REWITEC™
A Cargill Company

Wind turbines

REWITEC™ Application guide

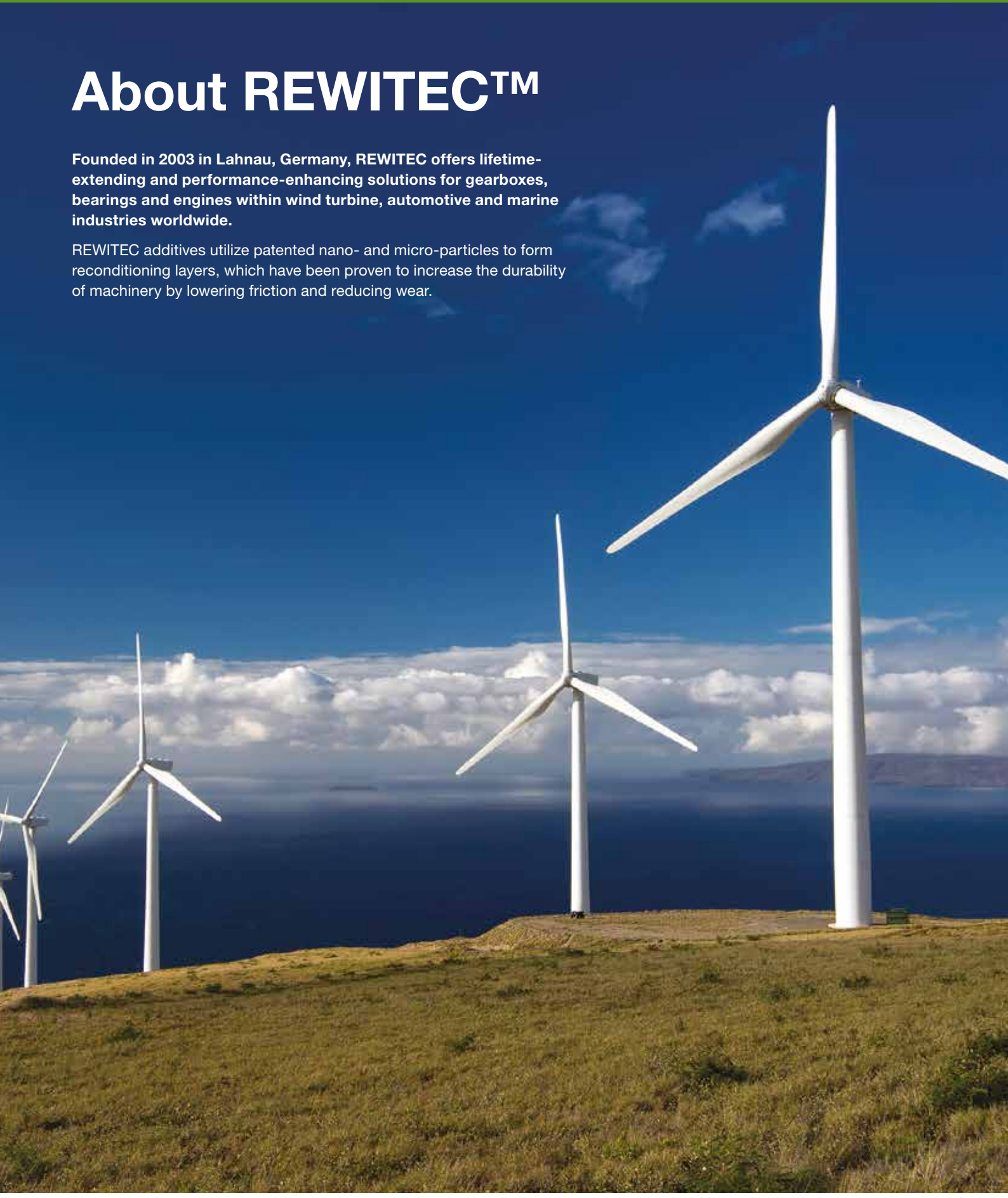
Cargill®

Contents

About REWITEC™

Founded in 2003 in Lahnau, Germany, REWITEC offers lifetime-extending and performance-enhancing solutions for gearboxes, bearings and engines within wind turbine, automotive and marine industries worldwide.

REWITEC additives utilize patented nano- and micro-particles to form reconditioning layers, which have been proven to increase the durability of machinery by lowering friction and reducing wear.



Technology for improved performance

Moving machinery poses many challenges to engineers everywhere: How to improve durability, longevity and reduce frictional losses? Frictional losses can significantly increase costs associated with down time, repair and replacement of components; as well as reduce energy efficiency.

REWITEC helps to address these challenges, protecting investments against wear and premature failure. REWITEC products improve the service life of lubricated moving machinery across a range of applications including wind turbines, marine, manufacturing, heavy industry, automotive and more.

