KLÜBER LUBRICATION

your global specialist

Industrial sector

Solutions for more Wind FORCE.

Speciality lubricants for taxing requirements in wind power generation

Speciality lubricants – a one-time investment offering long-term benefit

Wind turbines and their components are exposed to high loads. The constantly changing high loads, vibrations and varying operating conditions require tough equipment. Add to those the external factors such as humidity and extreme temperature variations, and components will really suffer. Wind turbine maintenance is an arduous task and performed only at long intervals, which makes trouble-free operation even harder to accomplish.

Selecting the right lubricant is therefore paramount – for initial lubrication of a component as well as for relubrication during operation.

After all, it is the lubricant that has to ensure reliable operation of each machine element. Both fluids (oils) and consistent lubricants (greases) are used in wind power plants. The main lubrication points are the main gearbox, the nacelle yaw gears, the main and generator bearings, the blade pitch mechanism and the yaw system.

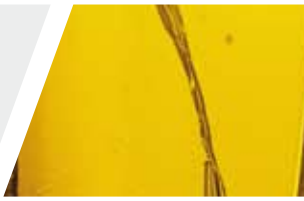
The lubricants used are required to offer reliable performance over a long service life over a wide temperature range as well as resist high load. For operators, these characteristics mean long relubrication intervals for greases and long lubricant life for oils.

What can you do to make your components and installations resist the extremely high stresses in a wind turbine?

Speciality lubricants made by Klüber Lubrication are always a good choice. As an expert in speciality lubricants, Klüber cooperates closely with the manufacturers of major components and OEMs to push the limits of what can be technically achieved even further: longer service intervals, longer component life and yet more reliable operation.

Have you ever considered how lubricants can influence your operating costs? The lubricant itself constitutes only a minor investment, but its effects can be tremendous.

Higher performance – lower cost



A high-performance oil for enclosed gears operating under extreme loads

As wind generators get ever larger, the power density in wind turbine gears is increasing, causing higher stress on the gears. Experience has shown that the conventional gear oils available on the market today often fail to meet taxing requirements in terms of wear protection for rolling bearings, micropitting resistance, foam and residue formation, and viscosity stability.

Why use a high-performance gear oil from Klüber Lubrication?

In an effort to overcome the weaknesses of existing products, Klüber Lubrication has developed a gear oil to accommodate the high loads in wind turbine gears.
Compared with standard oils, Klübersynth GEM 4-320 N shows good resistance to load and ageing as well as low friction. It enables long oil change intervals, has lower power losses and provides higher plant yield - by up to several thousand euros over the service life of a wind turbine. It offers excellent anti-foaming characteristics and protection against micropitting. It also contains no additives that might promote the formation of residues. Due to its high shear stability, the product‘s viscosity remains consistent.

Klübersynth GEM 4-320 N meets not only the requirements stipulated by manufacturers of gears, rolling bearings and wind turbines, but those of the operators as well.

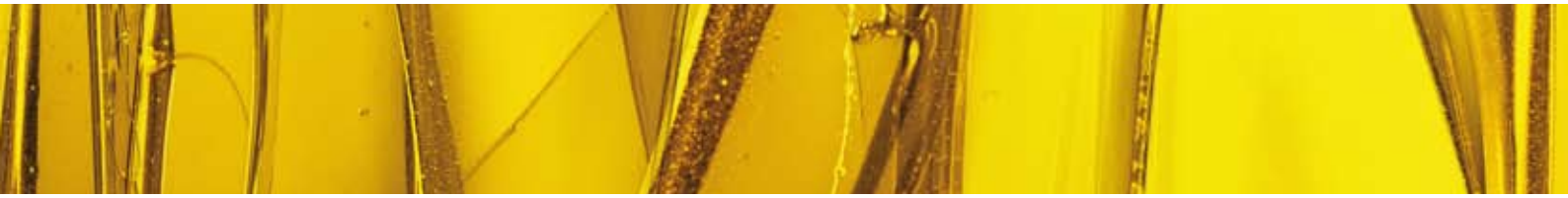
Besides an oil‘s viscosity, it is the additives that protect components reliably against micropitting and scuffing damage, hence enabling longer gear life.

Micropitting is a form of wear occurring on highly loaded gears, especially in the contact area subject to mixed friction and negative specific sliding. Material near the surface is plastically deformed, and micro-cracks form. To the naked eye, the damaged tooth flank area looks greyish. When sufficiently magnified, minute spalling and pores become visible. The principal causes of micropitting are:

- high load
- low gear speed, as this leads to reduced lubricant film thickness
- unfavourable tooth geometry leading to high local loads on the tooth flank
- roughness of the tooth flank
- wrong lubricant

Klübersynth GEM 4-320 N meets gear manufacturers‘ requirements in numerous tests

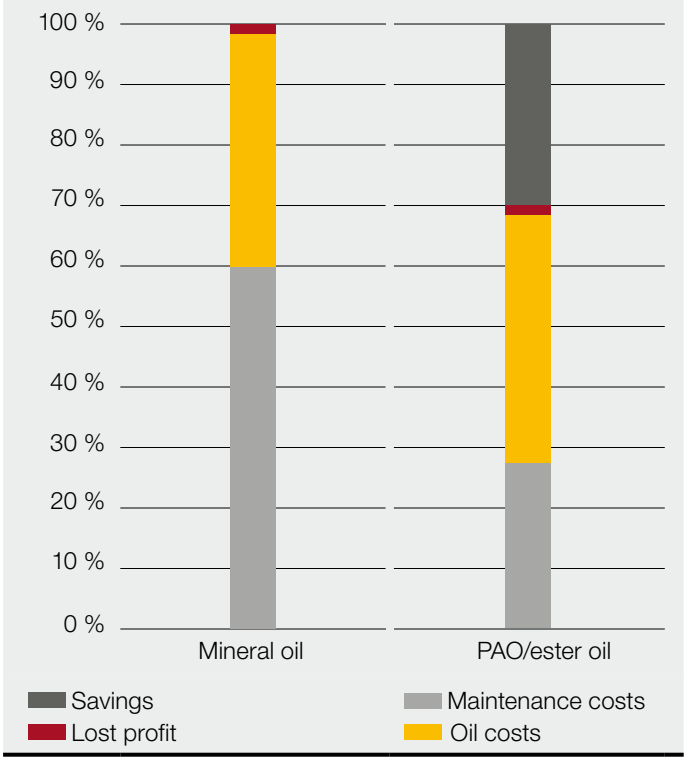
Requirements	Klübersynth GEM 4-320 N
Gear oil acc. to DIN DIN 51517-3	CLP HC
Elastomer compatibility 72 NBR 902	passed
Elastomer compatibility 75 FKM 585	passed
Foam behaviour ASTM D 892	passed
Flender foam test	< 15 %
Fine filtration	possible
FVA 54 IV micropitting resistance, 60 °C	high
FVA 54 IV micropitting resistance, 90 °C	high
FZG scuffing load test DIN ISO 14635-1, A/8,3/90	> 14
FZG scuffing load test based on DIN ISO 14635-1, A/16,6/90, failure load stage	> 14
FZG wear test	low
FAG FE8 wear and endurance test	0 mg rolling element wear
FAG 4-stage wind power test	≤ 1.0



