperature-related dissolution of refrigerant) – thus represents a compromise between minimum viscosity required for reliable compressor lubrication and the necessary low-temperature flowing properties needed to ensure sufficient oil circulation in the circuit. Apart from favourable solubility characteristics with the refrigerant, good low-temperature flowability, high thermal stability, good ageing resistance and high chemical stability in the presence of refrigerant are additional important parameters.

Research and Development – under the sign of climate protection

Our research and development department deals with comprehensive researches on refrigeration oils with all relevant refrigerants.

In general sustainable refrigerants are becoming more and more important. Low GWP refrigerants (GWP = Global Warming Potential = contribution of a refrigerant to the global warming) like e.g. carbon dioxide (GWP=1) and propane (GWP=3), but also synthetic fluorinated alternatives like HFO-1234yf (GWP=4) are already increasing in their use. On the contrary the use of common refrigerants like R404A (GWP=3922) will decrease already in the medium term.

At FUCHS stability tests are performed with the Sealed Tube apparatus and miscibility and solubility tests of refrigeration oils in diverse refrigerants are performed in special laboratory equipment. The very latest laboratory technology together with specially-constructed test rigs allow wear protection trials to be performed on refrigeration oil and refrigerant mixtures.

Long-term trials of hermetically-sealed compressors in gas-circuits can also be performed on FUCHS test rigs. The thermal and chemical stability of refrigerant-oil mixtures can be evaluated on special, high-pressure autoclaves. These FUCHS in-house laboratory test rigs guarantee exceptional expertise: Specific customer setups can be examined and suitable lubricants can be selected and further developed.

Because of the new challenges also for refrigeration oils which are coming up owing to the commencement of the new European F-gases regulation (EU no. 517/2014) a reliable and innovative manufacturer of lubricants like FUCHS becomes a more and more important partner in refrigeration technology.

Product portfolio:
- Mineral oil-based refrigeration oils
- Synthetic refrigeration oils based on alkyl benzene
- Synthetic refrigeration oils based on polyol esters
- Synthetic refrigeration oils based on polyalkylene glycol
- New refrigeration oils for CO2 applications

FUCHS Industrial Lubricants

The complete product line of high-performance refrigeration oils.

Scheme of refrigeration circuit

System 1: Dry evaporation

System 2: Flooded evaporator

* In the area of the miscibility gap:
  When the density of the refrigerant-enriched phase is greater than the oil-enriched phase.
The classification of refrigeration oils according to DIN 51503, part 1 (January 2011) is alphabetic and in line with the refrigerants used in the following groups:

**KAA** Refrigeration oils not miscible with ammonia – mineral oils and/or synthetic oils – based on polyalphaolefin (PAO) or alkyl benzene (AB) or hydrogenated mineral oils. In most cases, highly-refined, naphthenic refrigeration oils are used as KAA products. Hydrogenated mineral oils and PAO get more and more important.

**KAB** Refrigeration oils miscible with ammonia – generally polyalkylene glycols (PAG). The water content of fresh PAG lubricants used in ammonia applications should not exceed 350 ppm.

**KB** Refrigeration oils for carbon dioxide (CO₂) – synthetic polyol esters (POE), polyalkylene glycols (PAG) or polyalphaolefins (PAO). POE oils generally offer good CO₂ miscibility. PAG oils and CO₂ only allow limited miscibility (larger miscibility gap with CO₂). Synthetic, polyalphaolefin-based refrigeration oils are described as not miscible with CO₂.

**KC** Refrigeration oils for partly and fully-halogenated fluorinated and chlorinated hydrocarbons (CFC, HCFC) – as a rule, mineral oils and alkyl benzenes (in some cases ester oils also possible). Mostly, highly-refined, naphthenic mineral oils and specially-treated alkyl benzenes (alkylates) are used. The water content of fresh KC oils should be < 30 ppm. If the water content is higher, there is a danger of undesirable reactions with the refrigerant which can lead to the decomposition of the oil-refrigerant mixture.

**KD** Refrigeration oils for partly and fully-fluorinated hydrocarbons (HFC, FC) – as a rule, polyol esters (POE) or polyalkylene glycols (PAG). The refrigeration oils described in group KD are polar products with pronounced hygroscopic characteristics. For fresh polyol esters (POE), the water content should not exceed 100 ppm. Polyalkylene glycols (PAG) are often used in a/c systems. Their maximum fresh-oil water content should not exceed 350 ppm.

**KE** Refrigeration oils for hydrocarbons (e.g. propane, isobutane) – as a rule, mineral oils or synthetic oils based on alkyl benzene, PAO, POE or PAG. According to the oil group, the maximum permissible fresh-oil water content should not exceed 30 ppm for mineral oils and alkyl benzene, 50 ppm for PAG, 100 ppm for POE and 350 ppm for PAG.

The following typical properties are given to characterize a refrigeration oil:

<table>
<thead>
<tr>
<th>Property</th>
<th>DIN/Standard</th>
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</thead>
<tbody>
<tr>
<td>Colour</td>
<td>DIN ISO 2049</td>
</tr>
<tr>
<td>Viscosity</td>
<td>DIN EN ISO 3104</td>
</tr>
<tr>
<td>Density</td>
<td>DIN 51757</td>
</tr>
<tr>
<td>Neutralization number</td>
<td>DIN 51558-1</td>
</tr>
<tr>
<td>Water content</td>
<td>DIN 51777-1/2</td>
</tr>
<tr>
<td>Pourpoint</td>
<td>DIN ISO 2592</td>
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<tr>
<td>Flashpoint</td>
<td>DIN 51514</td>
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<tr>
<td>Refrigerant miscibility</td>
<td>ASHRAE 97-2007</td>
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<tr>
<td>Refrigerant stability (Sealed-Tube-Test)</td>
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</tbody>
</table>

Additional information on the characteristics of refrigeration oils is included in the appendix to DIN 51503, part 1. Important parameters such as the flocculation point with corresponding refrigerants, copper corrosion, electrical conductivity in correlation with water content, Falex lubricity test or the modified Almen-Wieland test under refrigerant atmosphere are included. The appendix also names the corresponding PVT diagrams (Daniel Plots) of the oil-refrigerant combinations.

The water contents given in DIN 51503, part 1, are the maximum permissible values of the fresh oils. Refrigeration oils should be delivered in gas-tight metal packages which allow no moisture to ingress even after longer periods of storage. When handling refrigeration oils, care should be taken that the containers are always resealed and that partly-used containers should be used up as soon as possible or alternatively stored in an inert gas atmosphere.
FUCHS Industrial Lubricants

Physical and chemical data of refrigeration oils.

The following typical data is used to characterize a refrigeration oil:

- **Colour according to DIN ISO 2049:** Colour is product-specific and can vary between crystal-clear (colour code 0) and dark brown (colour code 5).

