KLÜBER LUBRICATION

your global specialist

Special knowledge

# Always with the breeze

## Maximum yield with optimised lubrication concepts for wind power plants

# Safeguard your assets

The loads placed on wind power plants and their components are high. Consequently, choosing the right lubricant is vital – for the initial lubrication of a component as well as for relubrication during operation.

After all, it's the lubricant that has to ensure reliable function of each machine element. In wind turbines we find both fluid (oils) and consistent lubricants (greases). Major lube points are in the main gears, the nacelle yawing gears, the main and generator bearings, the blade pitch gears and the yaw system. The lubricants used are required to offer full performance over a long service life, good load resistance and good thermal stability. For the operators, these characteristics mean long relubrication intervals for greases and long lubricant life for oils.

So what can you do to make your components and equipment withstand the extremely high stresses of these applications?

With speciality lubricants made by Klüber Lubrication, you will always be ready to face any lubrication challenges. As an expert for speciality lubricants, Klüber Lubrication cooperates closely with the original equipment manufacturers of major wind turbine components to push the limits of what can be technically achieved even further: longer service intervals, longer component life and 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.

On the following pages, we offer you ideas on how to optimise the operation of wind turbines.

# Powerful oils for gears operating under extreme loads

## Better performance at lower cost

In the wind turbines of today more power is generated in increasingly compact spaces, inevitably resulting in higher loads and higher temperatures. Experience has shown that gear oils that are often in use today are not always able to fully meet the requirements in terms of wear protection in rolling bearings, micropitting resistance or foam and residue formation.

### Why use high-performance gear oils made by Klüber Lubrication?

To overcome the weaknesses of existing products, Klüber Lubrication has developed special gear oils that can withstand high loads. Following an extensive series of R&D activities and comprehensive testing, three synthetic high-performance gear oil series are meanwhile available:

- Klübersynth GEM 4 N (polyalphaolefin)
- Klübersynth GH 6 (polyglycol)
- Klübersynth GEM 2 (rapidly biodegradable ester)

Compared with standard oils, these products show better ageing resistance and load resistance, and lower friction. This allows long oil change intervals, less power loss and a considerably higher plant yield – adding up to several thousand Euros over the whole life of the plant.

Gear oils made by Klüber Lubrication meet not only the requirements of the gear manufacturers, rolling bearing manufacturers and wind turbine manufacturers, but those of the operators as well.

| Requirements | Klübersynth GEM 4-320 N Polyalphaolefin | Klübersynth GH 6-320 Polyglycol | Klübersynth GEM 2-320 Ester |
|---|---|---|---|
| Gear oil acc. to DIN 51 517 - 03 | CLP HC | CLP PG | CLP E |
| Approval by Flender | yes | yes | yes |
| Compatibility with elastomer 72 NBR 902 | passed | passed | passed |
| Compatibility with elastomer 75 FKM 585 | passed | passed | passed |
| Foaming behaviour ASTM D 892 | passed | passed | passed |
| Flender foam test | < 15 % | < 15 % | < 15 % |
| Fine filtration | possible | possible | possible |
| FVA 54 IV micro-pitting resistance, 60 °C | high | high | high |
| FVA 54 IV micro-pitting resistance, 90 °C | high | high | high |
| FZG scuffing load test A/8.3/90 | > 14 | > 14 | > 14 |
| FZG scuffing load test A/16,6/90 | > 14 | > 14 | > 14 |
| FZG wear test | low | low | low |
| Readily biodegradable[1)] | no | no | yes |

1) Biodegradability after 21 days is > 70 % acc. to CEC-L-33-A-33 test

In numerous tests, Klüber gear oils have shown they meet the requirements of the gear manufacturers. The table shows the performance data of the gear oils for use in wind power plants.

