Rapidly biodegradable industrial lubricants
LUBRICANTS. TECHNOLOGY. PEOPLE.

World’s largest independent lubricant specialist.

Complete ranges of industrial and automotive lubricants.

Leading first-fill competence for the German automotive industries.

Plants, Mannheim and Kiel.

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 company that offers powerful lubricants and associated 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 true lubricant specialist with our headquarters in Mannheim/Germany, 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.

Numbers and facts

PLANT: MANNHEIM AND KIEL

HOLDING: FUCHS PETROLUB SE

HEADQUARTERS: Mannheim

TRUE LUBRICANT SPECIALIST: 100 % focus on lubricants

FULL LINE OF PRODUCTS:
More than 2,000 products and 6,000 product-pack combinations

CERTIFIED BY: DIN EN ISO 9001:2008,
BS OHSAS 18001:2007, KTA 1401
Marine

Water is the most important basic source of nutrition, and is often derived from groundwater or rivers. These important reservoirs are almost exclusively polluted by watercraft, e.g. by propeller greases, chain or rope lubricants and many more. The FUCHS products PLANTOSYN, PLANTOGEAR and PLANTOGEL enable this pollution to be avoided.

All PLANTO products, which have been awarded the European Ecolabel, may be used in accordance with the new Vessel General Permit (USA).

Applications:
Fishery, navigation of waters, sailboats and motorboats, locks, oil platforms, dry docks

Energy industry

Renewable energies such as wind power and rapidly biodegradable lubricants share a common background: preservation of the environment and resources.

FUCHS PLANTO lubricants have proven ideally suited to wind energy plants with the most challenging lubricant requirements.

The FUCHS products ECO HYD S PLUS and GEARMASTER ECO 320 were developed specially for application in wind energy plants and are approved, rapidly biodegradable gear oils.

Applications:
Wind energy

Mountainous regions

The most important aspect for commercial use of rapidly biodegradable lubricants in mountainous regions is the preservation of an unspoilt and clean environment.

FUCHS offers a special range of PLANTO products that fulfill environmental protection requirements. These include the PLANTOSYN and PLANTOLUBE POLAR products, which also ensure the best possible lubrication of machinery in mountainous regions.

Applications:
Piste preparation, ski lifts, snowmobiles, snow cannons

Water management

The use of lubricants and greases in areas where they will come into direct contact with water demands a particularly high degree of protection against pollution.

Greases are needed for gears, pumps, hubs and much more, for drinking water treatment in sewage plants or for operating locks.

Alongside excellent performance and a high level of water resistance, the lubricants also need to be rapidly biodegradable in order to protect the environment.

For such applications, FUCHS offers numerous products, including the rapidly biodegradable PLANTOGEL ECO 2 N and PLANTOGEL ECO 2 S lubricating greases, which have also been awarded the Ecolabel (EEL).

Applications:
Sewage plants, water treatment, docks, locks
### Index

<table>
<thead>
<tr>
<th>Topic</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of ecological lubricants at FUCHS</td>
<td>8 – 9</td>
</tr>
<tr>
<td>PLANTO – real biogenic lubricants</td>
<td>10 – 11</td>
</tr>
<tr>
<td>Awarded the EU Ecolabel</td>
<td>12 – 13</td>
</tr>
<tr>
<td>Requirements of rapidly biodegradable lubricants</td>
<td>14 – 15</td>
</tr>
<tr>
<td>Rapidly biodegradable hydraulic oils</td>
<td>16 – 17</td>
</tr>
<tr>
<td>HEES test</td>
<td>18 – 19</td>
</tr>
<tr>
<td>“Dry TOST” test</td>
<td>20 – 21</td>
</tr>
<tr>
<td>Seal and elastomers</td>
<td>22 – 23</td>
</tr>
<tr>
<td>Rapidly biodegradable gear oils</td>
<td>24 – 27</td>
</tr>
<tr>
<td>Rapidly biodegradable lubricants for the marine segment</td>
<td>28 – 29</td>
</tr>
<tr>
<td>Rapidly biodegradable lubricants for the automotive industry</td>
<td>30 – 31</td>
</tr>
<tr>
<td>Rapidly biodegradable lubricating greases</td>
<td>32 – 33</td>
</tr>
<tr>
<td>Overview of PLANTO products</td>
<td>34 – 38</td>
</tr>
<tr>
<td>Overview of additional products</td>
<td>39</td>
</tr>
<tr>
<td>Checklist for switching hydraulic systems over to environmentally friendly hydraulic fluids</td>
<td>40 – 41</td>
</tr>
</tbody>
</table>

---

Checklist for switching hydraulic systems over to environmentally friendly hydraulic fluids

**Note:** The above index is a structured table of contents for the document, listing topics and their respective page numbers.
The dream of environmentally friendly lubricants is nothing new. Indeed, FUCHS was one of the first companies to enter the market with rapidly biodegradable lubricants back in the 70s, and since then FUCHS has invested heavily in researching and further developing these lubricants.

The reward for all this hard work: a priceless and unparalleled wealth of expertise and practical experience. Because one thing is certain: A good product alone is not enough. The user also needs competent advice when choosing the right product, switching over to rapidly biodegradable lubricants and for application. It really pays off to have an expert partner by your side – every day.
THE PERFECT MARRIAGE OF NATURE AND STATE-OF-THE-ART TECHNOLOGY

The new products from the PLANTO range are biogenic lubricants. In the past, so-called “bio-lubricants” could generally also be manufactured from oil products. Biogenic lubricants, on the other hand, contain a very high share of renewable raw materials. As such, they represent a further development of the “bio-lubricants”, taking into account the source of the raw materials as well as environmental compatibility.

For example, the carbon content derived from renewable raw materials is more than 50% for hydraulic fluids with the EU Ecolabel; for chainsaw oil this is over 70%, for two-stroke and gear oils more than 50% and for lubricating greases in excess of 45%.

Our rapidly biodegradable PLANTO products are based on synthetic esters or vegetable oils: This means that the natural oils are stabilized through chemical modification such that the finished products fulfill and surpass the required technical performance.
AWARDED THE EU ECOLABEL (EEL)

One global goal: protecting the environment

“Sustainability” has become a much-used buzzword over the last few years. However, we are only slowly becoming conscious of the finite nature of many resources and of the consequences of using lubricants. Renewable raw materials combine environmental friendliness with sustainability.

For example, so-called biogenic lubricants manufactured from renewable raw materials are predominantly CO₂-neutral, rapidly biodegradable and are thus more environmentally compatible than lubricants based on mineral oil.

As the awareness of the importance of environmental protection grows, ever more consumers are realizing that they can play an active role in protecting the environment by using products that pollute or damage the environment as little as possible.

The meaning of the EU Ecolabel (EEL)

The goal of the Ecolabel is to highlight products that – compared to conventional products – reduce the impact on the environment and thus make a contribution to environmental protection and sustainable development.

The Ecolabel is the official Ecolabel of the European Commission. “Marguerite” is a simple and reliable way to inform consumers of good, environmentally friendly quality. All products labeled with “Marguerite” have been independently tested for compliance with strict ecological and functional criteria.