- **Density according to DIN 51757:** Density refers to the mass of a fluid in relation to its volume. In general, to characterize a refrigeration oil, the density at 15 °C is reported. The density of a refrigeration oil is largely dependent on the temperature of the fluid because the volume increases with higher temperature. Density correspondingly falls at higher temperatures.

- **Neutralization number according to DIN 51558:**
  - The neutralization number serves to determine the amount of acidic components in a lubricant. Acids can corrode materials which come into contact with refrigeration oils. High levels of acids, which can be created by oxidation, hydrolysis or ageing, are therefore undesirable. The neutralization number is shown in mg KOH/g. A comparison with fresh oil values is essential when evaluating a used refrigeration oil. The neutralization numbers of refrigeration oils are very low compared to other lubricants. They are in the region of < 0.1 mg KOH/g. The neutralization number is identical with the so called total acid number (TAN) acc. to ASTM D974.

- **Flashpoint according to DIN ISO 2592:**
  - The flashpoint of a refrigeration oil provides information on the base oil or base oil-mixtures used. The flashpoint can also be used to provide indirect information about the oil-refrigerant mixtures, also known as Daniel Plots.

- **Pourpoint according to DIN ISO 3016:**
  - The pourpoint shows the lowest temperature at which an oil still flows when it is cooled down under defined conditions. According to DIN ISO 3016 the sample is cooled down and its flowing behaviour is tested in 3K steps. The pourpoint and threshold viscosity define the lowest temperature at which a pure refrigeration oil can be used. However, the pourpoint and flowing characteristics of refrigeration oils are significantly affected by the proportion of dissolved refrigerant. Dissolved refrigerant significantly reduces the pourpoint, i.e. a refrigeration oil can be used at far lower evaporation temperatures than the pourpoint of the pure oil would suggest. An estimation of the amount of refrigerant dissolved in refrigeration oil is given by pressure-viscosity-temperature charts (PVT diagrams) of oil-refrigerant mixtures.

- **Refrigerant miscibility according to DIN 51514:**
  - The miscibility behaviour of the refrigeration oil with various refrigerants is shown in miscibility-gap diagrams. This behaviour is determined in pressure-resistant glass tubes or in autoclaves. Different concentrations of oil-refrigerant mixtures are tested. The oil-refrigerant mixture is homogenized and cooled respectively heated in a defined way (3K steps). If the oil and refrigerant separate into two fluid phases (the phase separation is characterized by turbidity or emulsion formation in the initially clear fluid), this is the miscibility gap or the point of threshold solubility. These points from different concentrations form a phase diagram, more-commonly known as the miscibility-gap diagram.

Water content according to DIN 51777:
- Determining water content according to Karl Fischer, DIN 51777, Part 1 – direct method, Part 2 – indirect method. Water content according to Karl Fischer shown as mg/kg (+ppm: parts per million) is determined by titration. The quantity of dissolved water in refrigeration oils can only be determined with this method. It is recommended to apply the indirect method acc. DIN 51777 Part 2 because it is suitable for both refrigeration oil without additives as well as refrigeration oil with additives. Undisolved water (free water) can also be determined using the Water-Xylol method (ISO 3733 / IP 74). The content of water in refrigeration oils is very low when compared to other lubricants, refrigeration oils are normally used in “ultra-dried” form.

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Refrigerant compatibility according to ASHRAE 97-2007:

The compatibility of the refrigerant with the refrigeration oil used is of fundamental importance. In the Sealed-Tube-Test acc. to ASHRAE 97-2007: “Method to test the chemical stability of materials for use within refrigeration systems” a test tube or autoclave is filled with a defined quantity of oil and fluid refrigerant and a catalyst (pieces of iron, copper, aluminium). The test is performed at 175 °C for 14 days. At the end of the test, the oil is evaluated for changes, its neutralization number is tested and the surface of the metal pieces is examined for changes.

Chemical stability:
The chemical stability of a refrigeration oil depends on a number of important factors, but above all, on extremely low water content in the system. Refrigeration oils with excessive water contents must be replaced. The moisture absorption (hygroscopicity) of refrigeration oils.

Physical and chemical data of refrigeration oils.

Thermal stability:
The exposure of lubricating oils to high temperatures over longer periods of time can lead to the formation of decomposition products and these can cause serious problems. Ageing stability is thus an important lubricant selection criterion. Decomposition processes are generally complex chemical reactions which are catalyzed by metals such as copper, iron or aluminium. Also water in the system can lead to the formation of decomposition products. Experience shows that an increase in temperature of 10K doubles the speed of ageing. Some refrigerants, especially HFC, react chemically with water when subject to high temperatures and this can also reduce oil stability.

Well-known indicators of oil ageing are an increase in neutralization number (acid number) and copper plating. Copper plating means that copper (e.g. from the tubing) is chemically dissolved in the oil and then deposited elsewhere, usually on mechanically-stressed metal surfaces such as pistons, valves, etc. This can cause problems to machine parts with close tolerances. Copper plating occurs when the oil acidifies and is accelerated by moisture in the system along with advanced oil ageing.

Testing the ammonia-stability of refrigeration oils according to DIN 51538:

An ammonia-saturated stream of air is passed through the refrigeration oil to be tested. This test lasts for 168 hours at 120 °C in the presence of a steel catalyst. The base number (shown in mg KOH/g) of the thus aged oil is used as a criterion to evaluate the stability of the refrigeration oil when in contact with ammonia and oxygen in the air (deviation from fresh oil value, measured in line with DIN ISO 3771).

Dynamic & kinematic viscosity:

The arithmetical correlation between dynamic and kinematic viscosity is described by the following equation:

\[ \nu = \eta / \rho \]

\( \nu \) = kinematic viscosity
\( \eta \) = dynamic viscosity
\( \rho \) = fluid density

Kinematic viscosity according to DIN EN ISO 3104:

Viscosity (the thickness of the oil) is the most important characteristic describing the load-bearing capacity of an oil. Refrigeration oils along with other industrial lubricants, are classified according to their kinematic viscosity into ISO Viscosity Grades. The reference temperature is 40 °C and the official unit of kinematic viscosity is m²/s but in the lubrication sector, the units cSt or mm²/s are more common. DIN 51519 lays down 18 different viscosity grades from 2 to 1000 mm²/s at 40 °C for fluid industrial lubricants. Every viscosity grade is described by the mean viscosity at 40 °C and the permissible deviation of ± 10 % of this value.

