Higher Efficiency and Lifetime Improvement for Gears and Bearings in Wind Turbines.

Content

- Company and Products
- Scientific tests
- Examples of applications
- Conclusion

REWITEC®

COMPANY AND PRODUCTS

- Establishment in 2003
- Developer, manufacturer and distributor of nano and micro particle based surface refinement products for the protection and the repair of tribologic systems
- Patents Europe, China, USA
- World wide sales network
- Co-Founder and Managing Partner: Stefan Bill
- Acquisition by CRODA in 2019



Target Markets

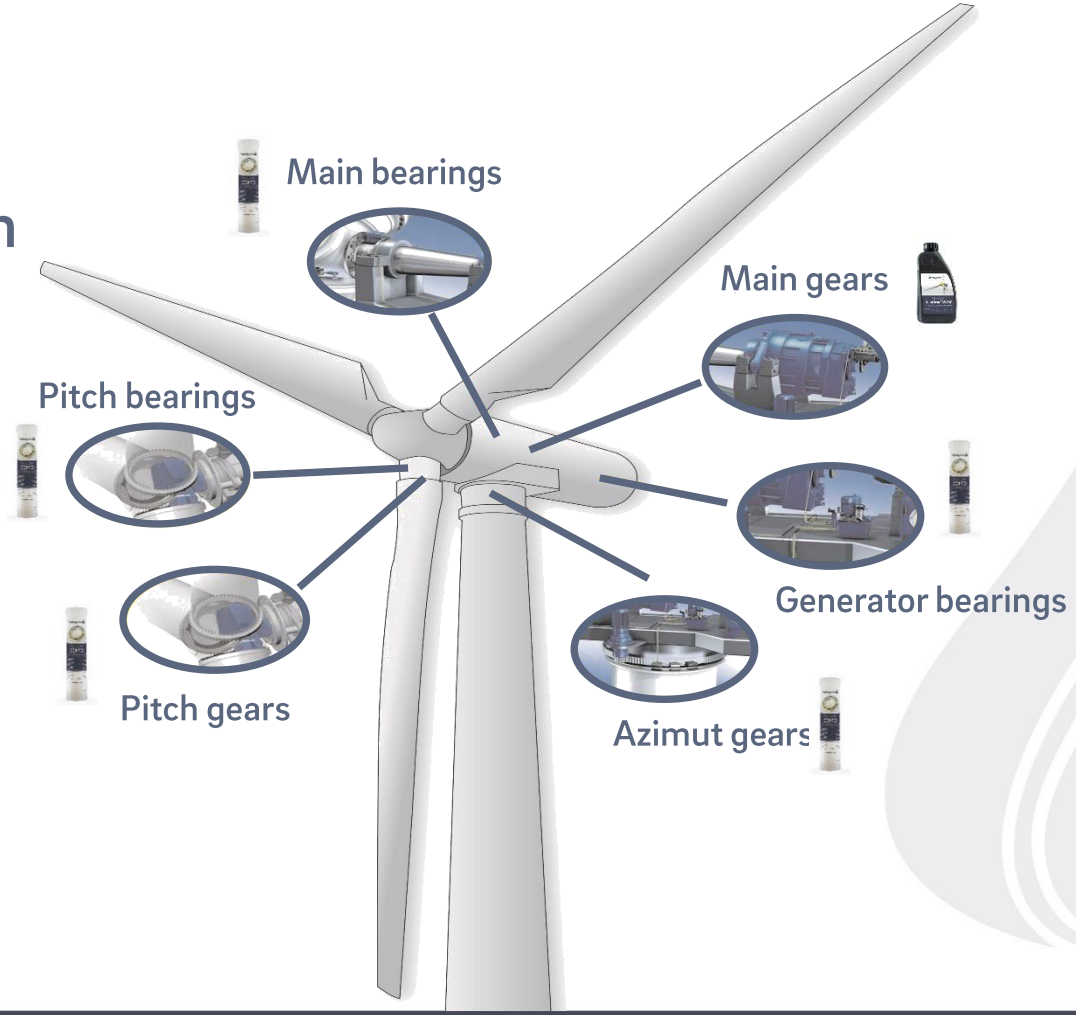
WIND ENERGY
- ONSHORE
- OFFSHORE

INDUSTRY
- STEEL
- CEMENT
- MINING
- OIL, GAS

SHIPPING
- MARINE
- INLAND
- YACHTS
- SUBMARINE

AUTOMOTIVE
- CONSUMER
- OEM
- MOTORCYCLES
- RACING
- OLDTIMER

Examples of application



Treated wind turbines

More than 2,000 treated wind turbine gears and bearings

Turbine manufacturer	Numbers	Type of wind turbine
AN Bonus	60	450 kW, 1.000 kW, 1.300 kW
DeWind	50	D4 (600 kW), D6 (1.000 kW), D8 (2.000 kW)
Gamesa	80	G47, G52, G8x
GE	1200	GE 1.5 sl, GE 1.6, GE 2.3, GE 3.6
Goldwind	50	750 kW
HSW	10	1.000 kW
Jacobs	10	600 kW
NEC Micon	250	600 kW, 800 kW, 1.000 kW
Nordex	300	N43, N52, N54, N60, N80, N117/2400, S70, S77
REpower	10	5M
Siemens	40	1.000 kW, 1.300 kW, 2.300 kW
Suzlon	20	Grease applications
Tacke	300	TW80, TW600, TW1.500
Vestas	400	V25, V39, V44, V47, V52, V66, V80, V90
CSIC Haizhuang	2	2.000 kW VSCF

Products

Higher Efficiency and longer Lifetime for gearbox with DuraGear® W100

Longer bearing life with GR400

GR400
(standard product)

GR400 +5
(concentrate for 5 kg grease)

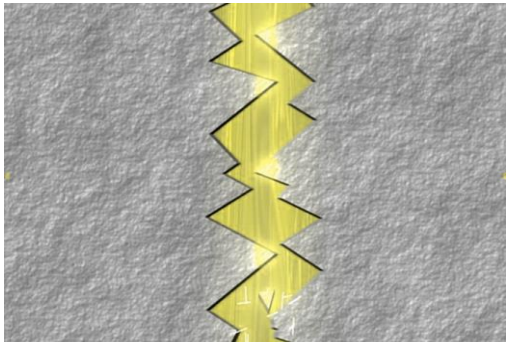
GR400 +10
(concentrate for 10 kg grease)

The coating process

Step 1

Chemical-physical process

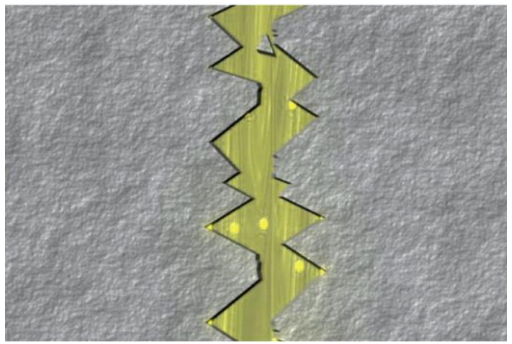
The product uses the lubricant as carrier to the mixed friction zones



Step 2

Chemical reaction

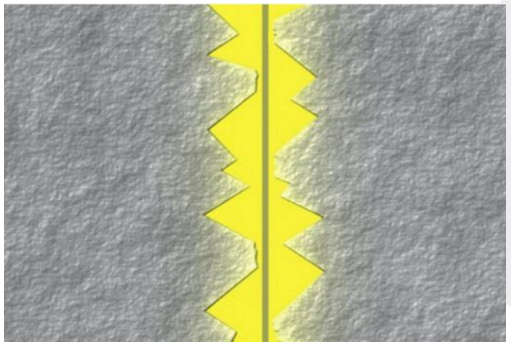
The coating particles ceramize the metal surfaces in mixed friction zones



Step 3

New metal-ceramic surface

Original material properties will be improved in terms of friction, temperature and wear significantly