Utilise the potential for savings

The following diagram shows the potential savings that can be attained by using high-performance gear oils. The costs arising from the main gear of an average wind turbine over its entire service life, taking into account oil costs, gear maintenance and gear efficiency, are indicated:

Compared by costs: Mineral oil, PAO/ester oil



The synthetic high-performance oils from Klüber Lubrication enable significant savings.

Higher reliability

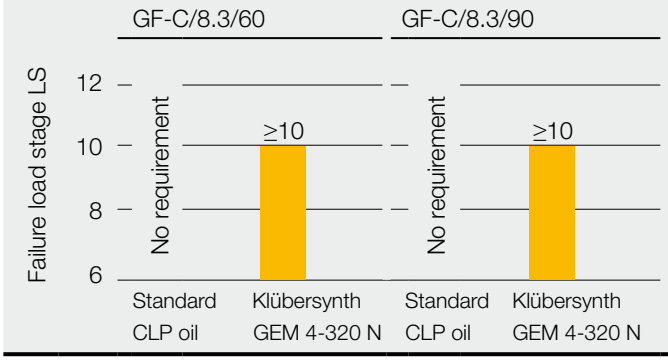
High micropitting resistance helps prevent premature fatigue damage

Highly loaded gears are susceptible to scuffing and micropitting. High pressure and temperature occurring in the mesh zone can cause tooth damage and consequently lead to premature gear failure. The risk of scuffing or micropitting damage is particularly high with less-than-perfect tooth profiles and surfaces, or where shock loads, vibration, high surface pressures or high sliding friction occur.

Micropitting changes the shape of the tooth flank, which may affect the mesh dynamics and the gear's noise characteristics. The cracks associated with micropitting may propagate, resulting in actual gear pitting.

With its advanced additives, Klübersynth GEM 4-320 N has a high micropitting resistance of load stage ≥ LS 10 (GFT "high") in the staged test according to FVA 54/7. In the associated endurance test, micropitting plateaus, showing that the product offers high long-term micropitting protection.
Klübersynth GEM 4-320 N exhibited this high degree of micropitting resistance not only at 90 °C, but also at 60 °C, which is the usual inlet temperature in wind turbine gears

FZG micropitting test (results)



Higher performance – lower cost

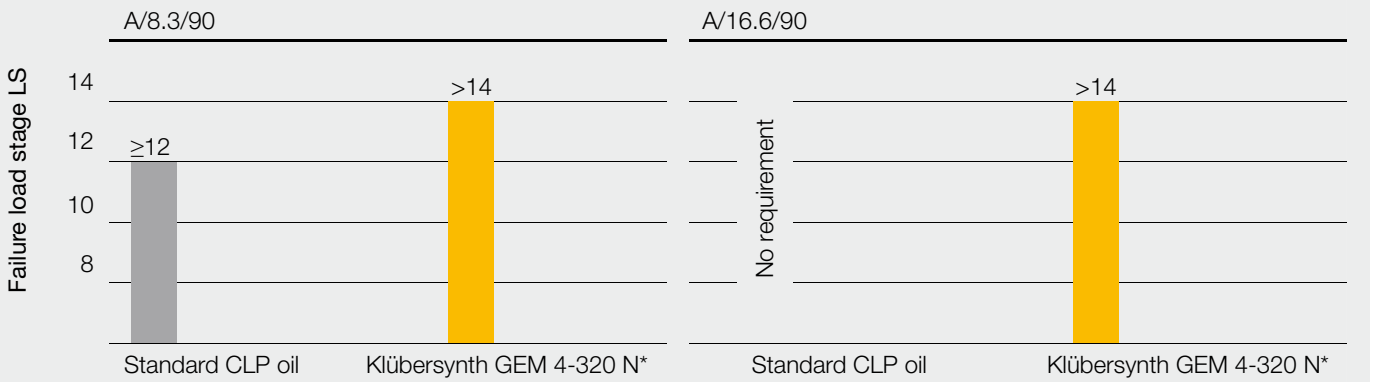
In field applications, micropitting formation is often reported even though industrial gear oils with a high micropitting load capacity are used. This is because such oils offer good micropitting resistance as examined in the load stage test.

Klübersynth GEM 4-320 N with its modern additives has shown to prevent propagation of this phenomenon through reaction at the surface of the tooth flanks already affected by micropitting.

Protection against scuffing damage

The FZG scuffing test according to ISO 14635-1 is generally undertaken to test the capability of gear oils to protect against scuffing damage. Load stage LS 12 of the FZG scuffing test is the minimum requirement for CLP oils according to DIN 51517-3, and for EP oils according to AGMA 9005/E02. Klüber Lubrication's gear oils exceed this requirement by a large margin, offering protection at significantly higher scuffing load stages and speeds even under extreme shock load conditions.