The thickness or viscosity of an oil falls with rising temperature. The Viscosity Index (VI) describes this temperature dependence and is calculated according to DIN ISO 2909 from the kinematic viscosity at 40 °C and 100 °C. A suitably high lubricant viscosity is necessary to form a load-bearing lubricating film in the bearings, cylinders etc. of the compressor. However, in the refrigerant circuit itself, the oil should have the lowest possible viscosity. Refrigeration oils of various viscosities are used depending on the type of compressor and the application in question. The viscosity to be applied is normally specified by the compressor manufacturer.

This information alone is often not enough to evaluate the suitability of a refrigeration oil for a particular application. Additional, interesting information is provided by the corresponding pressure-viscosity-temperature charts (Daniel Plots) which are product and refrigerant specific. These diagrams show how much of a particular refrigerant dissolves in the oil under certain pressure and temperature conditions and how the kinematic viscosity of the refrigeration oil changes as a result. These figures form the basis for evaluating the compressor lubrication under operation conditions.

In the past refrigeration systems were operated with chlorinated CFC/HFC refrigerants. The chlorine compounds in these products acted as anti wear (AW) additives. This additional protection is no longer available from chlorine-free refrigerants. Today’s refrigerants thus need correspondingly good lubricity.

To achieve reliable protection against wear the use of high-performance additives (AW additives) in combination with selected suitable base fluids is essential.
Mixture viscosity and vapour pressure; Daniel Plot; PVT diagram

The influence of the refrigerant dissolved in the oil on viscosity is illustrated by PVT diagrams, otherwise known as Daniel Plots. In these, saturation vapour pressure and mixture viscosity at defined concentrations are shown against temperature. The lower diagram (next page) shows, for example, the amount of refrigerant dissolved in the oil at a certain temperature and the corresponding system pressure.

Example:
Point A: 60 °C, 90 % → 14 mm²/s.

The resulting mixture viscosity at various pressures and temperatures shows the influence of refrigerant dissolved in the oil. This influence of refrigerant on oil viscosity is based on the suction pressure in the case of piston compressors and the outlet pressure (pressure in the oil separator) in the case of screw compressors.

Example:
Point A: 60 °C, 90 % → 14 mm²/s.

The resulting mixture viscosity can be taken from the upper diagram (next page) where the given temperature and the corresponding percentage of oil dissolved in the refrigerant meet.
Mineral oil-based refrigeration oils

- **RENISO K series**
  Highly refined, naphthenic mineral oils, free of additives. The RENISO K series can be used in NH₃, systems as well as for HCFC applications (e.g. R22 systems). As a result of their good ageing stability in the presence of ammonia and their worldwide availability, these oils play an important role in conventional NH₃ systems.

- **RENISO WF series**
  Selected, highly refined cuts with special anti-wear additives. The RENISO WF series – in the viscosity grades ISO VG 5-22 are perfect for the lubrication of hermetically sealed refrigerator compressors which use isobutane (R600a) as refrigerant. Diagrams of RENISO WF10A with isobutane (R600a) see page 15.

  The use of low viscous RENISO WF refrigeration oils in modern compressors can achieve significant improvements in energy efficiency.

- **RENISO TES 100**
  Special paraffinic mineral oil. Due to its good viscosity-temperature behaviour, RENISO TES 100 is particularly suitable for older turbo-compressors which were designed for use with refrigerants containing chlorine.

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**Example:**

Miscibility of RENISO WF 10 A with R600a

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**Example:**

Kinematic viscosity and vapour pressure (Daniel Plot)

- **RENISO WF based on mineral oil**

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**INNOVATION**

**SUSTAINABLE**
Synthetic refrigeration oils

Alkyl benzene (AB)

- **RENISO S series**
- **RENISO SP series**

Chemically and thermally highly stable alkyl benzene (AB) oils. A special refining treatment during the production process further improves the low-temperature properties as well as the chemical and thermal stability of these oils. These products display outstanding additive solubility. Because of their favourable miscibility with HFCFs, even at low temperature, RENISO SP series products are recommended for R22 and its mixtures. The RENISO SP grades containing additives are not suitable for NH₃ systems. The RENISO S series is recommended for NH₃ applications. RENISO S series products can also be used with HFC refrigerants such as R22 (the RENISO S series does not contain AW additives).

Polyalphaolefin (PAO) / synthetic hydrocarbons

- **RENISO SYNTH 68**

Thermally stable polyalphaolefin (PAO) with excellent cold-flowing properties for NH₃ systems with highly-stressed compressors and low evaporation temperatures. Due to its outstanding cold-flowing properties, RENISO SYNTH 68 is also recommended for use in plate evaporators operating at low temperature and with narrow tubing diameters.

RENISO SYNTH 68 can also be used, as a refrigeration oil for R723 (dimethyl ether-ammonia-mixture) and CO₂ applications (not miscible with subcritical CO₂). Due to its beneficial solubility behaviour (low dilution) and its extraordinary viscosity-temperature-behaviour (high VI), RENISO SYNTH 68 is especially suitable for the use with hydrocarbons like propane (R290) or propylene (R1270).

**RENISO UltraCool 68**

RENISO UltraCool 68 is used for ammonia refrigeration plants with deep evaporation temperatures down to < -45°C. Due to its thermal stability RENISO UltraCool 68 avoids the formation of oil deposits and sludge in the compressor. According to this maintenance costs of the refrigeration plant (filter replacement, inspection work etc.) can be considerably reduced. RENISO UltraCool 68 shows an outstanding low evaporation rate which is significantly lower than that of conventional and that of hydro treated mineral oils. In practice this means that there is less oil loss in the compressor (lower oil carry-over) which ends up in lower oil top-up volumes. This is also an important point with regard to cost savings in the refrigeration plant. RENISO UltraCool 68 combines the very good cold-flow and high-temperature properties of synthetic hydrocarbons with good elastomer properties (good compatibility with CR sealants) as they are only known from mineral oil products.

Polylol esters (POE)

- **RENISO TRITON SE/SEZ series**

RENISO TRITON SE/SEZ series products prove to have excellent cold flow properties and a highly stable lubricating film under high temperature conditions in hydrocarbon applications. All RENISO TRITON SE/SEZ products are characterized by excellent stability and outstanding lubricity.

All ester oils tend to absorb water. In extreme cases, hydrolytic decomposition reactions can occur if excessive water content in the oil and extreme stress combine. It is therefore necessary to ensure that these products do not come into contact with water or moisture during storage, handling or operation. All RENISO TRITON SE/SEZ products are ultra-dried and filled into gas-tight metal cans and drums in nitrogen atmosphere.

Determination of the flowability of refrigeration oils for NH₃: U-Tube-Test (DIN 51568) – without refrigerant (low temperature flowability)

Evaporation losses of refrigeration oils for NH₃ acc. ASTM D972 : 150° / 22h / air flow rate 2l/min
**FUCHS Industrial Lubricants**

**Refrigeration oil product groups.**

**Polyalkylene glycol (PAG)**

- **RENISO PG 68, RENISO GL 68**
  Synthetic, NH₃-miscible refrigeration oils based on special polyalkylene glycols (PAG) with an additive system designed to provide enhanced ageing stability.