Products awarded the EEL are a lesser burden on air, water, ground and human health than conventional mineral-oil based products on the market. Moreover, products with the EEL can be more cost-effective than their conventional or comparable mineral-oil based counterparts, and added value can often be achieved during use.

The Ecolabel is for the following product groups:

- Hydraulic fluids
- Lubricating greases
- Chainsaw oils
- Mould release oils and other total loss lubricants
- Two-stroke oils
- Gear oils for industrial and marine applications

The objectives of the EU Ecolabel (EEL)

The EU Ecolabel according to 2011/381/EU was created with the following specific objectives:

- Definition of standardized technical and ecological quality standards for “bio-lubricants”
- Reduced pollution of water and ground
- Reduced CO₂ emissions
- The “Marguerite” label makes it very easy to recognize the high quality of biodegradable lubricants from FUCHS

The EU Ecolabel – requirements of lubricants according to 2011/381/EU

- Biodegradable (according to OECD 301 > 60%)
- Aquatic toxicity (OECD 201, 202 and 203)
- Halogen compounds and nitrite compounds not used
- Organometallic compounds not used
- Proportion of renewable raw materials > 50% for oils (> 45% for greases)
- No hazard to the environment or human health
- No relevant risk declarations (R-phrases)
- Requirements for rapidly biodegradable hydraulic oils acc. to DIN ISO 15380
- Technical performance of gear oils acc. to DIN 51517-3
- Technical performance of chainsaw oils acc. to the requirements of the KWF test
What does “biodegradable” mean?

There is no single definition of the term “biodegradable”. The process of biological decomposition generally proceeds in various steps. In the first step of partial biological degradation, fragments of the initial material are formed, which can still be damaging to the environment. Only when the initial material has fully degraded to H2O, CO2, and biomass is a lubricant said to be fully biodegradable. In contrast to CEC L-33-A-93, the OECD 301 test analyzes the full biodegradability of lubricants. Biodegradability according to CEC L-33-A-93 is no longer the state of the art for the rapidly biodegradable lubricants on the market today. Although the CEC L-33-A-93 standard from 1993 was updated with CEC L-103-A-12 in 2012, the ultimate biodegradability tests according to OECD Guideline 301 are generally authoritative today.

The six test methods according to OECD 301

OECD Guideline 301 is divided into six different test methods: A, B, C, D, E and F. A fluid is designated biodegradable when the dissolved organic carbon (DOC) has reduced by at least 70% in all six test methods within 28 days or the theoretical oxygen demand (ThOD) and theoretical carbon dioxide production (ThCO2) is at least 60%. These requirements relating to the biodegradability of lubricants also apply for the EU Ecolabel. Test methods B, C and F are applied for water-insoluble products such as oils or greases and are therefore authoritative for FUCHS. Water-soluble products such as the RENOLIN PG 46 hydraulic oil are tested according to OECD 301 C.

The aquatic toxicity of lubricants

The OECD also defines three different test methods for testing the aquatic toxicity of lubricants: OECD 201, 202 and 203. The concentration for acute aquatic toxicity to algae (OECD 201), daphnia (OECD 202) and fish (OECD 203) must be at least 100 mg/l for hydraulic fluids and gear oils. For all other lubricants, the concentration must be at least 1,000 mg/l according to the EEL. The EC50 value must be checked after 72 hours for algae or after 48 hours for daphnia, and the LC50 value must be checked after 96 hours for fish.

The concentrations for acute aquatic toxicity to algae (OECD 201) and daphnia (OECD 202) must be at least 100 mg/l for hydraulic fluids and gear oils. For all other lubricants, the concentration must be at least 1,000 mg/l according to the EEL. The EC50 value must be checked after 72 hours for algae or after 48 hours for daphnia, and the LC50 value must be checked after 96 hours for fish.
MOBILE HYDRAULIC APPLICATIONS DEMAND ENVIRONMENTALLY FRIENDLY SOLUTIONS

Hydraulic fluids make up approximately 13-14% of total lubricant consumption in Germany. As such, hydraulic oils have a significant share of the lubricant market. Approximately 80-85% of hydraulic fluids are pressure oils based on mineral oil. Fire resistant hydraulic fluids have a market share of 7%, with rapidly biodegradable pressure fluids amounting to 5%.

Environmentally friendly, rapidly biodegradable pressure fluids have been developed primarily with a high level of environmental compatibility in mind. These generally contain heavy metal-free, toxicologically harmless additives and additive systems and are used in both mobile and stationary systems. They are claiming a growing share of the market and are replacing mineral oil-based hydraulic fluids in numerous areas, in particular in the field of mobile hydraulic applications.

The minimum technical requirements of rapidly biodegradable pressure fluids are described in DIN ISO 15380.

Rapidly biodegradable pressure fluids according to DIN ISO 15380 are divided into the following product groups:

- **HETG**: Triglyceride (vegetable oils) – generally only used rarely
- **HEES**: Synthetic esters – largest and most important group (unsaturated, partially saturated and saturated)
- **HEPG**: Polyalkylene glycols – only used in low quantities
- **HEPR**: Polyalphaolefins and related hydrocarbons – fluids based on hydrocarbon products

All PLANTO pressure fluids from FUCHS fulfill and surpass the requirements acc. to DIN ISO 15380.

### Comparison of the physical characteristics of hydraulic oils

<table>
<thead>
<tr>
<th>Designation / typical measured values</th>
<th>MO Mineral oil</th>
<th>Polyalphaolefins</th>
<th>HEES Ester</th>
<th>HEPG Polyalkylene glycols</th>
<th>HETG Triglycerides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product (example)</td>
<td>RENOLIN B 15 VG 46</td>
<td>RENOLIN UNISYN OL 46</td>
<td>PLANTOSYN 46 HVI</td>
<td>PLANTOHYD 46 S</td>
<td>RENOLIN PG 46</td>
</tr>
<tr>
<td>Density at 15 °C [kg/m³]</td>
<td>875</td>
<td>843</td>
<td>905</td>
<td>921</td>
<td>1029</td>
</tr>
<tr>
<td>Viscosity index</td>
<td>105</td>
<td>146</td>
<td>150</td>
<td>186</td>
<td>203</td>
</tr>
<tr>
<td>Kin. viscosity -10 °C [mm²/s]</td>
<td>1.591</td>
<td>593</td>
<td>403</td>
<td>814</td>
<td>670</td>
</tr>
<tr>
<td>0 °C [mm²/s]</td>
<td>593</td>
<td>403</td>
<td>440</td>
<td>336</td>
<td>866</td>
</tr>
<tr>
<td>40 °C [mm²/s]</td>
<td>46</td>
<td>46</td>
<td>46</td>
<td>49</td>
<td>46</td>
</tr>
<tr>
<td>100 °C [mm²/s]</td>
<td>6.9</td>
<td>7.9</td>
<td>8.2</td>
<td>9.6</td>
<td>9.7</td>
</tr>
<tr>
<td>Flash point [°C]</td>
<td>210</td>
<td>260</td>
<td>280</td>
<td>304</td>
<td>340</td>
</tr>
<tr>
<td>Water-soluble</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Biodegradability required by DIN ISO 15380 [%]</td>
<td>–</td>
<td>&gt;60</td>
<td>&gt;60</td>
<td>&gt;60</td>
<td>&gt;60</td>
</tr>
<tr>
<td>Biodegradability of FUCHS products acc. to OECD 301 B/ C [%]</td>
<td>ca. 0-15</td>
<td>ca. 30</td>
<td>92*</td>
<td>74*</td>
<td>72,8*</td>
</tr>
</tbody>
</table>

* Test report available

Fluids are allocated in accordance with the main component in the base oil. DIN ISO 15380 contains requirements with regard to environmental compatibility as well as technical performance.
HEES – ester-based, rapidly biodegradable pressure fluids

Ester oils are the most commonly used of all rapidly biodegradable pressure fluids with a share of approximately 80-90%. Ester oils are generally synthetics made from alcohol and fatty acids.

