Higher Efficiency and Longer Service Life for Gears and Bearings - Wind

REWITEC GmbH
Dr.-Hans-Wilhelmi-Weg 1
35633 Lahnau
Germany

Target Markets

- Industry
  - Steel
  - Cement
  - Mining
  - Oil, Gas
  - Railway

- **Wind energy**
  - **Onshore**
  - **Offshore**

- Automotive
  - Consumer
  - OEM
  - Motorcycles
  - Racing
  - Classic cars

- Marine
  - Shipping
  - Barges
  - Yachts
  - Submarine

REWITEC Products

DuraGear™

Gears

GR400

Bearings

PowerShot™

Engines

Sprays

Multi-purpose

Wind Turbine Maintenance Costs

- Design flaws, environmental conditions, missing or even wrong maintenance can cause unforeseen breakdowns:

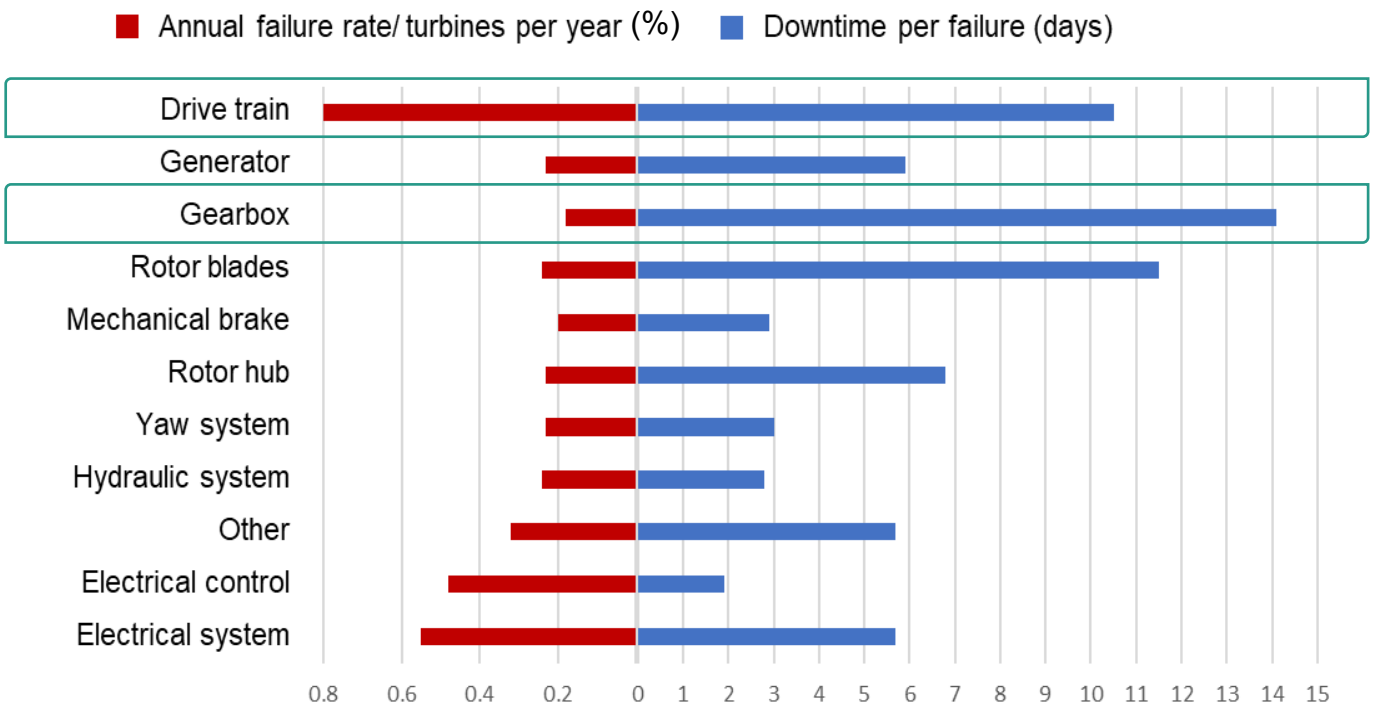
25% of the total wind turbine cost over its lifetime are maintenance costs