- **RENISO PAG 46 and PAG 100**
  Recommended for use in ammonia dry expansion (DX) systems. PAG refrigeration oils like RENISO PAG 46 and RENISO PAG 100 belong to the group KAB according to DIN 51503 (with ammonia miscible oils).

- **RENISO PAG 220 C – R134a applications**
  Synthetic, high-viscous refrigeration oil based on special polyalkylene glycols (PAG), which offer excellent miscibility with R134a. RENISO PAG 220 C was specially developed for use in R134a screw compressors. Its main application is in heat pumps and expanders. RENISO PAG 220 C can also be used with the refrigerants R236fa, R227ea, R245fa and R744 (CO₂).

- **RENISO PAG 46 and PAG 100**
  Selected polyalkylene glycols (PAG) for automotive air-conditioning systems which use R134a refrigerants. Also recommended for the use in ammonia dry expansion (DX) systems. PAG refrigeration oils like RENISO PAG 46 and RENISO PAG 100 belong to the group KAB according to DIN 51503 (with ammonia miscible oils).

**Lubricants for CO₂ applications**

- **RENISO C series**
  RENISO C series products are based on special synthetic, thermally stable ester oils. They have an excellent miscibility behavior together with CO₂, which secures safe oil transport and proper heat transfer in the cooling circuit. RENISO C refrigeration oils contain a special additive system which reliably protects highly-stressed compressors – as often found in CO₂ systems – from wear (see below).

  **Test in FUCHS axial roller bearing test rig**
  Test conditions: 140 °C / 50 bar CO₂ / axial loading 8 kN / 800 min⁻¹. Comparison of roller and bearing surface wear after 20 hours.

- **RENISO ACC 46 and RENISO ACC HV – for vehicle air conditioning systems**
  RENISO ACC 46 and RENISO ACC HV (ISO VG 68) were developed in years of joint research work together with leading compressor manufacturers and OEMs for the use in CO₂ vehicle air conditioning systems. The RENISO ACC products are based on double end-capped polyalkylene glycols (PAG) and are containing an efficient additive system to increase the wear protection and the chemical-thermal stability.

  RENISO ACC 46 and RENISO ACC HV totally fulfill the high requirements on refrigeration oils for CO₂ vehicle air conditioning systems.

- **RENISO ACC 68**
  RENISO ACC 68 was particularly developed for the use in trans-critical CO₂ applications such as air conditioning applications and heat pump systems. RENISO ACC 68 is formulated on the basis of special thermally-stable synthetic polyalkylene glycols. Highly effective additives ensure a reliable wear protection also under extreme operating conditions (high temperature, high pressure ratio).

**Lubricants for HFO refrigerants**

The use of environmentally acceptable refrigerants – i.e., refrigerants with a reduced contribution to the global warming potential, so-called Low-GWP refrigerants (GWP = Global Warming Potential) – is becoming even more important. In the meantime, with the EU regulation no. 517/2014 the legal framework to reduce the impact of HFC refrigerants to the worldwide greenhouse effect is given.

To fulfill the valid emission limits during the next years (reducing step by step the emission of HFC refrigerants to 21% of the initial value until 2030), the application of refrigerants with a high GWP value, will become more and more difficult. Beside natural refrigerants like carbon dioxide, ammonia and hydrocarbons the use of partly fluorinated olefins, so-called HFO (Hydrogenated Fluorinated Olefin) refrigerants, will increase.

The refrigerant HFO-1234yf (GWP=4) is already in use in air conditioning systems of new vehicle types as successor refrigerant for R134a (GWP=1300). But HFO-1234yf is at least disputed because of its flammability (classification A2L), HFO-1234ze (GWP=6) which has the same chemical composition but a different molecular structure has also thermodynamic properties which are making a use as refrigerant possible. But the volumetric refrigerating capacity is approx. 25% below the capacity of HFO-1234yf resp. R134a. Beside these pure substances mixtures of HFO refrigerants with HFC are also offered for having an efficient refrigeration medium available which has a distinctly lower flammability as HFO-1234yf.

Initial promising experiences with these new HFO refrigerants and refrigerant mixture do already exist. As refrigeration oils for this substance group the new developed PAG oils (RENISO PAG 1234) for vehicle air conditioning systems and POE oils (RENIOS TRITION SE/SEZ) for stationary applications have proven to be reliable lubricants. But for sure the steadily increasing practical experiences will be crucial for the evaluation of this new refrigerant class in the future. FUCHS is involved in numerous projects and field tests with HFO refrigerants and has thereby established itself as a reliable partner for the lubrication system in these sustainable low GWP applications.
FUCHS Industrial Lubricants

Refrigeration oil product groups.

Lubricants for sustainable vehicle air conditioning

- **RENSO PAG 1234 – for HFO-1234yf**

Using HFO-1234yf as successor of R134a in automotive a/c systems brings a lot of challenges for the refrigeration oil in the compressor. RENISO PAG 1234 on the basis of double-end-capped polyalkylene glycols (PAG) is characterized by a good miscibility with HFO-1234yf. Due to its newly developed additivation RENISO PAG 1234 ensures reliable compressor lubrication with excellent wear protection. The thermo-chemical stability of RENISO PAG 1234 in combination with HFO-1234yf guarantees a stable long-term operation of the a/c system.

Due to their comparatively polar structure, PAGs absorb water rapidly. This means that corresponding care must be taken when handling these products. The RENISO PAG series of products are ultra-dried and filled into gas-tight containers (e.g. 250 ml cans) in nitrogen atmosphere.

Example:
Daniel Plot:
Kinematic viscosity and vapour pressure
RENSO C B5 E – CO₂ mixture

All % figures represent mass of oil in the refrigerant.

Example:
Miscibility gap
Miscibility of RENISO C B5 E with CO₂
LAS – laboratory analysis system for refrigeration oils

Focused on the specific requirements of refrigerants, FUCHS offers a laboratory service which is designed to monitor the condition of refrigeration oils in use. This support service helps to guarantee the reliable operation of refrigeration plants.

The LAS kit contains all the necessary equipment for 5 analyses in the FUCHS laboratories. The determination of viscosity, water content, concentration of wear particles, additive content and the neutralization number (for ammonia systems: Determination of the base number) enables the on-going monitoring of refrigerating systems.

The LAS can help reduce maintenance costs and allow countermeasures to be taken in good time if danger signs are registered. Our “LAS for Refrigeration Oils” information pack describes the scope of the tests and the analyses performed.