The finished products created from these are known as “synthetically produced ester oils”. If the acid chains are of natural origin, they can be given the designation “based on renewable raw materials”.

All ester oils available on the market can hydrolyze when contaminated with water, i.e. ester products can be attacked in the event of exposure to water in the presence of oxygen at high temperatures.

Therefore, penetration of water in the system must be avoided when using ester oils. Hydrolysis is indicated by an increase of the acid number of the lubricant.

The more saturated the esters used, the less critically they react to water.

Advantages when using synthetic esters

- Biodegradable / minimum toxicity
- Reduction of CO₂
- Fuel saving / increased efficiency
- Long service life of lubricant
- Outstanding lubrication
- Very low coefficient of friction
- High performance
- Good oxidation and aging properties
- Partially excellent low-temperature properties
- Good viscosity-temperature properties (VI 120-180)
- High solubility

Miscible with many base fluids such as mineral oil, HEPR, HEPG

Hydraulic fluids based on unsaturated, partly saturated and saturated synthetic esters

Esters are generally created through the reaction of an organic acid with a polyvalent alcohol under separation of water.

The combination of different types of organic acids and alcohols allows many variations of esters to be created for lubricants.

Greases and oils are produced through the esterification of alcohols and fatty acids. Fatty acids consist of a carboxyl group and of hydrocarbon chains of various lengths. The acid chains can be fully saturated (very high stability), partly saturated (good stability) and unsaturated. One speaks of saturated fatty acids when the fatty acids have no double bonds in their hydrocarbon chain.

If there are one or more double bonds in the hydrocarbon chain of the fatty acid, the fatty acid is partly saturated or unsaturated.

The number of double bonds in the hydrocarbon chain of the fatty acid determine the properties of the ester.

Double bonds are highly reactive and may be attacked by oxygen, which could end up in oil aging.

Fully saturated HEES ester oils are synthetic fluids which are resistant to high temperatures and which surpass the performance of mineral oils. They are therefore thermally stable and resistant to oxidation. Although HEES ester oils can also be partly saturated, they can still be classified as stable and, if the appropriate care is taken, used in the same manner as mineral oil. If a HEES ester oil only has double bonds, it is unsaturated.

In order to test the aging stability of hydraulic oils, FUCHS applies the “Dry TOST” test according to DIN EN ISO 4263-1 (see following chapter). Unsaturated ester oils are usually tested with regard to their aging stability using the so-called Baader test. In the “Dry TOST” test, unsaturated ester oils display lower service lives.

The desired properties of the ester can be achieved by carefully selecting the raw materials.

Partly unsaturated linear fatty acids

\[- \text{OH} + R \cdot \text{CH} = \text{CH} \cdot \text{C OH} \]

Saturated linear fatty acids

\[- \text{OH} + R \cdot \text{CH} \cdot \text{CH} \cdot \text{C OH} \]

Saturated branched fatty acids

\[- \text{OH} + R \cdot \text{CH} \cdot \text{CH} \cdot \text{CH}_2 \cdot \text{C OH} \]

Fully saturated HEES ester oils are synthetic fluids which are resistant to high temperatures and which surpass the performance of mineral oils. They are therefore thermally stable and resistant to oxidation. Although HEES ester oils can also be partly saturated, they can still be classified as stable and, if the appropriate care is taken, used in the same manner as mineral oil. If a HEES ester oil only has double bonds, it is unsaturated.

In order to test the aging stability of hydraulic oils, FUCHS applies the “Dry TOST” test according to DIN EN ISO 4263-1 (see following chapter). Unsaturated ester oils are usually tested with regard to their aging stability using the so-called Baader test. In the “Dry TOST” test, unsaturated ester oils display lower service lives.

The desired properties of the ester can be achieved by carefully selecting the raw materials.

The PLANTOSYN HVI range from FUCHS fulfills and surpasses the minimum requirements of HEES hydraulic oils according to DIN ISO 15380 and HVLP according to DIN 51524-3.

All PLANTO hydraulic fluids from FUCHS are produced on the basis of synthetic esters (saturated or partly saturated).
**RAPIDLY BIODEGRADABLE HYDRAULIC OILS – “DRY TOST”-TEST**

**Aging stability of PLANTO products – “Dry TOST” test (DIN EN ISO 4263-1)**

The “Dry TOST” test has been used for many years to test the aging stability of hydraulic oils. It is performed in a modified form without water.

360 ml of the lubricant is filled into a container. One catalyst each of steel and copper is immersed into this fluid. The test is carried out in the dark at a temperature of 95°C. 3 l of oxygen per hour is added to the substance to be tested. A test duration of 1,000 hours is specified. Samples are removed at regular intervals and the neutralization number or change in kinematic viscosity of the lubricant is tested.

Oil aging generally becomes apparent through the increase in the neutralization number. The maximum permissible increase of the neutralization number is 2 mg KOH/g after 1,000 hours.

A further testing criterion is the change in kinematic viscosity of the lubricant at 40°C. The maximum permissible change is ± 20 %.

With the “Dry TOST” test FUCHS analyzes both the neutralization number and the change in kinematic viscosity of the lubricant in order to draw conclusions about its resistance to aging.

In the following diagrams, the “Dry TOST” test is carried out for a product based on unsaturated esters (VG 46) and the FUCHS hydraulic oil PLANTOSYN 46 HVI based on saturated esters.

The test criteria are the neutralization number and the change in kinematic viscosity at 40°C. For both test criteria, the product (VG 46) based on unsaturated esters already exceeds the permitted limit values after approximately 200 hours. PLANTOSYN 46 HVI – based on saturated esters – on the other hand has a stable neutralization number up to a test duration of 3,000 hours. The limit value for the change in kinematic viscosity is actually exceeded after 3,500 hours.

As such, the FUCHS product based on saturated esters has a far greater aging stability than the product based on unsaturated esters.

**Aging stability of PLANTOSYN 46 HVI in “Dry TOST” test, DIN EN ISO 4263-1**

**PLANTOSYN 46 HVI vs. unsaturated ester oil: neutralization number**

**PLANTOSYN 46 HVI vs. unsaturated ester oil: kinematic viscosity**
RAPIDLY BIODEGRADABLE HYDRAULIC OILS – SEALS AND ELASTOMERS

All hydraulic seals or elastomers used in the hydraulic system are fully or partially surrounded by the fluid medium during use. Interaction between the seal material and the hydraulic fluid is therefore unavoidable.