30-60 % of total maintenance costs are unscheduled maintenance costs

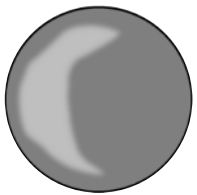
Up to **18 days** needed to replace gearboxes or main bearings

$300,000-400,000 are the average costs to replace a gearbox or main bearing

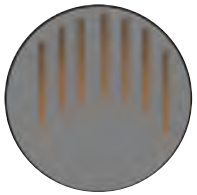
Wind Turbine Reliability Remains an Issue



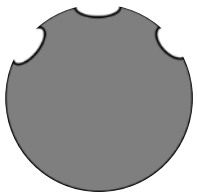
Typical Damage to Wind Turbine Gears & Bearings



Micropitting/ grey staining

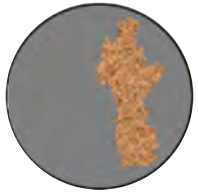


Fretting corrosion

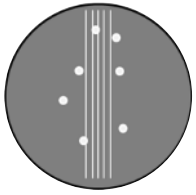


False brinelling

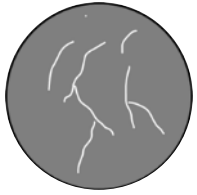
Smearing and scuffing



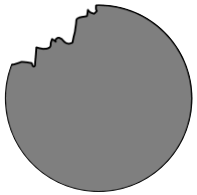
Chemical corrosion



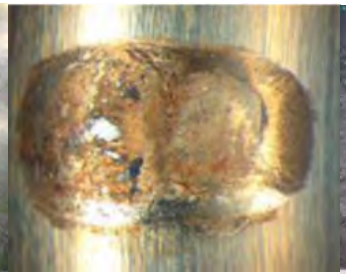
Electric damage



White etching areas/ cracks

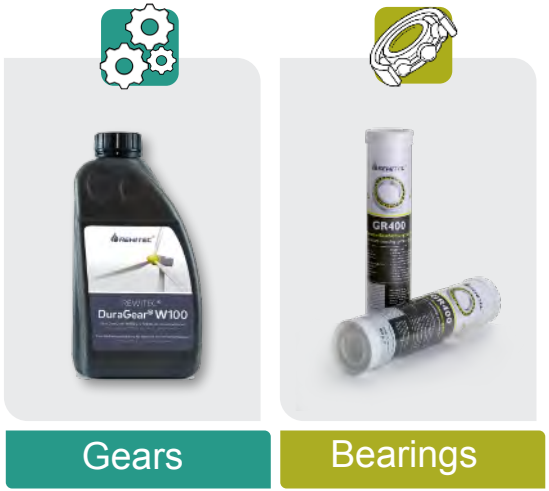