Threshold values for used RENISO refrigeration oils (in line with DIN 51503-2, draft version)

<table>
<thead>
<tr>
<th>Product</th>
<th>Group</th>
<th>Deviation in kinematic viscosity at +40 °C, mm²/s</th>
<th>Max. water content, mg H₂O/kg oil</th>
<th>Neutralization number, mgKOH/g</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DIN EN ISO 3104</td>
<td>DIN 51777-1</td>
<td>DIN 51777-2</td>
</tr>
<tr>
<td>Mineral oil</td>
<td>KAA</td>
<td>± 15% of fresh oil value</td>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>RENISO K</td>
<td>KC</td>
<td>± 15% of fresh oil value</td>
<td>80</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>KE</td>
<td>± 15% of fresh oil value</td>
<td>80</td>
<td>0.1</td>
</tr>
<tr>
<td>Polyalphaolefin (PAO)</td>
<td>KAA</td>
<td>± 15% of fresh oil value</td>
<td>100</td>
<td>0.1</td>
</tr>
<tr>
<td>RENISO SYNTH</td>
<td>KB</td>
<td>± 15% of fresh oil value</td>
<td>80</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>KE</td>
<td>± 15% of fresh oil value</td>
<td>80</td>
<td>0.1</td>
</tr>
<tr>
<td>Alkyl benzene (AB)</td>
<td>KAA</td>
<td>± 15% of fresh oil value</td>
<td>100</td>
<td>–</td>
</tr>
<tr>
<td>RENISO S/SP</td>
<td>KC</td>
<td>± 15% of fresh oil value</td>
<td>60</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>KE</td>
<td>± 15% of fresh oil value</td>
<td>80</td>
<td>0.1</td>
</tr>
<tr>
<td>Polyalkylene glycol (PAG)</td>
<td>KAB</td>
<td>± 15% of fresh oil value</td>
<td>500</td>
<td>–</td>
</tr>
<tr>
<td>RENISO PAG/ACC</td>
<td>KB</td>
<td>± 15% of fresh oil value</td>
<td>800</td>
<td>0.2</td>
</tr>
<tr>
<td>RENISO PG/GL</td>
<td>KD</td>
<td>± 15% of fresh oil value</td>
<td>800</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>KE</td>
<td>± 15% of fresh oil value</td>
<td>800</td>
<td>0.2</td>
</tr>
<tr>
<td>Ester oils (POE, complex esters)</td>
<td>KB</td>
<td>± 15% of fresh oil value</td>
<td>150</td>
<td>0.2</td>
</tr>
<tr>
<td>RENISO TRITON SE/SEZ</td>
<td>KC</td>
<td>± 15% of fresh oil value</td>
<td>150</td>
<td>0.1</td>
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<tr>
<td></td>
<td>KD</td>
<td>± 15% of fresh oil value</td>
<td>200</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>KE</td>
<td>± 15% of fresh oil value</td>
<td>200</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Threshold values for used refrigeration oils: Explanations

* In the case of kinematic viscosity manufacturer’s specifications should always be observed.
** Larger deviations from fresh oil values are possible in the case of ammonia refrigeration oils – acceptable in the direction of a higher viscosity.

The lubricant / compressor / installation manufacturer should be consulted if the threshold values are exceeded.

KAA – Ammonia refrigeration oils (not miscible e.g. mineral oils, alkyl benzene, polyalphaolefin)
KKB – Ammonia refrigeration oils (miscible e.g. polyalphaolefin glycol)
KOD – CO₂ refrigeration oils (CO₂ miscible e.g. polyol esters, polyalphaolefin glycol, CO₂ non-miscible e.g. polyalphaolefin glycol)
KCD – CFC refrigeration oils (gas e.g. mineral oils, alkyl benzene, complex and polyol esters)
KOD – HFC refrigeration oils (gas e.g. polyol esters, polyalphaolefin glycol, polyalphaolefin glycol)
KDE – Hydrocarbon refrigeration oils (e.g. mineral oils, alkyl benzene, polyalphaolefin, polyalphaolefin glycol, polyol esters)

Determining water content according to Karl Fischer

DIN 51777-1 (direct): For refrigeration oils without additives
DIN 51777-2 (indirect): For refrigeration oils with and without additives
The advantages of FUCHS refrigeration oils.

Logistic systems for refrigeration oils

RE宁ISO refrigeration oils are ultra-dried. PAG and POE are hygroscopic, i.e. they tend to absorb water more rapidly than hydrocarbon-based non-polar refrigeration oils such as mineral oil, alkyl benzene and PAO.

Our RENISO refrigeration oils are available in a variety of user-friendly containers ranging from 1 litre screw-top cans through to 1 m³ containers and special road tankers. All containers have passed long-term trials to test their ability to seal-out moisture.

Prior to shipping, our logistics concept involves all 1 m³ containers and tankers being permanently pressurized (with dried nitrogen) to stop the ingress of moisture. A sophisticated method of emptying and filling containers guarantees that the water content in fresh deliveries is absolutely negligible. If required, this can be certified on a document which details key data, such as product quantity, water content and container pressure. We will be glad to supply you with further information about our logistics system along with samples of the technical documentation.

FUCHS high-tech lubricants

We will gladly supply you with further details about the standard products, specialties and greases that make up our extensive lubricant program and our expert application engineers will be pleased to answer all of your technical questions.

The use of innovative refrigeration oils requires experienced and individual consultation. A detailed consultation should therefore precede every change of application parameters. This guarantees that the optimum lubricant system is selected. FUCHS lubrication specialists have the experience and technical expertise to give qualified lubricant recommendations as well as helping to solve problems.

The advantages of our refrigeration oils:

- Highest quality standards
  RENISO products use the highest quality raw materials. Development, production and filling are all subject to highest quality standards and controls.

- Joint product development
  Customers often need special solutions. We accept this challenge and together we develop suitable solutions which satisfy your applications and requirements.

- Individual problem-solving
  All RENISO refrigeration oils have been carefully developed, tested and formulated with years of acquired know-how. For the customer, this means more reliability and greater economy.

- Personal consulting – contact us now!
  What can FUCHS do for you in terms of products and service? Your personal contact person can tell you more.