REWITEC®

REWITEC® IN ACTION

SCIENTIFIC TESTS

Scientific tests

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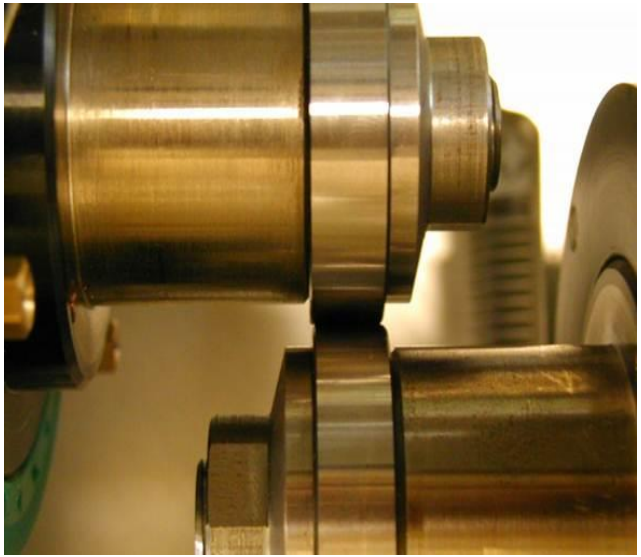
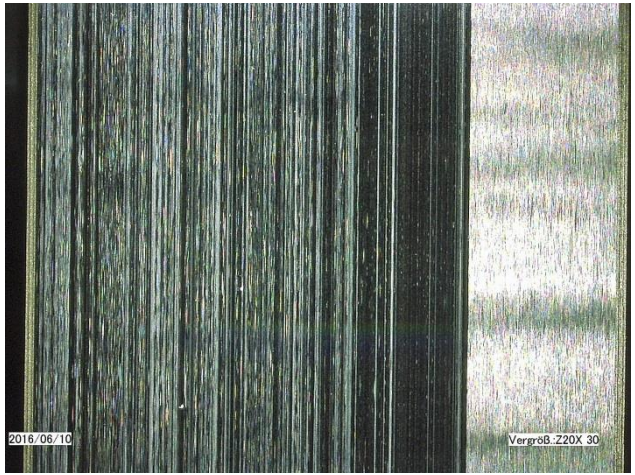
Competence Center of Tribology
Mannheim-Germany



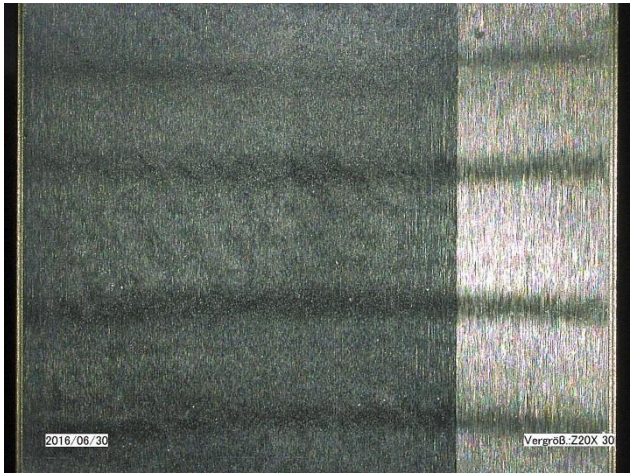
2-Disc Assembly Rolling Wear Tests

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

Scientific tests
2-Disc assembly rolling wear test
VW first fill manual gearbox oil



Steel disc treated **without REWITEC®**



Steel disc treated **with REWITEC®**

(1 GPa; 424 rpm / 339 rpm, slip 20 %; 40 h; 60 °C)

Scientific tests
2-Disc assembly rolling wear test – wind turbine oils

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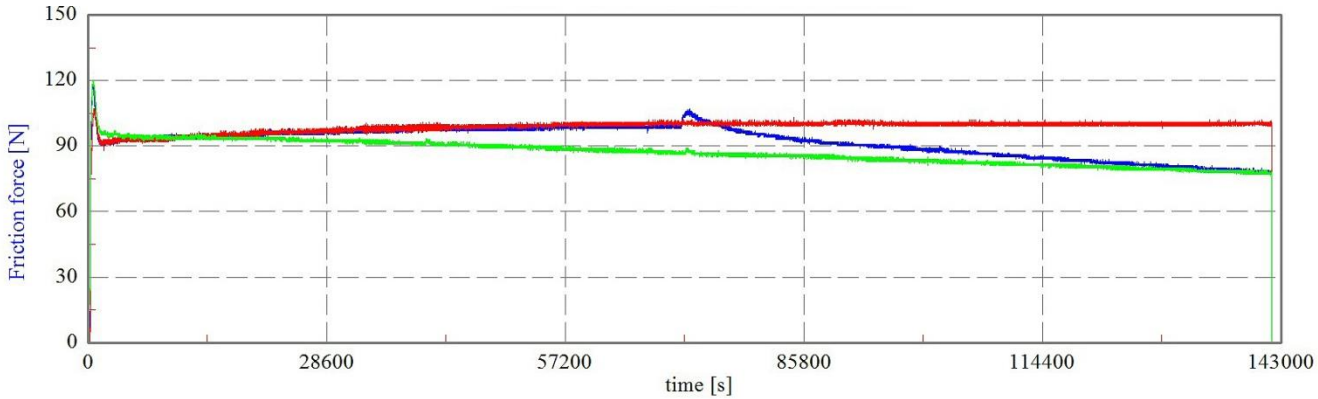

- Red graph without REWITEC®
- Blue graph with REWITEC® added after 20 hours
- Green graph with REWITEC® added at the beginning
- **Reduction of the surface roughness (R_a) due to wear up to 58 %**
- **Reduction of the friction force up to 22 %**

Scientific tests
2-Disc assembly rolling wear test – wind turbine oils

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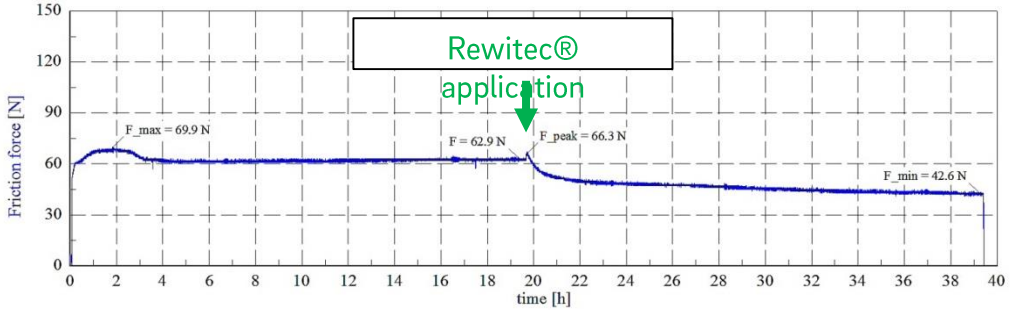
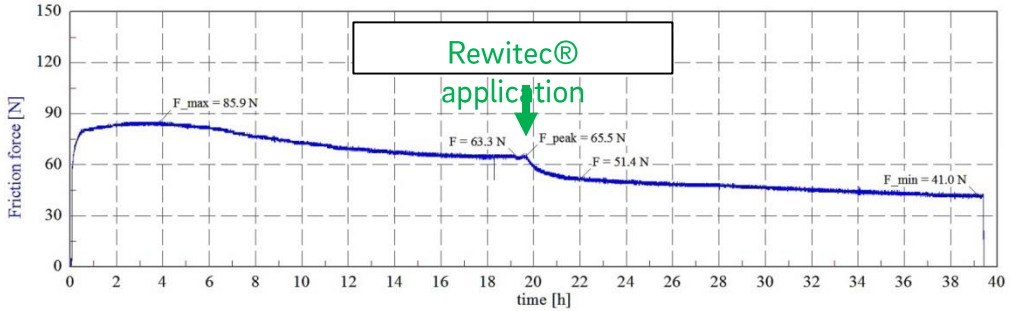