# Powerful oils for gears operating under extreme loads

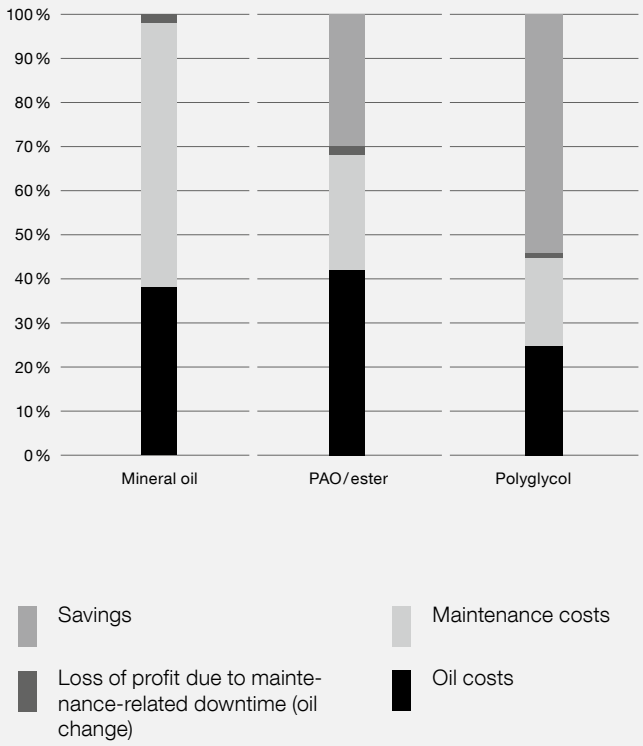
## Better performance at lower cost

| Average wind turbine specification | |
|---|---|
| Power output: 1.5 MW | Theoretical running time: 8760 h per year |
| Oil volume: 400 l | Utilisation: 20 % |
| Service life: 20 years | Tariff: 0.09 €/kWh |

### Savings potentials

The diagram shows the potential for savings offered by high-performance gear oils. Looking at 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 loss of profit, the figures speak for themselves:

**Compared costs of mineral oil, PAO/ester and polyglycol oil**




The synthetic high-performance gear oils made by Klüber Lubrication make savings possible.

## More reliability

**1. High micro-pitting resistance protects against premature fatigue damage**

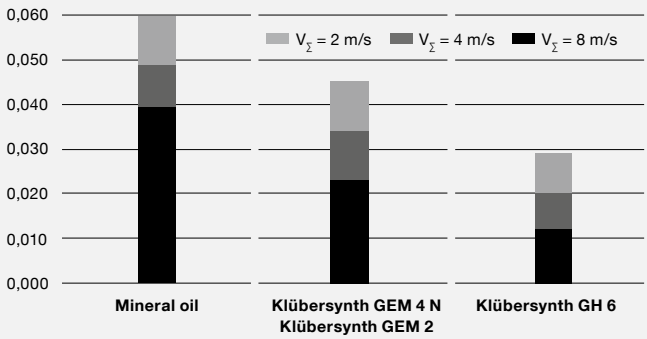
In addition to the lubricant's viscosity and film thickness, the additives also influence gear life because they can help to counteract micro-pitting and scuffing.

Micro-pitting is a type of wear encountered on gears operating under high loads. Their surfaces are subject to mixed and sliding friction, which can produce plastic deformation at and near the surfaces, and leads to the formation of micro-cracks. To the naked eye, tooth flank surfaces with this type of damage appear a dull grey colour. Strongly magnified, one can see that the grey appearance is caused by minute spalling and pores.

Micro-pitting occurs when two components are moved against each other with high load, a high sliding speed and a thin lubricant film. The major causes of micro-pitting are:

- high load
- low speed or lubricant temperature, as these cause low lubricant film thickness
- gear teeth geometry leading to high local loads on the tooth flanks
- high tooth roughness
- unsuitable lubricants

**Friction coefficients of different base oils, determined on two-disk test rig:**



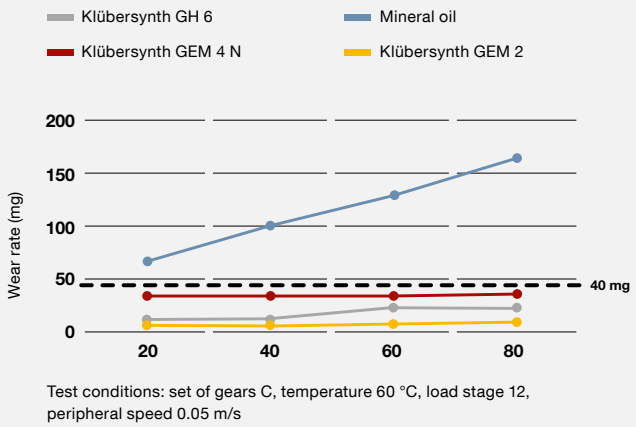

Test conditions: Hertzian pressure $P_H$ = 1 000 N/mm2, slip 20 %

Comprehensive tests prove that synthetic gear oils have a much lower friction coefficient than mineral oils.