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Wind Energy

Manufacturers and operators of wind turbines rely on smooth and continuous operation. REWITEC offers innovative ingredients for the wind industry that are able to prolong asset life and improve operational safety.

MAIN GEARS • MAIN BEARINGS • GENERATOR BEARINGS • PITCH AND AZIMUTH GEARS/BEARINGS

Industry

REWITEC offers long-term investment protection for engines, transmissions and bearings,leading to reduced downtime for maintenance.

GEARBOXES • GENERATORS • COMPRESSORS • BEARINGS

Marine

Low sulfur fuels can have a negative impact on marine 2-stroke engines. REWITEC can improve operational reliability in these challenging conditions, as well as in auxiliary 4-stroke engines and other lubricated moving machinery.

MAIN ENGINES & AUXILIARY DIESELS • WINCHES • SEPARATORS

Automotive

REWITEC provides a multitude of benefits for automotive applications. The mechanism of action of REWITEC allows for improved energy efficiency as well as reduced vibrations, noise and torque. REWITEC products are also suitable for construction and performance racing vehicles, having outstanding effects.

ENGINES • GEARBOXES • BEARINGS • DIFFERENTIALS

Introduction

A different perspective to lubrication

Although tribological research has made significant progress in recent years, especially in the field of computer simulation, it is still difficult or impossible in many cases to record all the influencing parameters on wear and tear.

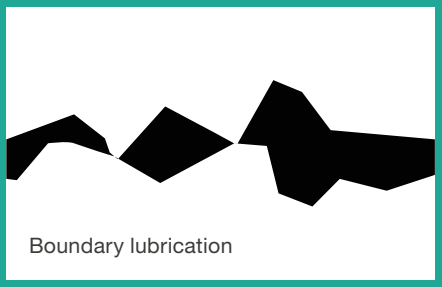
Therefore, since establishing ourselves in the field of lubrication, we have developed an unrivalled relationship with our customers and continue to work side-by-side with them in the field to understand and categorise the different challenges that they face.

This manual is mainly intended to assist service and maintenance personnel with the analysis and assessment of wear problems.

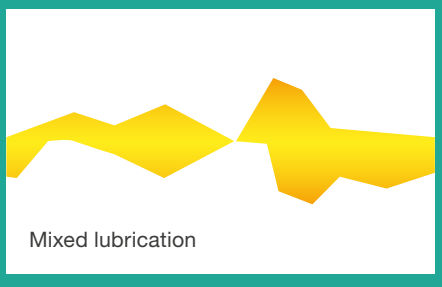
By providing this information, we hope to demonstrate that REWITEC is a key partner in overcoming your lubrication challenges and resolving them to optimise the reliability and safety of your wind turbine assets.

Lubrication regimes

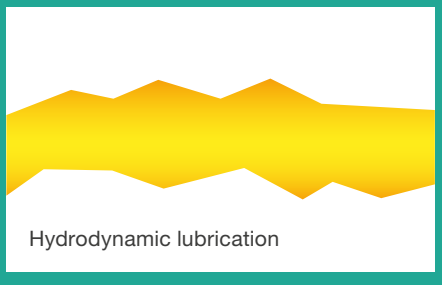
There are different types of lubricating regime, each describing the type of lubricating film that is created under specific operating conditions, and which are dependent on the degree of contact between two metal surfaces. Each regime is described below.



Boundary lubrication



Mixed lubrication



Hydrodynamic lubrication

Boundary lubrication

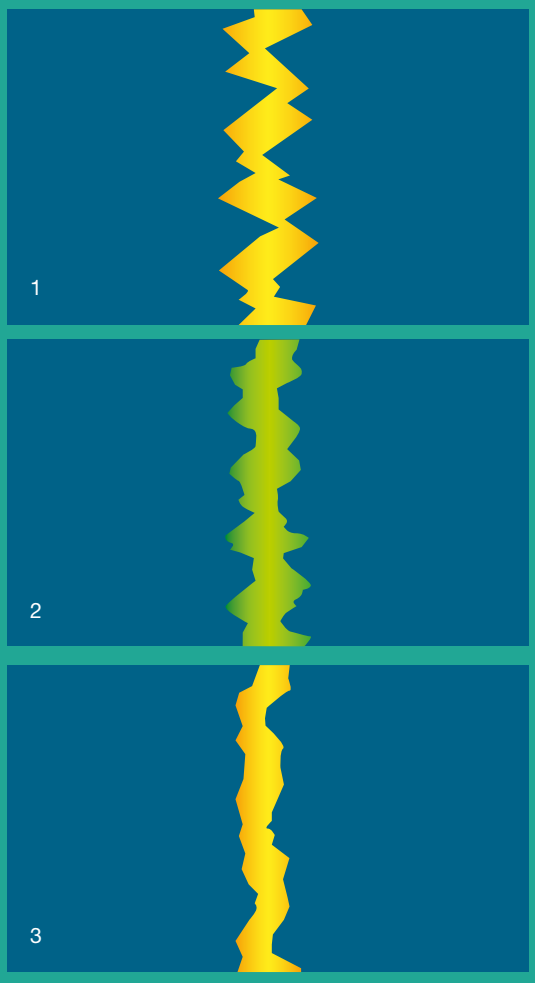
In the boundary lubrication regime, metal surfaces rub directly against each other without a lubricating film. Friction resistance and wear and tear are both high. Very high local temperatures can build up, which can lead to the jamming and destruction of touching parts. The boundary regime is commonly encountered when machinery is started up, but can occur in extreme circumstances, for example in case of failure of the supply of lubricant to the location of friction.