Castrol Optigear Synthetic X320
μ_{end} = 0.0198
Friction reduction -33 %



Mobilgear SHC XMP 320
μ_{end}=0.0191
Friction reduction -35 %

Scientific tests
2-Disc assembly rolling wear test – wind turbine oils

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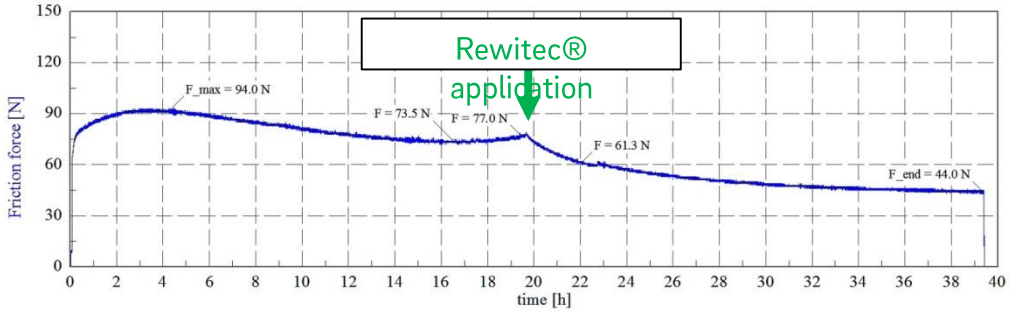
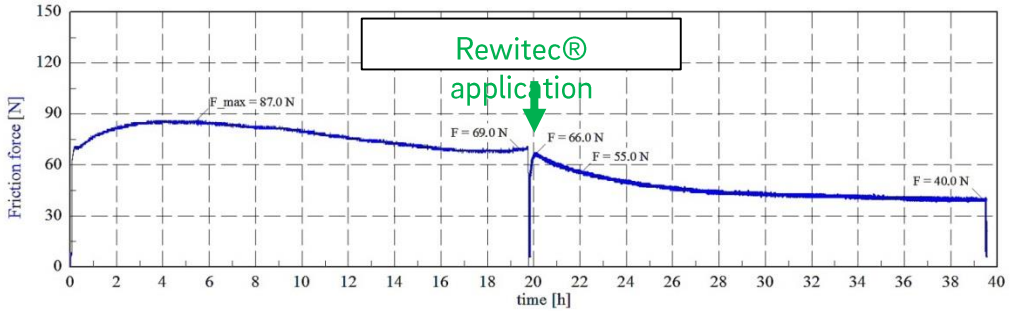


Klübersynth GEM 4-320N
μ_{end}=0.0210
Friction reduction -40 %



Fuchs Unisyn CLP 320
μ_{end}=0.0186
Friction reduction -36 %

Scientific tests
2-Disc assembly rolling wear test – wind turbine oils

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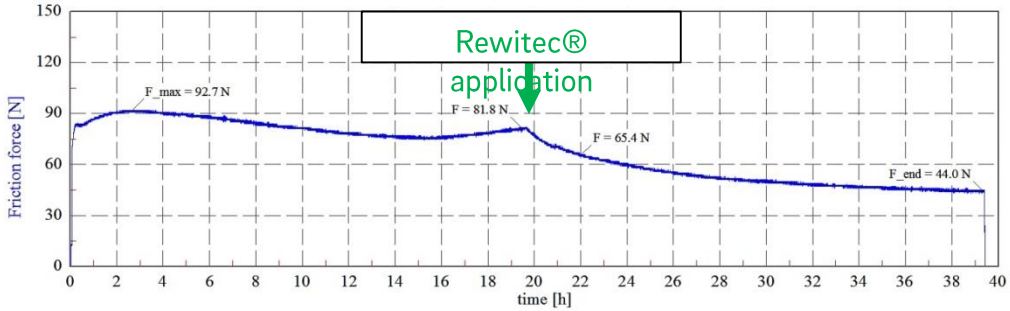
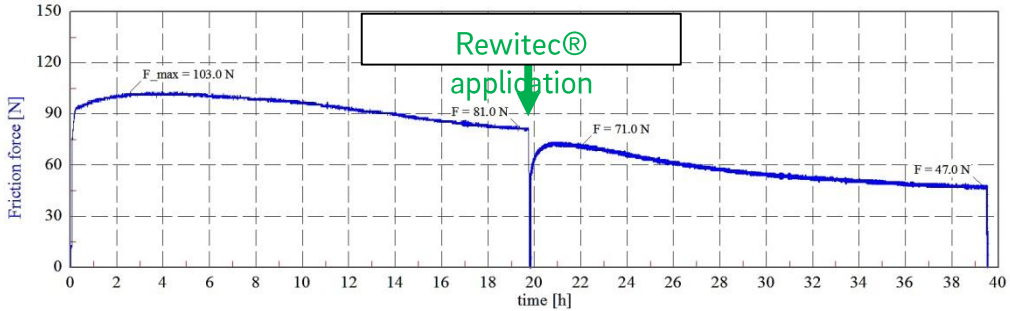


Amsoil PTN 320
μ_{end}=0.0205
Friction reduction -46 %



Shell Omala S4 GX 320
μ_{end}=0.0219
Friction reduction -42 %

Scientific tests
2-Disc assembly rolling wear test – wind turbine oils

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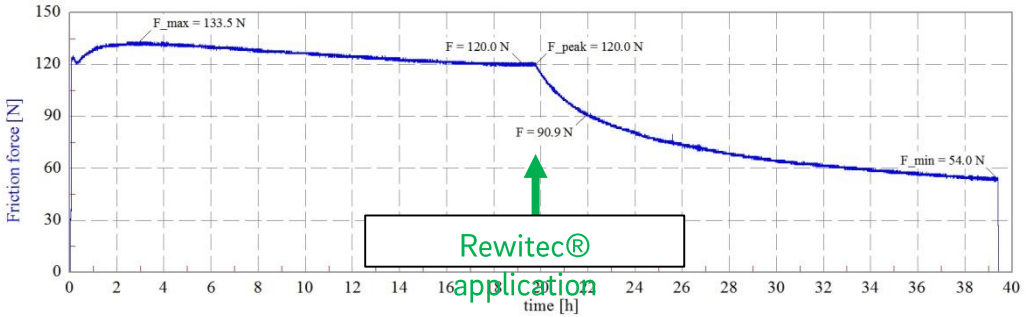

Klüberbio EG 2-150
μ_{end}=0.0251
Friction reduction -55 %

Oil analyses of the CASTROL X320

The following elements were found additionally in the tested oil after the application of the REWITEC DuraGear product:

- Si (Silicon up to 175ppm)
- Al (Aluminium up to 138ppm)
- Fe (Ferrum up to 6ppm)
- K (Potassium up to 9 ppm)

These elements are a part of the REWITEC formulation. All the other elements and additives in the oil are same concentration before and after the REWITEC DuraGear application.

Freshoil sample CASTROL X320

SAMPLE RATING			
Date tested			11.05.2016
Date of sample taken			-
Date of last oil change			-
Top-up since change			-
Operating time since change			-
Total operating time			-
Oil changed			-
WEAR			
Iron	Fe	mg/kg	0
Chrome	Cr	mg/kg	0
Tin	Sn	mg/kg	0
Aluminum	Al	mg/kg	0
Nickel	Ni	mg/kg	0
Copper	Cu	mg/kg	0
Lead	Pb	mg/kg	0
Manganese	Mn	mg/kg	0
PQ index	-		< 25
CONTAMINATION			
Silicon	Si	mg/kg	17
Potassium	K	mg/kg	0
Sodium	Na	mg/kg	0
Water	%		< 0.10
OIL CONDITION			
Viscosity at 40°C	mm²/s		323.15
Viscosity at 100°C	mm²/s		34.18
Viscosity index	-		149
Oxidation	A/cm		-
ADDITIVES			
Calcium	Ca	mg/kg	1895
Magnesium	Mg	mg/kg	5
Boron	B	mg/kg	0
Zinc	Zn	mg/kg	1
Phosphorus	P	mg/kg	367
Barium	Ba	mg/kg	0
Molybdenum	Mo	mg/kg	1094
Sulphur	S	mg/kg	1869

Freshoil sample CASTROL X320 after REWITEC DuraGear W 100

SAMPLE RATING			
Date tested			11.05.2016
Date of sample taken			-
Date of last oil change			-
Top-up since change			-
Operating time since change			-
Total operating time			-
Oil changed			-
WEAR			
Iron	Fe	mg/kg	4
Chrome	Cr	mg/kg	0
Tin	Sn	mg/kg	0
Aluminum	Al	mg/kg	138
Nickel	Ni	mg/kg	0
Copper	Cu	mg/kg	1
Lead	Pb	mg/kg	0
Manganese	Mn	mg/kg	0
PQ index	-		< 25
CONTAMINATION			
Silicon	Si	mg/kg	192
Potassium	K	mg/kg	9
Sodium	Na	mg/kg	3
Titanium	Ti	mg/kg	1
Water	%		< 0.10
OIL CONDITION			
Viscosity at 40°C	mm²/s		322.51
Viscosity at 100°C	mm²/s		34.37
Viscosity index	-		151
Oxidation	A/cm		-
ADDITIVES			
Calcium	Ca	mg/kg	1881
Magnesium	Mg	mg/kg	8
Boron	B	mg/kg	0
Zinc	Zn	mg/kg	1
Phosphorus	P	mg/kg	362
Barium	Ba	mg/kg	0
Molybdenum	Mo	mg/kg	1083
Sulphur	S	mg/kg	1903

Scientific tests
False-Brinelling test –
For pitch bearing evaluation

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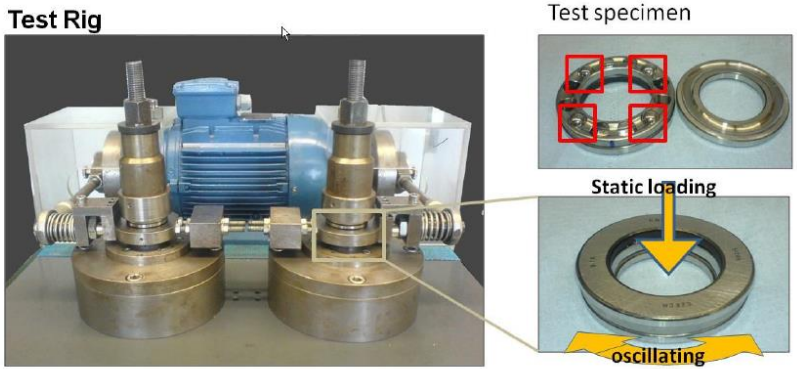
Influence of the Rewitec additive in greases against standstill marks and False-Brinelling damages on roller bearings.