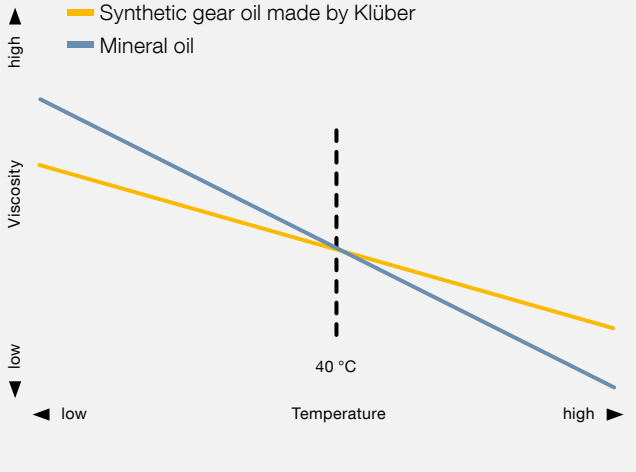
# Powerful oils for gears operating under extreme loads

## Better performance at lower cost

**Influence of low speeds on wear rate**




Test results obtained with high-performance gears oils made by Klüber Lubrication compared with mineral oil in FZG wear test




Klüber's high-performance gear oils show much better viscosity stability under varying operating conditions than mineral oils. A constant lubricant film can build up as the viscosity changes only slightly with temperature.

Micro-pitting may lead to deeper cracks and eventually to widespread spalling on the gear, referred to as pitting. Micro-pitting also changes the shape of the tooth flank, which may in turn affect the dynamics of the mesh and its noise behaviour.

The high-performance gear oils made by Klüber Lubrication attain load stage ≥ 10 in the micro-pitting test, i.e. a "high" rating. This high micro-pitting resistance is attained not only at 90 °C but also at 60 °C, which is the normal injection temperature in the gears of wind turbines. The lubricants were tested successfully at both temperatures.

Furthermore, it is the lubricant's antiwear characteristics at low gear speed that is decisive for a problem-free operation of the wind turbine. The planetary stage is the one running at the lowest speed.

A testing method developed by the FZG research centre for the study of gears and drive mechanisms shows that Klüber's gear oils pass the test run with less than 40 mg of wear and can therefore be classified as wear class "low", which is the best existing classification.

### 2. Longer gear life due to viscosity adjustment

Scuffing and micro-pitting resistance of a lubricant are influenced by the additives used, but also by the lubricant's viscosity and the film thickness. Case-hardened gears operating under high loads and/or high temperature are especially susceptible to scuffing and micro-pitting damage. With the use of synthetic gear oils with a favourable viscosity-temperature coefficient, gear life can be considerably extended.

### 3. What's good for gears must be good for rolling bearings

Many cases of gear damage are in fact a consequence of rolling bearing damage. The manufacturers of lubricants have therefore to prove that their products are not only suitable for the lubrication of the gears but also of the rolling bearings involved. For this purpose, the revised standard DIN 51 517, part 3 contains the FE 8 rolling bearing test developed by the rolling bearing supplier FAG. The FE 8 test rig serves to determine the wear behaviour of a lubricant, allowing also conclusions on the oil's influence on the bearing life. Wear on the rolling elements should be below 30 mg in this test. Klüber gear oils have passed the FAG FE 8 test with very good results. Tests with Klübersynth GEM 4-320 N, Klübersynth GH 6-320 and Klübersynth GEM 2-320 have shown that with these high-performance gear oils wear is only at about a third of the maximum permissible values, which means that they meet the performance criteria with ease.