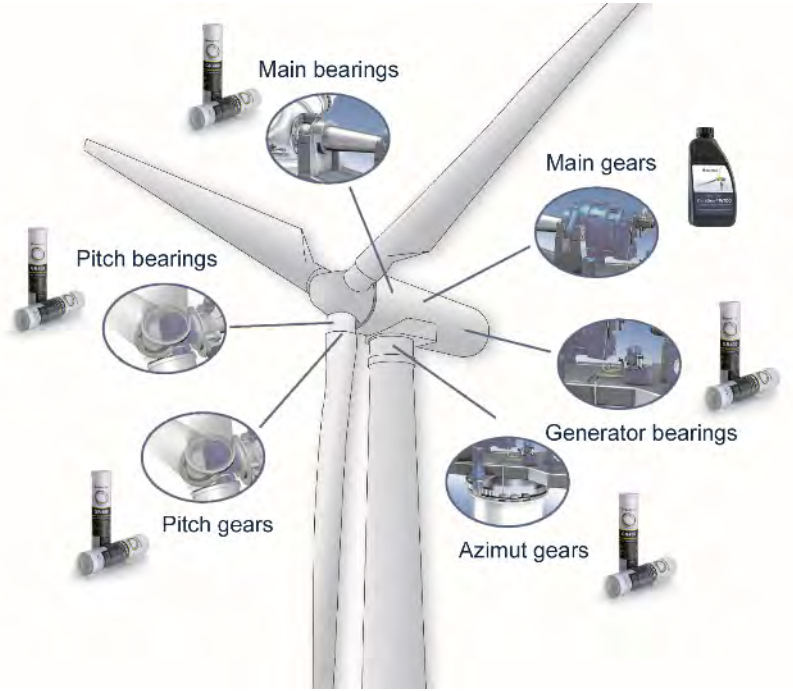
Macropitting



Application in Wind Turbines

- Surface damage can be costly, the technology can **prevent**, **repair** and **protect** them
  - More than 3,000 successfully treated wind turbines globally

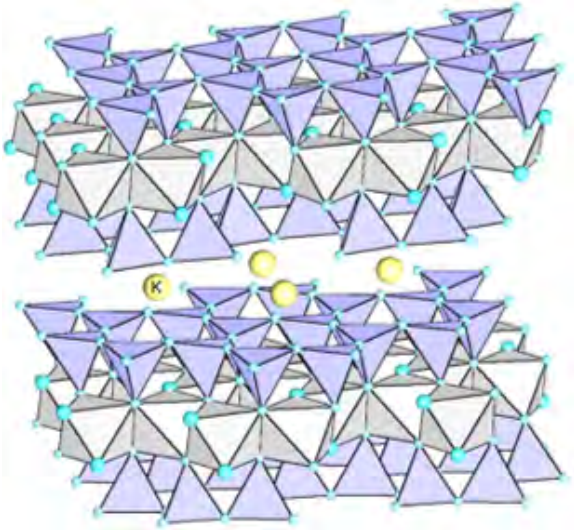




REWITEC Technology

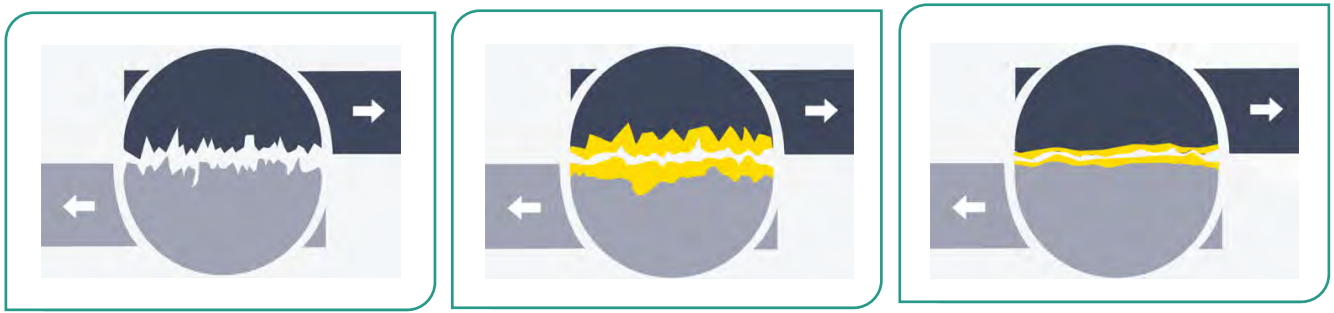
Phyllosilicate Based Particle Additives

- Platelet-shaped particles with layered crystal structure
  - Si-O and Al-O based layers
  - Strong *covalent* bonds within the layer
  - Weak *van der Waals* interaction between the layers
- Easy shearing between the layers
  - **Friction reduction**
- Big specific area with high adsorption ability
  - covering the surface, filling the holes
    - **Protective, repairing and smoothing effect**
- Particle size d90 = 4 µm
- Soft material: Mohs Hardness Scale 2.5 (like fingernail!)