False-Brinelling-Test-Rig

Standard test bearings for SNR- and standstill marks test with Fuchs LX460 grease will be used.



Data

Motor:	3kW/ 20,3 Nm
Oscillating Angle:	±0,1° till ± 3,0°
Oscillating Frequency:	5 - 25 Hz
Normal Load:	100 till 9000 N
Standardized Test Period:	1 min until 100 h

Data Bearing Type 51206

Diameter:	41 mm
Weight:	136 g
Material:	100Cr6
Hardness:	62 +/-2 HRC

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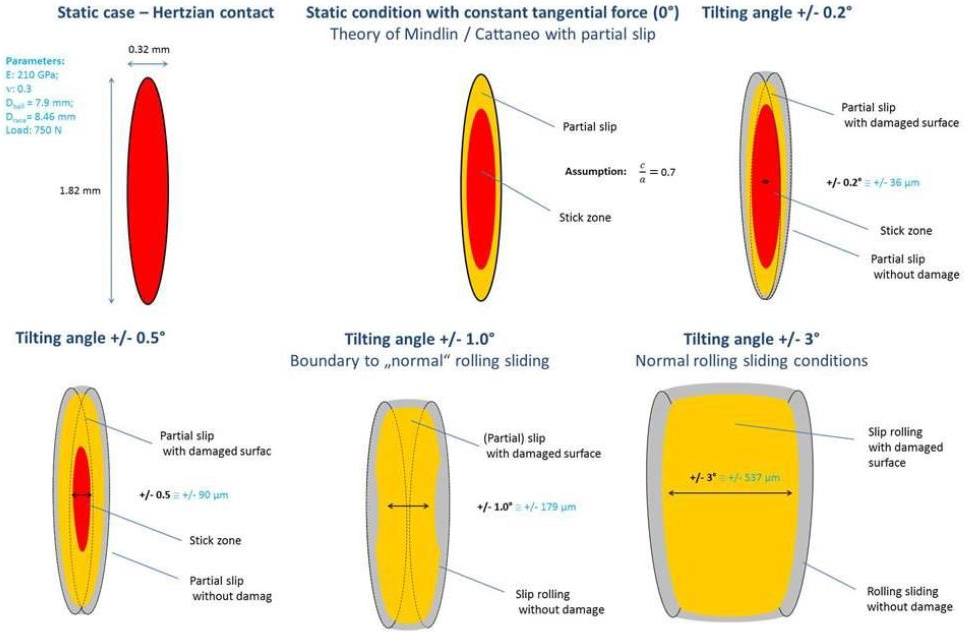
Drawing: Influence of the tilting angle



QSST → **SNR-FEB2**

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Frequency:	25 Hz
Oszillation angle:	+/- 0,5°
Axial load:	3 kN distributed to 4 balls (750 N per ball)
Temperature:	RT (-10°C to 80°C possible)
Test time:	1 min; 6 min; 1,3 h;
Test bearing:	ARKL Type 51206 with 4 rolling elements/test
Measured values:	Optical documentation and evaluation
Numbers of specimen:	1 grease type
Documentation:	Photos of the 16 wear marks after the test and evaluation
Statistics:	Each test with 2 bearings (Double test, left and right unit

This test method reflects the influence of a macroscopically stationary bearing with changing tangential forces, which are initiated due to very small pivoting movements or due to vibrations (quasi-standstill test - QSS test).

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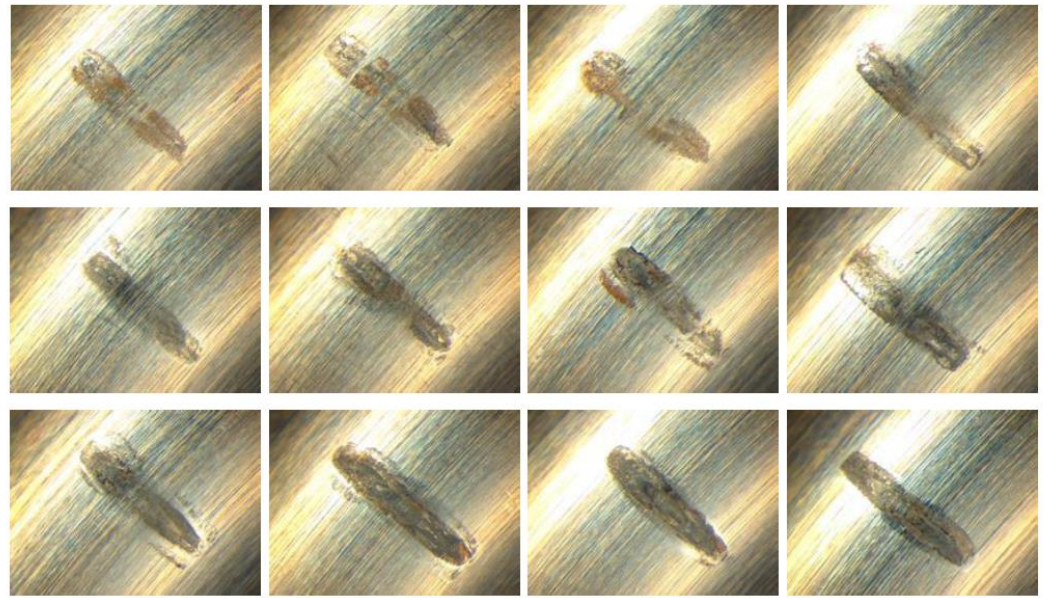
Standstill test with pure Stabyl LX460 SYN (3 kN; +/- 0,5)



Already clearly visible markings with mild adhesion and significant oxidation.

Moderate adhesion and average oxidation.

Significant damage. Medium strong adhesion and significant oxidation.

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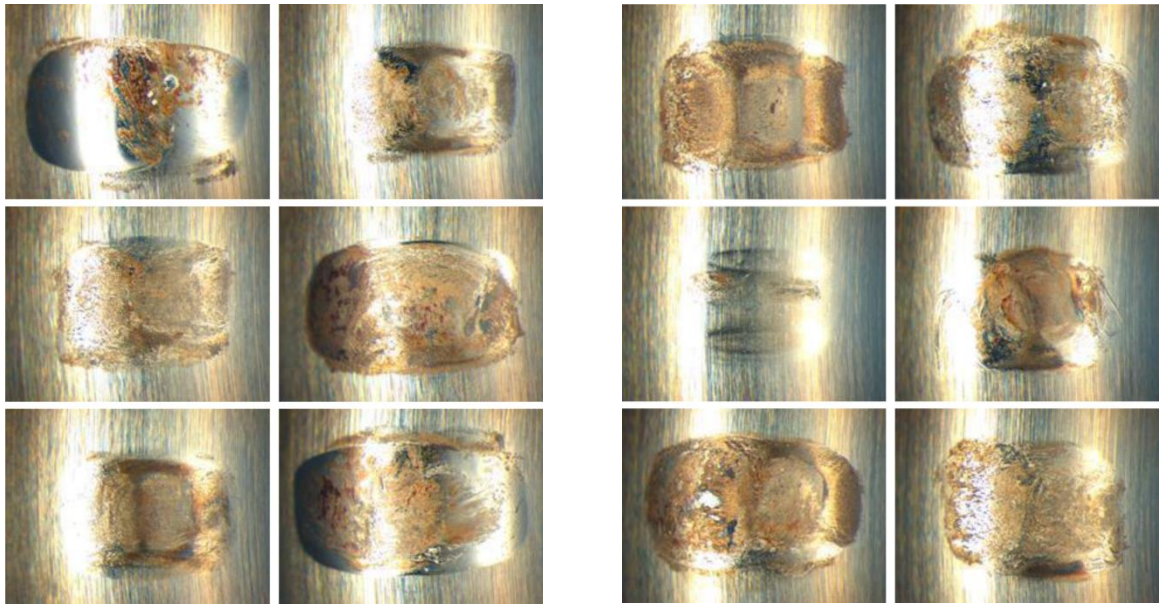
Without REWITEC®



