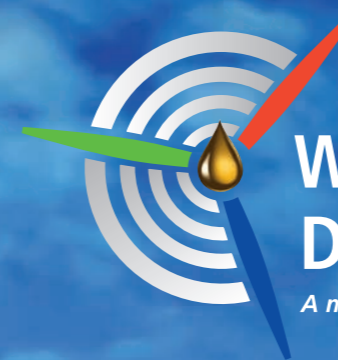


Special Lubricants for Wind Power Plants

FUCHS WINDPOWER DIVISION is a comprehensive service provider to the wind power industry.

- Individual selection and evaluation of lubricants based on lubricant recommendations and analyses.
- Full documentation with gearbox-condition reports and recommendations.
- Reliable gear oil reports with high-accuracy oil analyses which provide specific details about oil condition and allow oil change intervals to be scheduled exactly.
- Experts support your evaluation of grease analyses out of pitch-, yaw-, main- and generator bearings.

We make the wind win



**WINDPOWER
DIVISION**

A member of FUCHS PETROLUB AG

**Special Lubricants
for Wind Power Plants**

Your lubricant competence for wind power plants

Greases/Grease pastes:

FUCHS LUBRITECH GMBH
Werner-Heisenberg-Straße 1
67661 Kaiserslautern/Germany
Phone: +49 6301 3206-0
Fax: +49 6301 3206-940
E-mail: info@fuchs-lubritech.de
www.fuchs-lubritech.com
www.fuchs-windpower.com

Gear oils/Hydraulic oils:

FUCHS EUROPE SCHMIERSTOFFE GMBH
Friesenheimer Straße 19
68169 Mannheim/Germany
Phone: +49 621 3701-0
Fax: +49 621 3701-570
E-mail: zentrale@fuchs-europe.de
www.fuchs-europe.de
www.fuchs-windpower.com

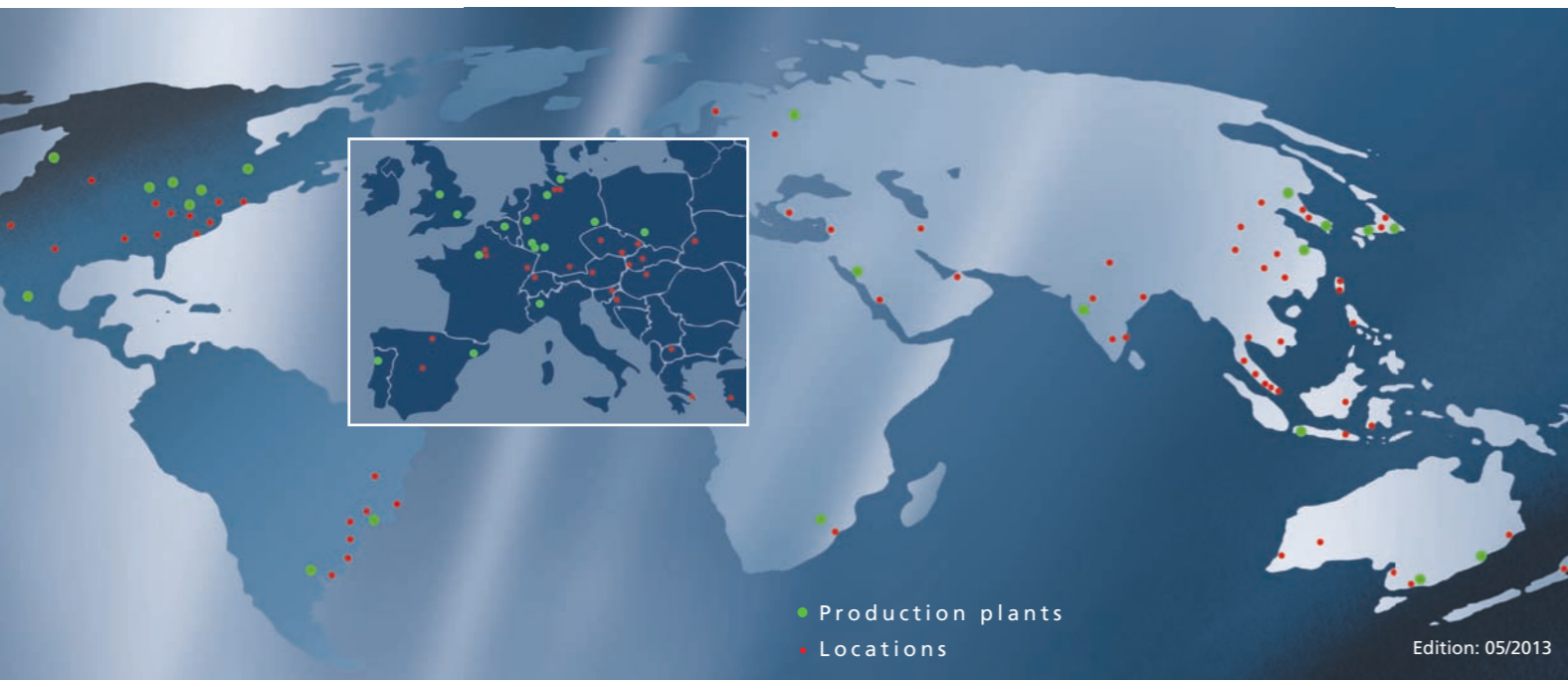
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LUBRICANTS.
TECHNOLOGY.
PEOPLE.