FZG scuffing test (results)



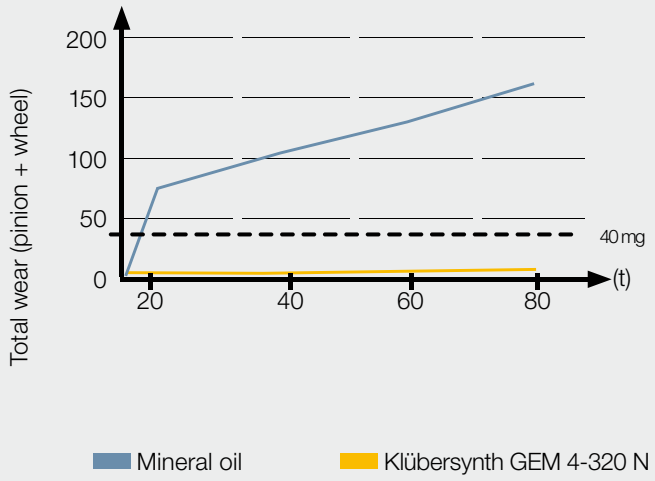
*based on KlüberComp Lube Technology

Wear in slow motion

The slow speed wear test C/0,05/60/12 according to DGMK 377-01 determines the wear characteristics of oils under mixed and boundary friction conditions.

The gear oils made by Klüber Lubrication pass the test run with material loss due to wear of less than 40 mg and are therefore classified under the “low” wear category. This is the best possible classification in DGMK 377-01.

FZG wear test



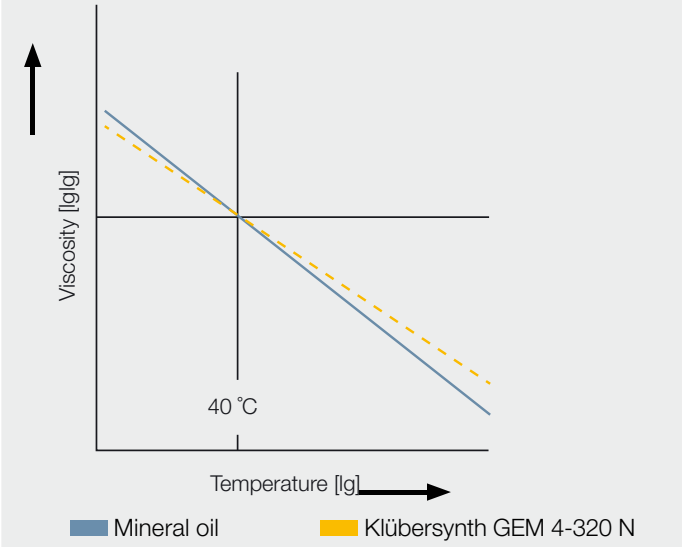
Longer gear life due to adjusted and constant viscosity ratings

The performance a lubricating oil offers are substantially influenced by its additive package and its viscosity. Gear life can be optimised by using synthetic gear oils showing a better viscosity-temperature behaviour.

The viscosity of Klübersynth GEM 4-320 N is considerably more constant than leading competitor oils under varying operating conditions.

Viscosity is of primary importance when selecting gear oils, as it significantly determines the formation of a lubricant film. Increasing viscosity results in thicker lubricant films, thus improving the antiwear and damping properties as well as scuffing load capacity. Viscosity decreases with increasing temperature and rises with increasing load. If the viscosity is too high, increased churning and squeezing losses can result in excessive heat, especially at elevated peripheral speeds. If the viscosity is too low, mixed friction conditions prevail and will result in increased wear.

Viscosity-temperature behaviour of oils



Hint: A high viscosity index makes for easier start-up at low outside temperatures, reduces power loss to a minimum and ensures the formation of a load-carrying lubricant film also at high temperatures.

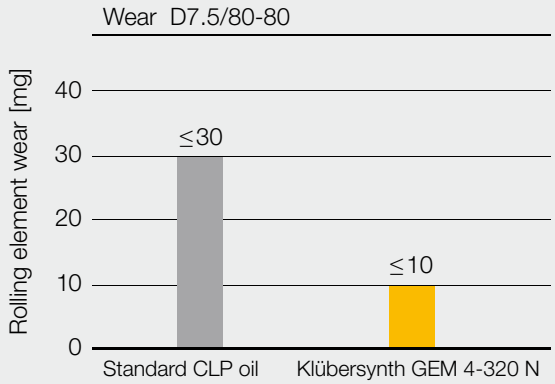
Higher performance – lower cost

What‘s good for gears needs to be good for rolling bearings

Gear damage is frequently associated with damaged rolling bearings. This is why lubricant manufacturers are required to prove that their products are not only suitable for the lubrication of gears, but also for the bearings in the gearbox. Consequently, the revised standard DIN 51517 part 3 contains the FE8 rolling bearing test developed by bearing manufacturer FAG. The FE8 test serves to determine the wear characteristics of a gear oil and forms the basis of estimating the effect a gear oil has on rolling bearing life. In this test run, rolling element wear should be less than 30 mg. Klübersynth GEM 4-320 N passes the FAG FE8 test with very good results, confirming the optimum anti-wear effect of this oil. Tests on Klübersynth GEM 4-320 N have shown the wear rate is < 10 mg, i.e. by far below the permissible maximum of < 30 mg. The standard‘s performance criteria are therefore met without difficulty.

Thanks to these characteristics, manufacturers and operators of wind turbines can benefit from higher availability and an enormous cost saving potential.

FE8 rolling bearing test (results)



Compatibility with radial shaft elastomer seals

Many complaints regarding gears are raised because of oil leakage. As conventional gear oils are frequently not sufficiently compatible with the seal elastomers, the sealing function can suffer and leakage occurs. High-performance lubricants from Klüber Lubrication were tested with excellent results in combination with numerous materials under dynamic conditions in specialised labs operated by the Freudenberg Group.

Longer gear oil life

As high-performance gear oils from Klüber Lubrication have a longer service life, OEMs can offer gear designs with reduced maintenance requirements. Wind turbine operators have to replace oils and filters less frequently, which results in lower disposal costs. Operators demand gear oils with a long service life. While engine oils in cars are normally changed after 15,000 to 30,000 km, i.e. after 300 to 600 operating hours based on an average driving speed of 50 km/h, wind turbine oils are expected to last for more than 25,000 hours. Standard lubricants specified in various standards do not meet the requirements of the wind energy sector today whereas, in contrast, gear oils from Klüber exceed them. Numerous tests show that our gear oils show a low foaming tendency and can thus be fine-filtered.