Scientific publication:
”Tribological properties of a phyllosilicate based microparticle oil additive”, Chizhik et al., Wear 426–427 (2019) 835–844

Mechanism of Action



Step 1 Step 2 Step 3

Significant reduction of friction, wear, roughness and temperature

Advantages:

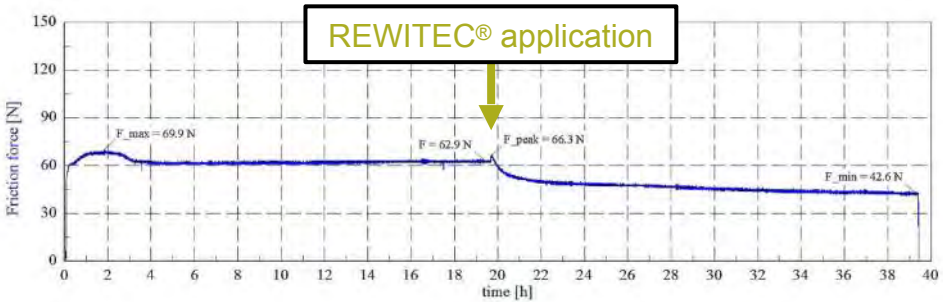
- Compatibility with all common lubricants
- Temperature independent
- No chemical interactions with other lubricant components
- Low dosage

Scientific Tests

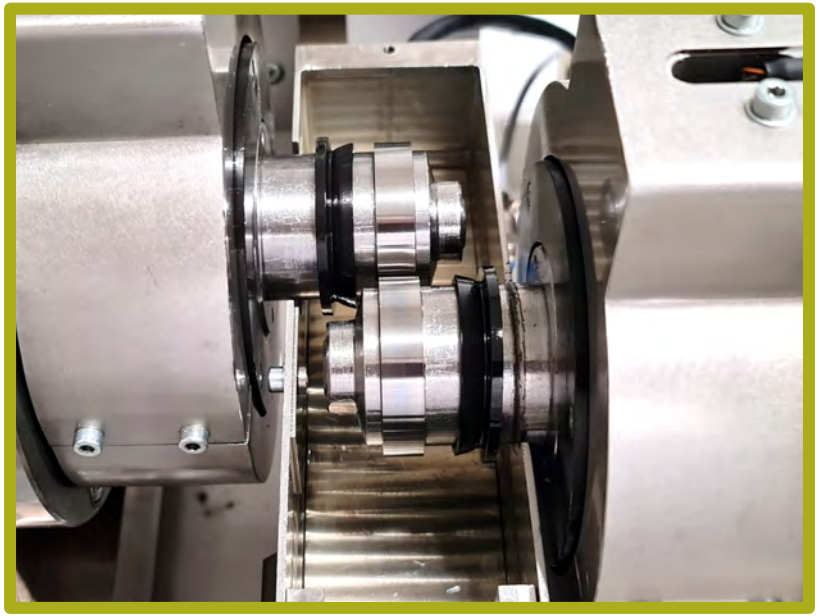
2-Disc Assembly Rolling Wear Test – Gear Oils

Reduction in friction

- Stress value: 1 GPa (normal force 2150 N)
- Rotating speed: 424 rpm / 339 rpm, slip 20 %
- Test-duration: 39,3 h
- Temperature: oil inlet temperature 60 °C
- Friction coefficient: μ=normal force/friction force



Castrol Optigear Synthetic X320

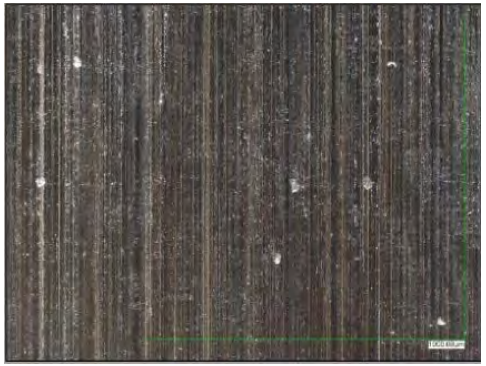


2-Disc Assembly Rolling Wear Test – Gear Oils

Oil	Friction reduction	Roughness reduction
Castrol Optigear Synthetic X320	33 %	41 %
Mobilgear SHC XMP 320	35 %	44 %
Klübersynth GEM 4-320N	40 %	54 %
Fuchs Unisyn CLP 320	36 %	50 %
Amsoil PTN 320	46 %	18 %
Shell Omala S4 GX 320	42 %	25 %
Klüberbio EG 2-150	55 %	40 %
Fuchs Pentosin EG FFL-7A	41 %	35 %
Automotive racing gear oil	55 %	40 %