Special Lubricants for Wind Power Plants

Optimal solutions – worldwide.



Two strong partners – one team.

FUCHS LUBRITECH GMBH, located in the German town of Kaiserslautern, employs more than 450 people worldwide. FUCHS LUBRITECH is one of the world's leading manufacturers of special lubricants for the most challenging applications.

Its product range includes a total of more than 1,000 special products that are precisely tailored to their respective applications. The company focuses on niche applications with the most challenging lubricant requirements and also provides the accompanying technical advice.

The result of this focused and innovative approach is a product range of high-performance lubricants that leaves nothing to be desired and no area of application uncovered.



Headquarter of FUCHS LUBRITECH in Kaiserslautern

The two sister companies FUCHS EUROPE SCHMIERSTOFFE and FUCHS LUBRITECH have joined forces in the wind power sector under the name of FUCHS WINDPOWER DIVISION. The two companies are wholly owned subsidiaries of FUCHS PETROLUB AG, the world's largest independent lubricant manufacturer.

The FUCHS WINDPOWER DIVISION offers customers in this sector a wide range of high-performance lubricants and greases as well as hydraulic and gear oils.

Thanks to the FUCHS Group's global network, the FUCHS WINDPOWER DIVISION is always local and can guarantee the availability of its lubricants worldwide – including expert advice, logistics and after sales service.

The FUCHS WINDPOWER DIVISION has the expertise to solve all lubrication-based challenges faced by wind turbine manufacturers, the manufacturers of drive components as well as wind farm operators. No matter which lubrication task is required in a wind turbine, the FUCHS WINDPOWER DIVISION can provide exactly the right lubricant.



FUCHS EUROPE SCHMIERSTOFFE GMBH is a German company that manufactures and markets lubricants and related specialties with a workforce in excess of 600 employees.

The company, which was founded in 1931 as RUDOLF FUCHS, is located in Mannheim. The company's degree of specialization and speed of innovation is far above the average for this industry.

The product portfolio includes almost 2,000 lubricants and related specialties for all walks of life, industrial processes and applications.

Sales and technology centre of FUCHS EUROPE SCHMIERSTOFFE GMBH in Mannheim



Notice

The information contained in this brochure is based on the experience and know-how of FUCHS LUBRITECH GMBH and 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 brochure 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 LUBRITECH GMBH or 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.

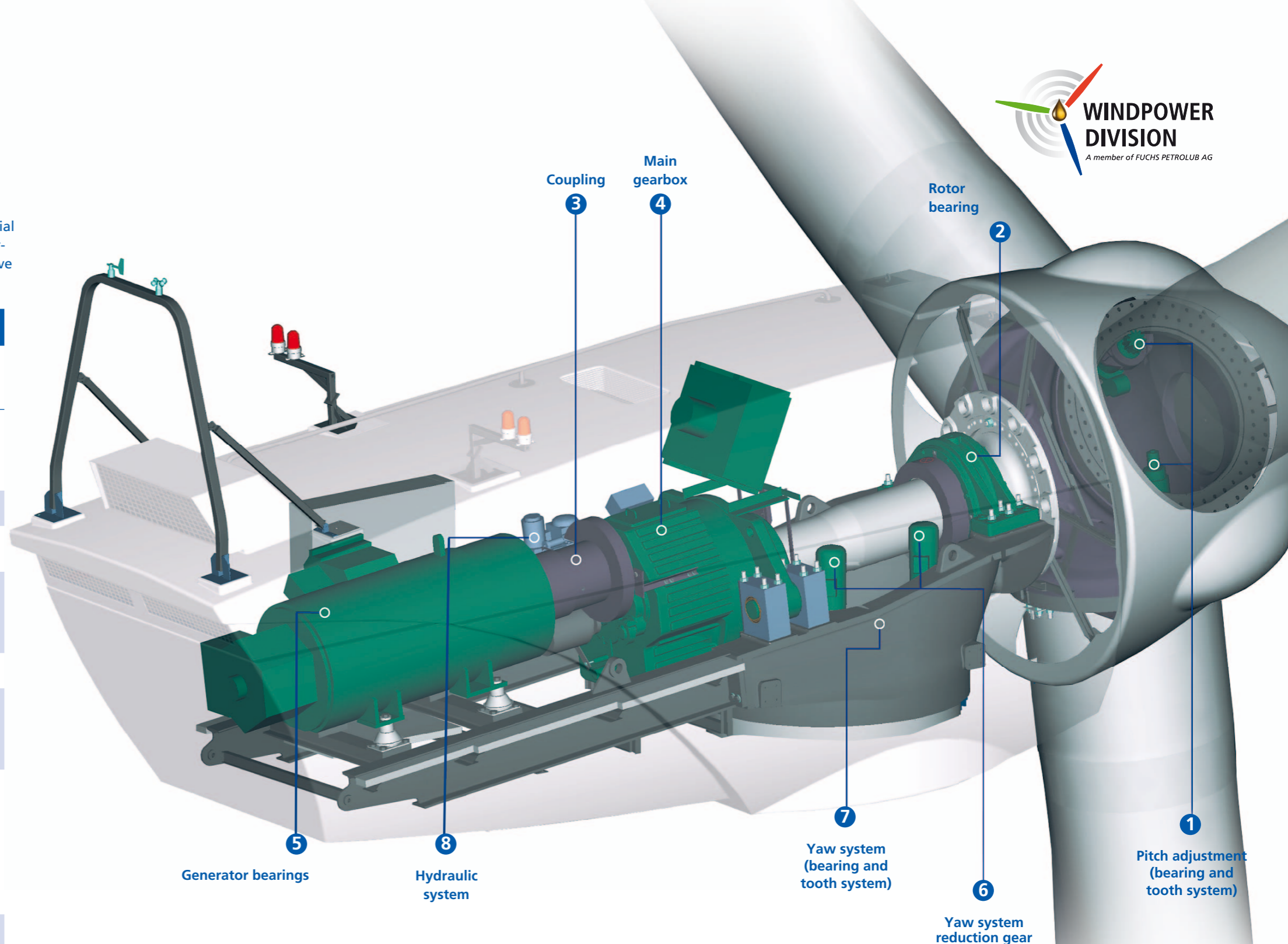
Our products undergo continuous improvement. We therefore retain the right to change our product program, the products, and their manufacturing processes as well as all details of our brochure at any time and without warning. With the publication of this brochure, all previous editions cease to be valid.

