

HIGHER EFFICIENCY AND LIFETIME IMPROVEMENT FOR GEARS, BEARINGS AND ENGINES





Outline



- Company and Products
- Technology
- Scientific Tests
- Examples of Application
- Gearbox and Bearing Lifetime Calculation
- Conclusion



REWITEC®

COMPANY AND PRODUCTS



<u>CRODA</u>

About Croda

The name behind the high-performance ingredients and technologies in some of the biggest, most successful brands in the world: creating, making and selling speciality chemicals that are relied on by industries and consumers everywhere.





Target Markets









WIND ENERGY

- ONSHORE
- OFFSHORE

INDUSTRY

- STEEL
- CEMENT
- MINING
- OIL, GAS

MARINE

- SHIPPING
- INLAND
- YACHTS
- SUBMARINE

AUTOMOTIVE

- CONSUMER
- OEM
- MOTORCYCLES
- RACING
- OLDTIMER





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Examples of application

- More than 3000 treated wind turbines
- Applications worldwide
- Offshore and onshore

Experience with all common wind turbine types (AN Bonus, DeWind, Gamesa, GE, Goldwind, HSW, Jacobs, NEC Micon, Nordex, Repower, Siemens, Suzlon, Tacke, Vestas, CSIC Haizhuang)



REWITEC[®] Typical damage to wind turbine gears & bearings







REWITEC®

TECHNOLOGY



Phyllosilicate based particle additive

- 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!)



Our scientific paper:

"Tribological properties of a phyllosilicate based microparticle oil additive"

Chizhik et al., Wear 426–427 (2019) 835–844

CALCE Phyllosilicate based particle additive



Significant reduction of friction, wear, roughness and temperature

Advantages:

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



REWITEC® SCIENTIFIC TESTS

Scientific tests 2-Disc assembly rolling wear test – gear oils



Supported by:





on the basis of a decision by the German Bundestag

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 %

Stress value:
Rotating speed:
Test-duration:
Temperature:
Friction coefficient:

1 GPa (normal force 2150 N) 424 rpm / 339 rpm, slip 20 % 39,3 h oil inlet temperature 60 °C μ=normal force/friction force



Scientific tests FE-8 roller bearing test



Supported by:







Speed:7.5 rpmTest duration:80 hTemperature:80°CLoad:80 kN

Advantages with REWITEC:

- 17 % less wear
- Smoother surface
- Better load distribution
- Protection for rolling elements and rings





Castrol X320 without REWITEC®





Castrol X320 with REWITEC®

Scientific tests SRV – FZG simulation



Temperature:98°CFrequency:50 HzStroke Length :4 mm

Testing concept for gear oils

Step tests with modified parameters

Hertzian surface pressure [N/mm ²]	FZG load step	SRV® normal force [N]
146	1	7
295	2	28
474	3	73
621	4	126
773	5	195
929	6	282
1080	7	381
1223	8	489
1386	9	628
1539	10	774
1691	11	934
1841	12	1107
2040	13	1360
2170	14	1538
SRVE Technology Platform	10	Excellence in Tribology

---- Castrol X320

---- Load

---- Castrol X320 + Rewitec

- 12 % wear reduction with Rewitec
- Up to 30 % friction reduction with Rewitec

Scientific tests 4 Ball test bench grease test



Supported by:

on the basis of a decision by the German Bundestag





According to DIN 51350 part 2 (welding force) / 3 (wear test):

Test load: Rotating speed: Test-duration: 2000 – 12000 N / 300 N 1450 rpm 1 min / 60 min

Test Rig	Test Method	Lubricant	Non Seizure Load [N]	Weld Load [N]	Wear Scar [mm]
VKA	Weld Load DIN 51350 Part 2	Mobil SHC Grease 681 WT	2000	2200	1.15
	Wear Scar DIN 51350 Part 3	Mobil SHC Grease 681 WT – modified with Rewitec	2400	2600	1.16

Advantages with **REWITEC**:

- 17 % higher non seizure load
- 15 % higher weld load

Scientific tests MTM test bench grease test



Load:	70 N
Temperature:	23°C
Time:	172 s

700 mm/s



Up to 38 % friction reduction with Rewitec

Scientific tests False-Brinelling test – For pitch bearing evaluation

Frequency: Oszillation angle: Axial load: Temperature: Test bearing: elements

25 Hz
+/- 0.5° -> +/- 3.0°
3 kN to 4 balls (750 N per ball)
room temperature
ARKL Type 51206 with 4 rolling





pre-damaging (1.3 h; +/- 0.5°)