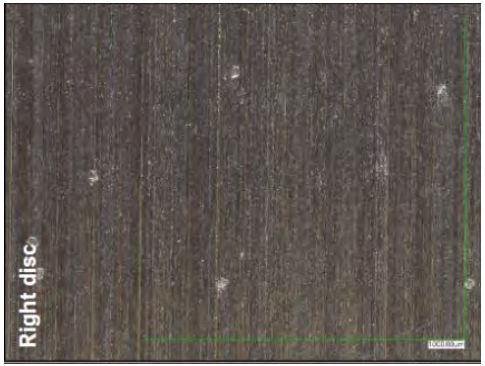
2-Disk surface roughness:
Ra reduced by 34 % / Rz reduced by 40 %

Blank disk



Ra = 0.30 µm
Rz = 2.70 µm

Gear oil + Phyllosilicate



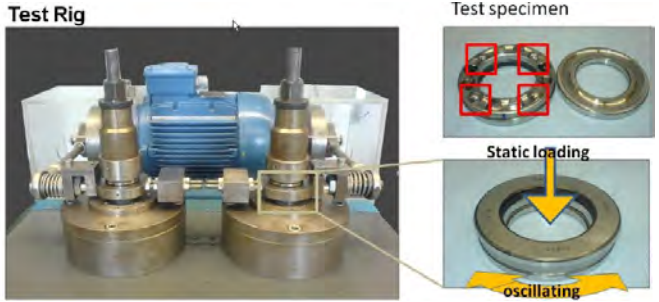
Ra = 0.20 µm
Rz = 1.62 µm

False-Brinelling Test – For Pitch Bearing Evaluation

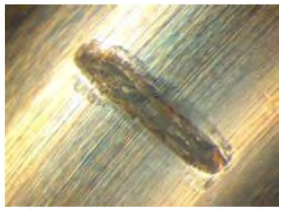
Supported by: Federal Ministry for Economic Affairs and Energy on the basis of a decision by the German Bundestag

KOMPETENZZENTRUM tribologie MANNHEIM

Frequency: 25 Hz
Oszillation angle: +/- 0.5° -> +/- 3.0°
Axial load: 3 kN to 4 balls (750 N per ball)
Temperature: room temperature
Test bearing: ARKL Type 51206 with 4 rolling elements

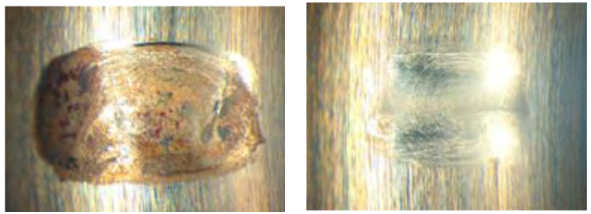


Fuchs LX460

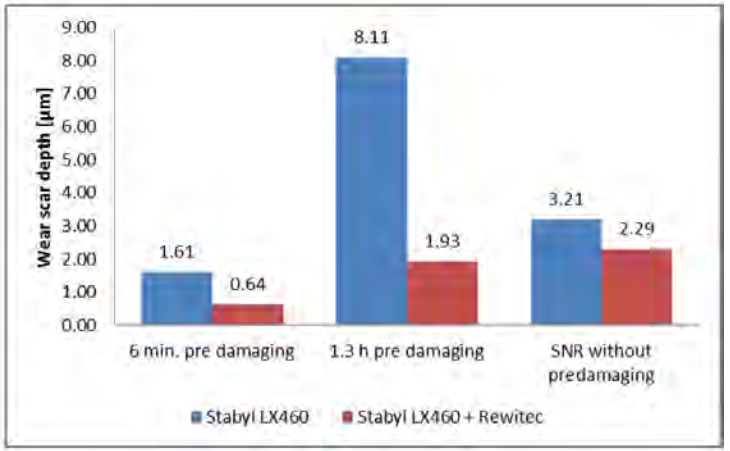


pre-damaging
(1.3 h; +/- 0.5°)