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Application areas.

The FUCHS WINDPOWER DIVISION offers a broad product portfolio of special lubricants for all wind power applications. Many approvals of turbine, gear-box and bearing manufacturers as well as suppliers of filtering systems prove the high performance and quality of our products.



Lubricant application	Lubricants
1 Pitch adjustment Bearing	gleitmo 585 K STABYL EOS E 2 STABYL LT 50
	CEPLATTYN BL WHITE CEPLATTYN BL gleitmo 585 K STABYL EOS E 2
2 Rotor bearing	STABYL EOS E 2
3 Clutch	gleitmo 585 K STABYL EOS E 2
4 Main gearbox	GEARMASTER ECO 320 RENOLIN UNISYN CLP 320 RENOLIN PG 320 RENOLIN CLP 320
5 Generator bearings	URETHYN XHD 2
6 Yaw system reduction gear	GEARMASTER ECO 220 RENOLIN UNISYN CLP 220 RENOLIN PG 220 RENOLIN CLP 220
7 Yaw system Bearing	gleitmo 585 K STABYL EOS E 2 STABYL LT 50
	CEPLATTYN BL WHITE CEPLATTYN BL gleitmo 585 K STABYL EOS E 2
8 Hydraulic systems	PLANTOHYD-Range RENOLIN UNISYN OL 46 RENOLIN HVLP-Range
Chain hoist	CEPLATTYN 300 <small>(and other local solutions available)</small>
Slip ring cleaner	Rivolta S.L.X Top
Fasteners/assembly aids	gleitmo WSP 5040
Rapid rust removers	FERROFORM LOCC FERROFORM ECO LOCC
Waxy rust-preventive	ANTICORIT CPX DECORDYN HF 91 DECORDYN 350

Further specialities for drive technology in wind power plants.

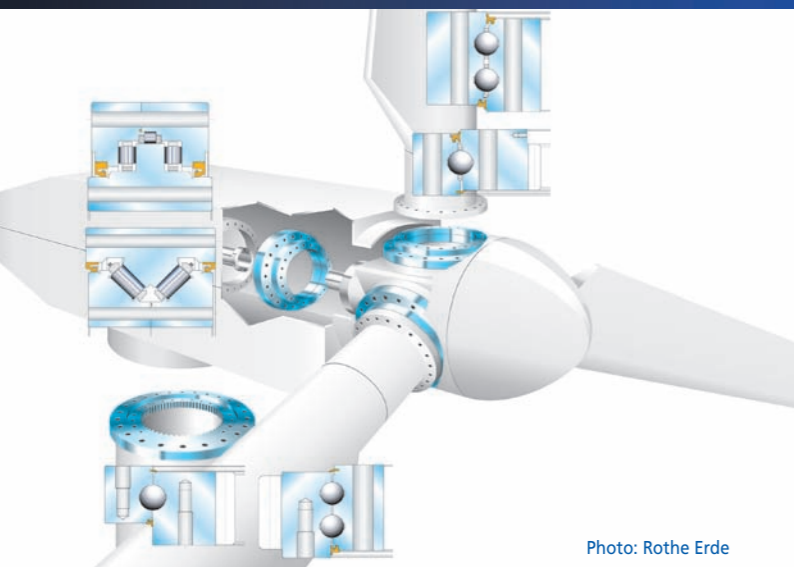
RENOLIN MR 90: Special running-in, corrosion protection and test rig oil; excellent cleaning and flushing properties, high corrosion protection, very good wear protection.