KlüberComp Lube Technology

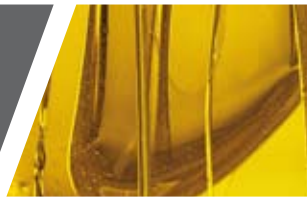
KlüberComp Lube Technology is a holistic approach to the taxing requirements of today‘s power transmission technology. For you as a gear manufacturer or operator, KlüberComp Lube Technology can help to bring a substantial increase in gear performance.

KlüberComp Lube Technology combines four important aspects

Components: focus on all gear components
Composition: lubricants formulated with high-quality raw materials
Competence: direct consultation and service
Competitive: highest performance level

Many gear manufacturers and operators have opted for gear oils made by Klüber Lubrication because of this comprehensive approach.

Oil change: How it‘s done



Oil change

Oil-lubricated enclosed gears require an oil change from time to time since due to the operating and ambient conditions the oil changes its characteristics beyond limits, e.g. in the form of ageing, abrasion and contamination. The objective of the oil change is to ensure continued reliable lubrication. This is also the objective when replacing a gear oil that is basically still fit for use, but not under the prevailing operating conditions.

When an oil change is performed, some residual oil will always remain in the gearbox. In many cases, these residues cannot be tolerated and must be removed. The simplest method is to flush the gearbox. If possible, the old oil is drained while still warm, i.e. immediately after the gears have stopped. With a subsequent flushing procedure, further residues are removed. The oil reservoir and inside gearbox walls can also be cleaned with a lint-free cloth - do not use cleaning wool - and a rubber blade.

A bigger problem is more profound contamination in the form of deposits caused by strongly aged oil. In such cases, cleaning oil has to be used, and all accessible parts of the gearbox cleaned manually. A suitable oil for cleaning gears is KlüberSummit Varnasolv, which quickly dissolves residues when added to mineral oil or PAO. After draining approx. 10 % of the gear oil, the oil fill is topped up with KlüberSummit Varnasolv. After 24 to 48 hours of operation, the oil can be drained. Any remaining residues can be removed mechanically.

Changeover from mineral to synthetic gear oil

Every changeover from mineral to synthetic oil should be performed with great care. It may not be enough to simply drain the used mineral oil and fill in the new synthetic oil. Older gearboxes, in particular, can be assumed to contain oil residues in the casing, the oil lines etc., which might be dissolved by synthetic oils. If such residues are not removed, they may cause problems during operation. Oil lines and filters may be clogged, seals, pumps and teeth damaged. By replacing approx. 10 % of the existing mineral oil fill with Klüber Summit Varnasolv, oil residues can be dissolved to make cleaning of the gears easier. To prevent damage, the gear or lubricant circulation system should be flushed with the new synthetic oil after the old oil has been drained, ideally at operating temperature.

The synthetic gear oil that was used for flushing must not be used for lubrication afterwards, however, it can be kept for further flushing operations. Prior to filling the fresh synthetic oil, oil filters or filter elements should be replaced.

Changeover from mineral oil to polyalphaolefin (PAO) – Klübersynth GEM 4-320 N

Polyalphaolefins have a chemical structure similar to that of mineral oils. Therefore, they can be mixed with residual mineral oil which cannot be removed by normal oil draining. However, in order to maintain the oil‘s full performance, residual mineral oil content in the gearbox, circulation system and oil containers should not exceed 5 %.

They must not be mixed with gear lubricants having a different synthetic base oil. PAO gear oils from different manufacturers can be mixed, though. The content of other oils should be kept as low as possible in order not to affect the properties of the original gear oil.

At operational oil temperatures over 80 °C, it is recommended to use only seals made of fluorinated rubber or polytetrafluoroethylene (PTFE). At temperatures below 80 °C, seals made from NBR are also resistant to PAO oils.

Epoxy and polyurethane paints are recommended for internal coating of housings.

Oil change checklist – Gear inspection

Clean gears

- Drain oil while warm
- Inspect teeth
- Replace filters
- Fill in new oil
- Put gear into operation and stop again
- Check oil level
- Take reference oil sample, if required

Contaminated gears

- Drain oil while warm
- Fill flushing oil
- Operate gear for approx. 30 to 60 min without load or injection system only
- Drain flushing oil
- Inspect teeth
- Replace filters
- Fill in new oil
- Put gear into operation and stop again
- Check oil level
- Take reference oil sample, if required

Strongly contaminated gears

- Drain approx. 10 % of the oil fill while warm
- Top up with Varnasolv
- Operate gears for 24 - 48 hours
- Drain oil while warm
- Fill flushing oil*
- Operate gear for approx. 30 to 60 min without load or injection system only*
- Drain flushing oil*
- Inspect teeth
- Replace filters
- Fill in new oil
- Put gear into operation and stop again
- Check oil level
- Take reference oil sample, if required

* if required

An innovative grease for all bearings

Lubrication of main, generator, blade pitch and yaw bearings

To date, operators of wind power plants frequently have had to obtain different types of grease to suit the varying speeds, loads, sizes and functions of the individual bearings involved. Commonly wind parks contain units from different manufacturers and different models, so various lubricant recommendations have to be followed.
This entails extra expenses for logistics, warehousing and grease disposal, as well as a permanent risk of lubricant confusion. Since most turbines are relubricated manually, service technicians have to carry all these different lubricants with them when on maintenance visits. All required lubricants may also not be always available at certain locations worldwide.

Innovation from Klüber Lubrication: a single grease for all wind turbine bearings

Klüber Lubrication can now serve the differing requirements of all bearings in a wind turbine with a single lubricant consisting of a special base oil mixture and a carefully selected additive package: Klüberplex BEM 41-141 is a speciality lubricant for rolling and plain bearings operating under high loads. It has been developed for

– the wind turbine main bearing, which rotates slowly and is subject to high loads and vibration.
– the relubrication of generator bearings, which run at high speeds and have a high temperature. Initial lubrication takes place at the manufacturer, e.g. with Klüberplex BEM 41-132.
– blade pitch and yaw bearings, which also operate under high loads, vibration and oscillating motion.