Consequently, these lubricants offer the manufacturers and operators of wind turbines higher plant availability and an enormous savings potential.

### 4. Compatibility with elastomer radial shaft seals

Complaints about gear malfunction are often due to leakage. Conventional gear oils and the elastomers used for radial shaft sealing rings are often not sufficiently compatible, which can affect the sealing function and eventually cause leakage. The high-performance gear oils made by Klüber Lubrication were tested for compatibility with numerous sealing materials under dynamic conditions in test labs of the Freudenberg Group with excellent results.

## Longer gear oil life

The longer service life of high-performance gear oils made by Klüber Lubrication enable OEMs to offer gears requiring minimum maintenance. For the operators, this means they need to exchange oil and filters less often. Oil disposal costs are reduced as well.

Wind power plant operators expect their gear oils to offer a long service life. In a passenger car, for example, the engine oil is exchanged after 15 000 to 30 000 km, amounting to 300 to 600 operating hours, based on an average speed of 50 km/h. In a wind turbine, by contrast, an oil change in the main gear will only be acceptable after 25 000 to 50 000 hours. Conventional lubricants characterised in several of today's standards do not meet these current expectations of the wind power industry – Klüber's gear oils do.

Numerous tests show that the gear oils from Klüber Lubrication have a good foaming behaviour and allow fine filtration.

# Powerful oils for gears operating under extreme loads

## Better performance at lower cost

### Hints for practice

In the following you will find information on what to observe in the lubrication of gears in a wind turbine. However, we still recommend seeking consultation with Klüber Lubrication prior to a lubricant changeover to ascertain that all factors are duly considered.

### What to observe during an oil change

A gear inspection should be done during every oil change. The required steps are described in the following overview.

**Gear inspection**

| Clean gears | Soiled gears | Badly soiled gears |
|---|---|---|
| – drain oil while warm<br>– inspect gear teeth<br>– replace filter<br>– fill fresh oil<br>– let run briefly, then stop; check oil level and take reference oil sample | – drain oil while warm<br>– fill with flushing oil<br>– let run without load for approx. 30 to 60 min<br>– drain flushing oil<br>– inspect gear teeth<br>– replace filter<br>– fill with fresh oil<br>– let run briefly, then stop; check oil level and take a reference oil sample | – drain approx. 10 % of oil while warm<br>– fill with cleaning concentrate Klüber Summit Varnasolv<br>– let run for approx. 24 hrs.<br>– drain oil while warm<br>– fill flushing oil, if necessary<br>– let run without load for approx. 30 to 60 min.<br>– drain flushing oil<br>– inspection<br>– replace filter<br>– fill fresh oil<br>– let run briefly, then stop; check oil level and take reference oil sample |

## What to observe during a gear oil changeover

### 1. Miscibility of different gear oil types

**Gear oils based on polyalphaolefins (PAO)**
Oils of the Klübersynth GEM 4 N series can be mixed with mineral oil residues that remain after draining the old oil.[1] However, they must not be mixed with other synthetic oils. Polyalphaolefin gear oils from different manufacturers can be mixed with one another, e.g. when refilling oil. It should be noted, though, that the selected oil should always make up the bulk of the oil volume so that its performance characteristics prevail.

**Gear oils based on polyglycol (PG)**
Klübersynth GH 6 oils are miscible neither with mineral oils nor with other synthetic oils. Polyglycol oils from different manufacturers as well as the different polyglycol gear oils made by Klüber can be mixed. However, other oils should be added in small quantities only so as to retain the characteristics of the selected gear oil.

**Gear oils based on ester**
Oils of the Klübersynth GEM 2 series can be mixed with mineral oil residues that remain after draining the old oil.[1] However, they must not be mixed with other synthetic oils. Ester gear oils from different manufacturers can be mixed with one another, e.g. when refilling oil. It should be noted, though, that only small quantities of a different oil should be added so as not to alter the properties of the original oil.

### 2. Changeover to new gear oils

We recommend to always seek consultation prior to an oil changeover. Our engineers will be pleased to assist you.