RENOLIN CLP VCI gear oil: EP-Gear oil with excellent corrosion protection properties; special developed VCI-components (VCI = Volatile Corrosion Inhibitors) for safe storage and transport of machines and components; machine elements and gears are protected against

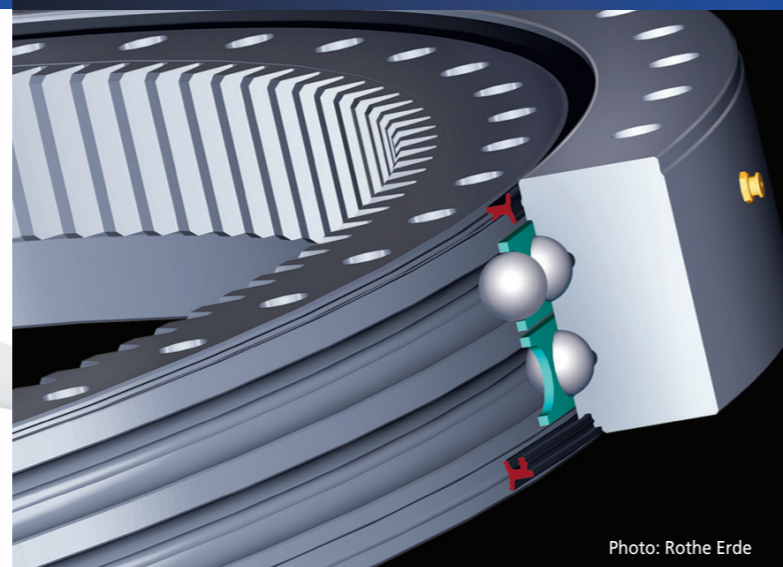
corrosion also in the vapour phase without direct contact of the oil with the metal surface.

RENOLIN HighGear Synth gear oil: Industrial gear oil newest additive technology based on polyalphaolefin (PAO); Plastic deformation (PD) technology; for pre-damaged gear sets and „critical applications“.

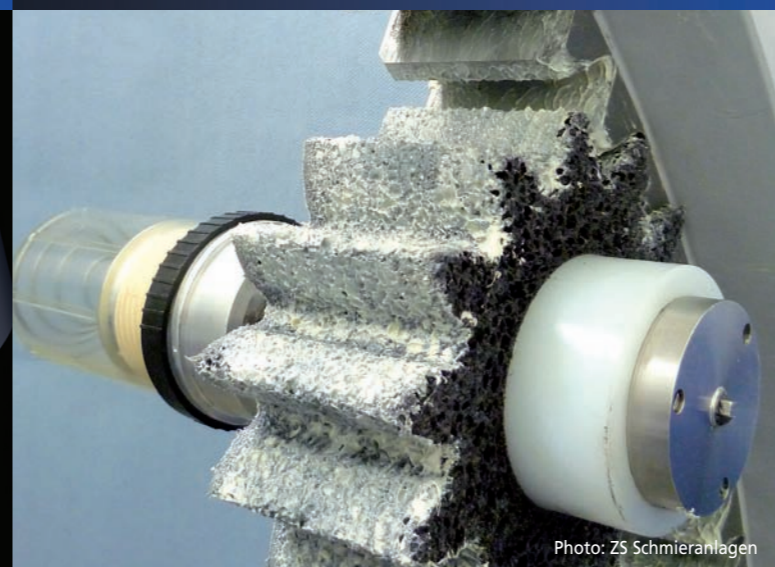
Large-size bearings in wind turbines



Double row large-size bearings



Special grease for open tooth systems



High temperature grease for long-term lubrication



gleitmo 585 K: Special lubricant for pitch and yaw bearings (tooth system and bearing).

gleitmo 585 K is a fully-synthetic special lubricant containing a synergistic combination of white solid lubricants. This combination offers excellent protection against wear especially under critical operation conditions like vibrations and oscillation movements under high load which are typical for pitch and yaw bearings on wind turbines. gleitmo 585 K is well known in the wind power industry and used as OEM first fill and service lubricant since many years with best results. Also for the tooth system of the yaw- and pitch bearings. Please use a lube pinion.

- Outstanding wear protection, especially at shock loads and oscillatory movements for the use in pitch and yaw bearings
- Extremely wide temperature range, suitable for all terms of climate conditions
- Temperature range: -45°C up to +130°C
- Consistency: NLGI grade 2
- Identification according DIN 51502: KPFHC 2 K-40
- Outstanding protection against false brinelling and fretting corrosion
- Very high load carrying capacity at low rotational speed
- Pumpable in automatic lube systems
- Approvals: Rothe Erde (ThyssenKrupp), IMO, ZS lubrication systems
- References: Most of the wind power plant manufacturers, users of wind power plants and parts

STABYL EOS E 2: High-performance grease for wind power applications (tooth system and bearing).

STABYL EOS E 2 is a high-performance grease based on a fully-synthetic ester and a lithium soap as thickener. It fulfils the highest technical requirements for modern lubricants used in wind turbines. STABYL EOS E 2 was developed in a perennial research project in cooperation with leading bearing manufacturers and is successfully in use on wind turbines as general purpose lubricant. Also for the tooth system of the yaw- and pitch bearings. Please use a lube pinion.

- Universal application on wind power units, especially for pitch, yaw and rotor bearings
- Extreme wide temperature range, suitable for all terms of climate conditions
- Temperature range: -40°C up to +130°C
- Consistency: NLGI grade 2
- Identification according DIN 51502: KPE 2 K-40
- Allows considerable reduction of lubricant diversity on wind turbine units
- Very good protection against false brinelling and fretting corrosion
- High load carrying capacity at low rotational speed
- Pumpable in automatic lube systems
- Approvals: Rothe Erde (ThyssenKrupp), IMO, ZS lubrication systems
- References: Most of the wind power plant manufacturers, users of wind power plants and parts

CEPLATTYN BL WHITE: White adhesive lubricant with good properties for low temperatures.