Physical influence
The hydraulic fluid can cause the seal material to swell or contract. This results in volume effects which change mechanical properties such as hardness, elasticity, tensile strength and stretching behavior. As a general rule, hydraulic oils should cause a slight increase in volume (small swelling).

Chemical influence
The temperature, oxygen, water and additives or aging products of the hydraulic fluid can also cause a negative change in the elastomer sealing material. In order to retain their flexibility, hydraulic oils generally should not harden the elastomers to a great degree.

Mechanical influence
The pressurization level or pressure pulsation through the medium can contribute to the mechanical load; furthermore, dynamically stressed seals wear due to the friction that occurs during the sliding movement. The tensile strength values should be influenced as little as possible in order to guarantee a long service life and prevent leakage.

Lubricant manufacturers analyze the behavior of hydraulic fluids and seal materials according to the standards DIN 51524, 53538 and 53505. These standards contain limit values for the change in volume or hardness of seal materials. Basic research and comparative tests of seal materials are carried out using reference liquids.

The mechanical wear of the seal is directly influenced by physical and chemical factors. Swelling leads to a softening of the material, higher friction and therefore also to higher wear and greater driving forces. Contraction can result in leakages.

The requirements of hydraulic fluids are therefore neutral behavior in contact with the seal materials and elastomers, protection of the seal from wear, removal of heat, minimization of friction and prevention of deposits at the sealing gap.

Compatibility of elastomers with hydraulic fluids

<table>
<thead>
<tr>
<th></th>
<th>NBR</th>
<th>HNBR</th>
<th>AU</th>
<th>FPM (FKM)</th>
<th>EPDM (mineral oil-free)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suitable operating temperature range of elastomers (in °C)</td>
<td>–30 (–40)/+100</td>
<td>–20 (–30)/+140</td>
<td>–30/+80 (+100)</td>
<td>–20/+200**</td>
<td>–50/+150**</td>
</tr>
<tr>
<td>HL/HLP/HLPD Mineral oils</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>HETG</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>HEES</td>
<td>+*</td>
<td>+*</td>
<td>+*</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>HEPG</td>
<td>+*</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

*deployment must be tested for dynamically stressed seals
**max. air temperature

Testing of rapidly biodegradable hydraulic fluids based on vegetable oil, esters and polyglycol according to DIN ISO 15380 takes place over a longer time period in order to attain greater practical relevance.

The behavior of rapidly biodegradable hydraulic fluids in comparison to standard reference elastomers (SRE) after 1,000 hours at different test temperatures (80 or 100°C) complies with CETOP R 81 H, ISO / DIS 6072. The seal materials in the test correspond to HNBR, FPM, NBR-1 and AU standards.

The tensile strength and elongation at break parameters have been added to the limit values for the change in hardness and volume. As such, the reduction in tensile strength and elongation at break must not exceed 30% when testing with rapidly biodegradable hydraulic fluids (DIN ISO 15380, VDMA 24568).
Synthetic gear oils withstand even the greatest loads and offer numerous advantages in comparison to mineral oil-based products:

- Service life two to three times longer
- Lower service costs
- Outstanding wear protection properties in gears and roller bearings
- Wider operating temperature range (multigrade characteristics)
- Lower disposal costs
- Better technical performance

The polar structure of ester oils provides for good cleaning properties and dirt holding capacity. Furthermore, saturated esters display excellent thermal stability.

Products from the PLANTOGEAR S series can also be used to clean gearboxes which have been contaminated with deposits and sludge.

The oils of the PLANTOGEAR S series surpass the minimum requirements of CLP-E lubricating oils according to DIN 51517-3 together with DIN 51502, ISO 6743-6 and ISO 12925-1: CKC, CKD, CKE.

FUCHS offers the GEARMASTER ECO 320, an approved wind energy plant gear oil, specially for the wind power sector.

The PLANTOGEAR S range and GEARMASTER ECO 320 from FUCHS are rapidly biodegradable according to OECD 301. In addition, the PLANTOGEAR S range has also been awarded the EU Ecolabel.

**Comparison of the physical characteristics of gear oils**

<table>
<thead>
<tr>
<th>Designation / typical measured values</th>
<th>MO Mineral oil</th>
<th>PAG Polyalphaolefins</th>
<th>POE Ester</th>
<th>PAG Polyalkylene glycols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product (example)</td>
<td>RENOLIN CLP 220</td>
<td>RENOLIN UNISYN CLP 220</td>
<td>PLANTOGEAR 220 S</td>
<td>RENOLIN PG 220</td>
</tr>
<tr>
<td>Density at 15 °C [kg/m³]</td>
<td>896</td>
<td>854</td>
<td>938</td>
<td>1,075</td>
</tr>
<tr>
<td>Viscosity index</td>
<td>97</td>
<td>155</td>
<td>152</td>
<td>218</td>
</tr>
<tr>
<td>Kin. viscosity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10 °C [mm²/s]</td>
<td>21,140</td>
<td>6,300</td>
<td>6,666</td>
<td>6,800</td>
</tr>
<tr>
<td>0 °C [mm²/s]</td>
<td>5,010</td>
<td>2,700</td>
<td>2,773</td>
<td>1,571</td>
</tr>
<tr>
<td>20 °C [mm²/s]</td>
<td>853</td>
<td>656</td>
<td>663</td>
<td>527</td>
</tr>
<tr>
<td>40 °C [mm²/s]</td>
<td>221</td>
<td>220</td>
<td>220</td>
<td>220</td>
</tr>
<tr>
<td>60 °C [mm²/s]</td>
<td>75,3</td>
<td>93,1</td>
<td>92,4</td>
<td>108,0</td>
</tr>
<tr>
<td>100 °C [mm²/s]</td>
<td>18,9</td>
<td>26,7</td>
<td>26,2</td>
<td>36,8</td>
</tr>
<tr>
<td>Flash point [°C]</td>
<td>260</td>
<td>260</td>
<td>280</td>
<td>240</td>
</tr>
<tr>
<td>Pour point [°C]</td>
<td>-24</td>
<td>-42</td>
<td>-30</td>
<td>-33</td>
</tr>
<tr>
<td>Water-soluble</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Biodegradability of FUCHS products acc. to OECD 301 B/ C [%]</td>
<td>ca. 0 – 10</td>
<td>ca. 15</td>
<td>90*</td>
<td>81,3*</td>
</tr>
</tbody>
</table>

*Test report available

**WIND ENERGY GENERATORS REQUIRE THE HIGHEST LEVEL OF RELIABILITY AND ENVIRONMENTAL FRIENDLINESS**

Although mineral oil-based gear oils continue to dominate, synthetic gear oils are becoming increasingly popular in the rapidly growing power transmission engineering market. The raised demands placed on gear oils by customers and gear manufacturers can often only be met with synthetic oils, as these offer greater performance characteristics.