FUCHS Industrial Lubricants

The service program.
## FUCHS Industrial Lubricants

### The RENISO product portfolio.

### RENISO K SERIES – MINERAL OIL BASED REFRIGERATION OIL

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<tbody>
<tr>
<td>RENISO WF 5 A</td>
<td>Special refrigeration oils for use with the refrigerant isolator (RIS6) - highly refined, low flocculation point with friction modifiers, containing additives to improve wear protection and ageing stability. DIN 51700 – KC, KE.</td>
<td>869 154</td>
<td>98 2.2</td>
<td>100 2.6</td>
<td>99</td>
<td>-</td>
<td>-53</td>
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<tr>
<td>RENISO WF 7 A</td>
<td>Highly refined, paraffinic mineral oil RENISO WF 7A for screw compressors. DIN 51700 – KC.</td>
<td>852 154</td>
<td>98 2.2</td>
<td>100 2.6</td>
<td>99</td>
<td>-</td>
<td>-53</td>
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<tr>
<td>RENISO WF 10 A</td>
<td>Highly refined, paraffinic mineral oil RENISO WF 10A for screw compressors. DIN 51700 – KC.</td>
<td>852 154</td>
<td>98 2.2</td>
<td>100 2.6</td>
<td>99</td>
<td>-</td>
<td>-53</td>
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<td>RENISO WF 15 A</td>
<td></td>
<td>852 154</td>
<td>98 2.2</td>
<td>100 2.6</td>
<td>99</td>
<td>-</td>
<td>-53</td>
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### RENISO S/SP SERIES – FULLY SYNTHETIC REFRIGERATION OILS BASED ON ALKYL BENZENE

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<tr>
<td>RENISO SP 32</td>
<td></td>
<td>819 154</td>
<td>172 32</td>
<td>4.6</td>
<td>31</td>
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<td>RENISO SP 66</td>
<td></td>
<td>875 154</td>
<td>199 46</td>
<td>5.6</td>
<td>26</td>
<td>-42</td>
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<tr>
<td>RENISO SP 100</td>
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<td>871 154</td>
<td>190 100</td>
<td>7.9</td>
<td>11</td>
<td>-24</td>
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<tr>
<td>RENISO SP 220</td>
<td></td>
<td>871 154</td>
<td>192 220</td>
<td>13.2</td>
<td>13</td>
<td>-27</td>
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<tr>
<td>RENISO S 3246</td>
<td>RENISO’s S 32 and RENISO S 68 do not contain AW additives and are not suitable for refrigeration oils.</td>
<td>877 154</td>
<td>180 40</td>
<td>5.1</td>
<td>17</td>
<td>-39</td>
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<tr>
<td>RENISO S 68</td>
<td>RENISO UltraCool 68 is new high thermal stability oil for screw and hermetic compressors.</td>
<td>869 154</td>
<td>188 68</td>
<td>6.2</td>
<td>-30</td>
<td>-33</td>
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### RENISO TRITON SE/SEZ SERIES – FULLY SYNTHETIC REFRIGERATION OILS BASED ON POLYOL ESTER (POE)

<table>
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<tr>
<td>RENISO TRITON SEZ 32</td>
<td></td>
<td>1,001 228</td>
<td>20 4.4</td>
<td>134</td>
<td>-57</td>
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<td>RENISO TRITON SEZ 68</td>
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<td>1,004 250</td>
<td>32 6.1</td>
<td>140</td>
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<td>RENISO TRITON SEZ 55</td>
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<td>1,009 286</td>
<td>55 8.8</td>
<td>137</td>
<td>-48</td>
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<td>RENISO TRITON SEZ 60</td>
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<td>790 258</td>
<td>68 8.8</td>
<td>125</td>
<td>-39</td>
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<td>RENISO TRITON SEZ 80</td>
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<td>952 251</td>
<td>82 10.4</td>
<td>115</td>
<td>-39</td>
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<tr>
<td>RENISO TRITON SEZ 100</td>
<td></td>
<td>970 260</td>
<td>100 11.4</td>
<td>130</td>
<td>-39</td>
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### RENISO SYNTH 68 / RENISO ULTRACOOL 68 – FULLY SYNTHETIC REFRIGERATION OILS BASED ON SYNTHETIC HYDROCARBONS (PAO)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>RENISO SYNTH 68</td>
<td>Synthetic refrigeration oil based on polyol ester fluids (PAO) for refrigeration oil applications.</td>
<td>835 260</td>
<td>68 10.5</td>
<td>142</td>
<td>-57</td>
<td></td>
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<tr>
<td>RENISO UltraCool 68</td>
<td></td>
<td>854 250</td>
<td>62 9.1</td>
<td>124</td>
<td>-48</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

NEW

*AW* = Anti-wear additive, VI = Viscosity Index, CR = Four-point, HNBR = Hydrogenated Nitrile Butadiene Rubber, NBR = Nitrile Butadiene Rubber.
The RENISO product portfolio.

**RENISO GL 68, PG 68 – FULLY SYNTHETIC REFRIGERATION OILS BASED ON POLYALKYLENE GLYCOL (PAG)**

**RENISO PAG SERIES – FULLY SYNTHETIC REFRIGERATION OILS BASED ON POLYALKYLENE GLYCOL (PAG)**

- **Product Name** Description
- **Density at 15 °C** [kg/m³]
- **Flp. Clev.** [°C]
- **Kin. Visc. 40°C** [mm²/s]
- **Kin. Visc. 100°C** [mm²/s]
- **VI (viscosity index)**
- **Pour-point** [°C]
- **Main Application Area**

**RENISO GL 68**
- Fully synthetic refrigeration oil based on polyalkylene glycol (PAG), miscibility gap 15% oil / 85% NH₃, partly miscible refrigeration oil, also suitable for hydration applications.
- DIN 51503 - KA, LE, KD.
- 1,010 270 68 10.5 140 -42
- RENISO PG 68 and GL 68 are ultra-dried, synthetic refrigeration oils based on PAG for NH₃ systems which operate on the principle of direct expansion. They differ in their suitability with NH₃.
- Suitable for screw and reciprocating piston compressors.

**RENISO PG 68**
- Fully synthetic refrigeration oil based on polyalkylene glycol (PAG), miscibility gap 15% oil / 85% NH₃, partly miscible refrigeration oil, also suitable for hydration applications.
- DIN 51503 - KA, LE, KD.
- 1,044 250 70 14.0 210 -52
- Warning: PAG oils are not compatible / miscible with mineral oils.
- PAG oils are hygroscopic. Avoid any contamination with water.
- Attention: Please contact our FUCHS application engineers.