Fuchs LX460 | Fuchs LX460 + REWITEC™



Run after the damaging
(3 h; +/- 3°)



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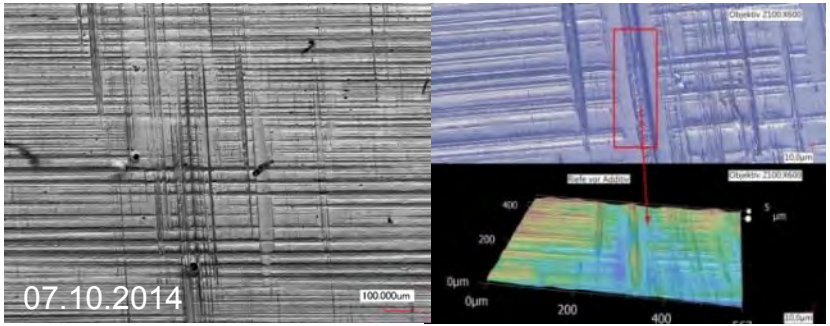
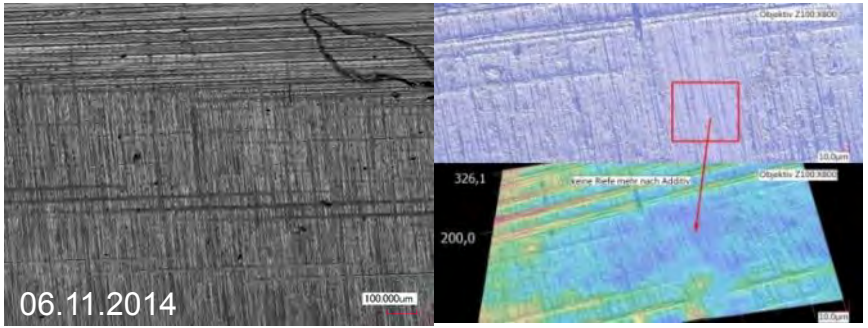
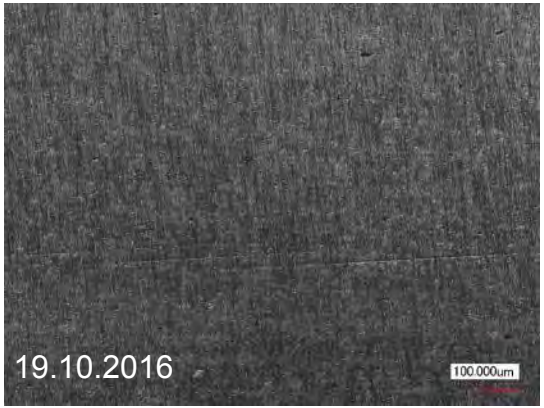
Examples of Application

GE 1.5 MW Wind Turbine Gearbox

- Wear development on a Bosch Rexroth gear tooth (GE 1.5 SL) over a period of two years





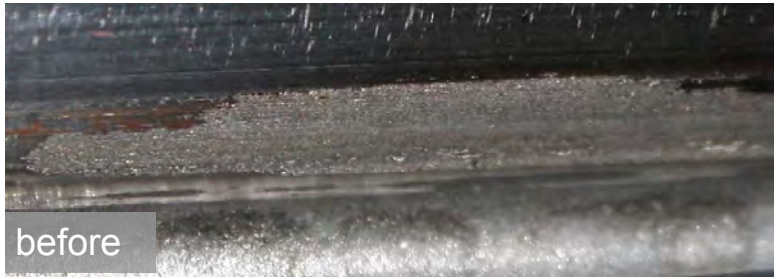


- Run through marks on the tooth flank after 6 weeks and 2 years:
  - Reduction of the surface roughness and friction force
  - Improved load carrying capacity
  - Less stress for the tooth flank