CEPLATTYN BL WHITE is a white adhesive lubricant with active reaction solid lubricants. It is used as a lubricant for machines and machine components operating under difficult conditions, e.g. gears, sliding tracks, chains, worm gears and ropes, as well as machine components that are subject to extreme temperature fluctuations and environmental influences. CEPLATTYN BL WHITE is used in particular for lubricating the tooth system of the yaw and pitch gears in wind turbines.

- For lubricating the tooth system of the yaw and pitch gears
- Very wide temperature range: -40/+160°C, up to +180°C for a short time, pumpable down to -30°C
- Very good adhesion to the tooth flanks
- High thermal and mechanical stability
- Protects the tooth system against corrosion
- Very good water resistance, thus also unlimited suitability for off-shore turbines
- Pumpable in automatic lubrication systems
- References: Manufacturers of slewing bearings and manufacturers of lubricating equipment

URETHYN XHD 2: Fully-synthetic polyurea grease for extreme application conditions.

URETHYN XHD 2 is a soft lubricating grease based on a synthetic hydrocarbon base oil and a very temperature resistant polyurea thickener. A selected additive package provides excellent wear protection, even under fluctuating speeds, temperatures and loads.

- High temperature lubricant for long-life lubrication of bearings at higher temperatures and high loads and speeds e.g. in generator bearings
- Temperature range: -30°C up to +180°C, short-term up to +200°C
- Consistency: NLGI grade 2
- Identification according DIN 51502: KPTHC 2R-30
- Extraordinary thermal stability
- High oxidation stability
- Pumpable in automatic lube systems

Gear oils with extended life time

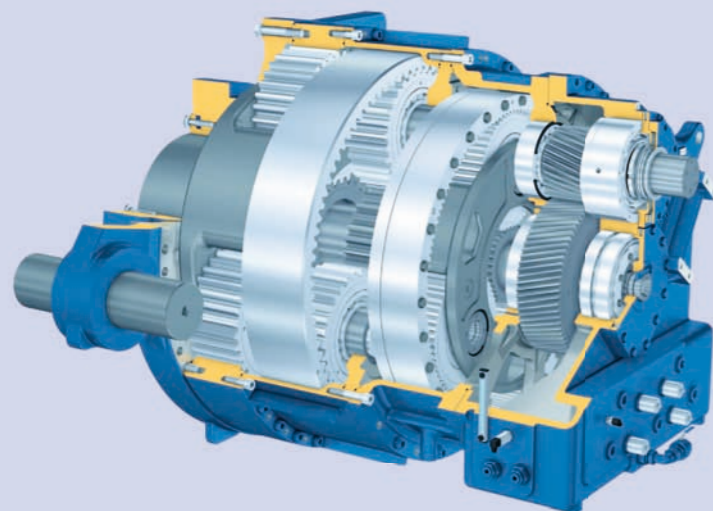
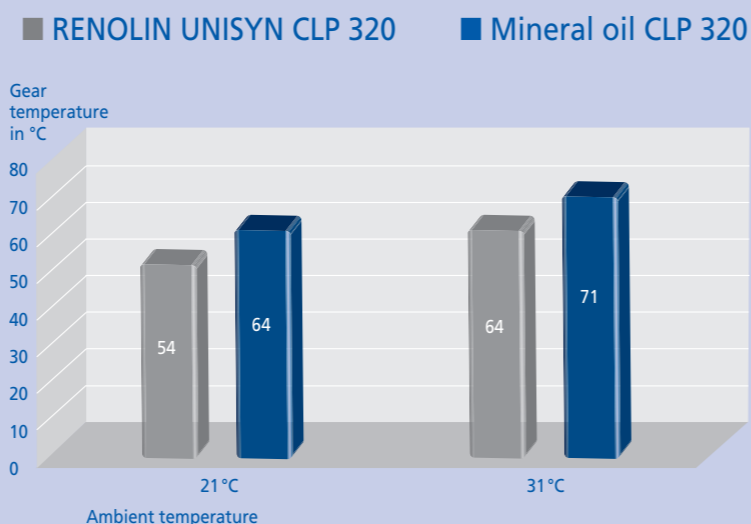
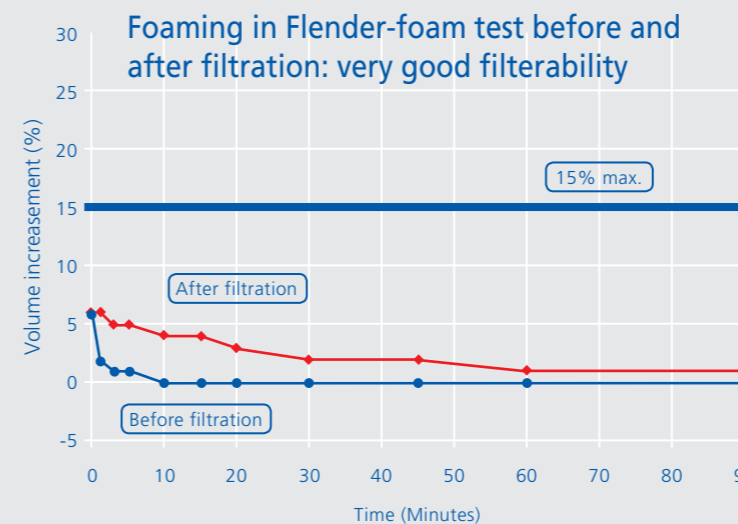


Photo: Bosch Rexroth AG

Gear oil in wind power plants



Environmentally friendly gear oils



Gear after change over to GEARMASTER ECO



Fully-synthetic industrial gear and lubricating oil-based on polyalphaolefin (PAO).