Mixed lubrication

There is no complete lubricating film between the metal surfaces, and different roughness peaks can touch each other. This condition always occurs in gearboxes and bearings during start-up and shut-down. Lubricants and additives are therefore essential in forming protective and reactive layers on sliding metal surfaces, to reduce friction and minimise wear.

Hydrodynamic lubrication

Both metal surfaces are separated completely by a lubricating film; friction (power loss) is low and wear and tear is equal to zero. This is the ideal condition.



How REWITEC makes a difference

The power of REWITEC

1. Damaged metal surfaces within a gearbox or bearing increase the likelihood of failure. The existing lubricant is used as a carrier to deliver REWITEC technology to the mixed friction areas within the lubricated component.

2. The REWITEC particles react to the increased temperatures produced in the mixed friction zones, forming a protective and reparative layer.

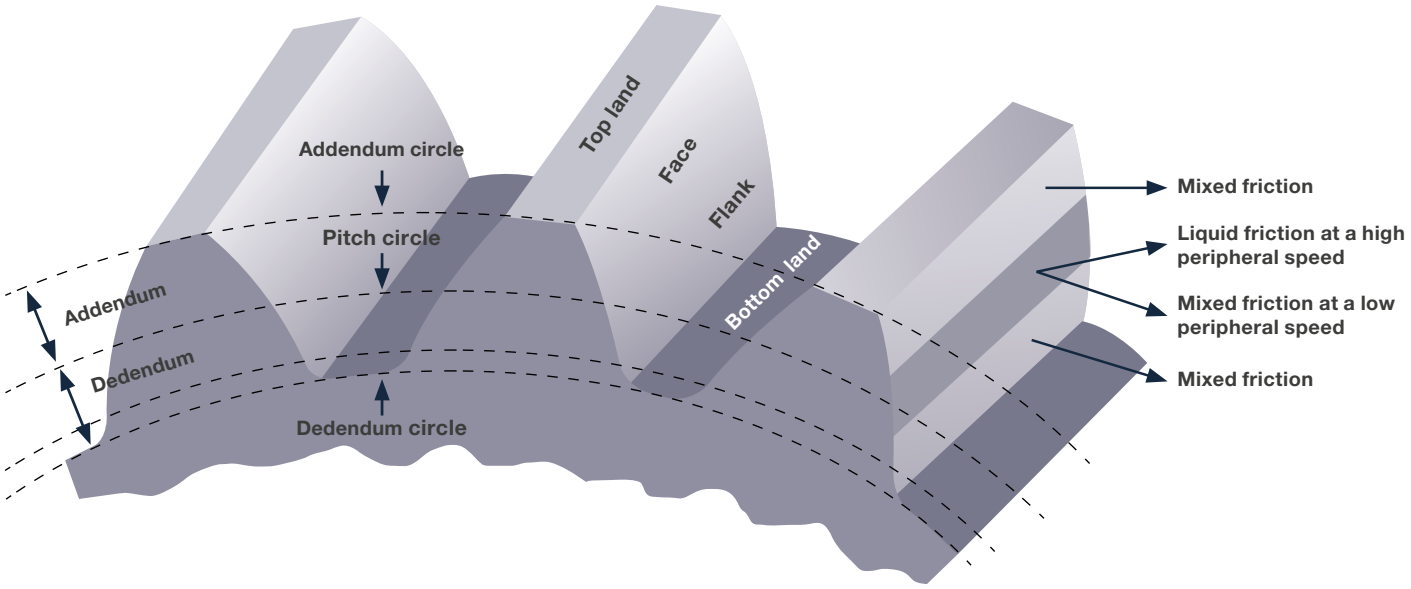
3. The modified surfaces provide a more even load distribution and friction, wear and temperatures become significantly reduced. The properties of the existing lubricant remain unchanged.

REWITEC: A multi-modal solution

Different lubrication conditions inevitably occur in mechanical systems, dependent on the changing load conditions in the metal contact zones and the lubricant used.