Example of a Gearbox Application

- Gearbox CSIC 2 MW VSCF

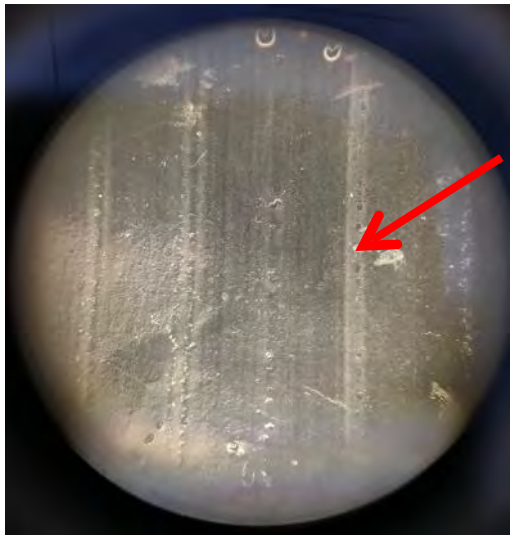
- Significant operational wear visible
- In the foot area visible micro pitting
- Oxidation visible



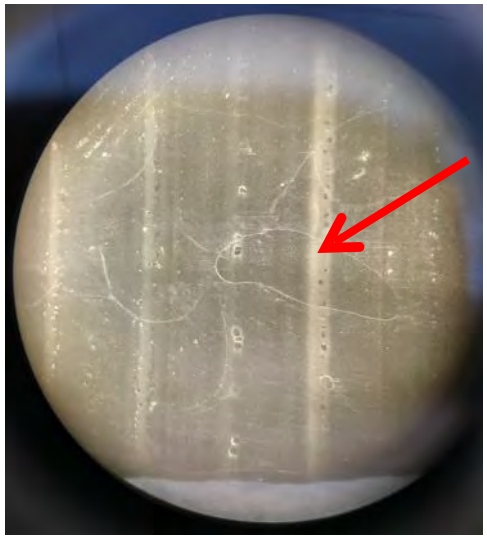
- Operational wear noticeable reduced
- Reduction of micro pitting
- The contact pattern is optimized

GE 1.5 MW Wind Turbine Main Bearing (Outer Ring)

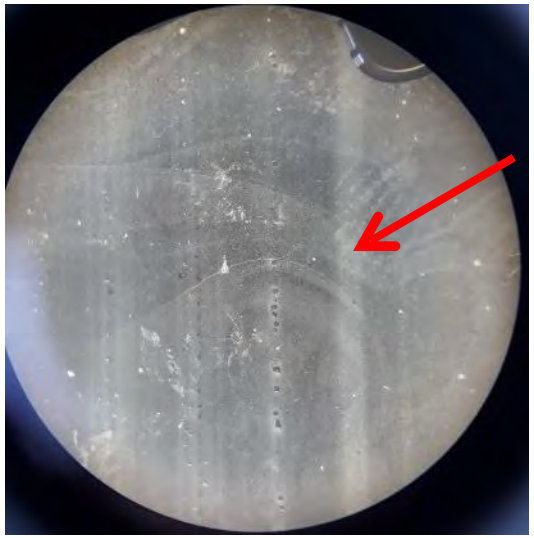
Picture: Before wind turbine was treated



Picture: **5 months** after wind turbine was treated with additive



Picture: **12 months** after wind turbine was treated with additive



→ Red arrow shows the same right track on the surface imprint

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GE 1.5 MW Wind Turbine Main Bearing (Outer Ring)

Picture: Before wind turbine was treated

Ra = 0,556 µm (within the track)

Picture: 5 months after wind turbine was treated with additive

Ra = 0,403 µm (within the track)