Klüberplex BEM 41-141 meets, and even exceeds, today's requirements of bearing and wind turbine OEMs and operators. The lubricant's wide service temperature range, its good pumpability and precise metering in centralised lubricating systems as well as the good grease distribution and oil release ensure trouble-free operation of the wind power plant.

Good wear protection - even under vibration - extends the bearings' service life. Klüberplex BEM 41-141 also helps to prevent the costly damage that tends to arise during standstill. The turbine may be stopped less often, which makes for a significant rise in productivity. The operator's repair and spare parts costs decrease, as does the cost for used grease disposal.
With Klüberplex BEM 41-141, the plant operator can restrict his lubricant range to a single grease! This means that lubricant confusion can be eliminated, and storage and logistics are simplified.

Why can Klüberplex BEM 41-141 be used for all bearings?

We have developed Klüberplex BEM 41-141 for the lubrication of bearings in wind turbines, taking into account all critical conditions under which the individual bearings operate. We attached particular importance to the lubricant's performance during standstill and swaying with brakes engaged. These are extremely taxing operating conditions because friction is concentrated on the same point over an extended period of time.
In Klüberplex BEM 41-141, the consistency and base oil viscosity were carefully tuned and combined with efficient oil release to enable reliable build-up of a protective lubricant film and excellent grease distribution.

Klüberplex BEM 41-141 testing

In order to satisfy the numerous requirements of bearing manufacturers and plant operators, Klüber Lubrication always performs a variety of tests prior to releasing a grease for specific applications. Besides a large number of static tests, special dynamic rolling bearing tests were performed on Klüberplex BEM 41-141, e.g. the FAG FE8 rolling bearing wear test and the SKF ROF grease life test. All tests showed that this lubricant by far exceeds the requirements of the industry.

Results obtained in SNR-FEB 2 rolling bearing grease test

The antiwear behaviour of lubricating greases in rolling bearings subject to small oscillating rolling and sliding motion is determined on the SNR FEB 2 rolling bearing grease tester. Since the wear pattern in this test resembles the indentation caused in the Brinell hardness test, the SNR FEB 2 test is also referred to as "false Brinell test". An axial load of 8000 N is applied, corresponding to a Hertzian pressure of 2100 N/mm2, with a frequency of 24 Hz and over an angle of oscillation of ± 3°. The test duration is 5 and 50 hours for a test temperature of the lower shaft washer of –20 °C and ambient temperature, respectively.

Klüberplex BEM 41-141 was tested at ambient temperature, resulting in less than 5 mg of wear, and at –0 °C, resulting in less than 20 mg – both excellent values!
Comparative tests of other lubricants available on the market showed that they fail to attain similarly good values even at ambient temperature.

Competitor product 1: wear limits were exceeded so test had to be stopped after 13.5 hours.

Competitor product 2: wear limits were exceeded so test had to be stopped after 39.6 hours.

Klüberplex BEM 41-141 attained maximum run-time of 50 hours.

An innovative grease for all bearings

Low-temperature characteristics of greases

In operation, wind power plants are often subject to huge temperature variations. The very low temperatures are especially tough for the operation of wind turbines. Electric components, plastic and other parts are not designed for temperatures below –10 or –15 °C, so turbines without a cold climate package are normally switched off if temperatures drop below these values. Still, the rolling bearing grease has to resist changing under such temperatures, even while the turbine is standing still. As soon as the outside temperatures rise to acceptable levels, the wind power plant restarts. Starting at cold temperatures is often facilitated by a heating system. At the time of start-up, the rolling bearing grease still has to provide its full performance. To make sure the grease is capable of doing so, it has to undergo numerous tests prior to approval.

The lower service temperature of a grease is normally determined by means of the standardised flow pressure test or the low-temperature torque test (IP 186). Upper service temperatures are ascertained on the FE9 rolling bearing tester (DIN 51821) or in the SKF-ROF test. For Klüberplex BEM 41-141, the low-temperature torque test resulted in a lower service temperature of –40 °C, and the SKF-ROF test in an upper service temperature of 150 °C.

The lower service temperature is the lowest temperature at which the product passed the flow pressure test or the low-temperature torque test. A product‘s lubricity, however, may not necessarily be sufficient at that temperature and it may not offer sufficient wear protection. This is why Klüber has in addition conducted the SNR FEB 2 test to determine the wear characteristics at –20 °C.

This test showed that both Klüberplex BEM 41-132 and Klüberplex BEM 41-141 retain their excellent lubricity at very low temperatures. It also demonstrates their outstanding antiwear characteristics. At this temperature, a bearing wear of less than 20 mg was attained with both lubricants – an excellent result.

A special exposure test has shown that both greases Klüberplex BEM 41-132 and Klüberplex BEM 41-141 meet the temperature requirements of the wind energy sector without difficulties - even if they are considerably lower than the grease‘s nominal lower service temperature. Even at temperature far below zero, the lubricant does not change. And no changes means it offers full performance when the turbine is started again.

Furthermore, Klüberplex BEM 41-132 and Klüberplex BEM 41-141 offer very god adhesion even at extremely low temperatures, which also contributes to good lubrication in the cold. Klüber has confirmed adhesion at low temperatures in an especially developed bent-strip test - conducted at temperature conditions considerably below the lower service temperature range.

Hints for practice

What to bear in mind when changing over to a different bearing grease

Comprehensive miscibility tests have shown that Klüberplex BEM 41-141 can be mixed with the bearing greases that are most widely used in the wind power sector today, including those from other manufacturers. No cleaning of the bearing is required prior to changeover. It should be noted, though, that Klüberplex BEM 41-141 will only deliver its full performance benefits when not mixed with other lubricants. For the changeover we recommend therefore relubrication with Klüberplex BEM 41-141 until it can be seen to ooze from the bearing.

Is Klüberplex BEM 41-141 compatible with the seals in contact?