Consider a gear tooth flank, drawn in the schematic below. Desirable hydrodynamic lubrication is generally only achieved at high circumferential speeds or low loads, whilst mixed lubrication is experienced under non-ideal conditions causing increased wear. As such, the different contact loads and contact angles of the gear tooth mean both lubrication mechanisms can exist at any one time.

REWITEC products are suitable for systems that experience both hydrodynamic and mixed lubrication regimes. A onetime application with REWITEC may be all that is required to solve wear problems and prolong the life of your delicate and complicated tribosystem.



Common damage and failure modes in gears and bearings

There are many factors that can lead to wear and damage within gear and bearing components. Poor lubrication systems can contribute, as well as environmental factors including rain and salt ingress during operation. The schematic below shows some of the main damage and failure modes that can occur within these important components.

Micropitting/grey staining

Degradation of gear tooth working surfaces under lubrication conditions where the film is too thin for the load. It appears under magnification as dense patches of micropits or microcracks.

Fretting corrosion

Surface damage caused by repeated small movements of one contacting surface over another with the formation of fine reddish/brown oxide particles.

Macropitting

Visible pits which are formed when small cracks get larger to the point where material is broken off.

Chemical corrosion

Surface degradation caused by chemical attack.

False brinelling

When a stationary component moves very slightly. It rocks against another. It pushes out the grease and can create indentations in the bearing and eventually parts can weil together.

White etching areas/cracks (WEAs)

Structural changes in the metal that form below the surface - subject to continuous debate as to their source

Smearing and scuffing

Caused by roller/raceway sliding under boundary/mixed lubrication. localised heating due to poor lubrication.

Electic arc damage

Caused by poor earthing, insulation or by induction effects allow electrical discharge through the bearing. Can melt surfaces and create small craters in the metal. Also causes fluting, where the bearing can give a washboard appearance which causes vibration.

Bearing damage classification

Damage to bearings is classified by ISO standard 15243:2017-03, as well as DIN 50320.

The damage classification tool below helps you identify how and when REWITEC products can make a difference.

- Initial, low severity damage can be reversed with REWITEC
- Further damage stopped, REWITEC provides an extension to the lifetime of the component that displays this damage mode
- Advanced damage, application not recommended, or due to its nature, damage cannot be treated with REWITEC

Wear terminology according to ISO 15243:2017	Wear resistance according to DIN 50320				REWITEC application		
	Adhesion	Abrasion	Surface breakdown	Tribochemical reaction	Recommended	Succesful application possible	Limited effectiveness
Rolling contact fatigue			●			●	●
Subsurface initiated fatigue			●			●	●
Surface initiated fatigue			●			●	●
Wear	●	●			●	●	
Abrasive wear		●			●	●	
Adhesive wear	●				●	●	
Corrosion				●		●	
Moisture corrosion				●		●	
Frictional corrosion				●		●	
Fretting corrosion				●			●
False brinelling			●		●	●	
Electrical erosion		●	●	●			●
Excessive current erosion		●	●	●			●
Current leakage erosion		●	●	●			●
Plastic deformation			●				●
Overload deformation			●				●
Indentations from particles			●				●
Cracking and fracture			●				●
Forced fracture			●				●
Fatigue fracture			●				●
Thermal cracking			●				●

Tooth flank damage classification

Damage on tooth flanks is classified by ISO standard 10825:1995 and DIN 50320.

The damage classification tool below helps you identify how and when REWITEC products can make a difference.

- Initial, low severity damage can be reversed with REWITEC
- Further damage stopped, REWITEC provides an extension to the lifetime of the component that displays this damage mode
- Advanced damage, application not recommended, or due to its nature, damage cannot be treated with REWITEC

Wear terminology according to ISO 10825:1995	Wear resistance according to DIN 50320				REWITEC application		
	Adhesion	Abrasion	Surface breakdown	Tribochemical reaction	Recommended	Succesful application possible	Limited effectiveness
Indications of surface disturbances	●				●	●	
Sliding wear	●	●			●	●	
Normal wear (running-in wear)	●	●			●	●	
Moderate wear	●	●			●	●	
Polishing		●			●	●	
Abrasive wear		●			●	●	
Excessive wear		●			●	●	
Moderate scratching (scoring)		●			●	●	
Severe scratching		●			●	●	
Interference wear						●	●
Corrosion				●	●	●	
Chemical corrosion				●	●	●	
Fretting corrosion				●	●	●	●
Scaling				●		●	●
Overheating				●		●	●
Erosion		●	●	●			●
Cavitation erosion		●	●	●			●
Hydraulic erosion		●	●	●			●
Electric erosion					●	●	
Scuffing	●				●	●	
Permanent deformations			●			●	