The bearings are 1.3 hours pre-damaged with very small swivel angles of +/- 0.5 ° and a force of 3 kN

Scientific tests
False-Brinelling test –
For pitch bearing evaluation

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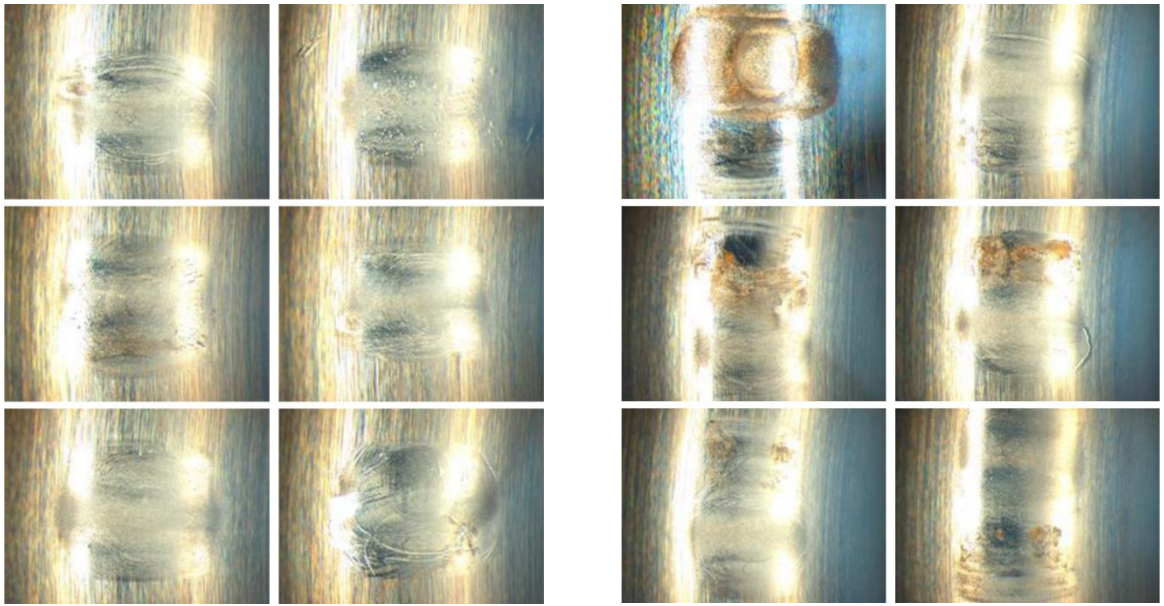
With REWITEC®



The bearings are 1.3 hours pre-damaged with very small swivel angles of +/- 0.5 ° and a force of 3 kN

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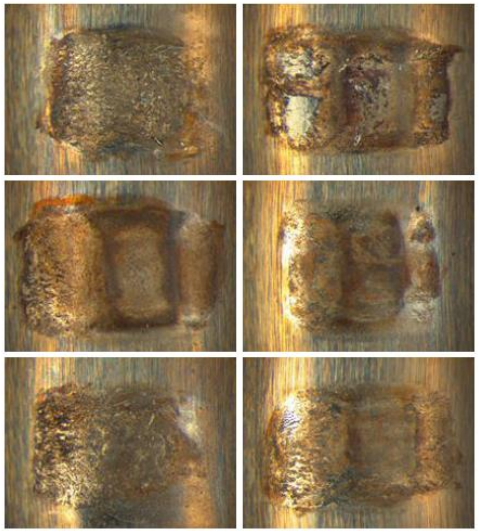
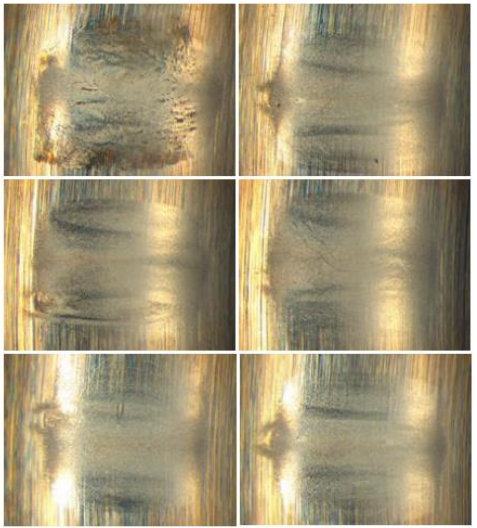
SKF grease 1 without REWITEC®



SKF grease 1 with REWITEC®



The bearings are 1.3 hours pre-damaged with very small swivel angles of +/- 0.5 ° and a force of 3 kN

Scientific tests
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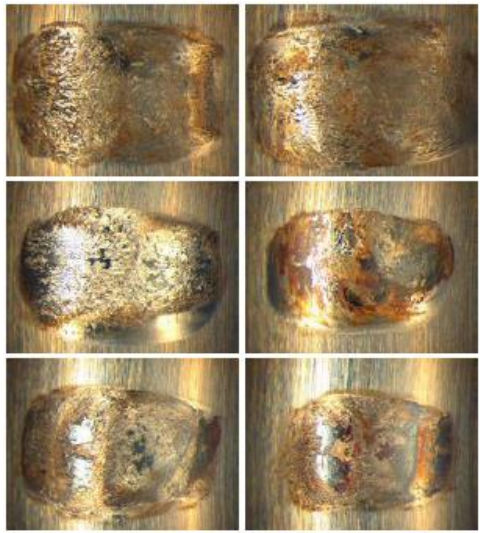
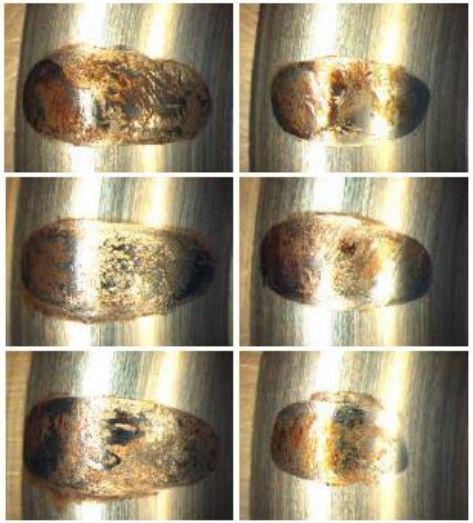
SKF grease 2 without REWITEC®



SKF grease 2 with REWITEC®



The bearings are 1.3 hours pre-damaged with very small swivel angles of +/- 0.5 ° and a force of 3 kN

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False-Brinelling test –
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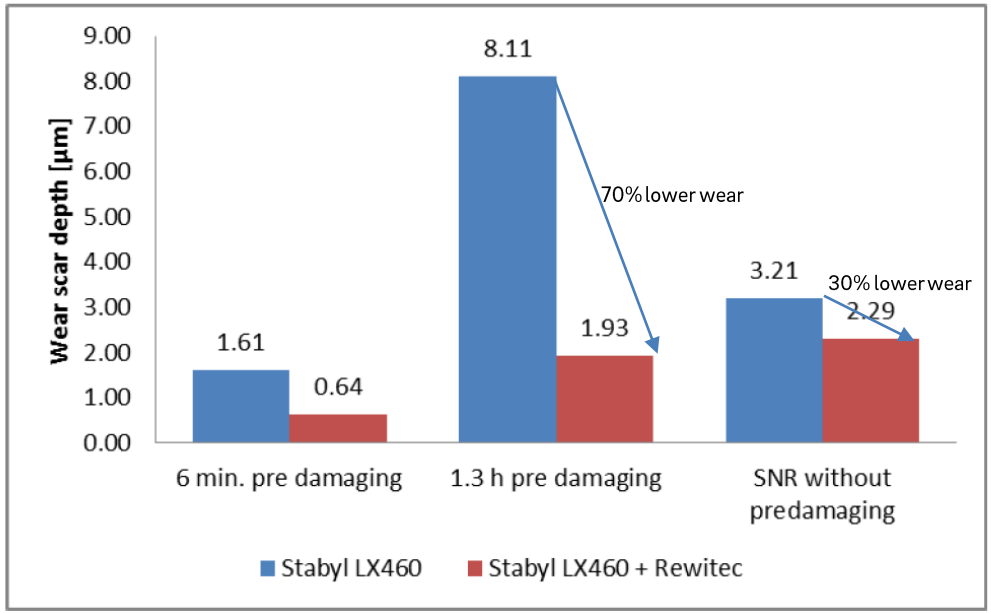
Overview wear mark depth

All wear mark depths were measured with an white light interferometer.