Klüberplex BEM 41-141 is compatible with all elastomers commonly used for seals. Extensive tests in Freudenberg's labs showed that the change of elastomer properties through the contact with this special grease are within permissible limits. The test duration was 28 days at a temperature of 60 °C.

Compatibility of Klüberplex BEM 41-141 with various sealing materials:

80 NBR B241	75 HNBR U467	85 NBR B248
Good	Very good	Very good

Relubrication quantities and relubrication intervals

Quantities and intervals for relubrication are determined by the bearing manufacturer or the wind turbine OEM. However, thanks to the excellent performance of Klüberplex BEM 41-141, the relubrication interval for the generator bearing, for example, can be extended from three or four to more than six months. This means additional flexibility for the operator when it comes to relubrication – there is no more need to stop the turbine for maintenance purposes at a time when the wind is blowing the right way.

Clean solution for the yaw and pitch bearing gear

The main problem with the open teeth of the slewing ring and the blade pitch adjustment is that the lubricant can drop off. This leads to insufficient lubrication and eventually higher wear. In addition, the black lubricants that have been used so far cause stains on the nacelle and the tower.

Klüber offers Klüberplex AG 11-461/462 (NLGI classes 1 and 2) and Klübersynth AG 14-61, white lubricants for the teeth of the slewing ring and the blade pitch bearings. They retain their good lubricity and remain highly adhesive even at temperatures of -40 °C, so they protect the gear teeth reliably against wear. The lubricants' good adhesion leads also to lower grease consumption and longer maintenance intervals.

Klüberplex AG 11-461/462 and Klübersynth AG 14-61 testing

Resistance to salt water

In the SKF Emcor test, Klüberplex AG 11-461/462 and Klübersynth AG 14-61 were tested for their anticorrosive characteristics while exposed to synthetic sea water.

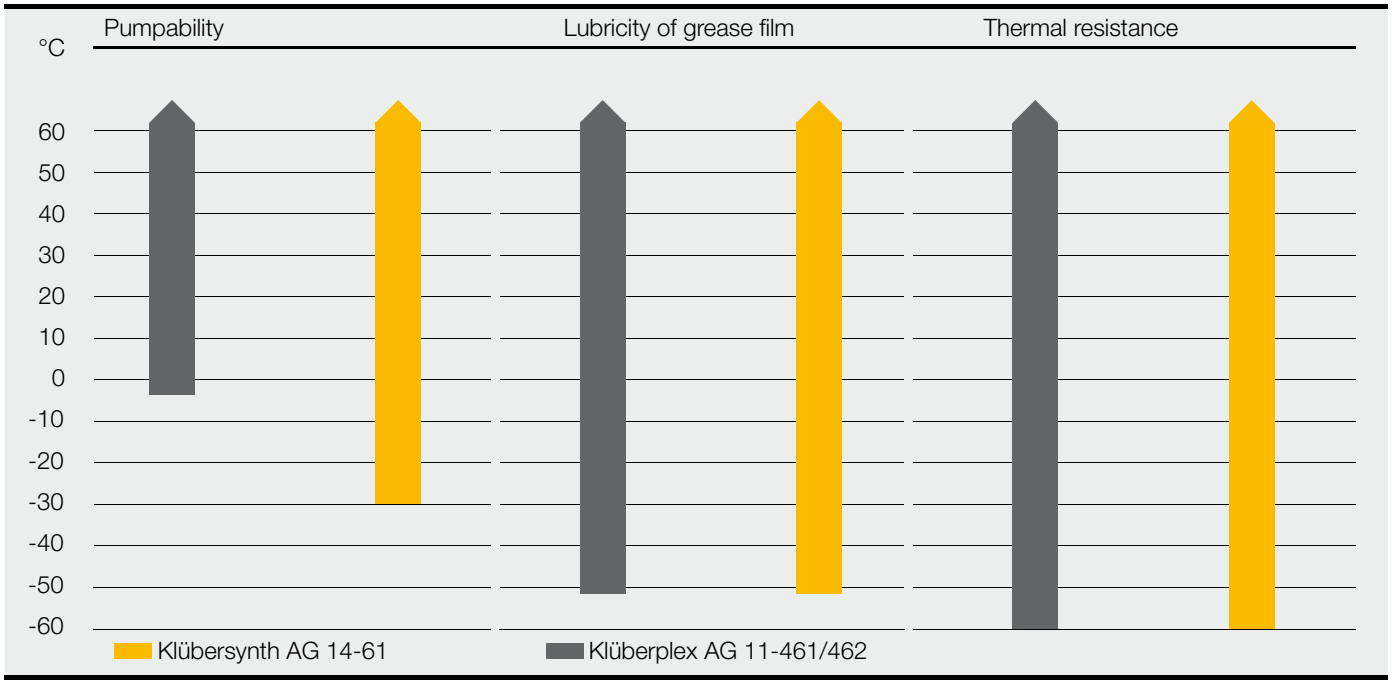
The corrosion degree ≤ 2 proves a good anticorrosive effect.

Load-carrying capacity

In the FZG test, Klüberplex AG 11-461/462 and Klübersynth AG 14-61 attain load stage 12, which means that all three products fully meet the requirements for a gear grease.

Low-temperature behaviour

Klüberplex AG 11-461/462 can be pumped using normal spraying systems without heating at temperatures down to approx. 0 °C, and Klübersynth AG 14-61 down to –30 °C. Tests in Klüber's own test bay have shown that all three products offer better adhesion than traditional black greases at –40 °C as well as at high temperatures. In tests performed on a vertical surface at 70 °C, none of the three products dropped from the surface even after 48 hours.