Wear terminology according to ISO 15243:2017	Wear resistance according to DIN 50320				REWITEC application		
	Adhesion	Abrasion	Surface breakdown	Tribochemical reaction	Recommended	Succesful application possible	Limited effectiveness
Indentation			●			●	
Plastic deformation			●			●	
Plastic deformation by rolling			●			●	
Plastic deformation by tooth hammer			●			●	
Rippling			●			●	
Ridging			●			●	
Burrs			●				●
Surface fatigue	●				●	●	
Pitting	●		●		●	●	
Initial pitting	●		●		●	●	
Progressive pitting	●		●		●	●	
Micro pitting	●		●		●	●	
Flake pitting	●		●			●	
Spalling	●		●			●	
Case crushing	●		●			●	
Fissures and cracks			●			●	●
Hardening cracks (quench cracks)			●			●	●
Grinding cracks			●			●	●
Fatigue cracks			●			●	●
Tooth breakage			●				●
Overload breakage			●				●
Brittle fracture			●				●
Ductile fracture			●				●
Semi-brittle fracture			●				●
Tooth shear			●				●
Breakage after plastic deformation (smeared fracture)			●				●
Fatigue breakage			●				●
Bending fatigue			●				●
Tooth end breakage			●				●

Gear tooth damage classification

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The following pictures illustrate various types of damage to gear tooth flanks and bearings. The photos were taken at various wind turbine sites.

3.1 Moderate wear

Definition according to ISO 10825:1995

Examination of gear tooth flanks reveals that metal has been removed from both the addendum and dedendum tooth surfaces.The pitch surface begins to show a continuous line as pictured in Figure 1.

- Moderate wear can be repaired, stopped or prevented by the use of REWITEC products.

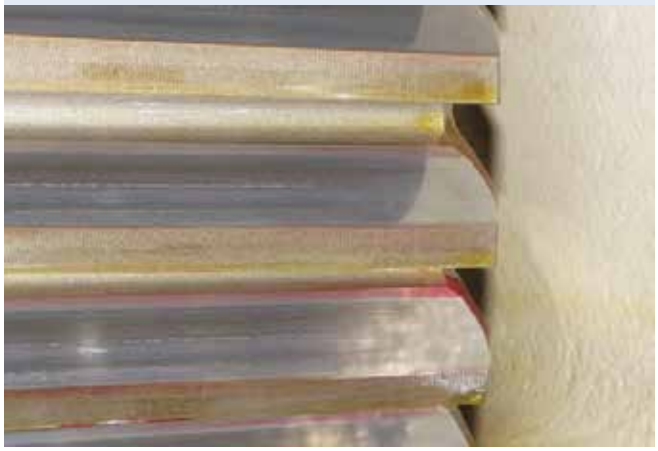

Figure 1 Wear observed on metal gear teeth

3.2 Overload breakage

Definition according to ISO10825:1995

Three types of overload fracture are possible:

- Ductile fracture
- Brittle fracture
- Semi-brittle fracture.
- Overload breakages cannot be restored with REWITEC products

Figure 2 Overload breakage on a tooth flank

3.2 Overload breakage

Definition according to ISO10825:1995

Three types of overload fracture are possible:

- Ductile fracture
- Brittle fracture
- Semi-brittle fracture.
- Overload breakages cannot be restored with REWITEC products

Figure 3 Overload breakage on a tooth flank

3.3 Interference wear

Definition according to ISO 10825:1995

Wear at the tip of one tooth or at the root of the mating tooth can be caused by excess material at the tip of one or at the roots of the complementary contact surface. The result is scraping and wear of both roots and tips of the teeth, hollowing the former and rounding the latter.

- Interference wear may be caused by errors in design or manufacture. These faults cannot be remedied with the use of REWITEC products but treatment with REWITEC may freeze the symptoms and further delay the replacement of the gearbox.

Figure 3 Interference wear

3.4 Chemical corrosion

Definition according to ISO 10825:1995

Surface degradation by chemical attack leads to symptoms such as fine pitting over the entire tooth surface and grain boundary oxidation. Sometimes, reddish brown rust traces are found, usually near active parts of the tooth flanks. Low corrosion on gear tooth surfaces are a result of chemical attack.

- Chemical corrosion can be reduced, removed or prevented with the use of REWITEC products.

Figure 4 Visible corrosion at the tooth flank

3.5 Fretting corrosion

Definition according to ISO 10825:1995

Fretting corrosion is a type of surface damage caused by repeated small movements of one contacting surface over another with the formation of fine reddish-brown oxide particles. These remain in the contact zone and their abrasive action adds to the rate of surface deterioration. Stationary gears may be thus affected if they are subjected to structure-borne vibrations such as those encountered during transport.

- Fretting corrosion can be reduced, removed or prevented with the use of REWITEC products.