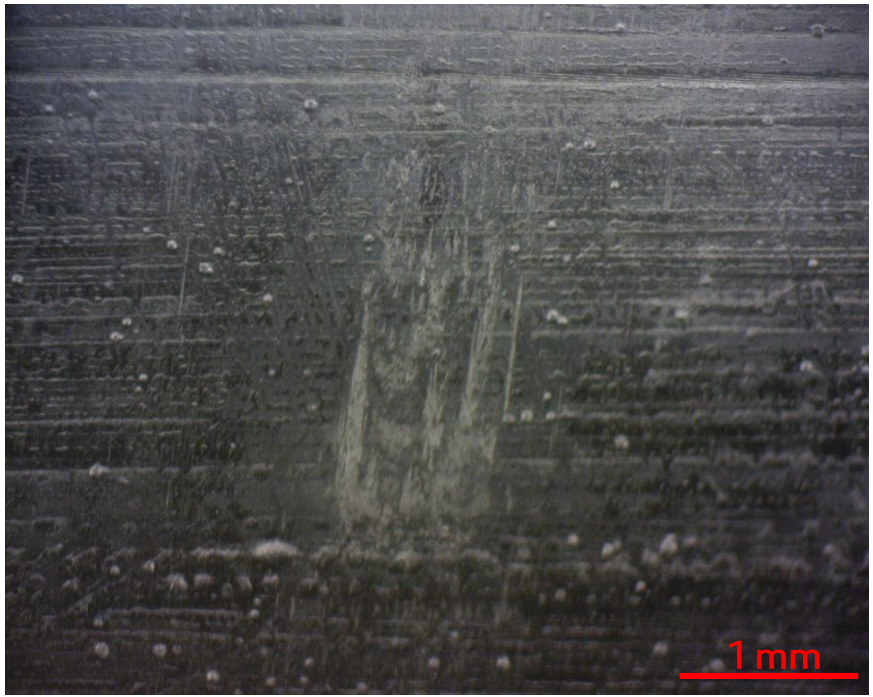
The values are the avarage of at least 8 single marks.

I can be seen clearly, that the use of Rewitec reduces the wear mark depth.
Especially the runs with a pre damaging by standstill conditions show significant advantages for the Rewitec modified grease.

WIND ENERGY | AUTOMOTIVE | MARINE | INDUSTRY

EXAMPLES OF APPLICATION

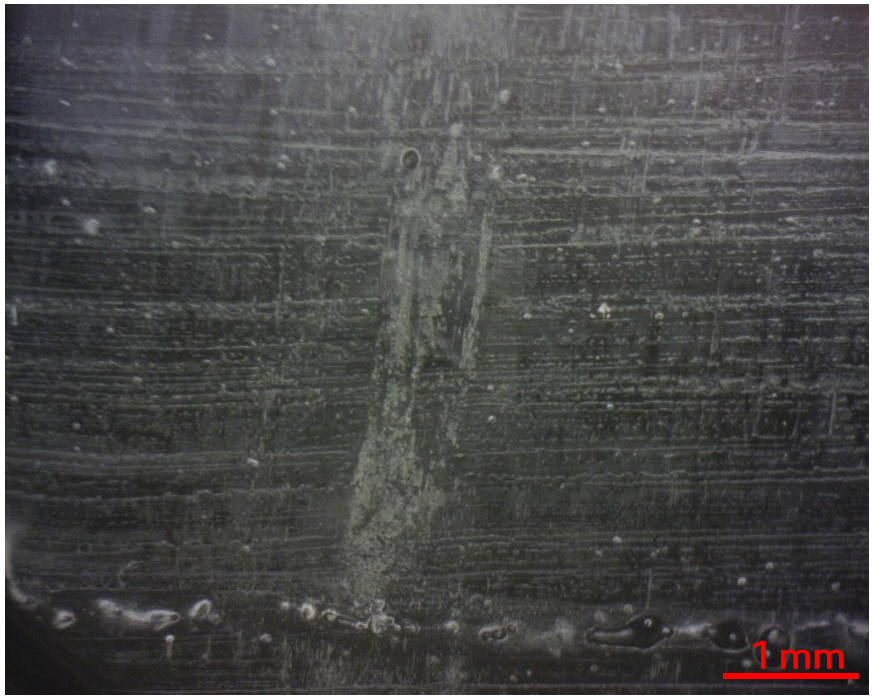
Wind Turbine Ebara 1.5 MW
High Speed Shaft, Tooth Flank



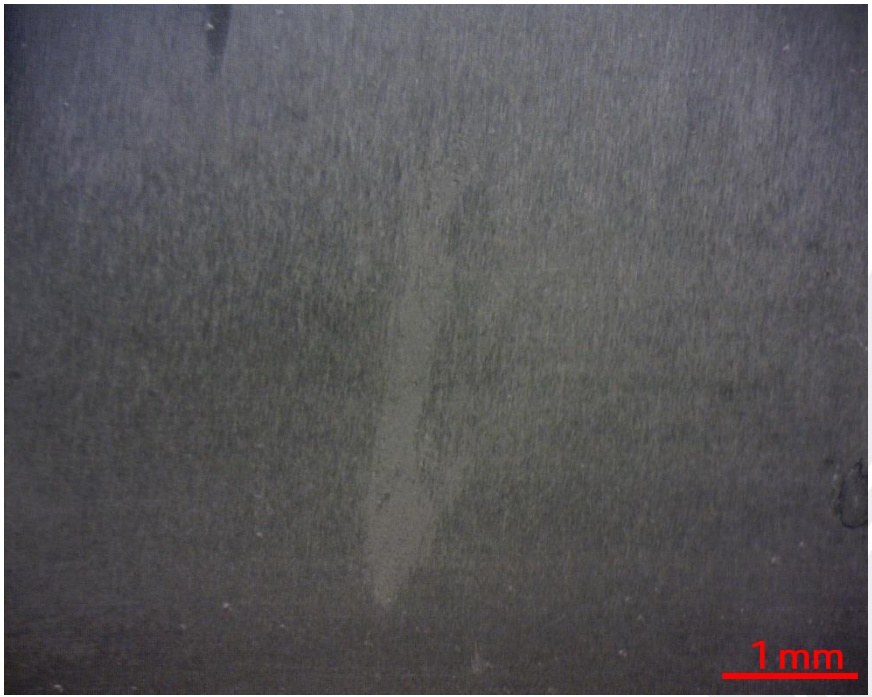
Bevor REWITEC®-treatment (20.03.19)

After REWITEC®-treatment (03.06.19)

Wind Turbine Ebara 1.5 MW
High Speed Shaft, Tooth Flank



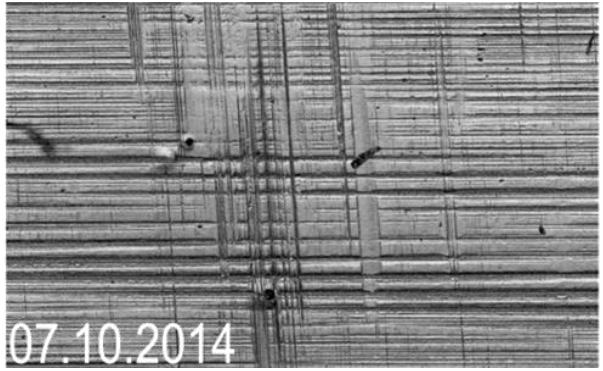
Bevor REWITEC®-treatment (20.03.19)

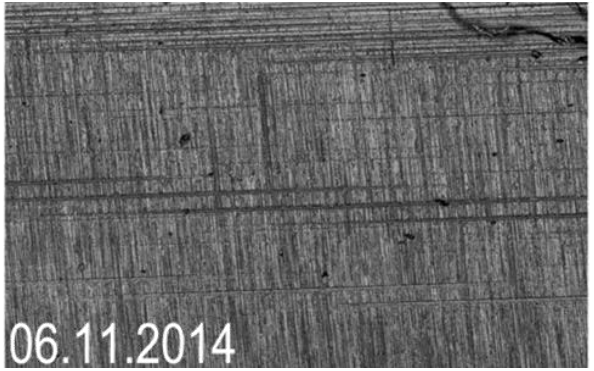


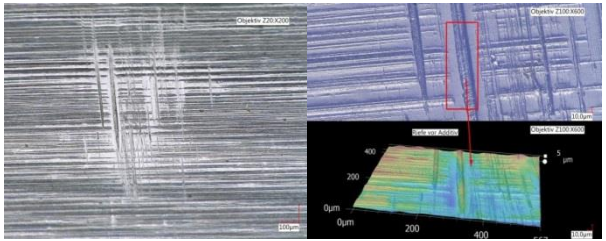
After REWITEC®-treatment (03.06.19)