In wind power in particular, synthetic gear oils are being used ever more frequently, as in many cases only these oils are capable of meeting the constantly growing technical performance requirements.
FZG scuffing load carrying capacity test A/8.3/90 (DIN ISO 14635-1)

Many gear wheel damages can be influenced by lubricants. In order to test the scuffing load carrying capacity of gear oils, for many years FUCHS has used the FZG scuffing load carrying capacity test A/8.3/90 (gear geometry A, 8.3 m/s circumferential speed in the pitch circle, 90°C starting oil temperature). ISO 14635-1 defines the test conditions for determining the scuffing load carrying capacity of lubricating oils at the FZG gear test rig.

The scuffing load carrying capacity is generally understood to be the greatest possible load a lubricant can be placed under in the specified conditions without scuffing occurring. The maximum scuffing load carrying capacity of the lubricant is described as the failure load stage. This is reached when the total of the gear damage is more than 20 mm.

To carry out the test, a test gear pair is immersed in the lubricant using the dip-feed lubrication method. The speed remains constant throughout the entire duration of the test. The test duration is 21,700 motor rotations. The load on the gear pair is increased in stages. The test begins at failure load stage 5. In the process, the oil temperature must be 90°C ± 3°C. Once the test duration has elapsed, the gears are removed and checked for fretting damage. If the total of the gear damage exceeds 20 mm, the test is ended. If no scuffing can be determined on the gear, the test is performed again at the higher failure load stage. This process is continued until scuffing of > 20 mm occurs or failure load stage 12 is reached.

In both bench tests and in practical application, the potential of synthetically-based gear oils to reduce oil sump temperatures by more than 10°C is apparent. Based on failure load stage 8 at a Hertzian pressure of max. 1,233 N/mm² and an oil sump temperature of 90°C, the failure load stages were continuously raised up to failure load stage 14 with a Hertzian pressure of approx. 2,138 N/mm². Under these conditions, an oil sump temperature 178°C was reached for the mineral oil-based RENOLIN CLP 220 gear oil.

In comparison, when using PLANTOGEAR 220 S gear oil based on synthetic esters, the oil sump temperature could be reduced by 13°C to 165°C under the same operating conditions.

On average, the oil sump temperature of the PLANTOGEAR 220 S gear oil was 8% lower than that of the RENOLIN CLP 220 gear oil during the entire duration of the test.

The PLANTOGEAR S range and GEARMASTER ECO 320 from FUCHS fulfill the minimum requirement according to DIN 51517-3, which specifies a failure load stage of at least 12.

PLANTOGEAR 220 S in FZG scuffing load carrying capacity test A/8.3/90 according to DIN ISO 14635-1

Comparison of oil sump temperatures of PLANTOGEAR 220 S based on synthetic esters and the mineral oil-based product RENOLIN CLP 220 under various load conditions.
RAPIDLY BIODEGRADABLE LUBRICANTS FOR THE MARINE SECTOR

ENVIRONMENTAL PROTECTION AGENCY STIPULATES ENVIRONMENTALLY COMPATIBLE LUBRICANTS FOR ALL SHIPS

In March 2013 the American Environmental Protection Agency (EPA) published the “Vessel General Permit” or VGP, which entered force in December of the same year. The new legislation stipulates that all ships must use environmentally compatible lubricants at all points where the lubricant comes into contact with water, unless this is technologically infeasible.

This law applies to all ships greater than 79 feet in length which operate in the waters of the United States up to a distance of three miles from the coast or on lakes. Environmentally acceptable lubricants (EAL) must be biodegradable, may only have minimal toxicity and must not be bioaccumulative.

Biodegradable means

- 90% w/w (mass percent) of the components of the lubricant (> 0.1%) must be 60% biodegradable in 28 days (according to OECD 301 B)
- Up to 5% of the ingredients of the lubricant do not need to be biodegradable if they are not bioaccumulative
- The remaining components (> 0.1%) should possess an inherent biodegradability of at least > 20% and < 60% (according to OECD 301 B)

Minimal toxicity means

- A substance that fulfills the requirements of OECD 201, 202 and 203
- The complete formula or individual components can be tested

Not bioaccumulative means

- Components that are not biodegradable must be determined in accordance with the defined standards (as per OECD 107 and 117)

Technically infeasible means

- No EAL or manufacturer specification for the equipment that is specified for a certain application
- Equipment that comes pre-lubricated (e.g. wire ropes) and have no available alternatives manufactured with EAL’s.
- Products meeting a manufacturer’s specification are not available in a ship’s port of destination
- The changeover and utilization of EAL can only be performed at the next dry dock

FUCHS PLANTO according to EU Ecolabel (also for VGP requirements)

In cooperation with LUKOIL Marine, FUCHS EUROPE SCHMIERSTOFFE GMBH offers rapidly biodegradable hydraulic oils and industrial gear oils based on saturated, synthetic esters for applications in the marine sector. The products deliver outstanding performance and fulfill the technological and ecological requirements of VGP.

The biodegradable PLANTOSYN HVI and PLANTOGEAR S ranges from FUCHS have been awarded the EU Ecolabel and can therefore be used for all applications in the marine sector in accordance with VGP.

All products awarded the Blue Angel, the EU Ecolabel, the Nordic Swan or that comply with the Swedish Standards SS 155434 and 155470 and the OSPAR Guidelines can be marketed as “environmental acceptable lubricants” and can thus be used in accordance with the VGP.
Alongside rapidly biodegradable hydraulic and gear oils, FUCHS also offers a rapidly biodegradable engine oil and a special fluid (UTTO).

The super high-performance PLANTOMOT SAE 5W-40 engine oil is based on synthetic esters. The product is suitable for turbocharged and non-turbocharged diesel engines in passenger vehicles, buses, trucks, minibuses and industrial engines.

PLANTOMOT SAE 5W-40 is rapidly biodegradable (> 60%) according to OECD 301 B and offers excellent engine performance as well as energy saving potential.

Moreover, PLANTOMOT SAE 5W-40 is compatible with bio-based diesel fuels such as vegetable oil or RME. Further properties of PLANTOMOT SAE 5W-40 include outstanding cold starting behavior at very low temperatures, faster oiling of the engine and good supply of all mechanical parts, which in turn leads to lower wear.

Furthermore, the PLANTOMOT SAE 5W-40 engine oil reduces oil consumption, and its high level of oxidation stability enables oil change intervals to be increased. The powerful cleaning properties of PLANTOMOT SAE 5W-40 result in excellent engine cleanliness.

In addition, FUCHS offers a special fluid (UTTO) – PLANTO HYTRAC PLUS – for farming tractor gears / hydrostatic units with and without wet brakes. PLANTO HYTRAC PLUS is the environmentally friendly alternative to conventional hydraulic and gear oils based on mineral oil.

It is based on vegetable oil and is therefore rapidly biodegradable (OECD 301 B > 60%). In the event of spillages or oil loss it remains in the upper layers of the earth to a large degree and is biologically degraded there. PLANTO HYTRAC PLUS is miscible and compatible with conventional hydraulic and gear oils with the same technology or specification.

It offers good flowability at low temperatures and ensures the fast supply of oil to all components. Furthermore, it displays excellent shear stability and thermal stability, as well as increasing oil change intervals and reducing deposits.