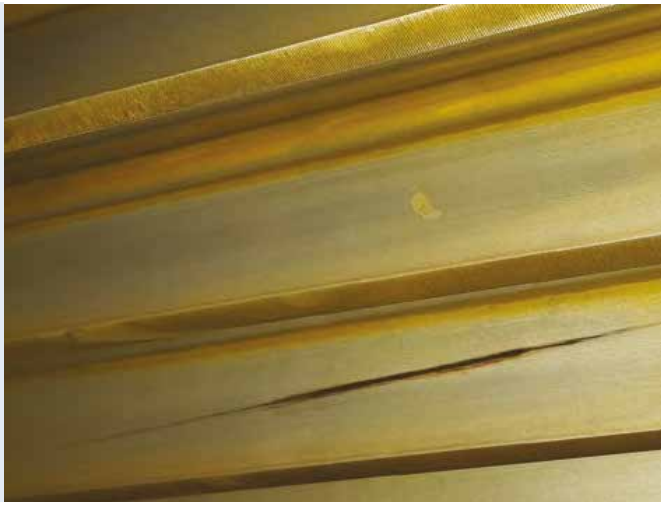

Figure 5 Fretting corrosion across the tooth flank

3.6 Pitting

Definition according to ISO 10825:1995

Surface fatigue phenomena occurring in the presence of rolling or mixed rolling and sliding contacts. Particles break out of the affected areas leaving surfaces pock marked with scattered holes.

- Pitting can be repaired, stopped or prevented by the use of REWITEC products.

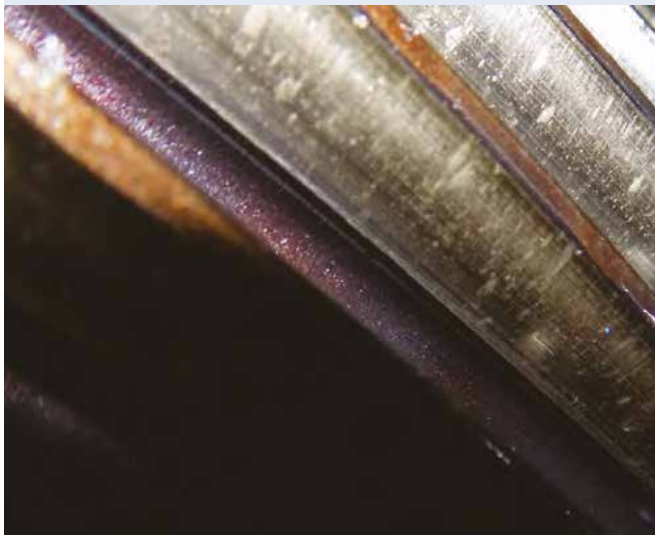

Figure 6 Visible pitting

3.7 Micropitting

Definition according to ISO 10825:1995

Degradation of gear tooth working surfaces under lubrication conditions where the film is too thin for the load. It appears under magnification as dense patches of micropits or microcracks.

Figure 7 impressively shows micropitting damage.

- Micropitting can be repaired, stopped or prevented by the use of REWITEC products.

Figure 7 Tooth flank with micropitting and corrosion

3.8 Flake pitting

Definition according to ISO 10825:1995

A form of tooth-surface damage involving the breaking out of thin flakes of material of a comparatively large area, leaving shallow cavities of roughly constant depth shaped like inverted triangles. Flake pitting present on the active flanks of heavily crowned spur gear. This through-hardened gear sustained a heavy overload which was the cause of the damage, as you can see in figure 8.

- Further damage due to flake pitting can be reduced or stopped with the application of REWITEC.

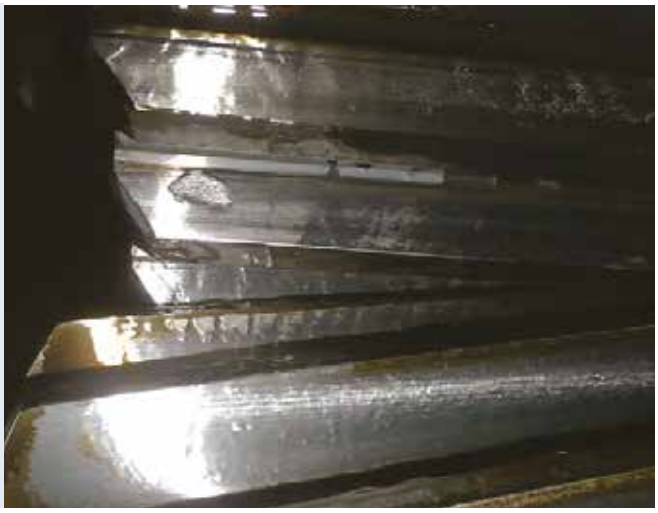

Figure 8 Visible corrosion at the tooth flank

Bearing damage classification

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Halting further damage

The following examples of damage cannot be repaired, but can only be stopped in order to wait for a replacement during a low wind period.