Examples of application:

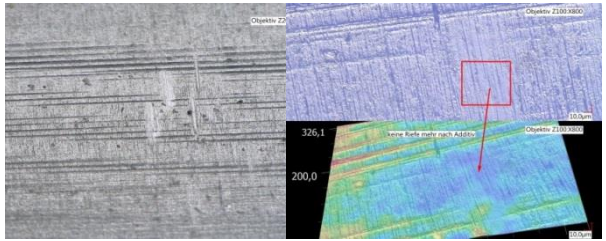
Wear development on a Bosch Rexroth gear tooth (GE 1.5 SL) over a period of two years







Run through marks on the tooth flank



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

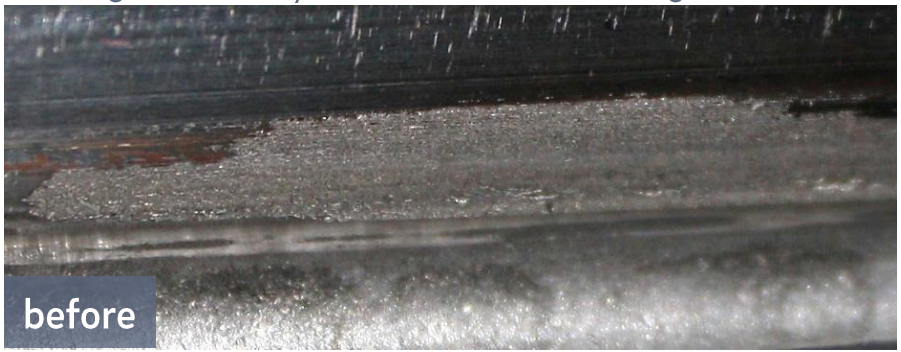
Examples of application:

Coating and analysis of a wind turbine gearbox CSIC 2 MW VSCF

- Tooth flank is marked with an oil-resistant paint
- Surface imprints before and after the application

Examples of application:

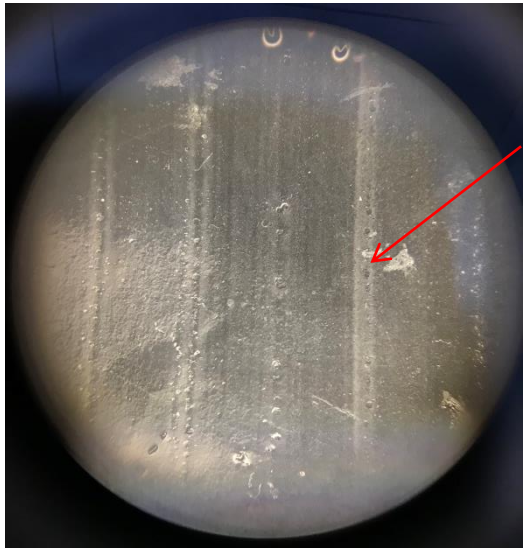
Coating and analysis of a wind turbine gearbox CSIC 2 MW VSCF



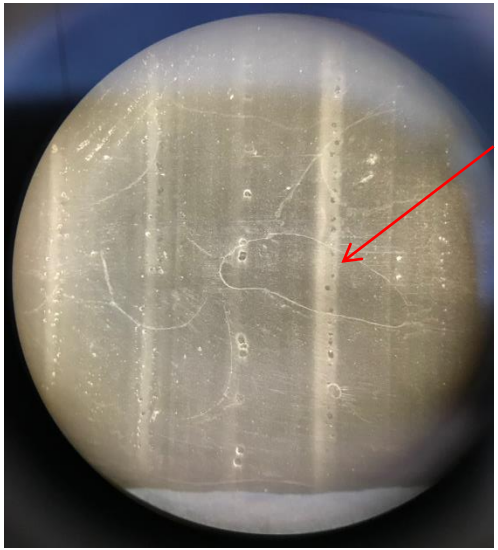
- Significant operational wear visible
- In the foot area visible micro pitting

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

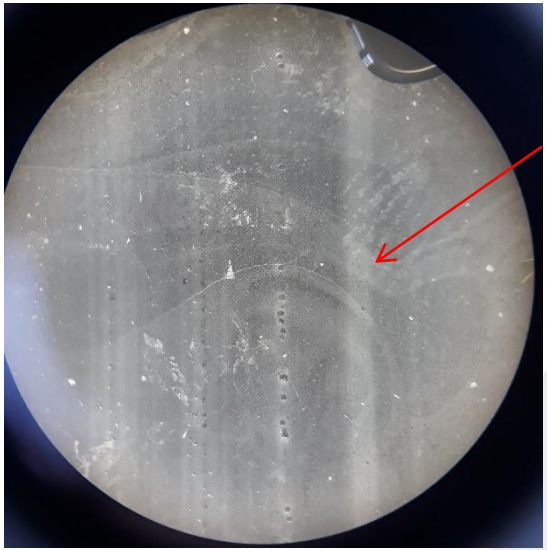
Coating and analysis of a main bearing GE 1.5 wind turbine



Picture: Before wind turbine was treated with REWITEC®



Picture: 5 months after wind turbine was treated with REWITEC®



Picture: 12 months after wind turbine was treated with REWITEC®

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

Coating and analysis of a main bearing GE 1.5 wind turbine

Picture: Before wind turbine was treated with REWITEC®

R_a = 0,556 µm (within the track)

Picture: 5 months after wind turbine was treated with REWITEC®

R_a = 0,403 µm (within the track)

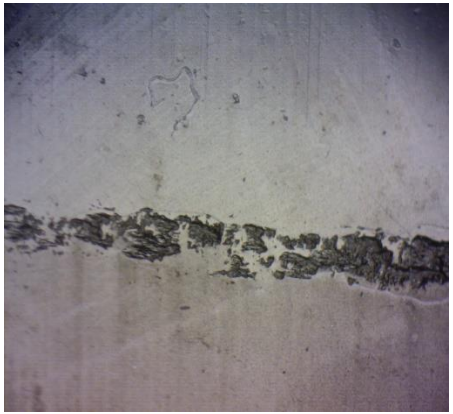
Picture: 12 months after wind turbine was treated with REWITEC®

R_a = 0,225 µm (within the track)

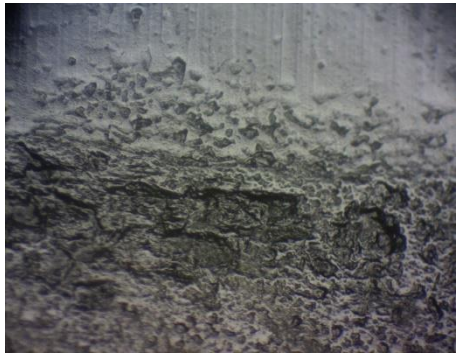
→ Red arrow shows the same track on the surface imprint

Coating and analysis of a main bearing Siemens SWT 2.3 wind turbine.