**Changeover to polyalphaolefins**
Klübersynth GEM 4 N
PAO oils – lubricating oils based on synthetic hydrocarbons – have a chemical makeup similar to that of mineral oils. The same applies to their compatibility with sealing materials and paints, i.e. they are normally compatible with the materials used in wind power plants. They should be disposed of or reprocessed in the same way as mineral oils. They are miscible with mineral oil residues.[2]

**Changeover to polyglycol oils**
Klübersynth GH 6
When changing over to PG oils – lubricating oils based on polyglycol – all paints and the materials used for seals and inspection glasses should be known so as to rule out undesirable interaction between these materials and the lubricating oil.[2]

**Changeover to ester oils**
Klübersynth GEM 2
When changing over to ester-based oils, all paints and the materials used for seals and inspection glasses should be known so as to rule out undesirable interaction between these materials and the lubricating oil.[2]

1) Generally, a residual oil quantity of 5 %, including oil container and filter, should not be exceeded.
2) To ensure that you can fully benefit from the performance capabilities offered by Klüber's gear oils, and to prevent gear damage, we highly recommend following the instructions given in the product information leaflets.

# The innovative grease for all bearings

## Lubrication of main-, generator-, blade pitch- and yaw bearings

Due to the varying speeds, loads, dimensions and functions of the individual bearings, the operators of wind power plants have so far had to use a large number of greases from different lubricant suppliers. Moreover, wind parks rarely consist of wind turbines from a single OEM only, so the operators have to follow varying lubricant recommendations. In addition, each manufacturer offers different turbine models. The multitude of lubricants entails high costs for logistics, storage and lubricant disposal, as well as a constant risk of picking the wrong lubricant when relubricating. Since most turbines are relubricated manually, maintenance staff have to carry a number of different lubricants up the tower. Further problems may arise if some lubricants are not available worldwide.

### The innovation from Klüber Lubrication: one lubricating grease for all 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. 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 and vibration and perform also 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 frequency of turbine stoppage can be reduced, which makes for a significant rise in productivity. Furthermore, the operator's repair and spare parts costs decrease, as do expenses for used grease disposal. With Klüberplex BEM 41-141, the plant operator can restrict his lubricant range to no more than a single grease! This means that mixing up lubricants can be eliminated, and storage and logistics are simplified.

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

Klüberplex BEM 41-141 has been developed for the lubrication of bearings in wind turbines, taking into account all critical conditions under which the individual bearings operate. Klüber Lubrication attached particular importance to the lubricant's performance during standstill and swaying operation 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 lubricant film and excellent grease distribution.

## Klüberplex BEM 41-141 testing

Klüber Lubrication always conducts several tests prior to approving a grease for certain applications in order to make sure the bearing manufacturers' and operators' requirements are met or even surpassed. Tests conducted include both static and special dynamic rolling bearing tests like the FAG-FE-8 rolling bearing friction and wear test and the SKF-ROF test of grease service life. The special lubricant Klüberplex BEM 41-141 successfully passed a comprehensive test program during its development stages. All tests showed that the lubricant by far surpasses the industry's requirements. In the following, we will be explaining the results of the SNR-FEB 2 rolling bearing grease test as an example.

**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/mm$^2$, with a frequency of 24 Hz and over an angle of oscillation of ± 3°. The test duration is 5 and 30 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 –20 °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 runtime of 50 hours

# The innovative grease for all bearings

## Lubrication of main-, generator-, blade pitch- and yaw bearings

### Low-temperature behaviour of greases

Wind turbines are normally subject to considerably varying operational temperatures often caused by changing climatic conditions. Operators face, therefore, particularly high challenges when it comes to operation at low temperatures. As electronic systems, plastics and other components are generally not designed for use at temperatures below –10 to –15 °C, turbines are normally switched off if outside temperatures fall below the threshold level unless they are equipped with a so-called “Cold-Climate control package”.

The rolling bearing grease, however, must not alter when subject to extremely low temperatures during the turbine idle period. Once outside temperatures rise to a sufficiently high level, the wind turbine is started up once again, often with the support of heating systems. The performance capacity of the rolling bearing grease must be fully available on start-up. To ensure that the lubricant meets these requirements, it must pass a wide variety of tests prior to approval.