Hints for practice

What to bear in mind when changing over to Klüberplex AG 11-461/462 or Klübersynth AG 14-61

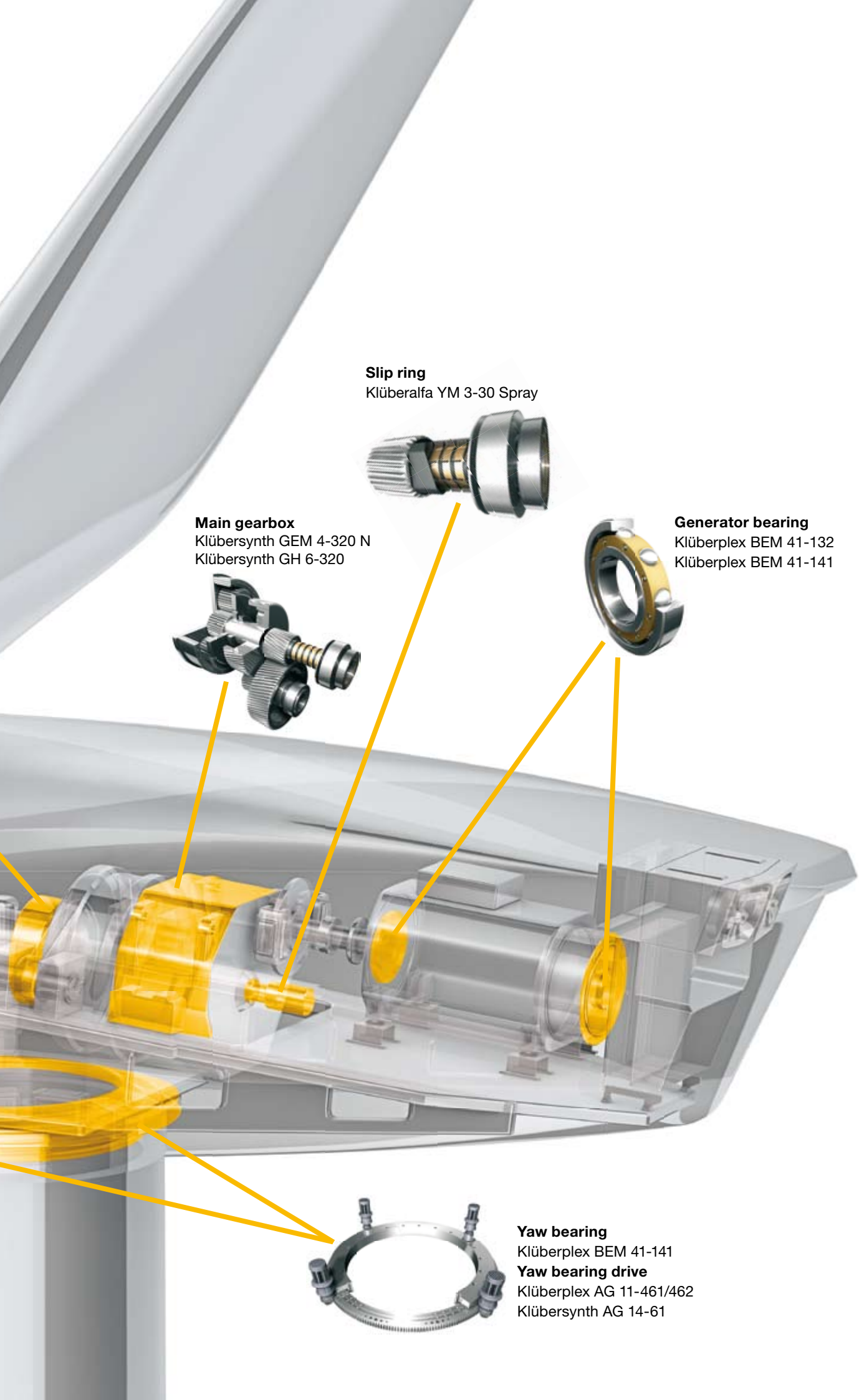
For manual relubrication, the drive components don't have to be cleaned – even if a black lubricant was previously used. When using a centralised lubricating system, however, the storage container should be drained prior to filling with Klübersynth AG 14-61. As is always the case with mixing lubricants, it should be noted that this special grease will only deliver its full performance benefits when not mixed with other lubricants.

Optimally equipped with our speciality lubricants

Main bearing
Klüberplex BEM 41-141

Gear motor
Klübersynth GEM 4 N series
Klübersynth GH 6 series

Blade pitch bearing
Klüberplex BEM 41-141
Blade pitch bearing drive
Klüberplex AG 11-461/462
Klübersynth AG 14-61



Slip ring
Klüberalfa YM 3-30 Spray

Main gearbox
Klübersynth GEM 4-320 N
Klübersynth GH 6-320

Generator bearing
Klüberplex BEM 41-132
Klüberplex BEM 41-141

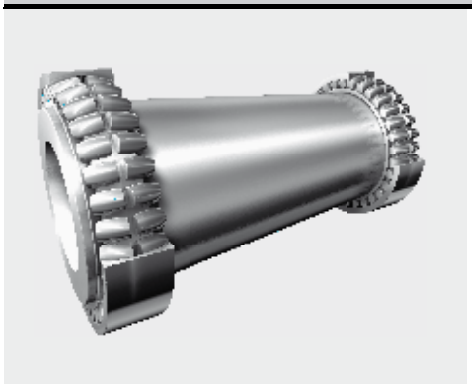
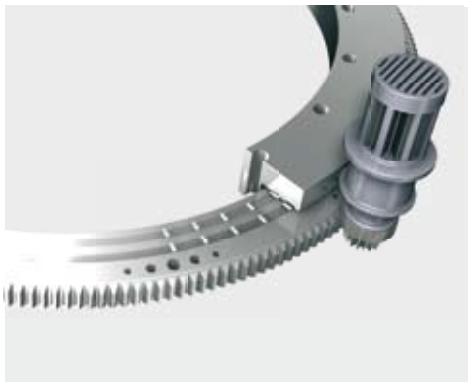
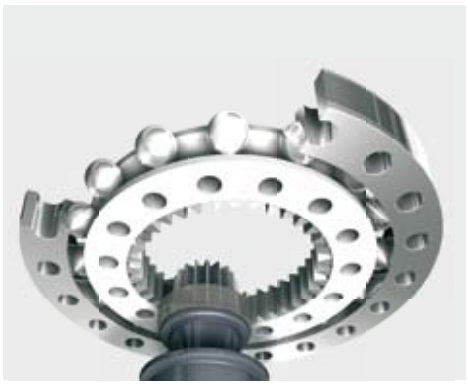
Yaw bearing
Klüberplex BEM 41-141
Yaw bearing drive
Klüberplex AG 11-461/462
Klübersynth AG 14-61

Lubricants for enclosed gears

Component		Requirements
	**Main gearbox**	– High scuffing resistance and excellent micro-pitting resistance required – Compatibility with paints and elastomers required – Gear operation depends also on reliability of the rolling bearings. Requirements of rolling bearing manufacturers must therefore also be met.
	**Gear motors**	– High scuffing resistance and excellent micro-pitting resistance required – Compatibility with paints and elastomers required – Gear operation depends also on reliability of the rolling bearings. Requirements of rolling bearing manufacturers must herefore also be met.