Manufacturers and operators of wind power plants have increasingly become aware of the advantages of synthetic gear oils. From the beginning, FUCHS has focused on the high-performance industrial gear oils of the RENOLIN UNISYN CLP Series to meet the high technical requirements in wind power plants. With several thousand windmills world-wide and numerous Gigawatt of power generation, FUCHS is one of the most experienced companies regarding the use of synthetic lubricants in the market. RENOLIN UNISYN CLP 320 is based on special fully-synthetic hydrocarbons (polyalphaolefins). Synergistic acting additives guarantee excellent wear protection, excellent corrosion protection, high thermal stability, high oxidation stability and a long lifetime. In comparison to mineral oil-based products a 4–5 times higher lifetime can be achieved by using RENOLIN UNISYN CLP products. Due to our experience and due to other

field results, it is reported that RENOLIN UNISYN CLP can decrease the oil sump temperature by 5–10 °C (low friction coefficient under load in comparison to mineral oil-based products). This leads besides to a significant reduction of the temperature of the oil and the parts to an increase of the efficiency up to 3%. RENOLIN UNISYN CLP 320 is used with great success in wind turbine applications over many years worldwide. The test results in the FAG 4-stage test (wind turbine test for industrial gear oils, Schaeffler Group) demonstrate the excellent wear protection properties of RENOLIN UNISYN CLP 320. Total Rating 1 (excellent) shows the superior wear protection properties of RENOLIN at different mixed friction conditions, under different load, speed and temperature conditions. Even under EHL (Elasto-Hydrodynamic Lubrication) conditions and under the influence of contamination in form of emulsified water, the products show no wear and no sludge. These additives avoid also micro pitting failures over a wide temperature range.

- Fully-synthetic gear oil-based on PAO
- Miscible and compatible with mineral and ester oil
- Micro pitting test FZG-GFT: LS >10, high protection at +60°C and +90°C
- FZG-scuffing test: high protection FZG A/8,3/90: load stage >14 FZG A/16,6/140: load stage >12
- FAG wind turbine test – 4 stage test: rating 1,0 (excellent wear protection, no wear)
- FE 8-roller bearing wear test, 7,5/80/80 and 7,5/100/80: no wear

- Excellent oxidation stability
- Excellent thermal stability – SKF WTGU test at +100°C: passed
- Excellent filterability
- Low foaming tendency
- Excellent air release properties
- Excellent material compatibility
- Approvals and references: Acciona, Bosch Rexroth, Enercon, Flender, Gamesa, GE, Hansen, Jahnel+Kestermann, Liebherr, Siemens, Winergy, Zollern and other leading manufacturers of gearboxes and wind power plants

Environmentally harmless lubricating and gear oils based on synthetic ester.

GEARMASTER ECO industrial EP gear oils are based on special fully-synthetic saturated ester. Especially in the wind power sector, plant operators increasingly favour the use of materials which have the least harmful effect on the environment and the natural resources. Based on decades of experience and as a market leader in the field of biodegradable and biogenic lubricants, FUCHS developed and successfully introduced in the market a gear oil, which meets the high technical requirements for gear oils in wind power plants, and which at the same time is environmentally friendly (biodegradability >60 % according to OECD 301 C) and contributes to the conservation of natural resources (the formulation is based on a high share of renewable resources). GEARMASTER ECO products are based on polar saturated esters which have excellent wetting and cleaning properties („Clean Gear Technology“).

- Fully-synthetic biodegradable gear oil-based on synthetic ester
- Miscible and compatible with mineral oil and PAO
- Micro pitting test FZG-GFT: LS > 10, high protection at +60°C and +90°C
- FZG-scuffing test: high protection FZG A/8,3/90: load stage 14 FZG A/16,6/140: load stage >12
- FAG wind turbine test – 4 stage test: rating 1,0 (excellent wear protection, no wear)
- FE 8-roller bearing wear test, 7,5/80/80 and 7,5/100/80: no wear

They provide excellent wear protection, excellent corrosion protection, high thermal stability, high oxidation stability and a long lifetime. Gear oil temperatures can be reduced and the efficiency can be increased.