Picture: 12 months after wind turbine was treated with additive

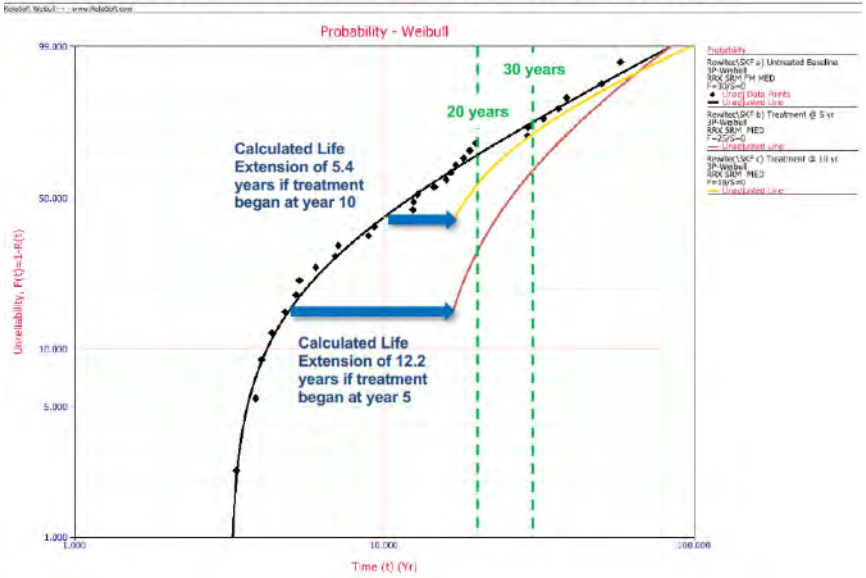
Ra = 0,225 µm (within the track)

Red arrow shows the same right track on the surface imprint

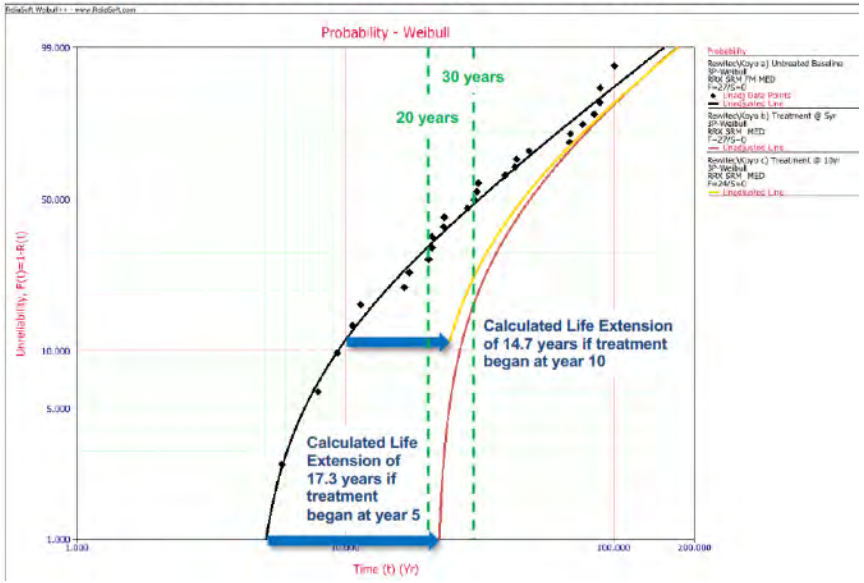
Lifetime Calculation

Calculated life extension of upto 17 Years

Acciona AW1500 Generator Side Mainshaft bearing – SKF 23188



GE Energy 1.6/1.7-100 Mainshaft bearing – KOYO Model 240/710



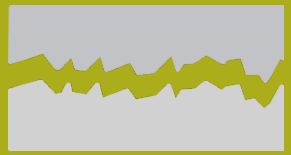
Significant reduction in the probability of failure of a main bearing post application

The earlier the application, the greater the lifetime extension

REWITEC®

Our Services

Technical consulting, up-tower inspections



Component surface imprinting

Component damage analysis and reporting

Conclusion

- Less surface roughness, friction and temperature in the drive train system means:
  - Less stress and wear for gearboxes and bearings
  - In-situ repair and protection up tower
  - Higher efficiency
  - Significant improvement of the service life
  - Cost savings, higher earnings

Do you need more information?

Please do not hesitate to contact us.

REWITEC GmbH
Dr.-Hans-Wilhelmi-Weg 1
35633 Lahnau
Germany

Tel.: +49 6441 445990
info@rewitec.com
www.rewitec.com

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