In addition, FUCHS offers a special fluid (UTTO) – PLANTO HYTRAC PLUS – for farming tractor gears / hydrostatic units with and without wet brakes. PLANTO HYTRAC PLUS is the environmentally friendly alternative to conventional hydraulic and gear oils based on mineral oil.

It is based on vegetable oil and is therefore rapidly biodegradable (OECD 301 B > 60%). In the event of spillages or oil loss it remains in the upper layers of the earth to a large degree and is biologically degraded there. PLANTO HYTRAC PLUS is miscible and compatible with conventional hydraulic and gear oils with the same technology or specification.

It offers good flowability at low temperatures and ensures the fast supply of oil to all components. Furthermore, it displays excellent shear stability and thermal stability, as well as increasing oil change intervals and reducing deposits.
RAPIDLY BIODEGRADABLE LUBRICATING GREASES

100% ENVIRONMENTAL COMPATIBILITY IS ESSENTIAL FOR DIRECT CONTACT WITH WATER

Rapidly biodegradable, environmentally friendly lubricating greases based on rape seed oil or synthetic esters are recommended for all friction points to which conventional greases are normally applied, but in which a hazard to river water, groundwater, drinking water and ground cannot be ruled out when using conventional lubricating greases.

Rapidly biodegradable lubricating greases can also be used as total loss lubricants in drainage basins, agriculture, forests and hydroelectric power stations.

Simple greases based on rape seed oil can be replaced by fully synthetic ester-type greases here when particularly good UV and oxidation stability are required. Rapidly biodegradable lubricating greases should always be water-resistant, offer protection from corrosion, reduce wear, be sufficiently resistant to oxidation and be easy to pump in central lubricating systems.

For slow-rotating, highly stressed roller and plain bearings of all types, rapidly biodegradable lubricating greases with black solid lubricants and the corresponding dry running properties are used.

Rapidly biodegradable lubricating greases of the consistency class NLGI 2 are used for all roller and plain bearing applications, while rapidly biodegradable fluid greases are deployed for gears subjected to low to medium loads.

Biodegradability is tested according to OECD 301 B. A lubricating grease is deemed to be biodegradable if it has decomposed by at least 50% in this test.

In order to cut down on the variety of designations among rapidly biodegradable lubricating greases, a single definition for rapidly biodegradable lubricants has been established in Europe.

For this purpose, the following minimum requirements have been laid down for high-performance, rapidly biodegradable lubricating greases:

- The content of renewable raw materials according to ASTM D-6866 must be at least 25%.
- Biodegradability according to OECD 301 B must be at least 50%.
- The lubricating grease must not be designated as an environmentally harmful substance.

The PLANTOGE range from FUCHS fulfills these requirements and the products can therefore be used as rapidly biodegradable lubricating greases.
PLANTOHYD 32 N
Vegetable oil-based hydraulic oil with additives to increase oxidation and aging stability. Biodegradable (OECD 2031) >90%.
High wear protection (FZG stage 12). Surpasses the minimum requirements of DIN 51524-3 HVLP. Exceptions: DIN 51524-3 "TOST" test. Miscible with conventional, mineral oil-based hydraulic oils.
PLANTOHYD 32 S
High wear protection (FZG stage 12). Surpasses the minimum requirements of DIN 51524-3 HVLP. Exceptions: DIN 51524-3 "TOST" test. Miscible with conventional, mineral oil-based hydraulic oils.
PLANTOHYD 46 S
High wear protection (FZG stage 12). Surpasses the minimum requirements of DIN 51524-3 HVLP. Exceptions: DIN 51524-3 "TOST" test. Miscible with conventional, mineral oil-based hydraulic oils.

PLANTOHYD 15 S
Synthetic ester oil with additives to increase aging stability. Biodegradable (OECD 2031) >90%.
PLANTOHYD 22 S
High wear protection (FZG stage 12). Surpasses the minimum requirements of DIN 51524-3 HVLP. Exceptions: DIN 51524-3 "TOST" test. Miscible with conventional, mineral oil-based hydraulic oils.
PLANTOHYD 46 S
High wear protection (FZG stage 12). Surpasses the minimum requirements of DIN 51524-3 HVLP. Exceptions: DIN 51524-3 "TOST" test. Miscible with conventional, mineral oil-based hydraulic oils.
PLANTOHYD 68 S
High wear protection (FZG stage 12). Surpasses the minimum requirements of DIN 51524-3 HVLP. Exceptions: DIN 51524-3 "TOST" test. Miscible with conventional, mineral oil-based hydraulic oils.

Environmentally friendly, high-quality hydraulic and hydraulic oils

PLANTOLUBE POLAR 15 S
PLANTOLUBE POLAR 22 S
Mineral oil. Miscible and compatible with conventional, mineral oil-based hydraulic oils. POLAR 22 S: HVLP 22, HEES 22. Designation according to DIN ISO 15380 HEES.
PLANTOLUBE POLAR 32 S
PLANTOLUBE POLAR 46 S
Mineral oil. Miscible and compatible with conventional, mineral oil-based hydraulic oils. POLAR 46 S: HVLP 46, HEES 46. Designation according to DIN ISO 15380 HEES.
PLANTOLUBE POLAR 68 S
Mineral oil. Miscible and compatible with conventional, mineral oil-based hydraulic oils. POLAR 68 S: HVLP 68, HEES 68. Designation according to DIN ISO 15380 HEES.

Environmentally friendly industrial and hydraulic oils

PLANTOSYN 32 HVI
Environmentally friendly hydrazonic and circulating oils based on synthetic saturated esters. Rapidly biodegradable according to OECD 301 B >90%. High degree of near protection, good seal and non-fouling metal compatibility. Excellent oxidation stability. Fulfills the minimum requirements of HEES hydraulic oils according to DIN ISO 15380 and HVLP according to DIN 51524-3. Awarded the EU Ecolabel.
PLANTOSYN 46 HVI
Environmentally friendly, high-quality hydraulic oil based on synthetic saturated esters. Rapidly biodegradable according to OECD 301 B >90%. Surpasses the minimum requirements of HEES hydraulic oils according to DIN ISO 15380 and HVLP according to DIN 51524-3. Awarded the EU Ecolabel.

Environmentally friendly industrial and hydraulic oils

PLANTOSYN 3268
Environmentally friendly, high-quality hydraulic oil based on synthetic esters (HEES), rapidly biodegradable according to OECD 301 B >90%. Awarded the EU Ecolabel.

Environmentally friendly industrial and hydraulic oils

PLANTOSYN 3268 ECO+
Environmentally friendly, mineral-based hydraulic oil. Rapidly biodegradable according to OECD 301 B >90%.

Sideway oils, machine oils

PLANTOLUBE CGLP 68 S
Sideway oils based on synthetic esters with very good biodegradability, without synthetic esters. Can be used where high oil chain stability is required. Can be used where seaweed and marine life are a concern.
PLANTOLUBE CGLP 220 S
Sideway oils based on synthetic esters with good biodegradability. Can be used where seaweed and marine life are a concern.