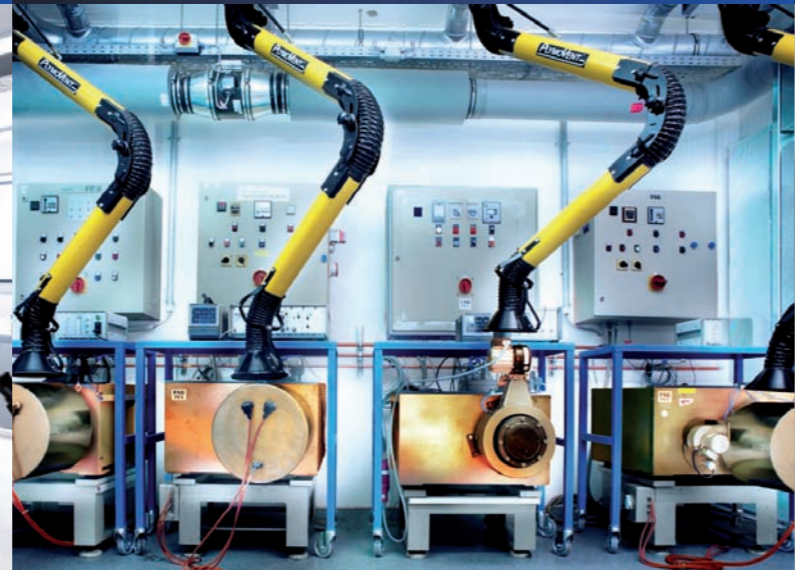
GEARMASTER ECO 320 have been used with great success in wind turbine applications worldwide over many years as a high-performance EP gear oil. The test results in the FAG 4-stage test (wind turbine test for industrial gear oils, Schaeffler Group) demonstrate the excellent wear protection properties of GEARMASTER ECO 320. Total Rating 1 (excellent) shows the superior wear protection properties at 4 defined test conditions (different mixed friction conditions, different load, speed and temperature conditions). Special AW/EP additives guarantee high scuffing wear protection.

- Excellent oxidation stability
- Excellent thermal stability – SKF WTGU test at +100°C: passed
- Excellent cleaning properties „Clean Gear Technology“
- Excellent filterability
- Low foam tendency, excellent air release properties
- Excellent material compatibility
- Approvals and references: Bosch Rexroth, Chongqing Chongchi, Flender, Moventas, Winergy (GE) and other leading manufacturers of gearboxes and wind power plants

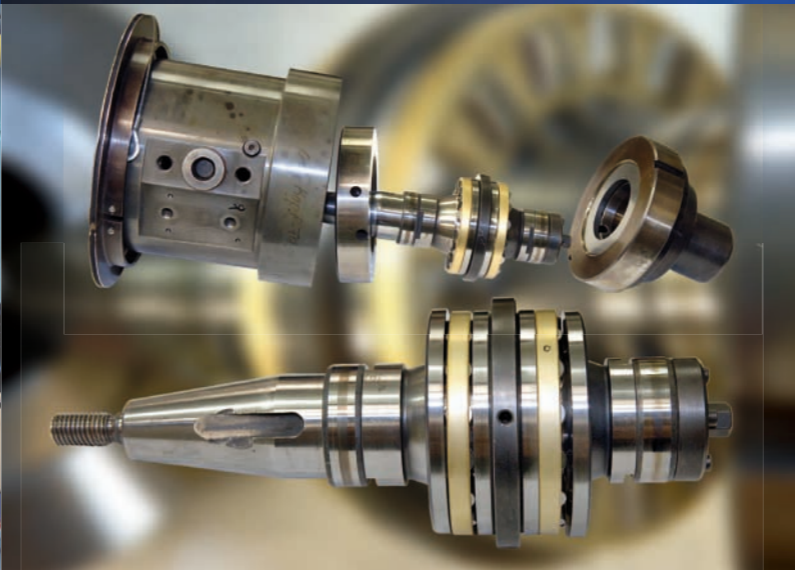
Research and development for perfect solutions



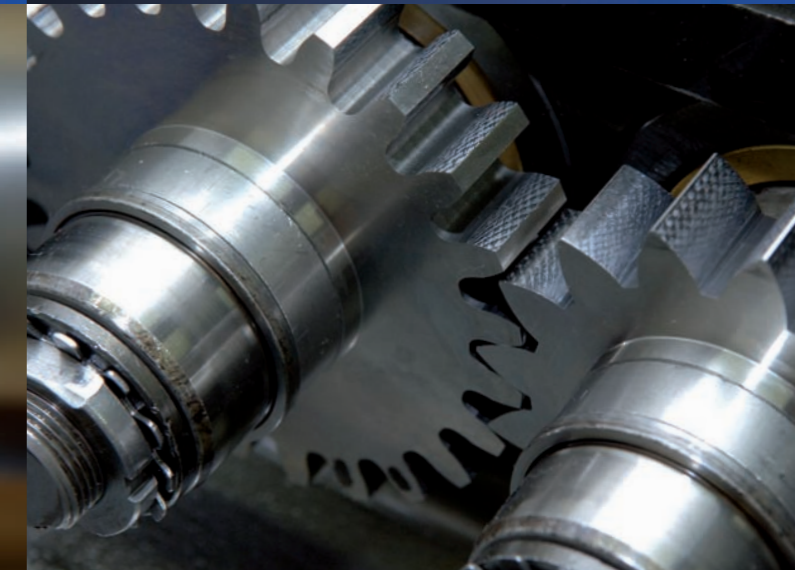
Wear protection right from the start



FAG FE 8-roller bearing wear test rig



FZG gear test rig



RENOLIN UNISYN CLP 320: FAG 4-stage test



Oil: Fuchs Renolin Unisyn CLP 320 tested as VP LA_4_05_005 Var. 6.1
Supplier: Fuchs Europe
Oil type: PAO