Fuchs LX460





Fuchs LX460 + **REWITEC**

Run after the damaging (3 h; +/- 3°)



Supported by:



Test specimen





Static loading





Scientific tests Pin-on-disk Tribometer











Honda Ultra Next motor oil (0W-8) Room temperature; load 5 N; 4000 min⁻¹



Friction reduction 30 % after 1 hour





REWITEC TECHNOLOGY

EXAMPLES OF APPLICATION



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: Wind turbine 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

Wind Turbine Ebara 1.5 MW High Speed Shaft, Tooth Flank



Before REWITEC[®]-treatment (20.03.19)

After REWITEC[®]-treatment (03.06.19)



Coating and analysis of a main bearing GE 1.5 wind turbine



Picture: main bearing roller 18 months **before** REWITEC[®] treatment



Picture: main bearing roller 5 months <u>after</u> REWITEC[®] treatment



Coating and analysis of a main bearing (outer ring) 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 (outer ring) GE 1.5 wind turbine



-->Red arrow shows the same track on the surface imprint

· -2

-5

- -9



Main bearing (outer race) GE 1.5 wind turbine





Before wind turbine was treated with REWITEC[®]





6 months after wind turbine was treated with REWITEC[®]



Roughness	Before	After	Difference
S _a	3.00 µm	1.47 μm	- 51 %
Sz	56.7 μm	19.8 µm	- 65 %
R _a	0.789 μm	0.600 µm	- 24 %
R _z	4.10 μm	3.38 µm	- 18 %

Coating and analysis of a main bearing GE 1.5 wind turbine





Roughness	Before	After	Difference
S _a	0.266 µm	0.159 μm	- 40 %
Sz	22.2 μm	11.6 µm	- 48 %
R _a	0.145 μm	0.064 μm	- 56 %
R _z	1.31 µm	0.767 μm	- 41 %

Coating and analysis of a main bearing GE 1.5 wind turbine





Coating and analysis of a main bearing <u>Siemens 2.3</u> wind turbine.



Picture: <u>Before</u> wind turbine was treated with REWITEC^*



Picture: <u>After</u> wind turbine was treated with REWITEC[®]

Wind turbine 1.5 MW GE 1.5





Before REWITEC[®]-treatment





Examples of application

Nissan GT-R R32 engine treatment by M. Krumm



Test dynamometer:

Dynapack Chassis Dynamometers Evolution 3000

Baseline: 281 BHP / 348 Nm

Treatment with REWITEC[®] PowerShot[®] L (29.01.2016) Improvement after 2 h: **+16 BHP / 15 Nm**

Additional transmission treatment with REWITEC[®] G5 (30.01.2016)

Complete end-result-improvement after 6 weeks: +28 BHP



Examples of application:

Nissan GT-R R32 engine treatment by M. Krumm











17.03.2016

Examples of application

Application in Audi A3 1.4 TFSI

All measurements performed in 3th gear







Scientific testings

Application in BMW X1:

- 2010 model, 3.000 ccm, all-wheel drive
- 11739 km after REWITEC application
- 5% lower fuel consumption





Compression Readings



Examples of application: Coating and analysis of a diesel generator

<u>Task:</u>

Fuel saving

Result:

In long-term testing with certificated measurement instruments, the following was noted:

• Up to 9 % fuel savings in the tested diesel generator







Examples of application: Coating and analysis of a ship generator

<u>Task:</u>

Fuel saving

Result:

In long-term testing with certificated measurement instruments, the following was noted:

- Significant fuel savings in the tested diesel generator "Daihatsu 6 DK28"
 - \rightarrow 3,8% fuel consumption reduction





Scientific tests Pin-on-disc test – Exxon Marine Oils





Oil Mobilgard 412 for A/E Oil Mobilgard 300C for M/E Circ. Oil Mobilgard 5100 L.O. Cyl.

Parameter: 70° C; 7 N; 2,500 min⁻¹



REWITEC® WIND TURBINE LIFETIME CALCULATIONS SENTIENT SCIENCE

Sentient Science Lifetime Calculation



Calculation based on bearing geometry, friction coefficient and surface topography:





Sentient Science Lifetime Calculation



Acciona AW1500 Generator Side Mainshaft bearing – SKF 23188



Sentient Science Lifetime Calculation



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



Conclusion

- Significant reduction friction and temperature
- Repair and protection effect, wear reduction
- Lower roughness, better load distribution
- ➢ Higher efficiency
- Higher reliability and availability, no downtime
- Significant lifetime improvement
- Cost savings, higher earnings





Our services





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