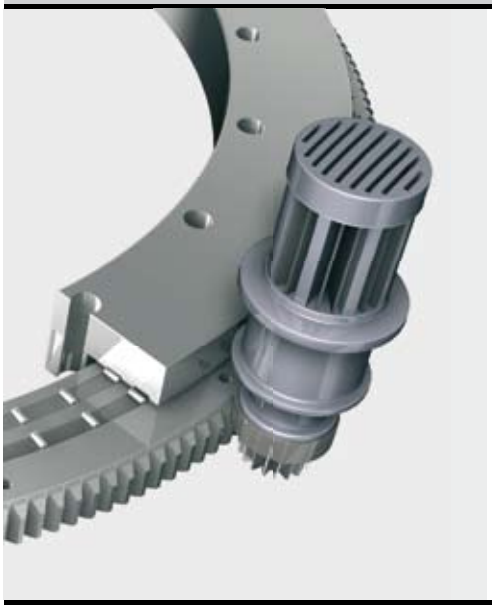
	Speciality lubricant	Comment	Benefits
	Klübersynth GEM 4-320 N Klübersynth GH 6-320	– Synthetic high-performance gear oil for particularly low and elevated temperatures and high loads – Oil life approx. 5 x longer than that of mineral oil based lubricants	– High FZG scuffing resistance > 14 offers protection at normal and elevated loads. – High micro-pitting resistance, both at 90 °C and 60 °C, protects against premature fatigue failure. – Good wear protection prevents premature rolling bearing failure. – Dynamic seal compatibility tests with NBR and FKM document protection against oil-induced leakage. – Considerably longer service life due to excellent ageing and oxidation resistance, enabling much longer service intervals. – Sufficient lubricant film also at high temperatures due to excellent viscosity-temperature behaviour. – Good protection of all lubricated parts against wear and scuffing. – No filter clogging - lubricated components are supplied with enough clean oil to attain optimum service life.
	Klübersynth GEM 4 series Klübersynth GH 6 series	– Synthetic high-performance gear oil for particularly low and elevated temperatures and high loads – Oil life approx. 3 x longer than that of mineral oil based lubricants	

Lubricants for bearings

Component		Requirements
	**Main bearing**	– Low speeds – Occasional oscillating motion – High loads – Vibration
	**Yaw bearing**	– Oscillating motion – High loads – Vibration
	**Blade pitch bearing**	– Oscillating motion – Low temperatures – High loads – Vibration
	**Generator bearing**	– High and low speeds – Occasional oscillating motion – High temperatures – High loads – Vibration

	Speciality lubricant	Comment	Benefits
			– Less downtime, more production time – Reduction of repair and spare parts costs – Simpler logistics due to leaner range of products and less storage
	Klüberplex BEM 41-141	The ADDED Value The special grease Klüberplex BEM 41-141 fulfills and exceeds all the requirements of the bearing and wind turbine manufacturers as well as the aftermarket operators. The wide service temperature range, good pumpability and metering in centralised lubricating systems plus the good grease distribution and oil release ensure trouble-free operation of wind turbine bearing systems. The good wear protection properties, even under vibration conditions, lead to extended bearing life.	– Less downtime, more production time – Reduction of repair and spare parts costs – Simpler logistics due to leaner range of products and less storage
			– Less downtime, more production time – Reduction of repair and spare parts costs – Simpler logistics due to leaner range of products and less storage
	For initial lubrication and relubrication: Klüberplex BEM 41-132 **For relubrication:** Klüberplex BEM 41-141		– Less downtime, more production time – Reduction of repair and spare parts costs – Simpler logistics due to leaner range of products and less storage

Lubricants for slew ring drives and slip rings

Component		Requirements
	**Slew ring drive** (yaw and pitch control)	– Low motion amplitude – High load – Vertical tooth flanks – Tendency towards corrosion

Component		Requirements
	**Slip rings**	– Wear and corrosion increase transition resistance

Speciality lubricant	Benefits
Klüberplex AG 11-461 Klüberplex AG 11-462 Klübersynth AG 14-61	– The product offers good adhesion and does not drop from the tooth flanks, even in the vertical orientation (unlike other lubricants). This reduces lubricant consumption, disposal and nacelle cleaning costs. – Light colour prevents staining of the nacelle and tower. – Good pumpability and metering in centralised lubricating systems, hence trouble-free turbine operation- and availability. – Anti-corrosive effect provided during non-operation as well as in offshore applications where the nacelle is exposed to salty, humid air. – Klüberplex AG 11-461/462 can be used for large and small open gears.

Lubricant	Benefits
Klüberalfa YM 3-30 Spray	– Longer contact life and equipment availability as Klüberalfa YM 3-30 protects the contact against harmful influences. – Klüber YM 3-30 Spray is a slip-ring oil with long-term resistance and a particular low base oil viscosity. Spray application is particularly even, simple and clean, making for low-maintenance operation.

The data in this document is based on our general experience and knowledge at the time of publication and is intended to give information of possible applications to a reader with technical experience. It constitutes neither an assurance of product properties nor does it release the user from the obligation of performing preliminary fi eld tests with the product selected for a specifi c application. All data are guide values which depend on the lubricant's composition, the intended use and the application method. The technical values of lubricants change depending on the mechanical, dynamical, chemical and thermal loads, time and pressure. These changes may affect the function of a component. We recommend contacting us to discuss your specifi c application. If possible we will be pleased to provide a sample for testing on request. Products from Klüber Lubrication are continually improved. Therefore,
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