* Tested by FUCHS report PFMA-06-0110 (unknown batch number)
** Tested by Assmann report 4206b - batch V6.2
*** Step 3 and 4 tested by Schaeffler KG

Criterion	Test	Result
Stage 1*	wear at boundary lubrication FEB-80h	1,0 passed
Stage 2**	fatigue beh. at mixed friction cond. FEB-80h	1,0 passed
Stage 3***	fatigue behaviour at EHL-cond. L11-700h	1,0 passed
Stage 4***	fatigue behaviour and residues with water added FEB-WKA	1,0 passed
summary:		1,0 passed

Result:	1	2	3	4	5	Test	Result	Rating	
Stage 1*	wear of rollers V50WK	< 10	< 15	< 20	< 30	< 30	yes	0	1
	rippings	no	-	small	ro or wash	ro + wash	yes	no	1
	micro pittings	no	-	-	no	strong	yes	no	1
							stage 1	1,0	passed
Stage 2**	running time (hours)	>= 800	-	-	-	< 800	yes	800	1
	wear of rollers V50WK	< 10	< 15	< 20	< 30	< 30	yes	2	1
							stage 2	1,0	passed
Stage 3***	no fatigue damage forced by additives up to L50 (hours)	700	650	600	550	< 550	yes	700	1,0
Stage 4***	running time 600 hours	>= 600	-	-	-	< 600	yes	600	1
	filter blocking	no	-	-	-	-	yes	no	1
	wear of rollers V50WK	< 10	-	-	-	-	yes	0	1
	wear of cage V50KF	< 20	-	-	-	-	yes	84	no
	fatigue damages	no	-	-	-	-	yes	no	1
	residues at the bearing	slight	sl/mod	moderate	mod/heavy	heavy	yes	slight	1
	residues at the preheating system	slight	sl/mod	moderate	mod/heavy	heavy	yes	slight	1
							stage 4	1,0	passed
summary:							1,0	passed	

Special hydraulic fluids for wind power applications.

ECO HYD S PLUS:
Rapidly biodegradable hydraulic fluid based on saturated synthetic esters

Fully-synthetic, high-performance hydraulic fluid and lubricating oil-based on special saturated synthetic esters.
Multigrade characteristic due to excellent viscosity temperature behaviour (natural high shear stable viscosity index, VI >150), excellent low temperature properties, good lubrication film stability, high wear protection (FZG A/8,3/90 failure load stage >12) rapidly biodegradable (>60 % according to OECD 3001C). The ISO guideline 15 380 should be observed when changing systems from mineral or synthetic oil to biodegradable lubricants.

RENOLIN HVI 32 GA:
Special multigrade hydraulic fluids – mineral oil-based

RENOLIN HVI 32 GA is a specially developed multigrade hydraulic oil-based on selected base oils. Due to the base oil properties together with synergistic acting additives the product has a wide operating temperature range. RENOLIN HVI 32 GA has a high shear stable viscosity index, VI >160. This high viscosity index (flat viscosity temperature graph) guarantees excellent cold flow properties and high lubricating film stability. The fluid guarantees high wear protection, high stability and good corrosion protection.

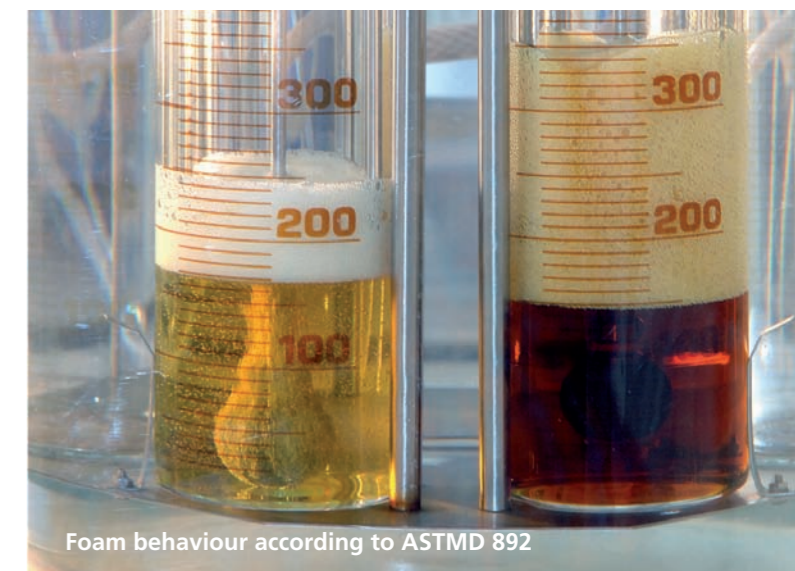
Multigrade hydraulic fluids from FUCHS.

RENOLIN UNISYN OL series

Fully-synthetic hydraulic fluid based on synthetic hydrocarbons (polyalphaolefin). Excellent low temperature properties (pour point <-50°C).

RENOLIN EXTREME TEMP series

Semi-synthetic hydraulic fluids based on hydro-treated base oils, high share stability, excellent wear protection, long lifetime.



Foam behaviour according to ASTM D 892