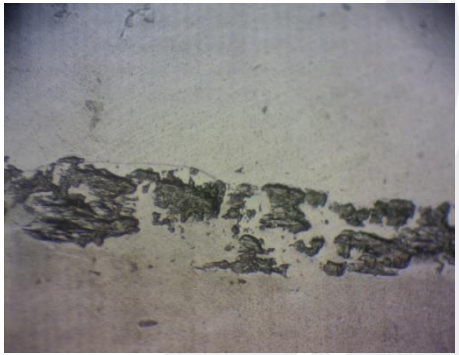
Picture: Before wind turbine was treated with REWITEC®



Picture: 2 months after wind turbine
was treated with REWITEC®



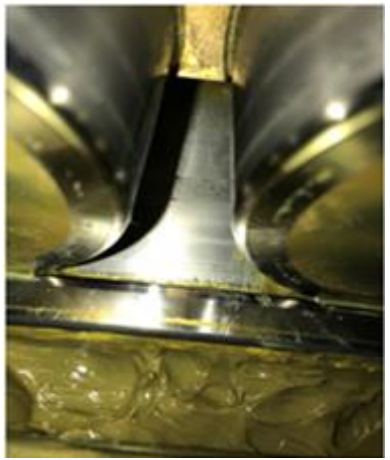
Picture: Before wind turbine was treated with REWITEC®



Picture: 2 months after wind turbine
was treated with REWITEC®

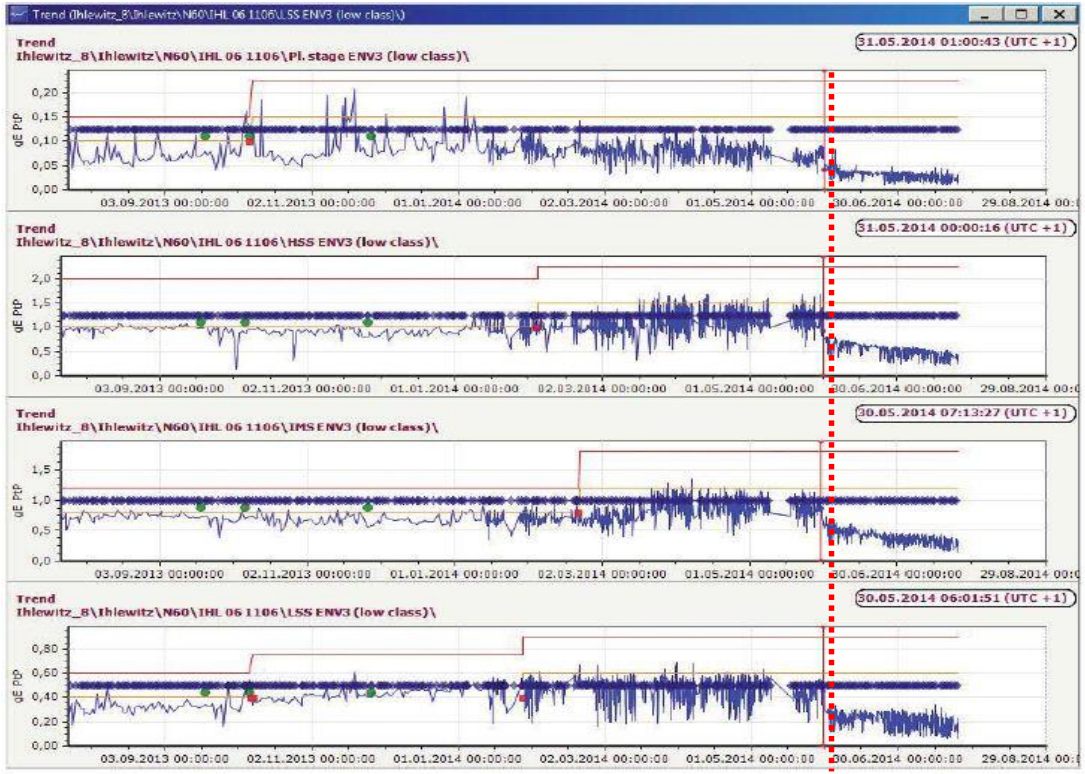
Coating and analysis of a main bearing Siemens 2.3 wind turbine.

Picture: Before wind turbine was treated with REWITEC®



Picture: After wind turbine was treated with REWITEC®

Examples of application



REWITEC

Goal of application:

- Wear protection of a Nordex N60 gearbox by REWITEC® coating concentrate in May 2014
- Protection against further wear and prolongation of lifetime
- Analysis via SKF Maintenance Services GmbH

Results after 2 months:

- The report shows a significant difference. Stop of the high vibration level, decrease of the damage frequency

REWITEC®

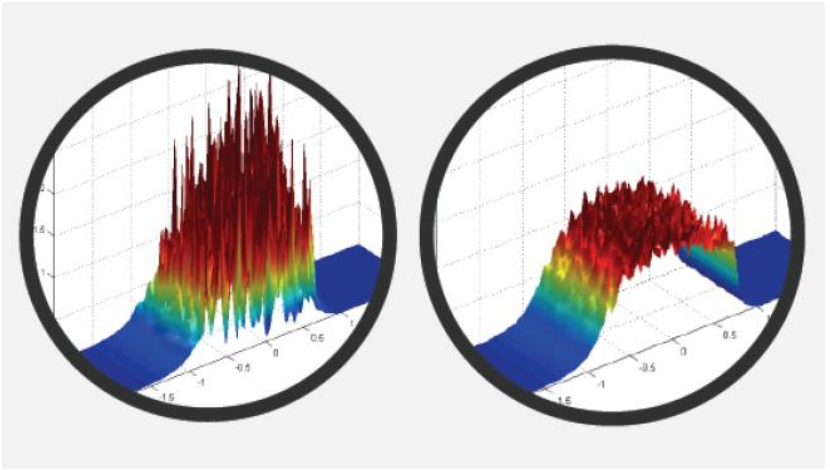
REWITEC® LIFETIME CALCULATIONS

SENTIENT SCIENCE

Mixed-EHL Solution for Life Prediction

SentientScience

Left: Surface pressure of two rough surfaces interacting without REWITEC®

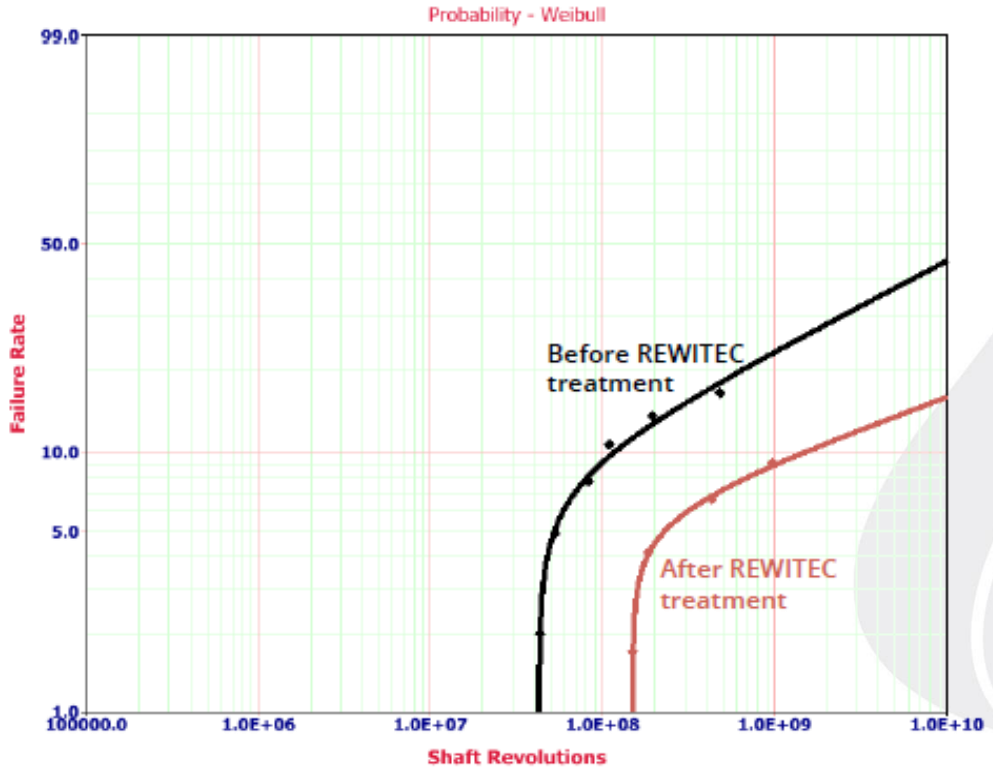


Right: Surface pressure of two smooth surfaces interacting with REWITEC®

Sentient Science
LIFETIME CALCULATIONS

Component	Simulation	Life, L50
Intermediate Pinion Bearing	Baseline	16.6 yrs
	Rewitec	> 50 yrs
	Life Extension	> 3
Planetary Bearing	Baseline	4.3 yrs
	Rewitec	14.2 yrs
	Life Extension	3.3

Component	Simulation	Life, L50
Intermediate Pinion Gear	Baseline (damaged)	2.7 yrs
	Rewitec	6.9 yrs
	Life Extension	2.6



AT A GLANCE

CONCLUSION

Conclusion

- Less surface roughness, friction and temperature in the tribological system
- Less stress and wear for the gearbox and the bearings
- Less stress for the lubricants
- Elimination of standstill marks on roller bearings

- ➢ Higher efficiency
- ➢ Higher reliability and availability, no downtime
- ➢ Cost savings, higher earnings
- ➢ Possible lifetime improvement by 2.6 – 3.3

Many thanks
FOR YOUR ATTENTION

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