**RENISOL C SERIES – FULLY SYNTHETIC REFRIGERATION OILS BASED ON POLYOLO ESTER (POE) FOR CO₂ APPLICATIONS**

- **Product Name** Description
- **Density at 15 °C** [kg/m³]
- **Flp. Clev.** [°C]
- **Kin. Visc. 40°C** [mm²/s]
- **Kin. Visc. 100°C** [mm²/s]
- **VI (viscosity index)**
- **Pour-point** [°C]
- **Main Application Area**

**RENISO ACC 68 – FULLY SYNTHETIC REFRIGERATION OILS BASED ON POLYALKYLENE GLYCOL (PAG)**

- **Product Name** Description
- **Density at 15 °C** [kg/m³]
- **Flp. Clev.** [°C]
- **Kin. Visc. 40°C** [mm²/s]
- **Kin. Visc. 100°C** [mm²/s]
- **VI (viscosity index)**
- **Pour-point** [°C]
- **Main Application Area**

**RENISO C 55 E**
- Synthetic refrigeration oils based on special polyol esters with anti-wear additives for use with the refrigerant CO₂ (subcritical and transcritical applications).
- Also suitable for HFC / FC refrigerants.
- DIN 51503 - KB.
- 1,009 286 55 10.6 175 -42

**RENISO C 85 E**
- Synthetic refrigeration oils based on special polyol esters with anti-wear additives for use with the refrigerant CO₂ (subcritical and transcritical applications).
- Also suitable for HFC / FC refrigerants.
- DIN 51503 - KB.
- 1,069 286 55 10.6 187 -42

**RENISO C 170 E**
- Synthetic refrigeration oils based on special polyol esters with anti-wear additives for use with the refrigerant CO₂ (subcritical and transcritical applications).
- Also suitable for HFC / FC refrigerants.
- DIN 51503 - KB.
- 1,009 286 55 10.6 175 -42

**RENISO PAG 46**
- Synthetic refrigeration oils based on special polyalkylene glycol (PAG) for automotive air conditioning systems.
- DIN 51503 - KB, KD, LE.
- 992 240 55 10.6 175 -42
- Refrigeration oils based on special polyalkylene glycol (PAG) for automotive air conditioning systems.
- Suitable for sub- and transcritical CO₂ applications.

**RENISO PAG 100**
- Synthetic refrigeration oils based on special polyalkylene glycol (PAG) for automation air conditioning systems.
- DIN 51503 - KB, KD, LE.
- 996 240 120 21.0 202 -45
- Refrigeration oils based on special polyalkylene glycol (PAG) for automation air conditioning systems.
- Suitable for sub- and transcritical CO₂ applications.

**RENISO PAG 1234**
- NEW
- Synthetic refrigeration oil on the basis of special polyalkylene glycol (PAG) for vehicle A/C systems with HFO-1234yf.
- DIN 51503 - KB.
- 993 224 44 9.8 218 -45
- Refrigeration oils based on polyalkylene glycol (PAG) for HFC refrigerants such as R-134a, R-245fa.
- Especially suited for screw compressors.

**RENISO PAG 220 C**
- Synthetic refrigeration oil on the basis of special polyalkylene glycol (PAG) for vehicle A/C systems with HFO-1234yf.
- DIN 51503 - KB, KD, LE.
- 1,072 255 226 39.1 226 -39
- Refrigeration oils based on polyalkylene glycol (PAG) for HFC refrigerants such as R-134a, R-245fa.
- Especially suited for screw compressors.
- Also suitable for CO₂ applications (oil which is not miscible with CO₂).

**RENISO C 170 C**
- Synthetic refrigeration oils based on special polyol esters with anti-wear additives for use with the refrigerant CO₂ (subcritical and transcritical applications).
- Also suitable for HFC / FC refrigerants.
- DIN 51503 - KB.
- 1,099 290 55 10.6 175 -42
- Refrigeration oils based on special polyol esters with anti-wear additives for use with the refrigerant CO₂ (subcritical and transcritical applications).
- Also suitable for HFC / FC refrigerants.
- DIN 51503 - KB.
- 1,099 286 55 10.6 175 -42

**RENOLIN LPG SERIES – FULLY SYNTHETIC GAS COMPRESSOR OILS BASED ON POLYALKYLENE GLYCOL (PAG)**

- **Product Name** Description
- **Density at 15 °C** [kg/m³]
- **Flp. Clev.** [°C]
- **Kin. Visc. 40°C** [mm²/s]
- **Kin. Visc. 100°C** [mm²/s]
- **VI (viscosity index)**
- **Pour-point** [°C]
- **Main Application Area**

**RENOLIN LPG 100**
- Synthetic gas compressor oils based on polyalkylene glycol (PAG).
- Suitable for process gases, refinery gases (thiophene gases), waste gases (gas, waste gas, biogas, etc.) and their blends.
- 1,002 270 100 16.2 175 -39
- Attention: RENOLIN LGP 100 and LPG 185 are not recommended in the absence of hydrogen gases in the oil.
- Due to the use of special base oils, the dissolution of the lubricant in operation (slight to significantly) is minimized.
- Thorough, reliable wear protection and excellent lubricating properties are guaranteed.
- Additional additives provide additional security in terms of minimal oxidation stability and wear protection of the lubricant under gas atmosphere.
# Refrigeration Lubricant Selection Guide for Industrial Systems

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Evaporator Temperature</th>
<th>Compressor Type</th>
</tr>
</thead>
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<td><strong>Type</strong></td>
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<td>R502</td>
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<tr>
<td>R22</td>
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<tr>
<td>R22</td>
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<td>-30</td>
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<tr>
<td>R22</td>
<td>HCFC</td>
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<tr>
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<tr>
<td>R402A</td>
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<td>R1270</td>
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<tr>
<td>R600</td>
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<tr>
<td>R600a</td>
<td>Isobutane</td>
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<tr>
<td>R717</td>
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<td>R717</td>
<td>NH₃</td>
<td>-50</td>
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<tr>
<td>R744</td>
<td>CO₂ - subcritical</td>
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<tr>
<td>R744</td>
<td>CO₂ - transcritical</td>
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<tr>
<td>R23</td>
<td>HFC</td>
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<td>HFC</td>
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<tr>
<td>R404A</td>
<td>HFC</td>
<td>-40</td>
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<tr>
<td>R404A</td>
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<td>-50</td>
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<td>R407C</td>
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<td>R410A</td>
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<td>HFC</td>
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<td>R422A</td>
<td>HFC</td>
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<td>R422D</td>
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<td>R422D</td>
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<td>R427A</td>
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<tr>
<td>R427A</td>
<td>HFC</td>
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<tr>
<td>R507</td>
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<tr>
<td>R507</td>
<td>HFC</td>
<td>-20</td>
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</tbody>
</table>

Additional explanations:
- **P** = Preferred recommendation
- *Selection of viscosity grade acc. to recommendation of compressor manufacturer

More information about lubricant series can be found in the accompanying table:

<table>
<thead>
<tr>
<th>PAO / synth. HC</th>
<th>MO</th>
<th>POE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RENISO SYNTH 68</td>
<td>RENISO UltraCool 68</td>
<td>based on PAO / synthetic hydrocarbon</td>
</tr>
<tr>
<td>RENISO K - Reihe</td>
<td>RENISO TES 100</td>
<td>based on mineral oils</td>
</tr>
<tr>
<td>RENISO S - SP series</td>
<td>RENISO TRITON SE - SEZ series</td>
<td>based on alkyl benzenes</td>
</tr>
<tr>
<td>RENISO PG / GL / PAG</td>
<td>RENISO C series</td>
<td>based on polyol esters</td>
</tr>
<tr>
<td>RENISO ACC 68</td>
<td>RENISO PG / GL / PAG</td>
<td>based on polyalkylene glycols for CO₂</td>
</tr>
</tbody>
</table>

Extra information:
- **AB**
- **PAE**
- **POE - C**
- **PAG - C**
FUCHS Industrial Lubricants

4 good reasons for using RENISO Refrigeration Oils.