The lower service temperature of lubricating greases is normally determined by means of the standardised flow pressure test or the low-temperature torque test (IP 186). The FE 9 rolling bearing grease test rig (DIN 51821) or the SKF-ROF test rig are used to determine the upper service temperature of lubricating greases. For Klüberplex BEM 41-141, the lower service temperature determined via the low-temperature torque test is –40 °C and the upper service temperature, which was determined via the SKF-ROF test, is 150 °C.

The lower service temperature is the temperature at which the product still passes the flow pressure test or the low-temperature torque test. It is important to recognise that the service temperature values stated by the lubricant manufacturer do not necessarily indicate that the lubricant offers an adequate lubricating effect and hence good wear protection in all cases at low temperature. Klüber therefore examines the grease’s anti-wear behaviour at –20 °C using the SNR-FEB 2 test, in addition to the tests mentioned above. The SNR-FEB 2 test confirms that Klüberplex BEM 41-132 and Klüberplex BEM 41-141 have good lubricating capacity also at very low temperatures with less than 20 mg bearing wear measured – a very good high-performance result!

During a special storage test, Klüberplex BEM 41-132 and Klüberplex BEM 41-141 proved to withstand the survival temperatures required by the wind industry without difficulty – even temperatures below the normal lubricant service temperature. As the lubricant does not alter when exposed to minus temperatures, its full capacity is available on machine start-up.

Klüberplex BEM 41-132 and Klüberplex BEM 41-141 offer very good adhesion, even at extremely low temperatures, which again contributes to good low-temperature lubricating properties. Klüber confirmed their adhesion properties at low temperatures with an especially developed bent strip test at temperatures which are significantly lower than the normal service temperature.

## Hints for practice

### What to observe during the changeover to a new bearing grease

Miscibility tests have shown that Klüberplex BEM 41-141 can be mixed with the bearing greases that are most wide-spread 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 deliver its full performance benefits only 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 |

Klüber Lubrication offers a service section on its website where you will find information on elastomer compatibility of the individual lubricants. Of course, we will also be pleased to provide advice in this matter.

### Relubrication quantities and relubrication intervals

Quantities and intervals for relubrication are determined by the bearing manufacturer and/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 yaw bearing and blade pitch bearing teeth

The grease distrbution run at load step 12 showed that Klüberplex AG 11-461 / 462 adheres well to the tooth flanks and is not thrown off.

## Hint for practice

### What to observe for the changeover to Klüberplex AG 11-461 / 462

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 in Klüberplex AG 11-461 / 462. As is always the case with mixing lubricants, it should be noted that the special grease will deliver its full performance benefits only when not mixed with other lubricants.

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 Lubrication offers Klüberplex AG 11-461 (NLGI class 1) and 462 (NLGI class 2), a white lubricant for the teeth of the slewing ring and the blade pitch bearings. It retains its good lubricity and remains highly adhesive even at temperatures of –40 °C, so it won't fall of even at very low temperatures and protect the teeth reliably against wear. The lubricant's good adhesion leads also to lower grease consumption and longer maintenance intervals.

### Klüberplex AG 11-461 and 462 testing

**Resistance to salt water**
In the SKF Emcor test, Klüberplex AG 11-461 / 462 was tested for its 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 attains load step 12, which means that it fully meets the requirements for a gear grease.

**Low-temperature behaviour**
Klüberplex AG 11-461 / 462 can be sprayed using normal spraying systems without heating at temperatures down to 0 °C. Tests in Klüber's own test bay have shown that Klüberplex AG 11-461 / 462 offers better adhesion than comparable black greases at 40 °C as well as at high temperatures. In tests performed on a vertical surface at 70 °C, Klüberplex AG 11-461 / 462 did not flow down the surface even after 48 hours.