4.1 Surface fatigue phenomena

Definition according to ISO 15243:2004

Material damage due to surface and subsurface stresses produced by the repeated application of forces. It is characterised by removal of metal and formation cavities.

Damage of this type is classified as fatigue damage and not wear.

- The spread of damage to previously damaged surface can be stopped with the use of REWITEC products.

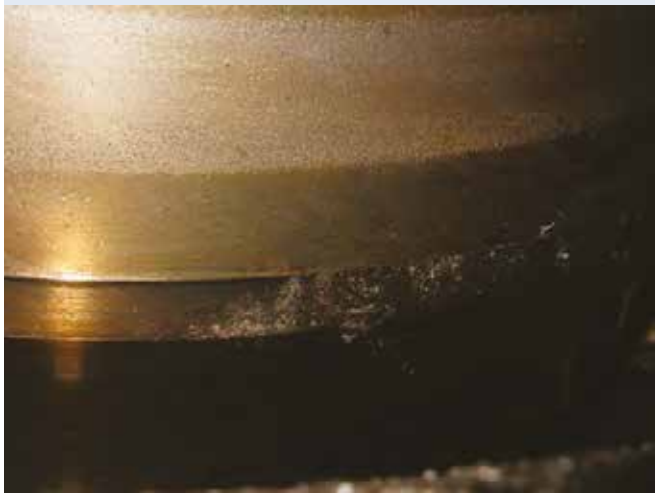

Figure 9 Surface fatigue phenomena on a bearing ring

4.2 Pitting on a bearing element

Figure 10 shows pitting on a cylinder roller bearing, a damage mode that can not be repaired using REWITEC technology. The technology does allow for the damage to be stopped and prevents worsening, until the part can be replaced during a low wind period.

- The spread of damage to previously damaged surface can be stopped with the use of REWITEC products.

Figure 10 Pitting on a cylinder roller bearing

4.3 Fatigue on a bearing element

Figure 11 shows an endoscopic diagnosis performed on a cylinder roller bearing. A tear can be clearly seen, as well as the significant effect of tribological and usage-related fatigue.

- Further damage due to fatigue can be reduced or stopped with the application of REWITEC.

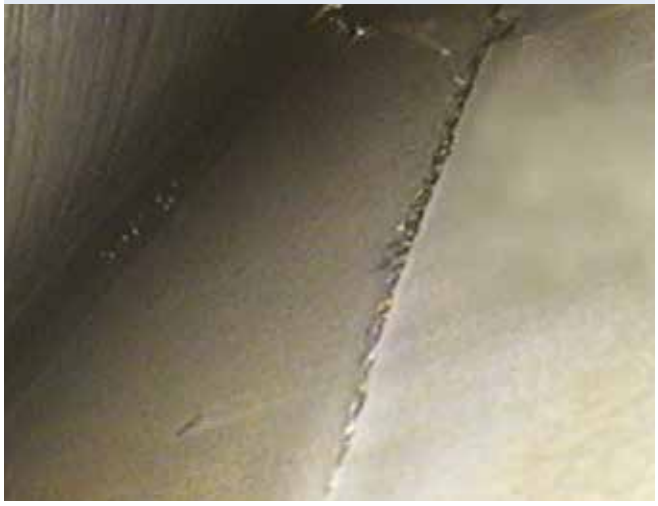

Figure 11 Fatigue phenomena of a bearing element

4.4 Spalling damage

Figures 12 and 13 show spalling damage on a bearing.

- Further damage due to spalling can be reduced or stopped with the application of REWITEC.