Synthetically based compressor oils / circulating oils

PLANTOLUBE SC 46 S

* The relevant products are qualified according to the EU Ecolabel.
OVERVIEW OF PLANTO PRODUCTS

**Synthetic circulating and gear oils**

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Description</th>
<th>Density at 15°C [g/ml]</th>
<th>Flash point [°C]</th>
<th>Kin. Visc. at 40°C [mm²/s]</th>
<th>Kin. Visc. at 100°C [mm²/s]</th>
<th>Cu corr. at 100°C</th>
<th>VI (viscosity index)</th>
<th>Pour point [°C]</th>
<th>Main application area</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLANTOGEAR 100 S</td>
<td>Rapidly biodegradable high-performance gear oils on the basis of special, saturated waxes. Extremely high thermal and aging stability, high viscosity index (seven-stable), good viscosity-temperature behaviour, for low-temperature applications, excellent cleaning power due to polar waxes, structures, reduced friction, excellent wear protection, good V2O5 scavenging load carrying capacity, good protection against corrosion, outstanding TEH performance, rapidly biodegradable and self-cleaning. The oils of the PLANTOGEAR S series of oils surpass the minimum requirements of CLP-E lubricating oils according to DIN 51517-3 together with DIN 51524, ISO 6743-6 and ISO 12925-1. CEC, C6, C8. The PLANTOGEAR S range has been awarded the EU Ecolabel.</td>
<td>924</td>
<td>280</td>
<td>100</td>
<td>13,7</td>
<td>–</td>
<td>138</td>
<td>–33</td>
<td></td>
</tr>
</tbody>
</table>

**Adhesive oils, machine oils**

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Description</th>
<th>Density at 15°C [g/ml]</th>
<th>Flash point [°C]</th>
<th>Kin. Visc. at 40°C [mm²/s]</th>
<th>Kin. Visc. at 100°C [mm²/s]</th>
<th>Cu corr. at 100°C</th>
<th>VI (viscosity index)</th>
<th>Pour point [°C]</th>
<th>Main application area</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLANTOTAC HV 320 N</td>
<td>Rapidly biodegradable high-performance gear oils on the basis of special, saturated waxes. Extremely high thermal and aging stability, high viscosity index (seven-stable), good viscosity-temperature behaviour, for low-temperature applications, excellent cleaning power due to polar waxes, structures, reduced friction, excellent wear protection, good V2O5 scavenging load carrying capacity, good protection against corrosion, outstanding TEH performance, rapidly biodegradable and self-cleaning. The oils of the PLANTOGEAR S series of oils surpass the minimum requirements of CLP-E lubricating oils according to DIN 51517-3 together with DIN 51524, ISO 6743-6 and ISO 12925-1. CEC, C6, C8. The PLANTOGEAR S range has been awarded the EU Ecolabel.</td>
<td>958</td>
<td>264</td>
<td>381</td>
<td>42,4</td>
<td>–</td>
<td>166</td>
<td>–27</td>
<td></td>
</tr>
<tr>
<td>PLANTOTAC HV 460 N</td>
<td>Same as above.</td>
<td>977</td>
<td>260</td>
<td>460</td>
<td>43,3</td>
<td>–</td>
<td>146</td>
<td>–30</td>
<td></td>
</tr>
<tr>
<td>PLANTOTAC HV 100 S</td>
<td>Same as above.</td>
<td>924</td>
<td>300</td>
<td>100</td>
<td>17,5</td>
<td>–</td>
<td>193</td>
<td>–36</td>
<td></td>
</tr>
</tbody>
</table>

**Forming and mould release oils**

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Description</th>
<th>Density at 15°C [g/ml]</th>
<th>Flash point [°C]</th>
<th>Kin. Visc. at 40°C [mm²/s]</th>
<th>Kin. Visc. at 100°C [mm²/s]</th>
<th>Cu corr. at 100°C</th>
<th>VI (viscosity index)</th>
<th>Pour point [°C]</th>
<th>Main application area</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLANTO SCHALUNGSÖL N*</td>
<td>Based on vegetable oil, rapidly biodegradable.</td>
<td>904</td>
<td>194</td>
<td>12,8</td>
<td>–</td>
<td>–</td>
<td>–18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For high-stressed spur, bevel and worm gears, above all, in areas where leakage could prevent a balanced flow to soil and the ground or surface water. For both high and low application temperatures, high, shear-stable viscosity index. Can be used as a cleaning fluid.

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Description</th>
<th>Density at 15°C [g/ml]</th>
<th>Flash point [°C]</th>
<th>Kin. Visc. at 40°C [mm²/s]</th>
<th>Kin. Visc. at 100°C [mm²/s]</th>
<th>Cu corr. at 100°C</th>
<th>VI (viscosity index)</th>
<th>Pour point [°C]</th>
<th>Main application area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chainsaw oil</td>
<td>Rapidly biodegradable, highly viscous and strongly adhesive chainsaw oil based on renewable raw materials. Awarded the EU Ecolabel.</td>
<td>924</td>
<td>–</td>
<td>–</td>
<td>55,32</td>
<td>11,83</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

**Planto TAC 68 is also used in other areas in which an excellent chain lubricating oil is required.**

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Description</th>
<th>Density at 15°C [g/ml]</th>
<th>Flash point [°C]</th>
<th>Kin. Visc. at 40°C [mm²/s]</th>
<th>Kin. Visc. at 100°C [mm²/s]</th>
<th>Cu corr. at 100°C</th>
<th>VI (viscosity index)</th>
<th>Pour point [°C]</th>
<th>Main application area</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLANTOMOT SAE 5W-40</td>
<td>Super high-performance SAE class 5W-40 diesel engine oil.</td>
<td>918</td>
<td>244</td>
<td>76,8</td>
<td>14,2</td>
<td>–</td>
<td>193</td>
<td>–42</td>
<td></td>
</tr>
</tbody>
</table>

For use in machines and commercial vehicles, e.g. construction machines, buses, forestry and agricultural equipment or point maintenance machinery as well as passenger vehicles. When using diesel or biodiesel, engines can be changed over to PLANTOMOT without flushing, regardless of their mileage.

**PUOIS recommendations:** AEC E835, AP CG-4, KUBOTA, DAF, ZETOR

**PLANTOMOT HYTRAC PLUS**

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Description</th>
<th>Density at 15°C [g/ml]</th>
<th>Flash point [°C]</th>
<th>Kin. Visc. at 40°C [mm²/s]</th>
<th>Kin. Visc. at 100°C [mm²/s]</th>
<th>Cu corr. at 100°C</th>
<th>VI (viscosity index)</th>
<th>Pour point [°C]</th>
<th>Main application area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>Special fluid (STT) for forming tractor gears / hydrostatic units with and without wet brakes.</td>
<td>914</td>
<td>&gt; 200</td>
<td>–</td>
<td>10,3</td>
<td>211</td>
<td>–</td>
<td>–40</td>
<td></td>
</tr>
</tbody>
</table>

*The relevant products are qualified according to the EU Ecolabel.*
## OVERVIEW OF PLANTO PRODUCTS