# Low resistance at the slip ring

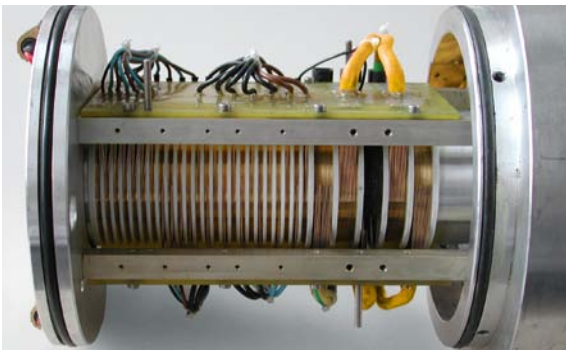
Wherever electric energy and/or signals are to be transmitted from a stationary to a rotating machine component – e.g. from the control unit to the rotor blades for pitch adjustment – electrical connections are required. For blade control, these are fitted in the form of slip rings.

Any failure of the blade pitch adjustment may cause total turbine breakdown. The lubricating oil on the slip rings plays an important role in this context since it ensures trouble-free signal transmission. The lubricant is expected to achieve this with as little maintenance as possible.

To enable reliable protection against wear and to generate a protective atmosphere in the contact zone ensuring a constant low transition resistance, a special mixture of different synthetic oils is required. The lubricants used must not affect the contact materials and should be resistant to oxidation.

Klüber Lubrication has developed a lubricant that meets all requirements of control- as well as of power transmission contacts: Klüberalfa YM 3-30.

**What is the effect of Klüberalfa YM 3-30 on slip ring contacts?**
Klüberalfa YM 3-30 is based on a PFPE oil with a viscosity that is ideally matched to the application. It is chemically and thermally stable. Klüberalfa YM 3-30 reduces the friction coefficient and wear considerably. Furthermore, it protects the contact against harmful influences from the environment and does not decompose into insulating solid compounds. Slip rings lubricated with Klüberalfa YM 3-30 spray show less contact consumption and hence last longer. This in turn leads to less maintenance on the slip rings and reduced associated downtimes.



## Hints for practice

### What to observe for the changeover to Klüberalfa YM 3-30

Prior to using Klüberalfa YM 3-30, the roller should be cleaned with white spirit 180/210 using a brush. The contacts are best cleaned with a soft cotton cloth and white spirit.

### What to observe regarding the compatibility with contact materials

Make sure that the lubricant is in principle compatible with the contact- and surrounding materials. Most contacts in wind turbines are electroplated with a gold alloy of varying hardness, but there is a large variety of other materials that may be used for slip ring contacts. If the materials used are less inert than gold, the PFPE's capability to protect the base materials against oxidation and other chemical effects should be checked.

# A service-driven approach

Klüber Lubrication is more than a mere supplier of speciality lubricants. Our experts are there to consult and assist you whenever you so wish. To be available wherever you need us, we have built up a global network of consultants and production sites.

## Development

Our speciality lubricants for wind power plants have been developed in close cooperation with specialists from the wind energy sector. From the start, we aimed for offering speciality lubricants that can be used in as many lube points as possible. We also offer our partnership and tribological expertise to develop customer-specific lubricants. All development activities proceed with specific component tests on our test rigs.

## Consulting

Our application engineers are always the right address to turn to when you require advice. They are experts both on your application and the lubricants to be used in them.
Our engineers will also support you with the testing of specific lubricants, for which we provide samples on request. They are also glad to assist in starting operation with a new lubricant. The reduction of the lubricant inventory to a necessary minimum is also a topic on which we can advise you.

## Training

Klüber Lubrication offers you staff training – ranging from an introduction to tribology, instructions on lubricant use, to seminars for further qualification of your maintenance staff.

## Allround service

Of course, Klüber Lubrication will also support you in generating plant lubrication charts. On request, we perform also chemical analyses and assessments of used lubricants.



The data in this brochure is based on our general experience and knowledge at the time of printing 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 tests with the selected product. We recommend contacting our Technical Consulting Staff to discuss your specific application. If required and possible we will be pleased to provide a sample for testing.

Klüber products are continually improved. Therefore, Klüber Lubrication reserves the right to change all the technical data in this brochure at any time without notice.

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www.klueber.com

## Klüber Lubrication – your global specialist

Innovative tribological solutions are our passion. Through personal contact and consultation, we help our customers to be successful worldwide, in all industries and markets. With our ambitious technical concepts and experienced, competent staff we have been fulfilling increasingly demanding requirements by manufacturing efficient high-performance lubricants for more than 80 years.

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