Performance comparison RENISO TRITON SEZ 80 versus standard-POE-refrigeration oils.

1. High thermo-chemical stability:
   e.g. in Sealed Glass Tube Test (ASHRAE 97-2007)
   - High stability
   - Standard POE refrigeration oils
   - RENISO TRITON SEZ 80
   - based on polyol ester (POE)

2. Very good miscibility
   with HFKW/FKW: e.g. in small miscibility gap (DIN 51514)
   - Good miscibility
   - Standard POE refrigeration oils
   - RENISO TRITON SEZ 80
   - based on polyol ester (POE)

3. Low varnish / low sludge formation
   e.g. in FUCHS In-house test (oil deposits in beaker with bearing roller after 168h at 135°C)
   - No deposits
   - Standard POE refrigeration oils
   - RENISO TRITON SEZ 80
   - based on polyol ester (POE)

4. Reliable wear protection
   e.g. in bearing wear testing (DIN 51819-3)
   - No Wear
   - Standard POE refrigeration oils
   - RENISO TRITON SEZ 80
   - based on polyol ester (POE)

In addition to the RENISO brochure you can find further information about refrigeration oils in several publications, e.g.

This guide leads you to the relevant aspects when changing from R22 to a chlorine-free refrigerant system.

Available only in German.

A broad overview over the field of refrigeration oils – including a lot of application engineering data and diagrams for numerous oil-refrigerant-mixtures.

Available only in German from VDE Verlag:
ISBN 978-3-8007-3271-5

Note

The information contained in this product information is based on the experience and know-how of FUCHS EUROPE SCHMIERSTOFFE GMBH in the development and manufacturing of lubricants and represents the current state-of-the-art. The performance of our products can be influenced by a series of factors, especially the specific use, the method of application, the operational environment, component pretreatment, possible external contamination, etc. For this reason, universally valid statements about the function of our products are not possible. The information given in this product information represents general, non-binding guidelines. No warranty expressed or implied is given concerning the properties of the product or its suitability for any given application.

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## FUCHS Industrial Lubricants

### The RENISO product portfolio.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mineral oils (MO)</strong></td>
<td>RENISO KM 32, RENISO KS 46, RENISO KC 68, RENISO KES 100, RENISO KW 150</td>
</tr>
<tr>
<td><strong>for NH₃ and R22</strong></td>
<td></td>
</tr>
<tr>
<td><strong>for HFCKW (turbo compressors)</strong></td>
<td>RENISO TES 100</td>
</tr>
<tr>
<td><strong>for hydrocarbons (e.g. R600a - hermetic compressors)</strong></td>
<td>RENISO WF 5 A, RENISO WF 7 A, RENISO WF 10 A, RENISO WF 15 A</td>
</tr>
<tr>
<td><strong>Synthetic hydrocarbon</strong></td>
<td>RENISO UltraCool 68</td>
</tr>
<tr>
<td>for NH₃</td>
<td></td>
</tr>
<tr>
<td><strong>Polyalpaholefin (PAO)</strong></td>
<td>RENISO SYNTH 68</td>
</tr>
<tr>
<td>for NH₃, CO₂ (not miscible) and hydrocarbons</td>
<td></td>
</tr>
<tr>
<td><strong>Polyalkylene glycols (PAG)</strong></td>
<td>RENISO SP 68, RENISO GL 68</td>
</tr>
<tr>
<td>for NH₃ (miscible with NH₃) and hydrocarbons</td>
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<tr>
<td><strong>Alkyl benzenes (AB)</strong></td>
<td>RENISO S 3246, RENISO S 68</td>
</tr>
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<td>for R22 and hydrocarbons</td>
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</tr>
<tr>
<td><strong>Alkyl benzenes (AB)</strong></td>
<td>RENISO S 32, RENISO S 46, RENISO S 100, RENISO S 220</td>
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<td>for R22, hydrocarbons and NH₃</td>
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<tr>
<td><strong>Polyol esters (POE)</strong></td>
<td>RENISO TRITON SEZ 22, RENISO TRITON SEZ 32</td>
</tr>
<tr>
<td>for HFC/FC, e.g. R134a, R404A, R507</td>
<td>RENISO TRITON SEZ 35 SC, RENISO TRITON SE 55, RENISO TRITON SEZ 68, RENISO TRITON SEZ 80, RENISO TRITON SEZ 100, RENISO TRITON SE 170, RENISO TRITON SEZ 220, RENISO TRITON SEZ 320</td>
</tr>
<tr>
<td>for HFO and HFO/HFC blends</td>
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<tr>
<td><strong>Special polyol esters (POE)</strong></td>
<td>RENISO C 55 E, RENISO C 85 E, RENISO C 170 E</td>
</tr>
<tr>
<td>for CO₂ (transcritical and subcritical)</td>
<td></td>
</tr>
<tr>
<td><strong>Special polyalkylene glycol (PAG)</strong></td>
<td>RENISO ACC 46, RENISO ACC HV, RENISO ACC 68</td>
</tr>
<tr>
<td>for CO₂ transcritical systems (heat pumps, a/c systems)</td>
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<tr>
<td><strong>Polyalkylene glycol (PAG)</strong></td>
<td>RENISO PAG 220 C</td>
</tr>
<tr>
<td>for CO₂ and HFC/FC (screw compressors, e.g. in heat pumps)</td>
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<tr>
<td><strong>Polyalkylene glycols (PAG)</strong></td>
<td>RENISO PAG 46, RENISO PAG 100</td>
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<tr>
<td>for R134a in vehicle a/c systems and for NH₃ (miscible with NH₃)</td>
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<tr>
<td><strong>Special polyalkylene glycols (PAG)</strong></td>
<td>RENISO PAG 1234</td>
</tr>
<tr>
<td>for HFO-1234yf and R134a vehicle a/c systems</td>
<td></td>
</tr>
</tbody>
</table>
Innovative refrigeration oils need experienced application engineers

Every lubricant change should be preceded by expert consultation on the application in question. Only then the best lubricant system can be selected. Experienced FUCHS engineers will be glad to advise on products for the application in question and also on our full range of lubricants.

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