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Description</th>
<th>Density at 15 °C [g/ml]</th>
<th>Flash point n. Clev. °C</th>
<th>Kin. visc. at 40 °C [mm²/s]</th>
<th>Cu corr. at 100 °C</th>
<th>VI (viscosity index)</th>
<th>Pour point [°C]</th>
<th>Main application area</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLANTOGEL ECO 2 N (based on rape seed oil)</td>
<td>Calcium soap, light brown, also available in NLGI 1. Awarded the EU Eco-label.</td>
<td>2 ±110</td>
<td>265–295</td>
<td>–20 bis +70</td>
<td>1–90</td>
<td>0–0</td>
<td>36</td>
<td>Lubricating greases for lock gates, sewage plants, agriculture and forestry.</td>
</tr>
<tr>
<td>PLANTOGEL ECO 2 S (based on synthetic esters)</td>
<td>Lithium soap Awarded the EU Eco-label.</td>
<td>2 ≥ 170</td>
<td>265–295</td>
<td>–40 bis +120</td>
<td>1–90</td>
<td>0–0</td>
<td>110</td>
<td>for lubricating roller and plain bearings, e.g. in water turbines, agriculture and forestry.</td>
</tr>
</tbody>
</table>

## OVERVIEW OF ADDITIONAL PRODUCTS

### Ester-based cutting oils

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Description</th>
<th>Density at 15 °C [g/ml]</th>
<th>Flash point n. Clev. °C</th>
<th>Kin. visc. at 40 °C [mm²/s]</th>
<th>Cu corr. at 100 °C</th>
<th>Main application area</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLANTOCUT 7 SR Plus SR-range 10</td>
<td>Synthetic esters based on virgin raw materials, low hazard to water, rapidly biodegradable – low evaporation and low oil mist. Available in ISO VG 7, 10, 22 and 40 versions. PLANTOCUT 7 SR Plus and 10 SR are ISO4-free.</td>
<td>0,87</td>
<td>198</td>
<td>7</td>
<td>1</td>
<td>Suitable for all materials – therefore particularly suitable for all processes using a defined cutting edge and for grinding.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0,86</td>
<td>206</td>
<td>10</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0,95</td>
<td>215</td>
<td>22</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0,92</td>
<td>216</td>
<td>40</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PLANTOCUT 18 S-CS</td>
<td>Synthetic esters based on virgin raw materials, low evaporation and low oil mist.</td>
<td>0,93</td>
<td>200</td>
<td>18</td>
<td>4</td>
<td>For heavy machining, used for processing magnetic malleable iron.</td>
</tr>
<tr>
<td>UNIFLUID-range 10</td>
<td>Low oil mist, copper-inactive universal product for metalworking and hydraulics based on synthetic esters, fully saturated, non-hazardous to water. Available in ISO VG 10 (H3O4-free) and ISO VG 32 versions.</td>
<td>0,87</td>
<td>220</td>
<td>9,8</td>
<td>32</td>
<td>Multifunctional oil for use in the field of metalworking and hydraulics for the same viscosity, only with A10 VSO 71 DR axial piston pump from BOSCH REXROTH, universally usable for aluminium, cast iron and medium-strength steels. Product can also be used for honing and grinding.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0,96</td>
<td>256</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

### Ester-based minimum quantity lubrication

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Description</th>
<th>Density at 15 °C [g/ml]</th>
<th>Flash point n. Clev. °C</th>
<th>Kin. visc. at 40 °C [mm²/s]</th>
<th>Cu corr. at 100 °C</th>
<th>Main application area</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLANTO MIKRO-range 10 SR UNI</td>
<td>Synthetic esters based on virgin raw materials, low hazard to water, rapidly biodegradable – low evaporation and low oil mist.</td>
<td>0,86</td>
<td>206</td>
<td>10</td>
<td>1</td>
<td>Universal for all materials, suitable for one and two-channel spray systems.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0,88</td>
<td>200</td>
<td>15</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

### Metaforming lubricants, not water-miscible

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Description</th>
<th>Density at 15 °C [g/ml]</th>
<th>Flash point n. Clev. °C</th>
<th>Kin. visc. at 40 °C [mm²/s]</th>
<th>Cu corr. at 100 °C</th>
<th>Main application area</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLANTOFORM BSO 1002</td>
<td>Synthetic, easily biodegradable ester.</td>
<td>0,865</td>
<td>130</td>
<td>5,4/20°C</td>
<td>49</td>
<td>Cold extrusion of small parts made of non-ferrous metals, in particular copper and aluminium, also some applications with stainless steel.</td>
</tr>
<tr>
<td>PLANTOFORM MBO 2797</td>
<td></td>
<td>0,921</td>
<td>300</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**CHECKLIST FOR SWITCHING HYDRAULIC SYSTEMS OVER TO ENVIRONMENTALLY FRIENDLY HYDRAULIC FLUIDS**

In case of questions to the range of products or to the changeover, please send the checklist to the responsible FUCHS-application engineer!

<table>
<thead>
<tr>
<th>Adress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
</tr>
<tr>
<td>Company</td>
</tr>
<tr>
<td>Date</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport, construction, municipal vehicles</td>
</tr>
<tr>
<td>Agriculture and forestry</td>
</tr>
<tr>
<td>Energy</td>
</tr>
<tr>
<td>Marine</td>
</tr>
<tr>
<td>Others</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recently used hydraulic fluid / type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydraulic oils</td>
</tr>
<tr>
<td>Gear oils</td>
</tr>
<tr>
<td>Engine oils</td>
</tr>
<tr>
<td>Other specifications</td>
</tr>
</tbody>
</table>

**Hydraulic tank**

- With coating or paint finish
- Tanc temperature display: yes [ ] no [ ]
- Tanc temperature under operating conditions: from ___ °C to ___ °C
- Tanc capacity (manufacturer information): ca. ___ litres
- Total content of the hydraulic system: ca. ___ litres
- Operating pressure: from ___ bar to ___ bar
- Volume flow: min. ___ litre/min. max. ___ litre/min.

**Tube materials**

- Manufacturer
- Type/Description
- Elastomer material
- Proved compatibility: yes [ ] no [ ]

**Pump**

- Manufacturer
- Type/Description

**Filter elements**

- Manufacturer
- Material

**Are there any other machines or equipment with environmental acceptable hydraulic oils in use?**

- Based on Polyglycols (HEPG)
- Based on rape seed oil (HETG)
- Saturated synth. Ester (HEES)
- Partly saturated synth. Ester (HEES)
- Others (e.g. HEPR – Poly-alphaolefins)
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 pre-treatment, 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.

We therefore recommend that you consult a FUCHS EUROPE SCHMIERSTOFFE GMBH application engineer to discuss application conditions and the performance criteria of the products before the product is used. It is the responsibility of the user to test the functional suitability of the product and to use it with the corresponding care.

Our products undergo continuous improvement. We therefore retain the right to change our product program, the products, and their manufacturing processes as well as all details of our product information sheets at any time and without warning, unless otherwise provided in customer-specific agreements. With the publication of this product information, all previous editions cease to be valid.

Any form of reproduction requires express prior written permission from FUCHS EUROPE SCHMIERSTOFFE GMBH.

© FUCHS EUROPE SCHMIERSTOFFE GMBH. All rights reserved. Edition 08/2014
Innovative lubricants 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.