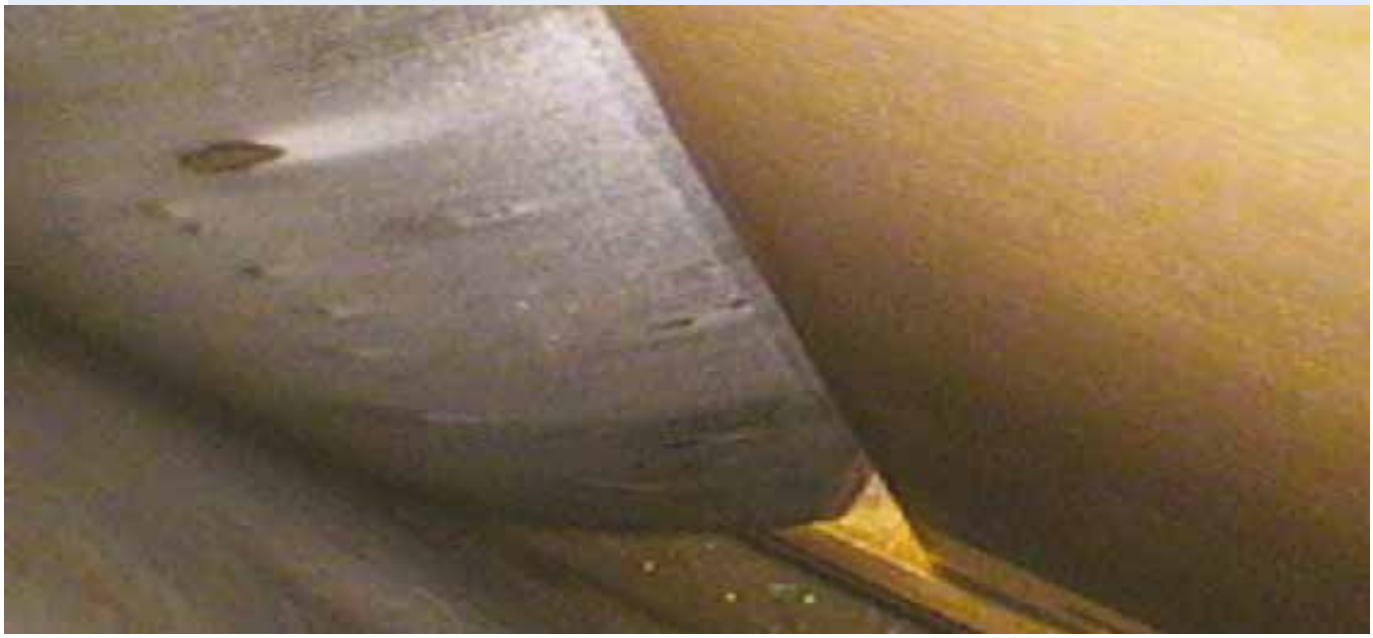

Figure 12 Spalling on a bearing

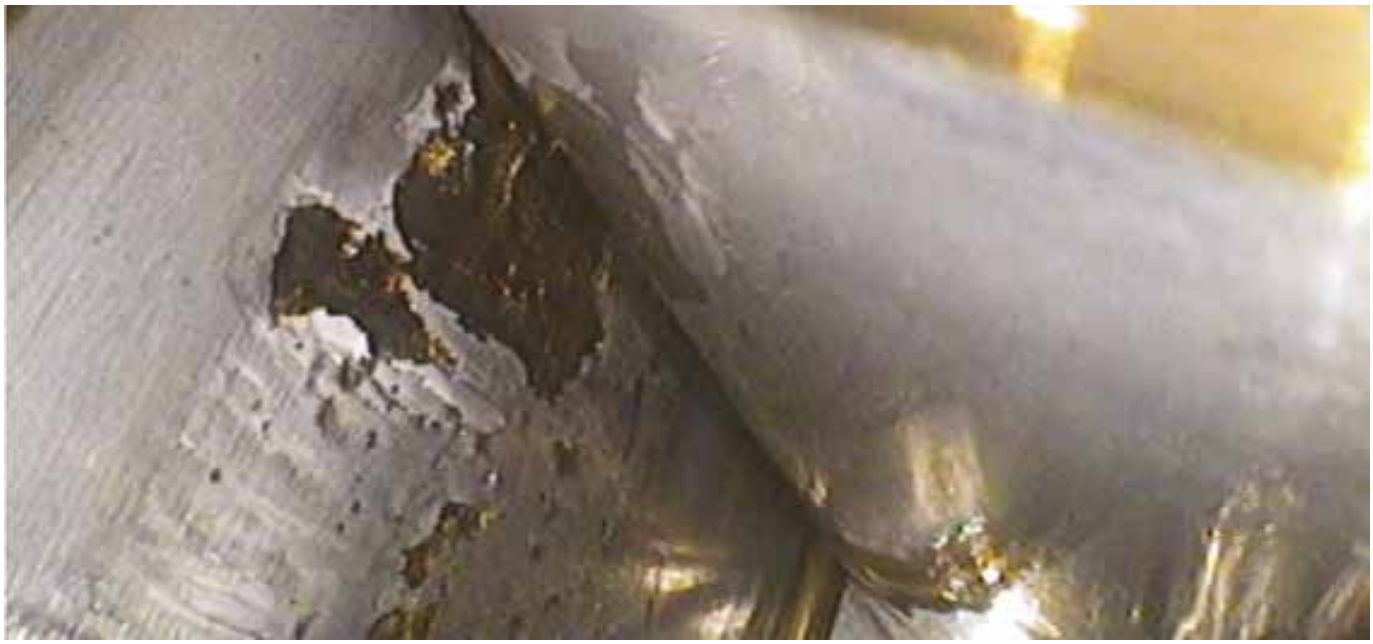

Figure 13 Spalling on a bearing

REWITEC in action

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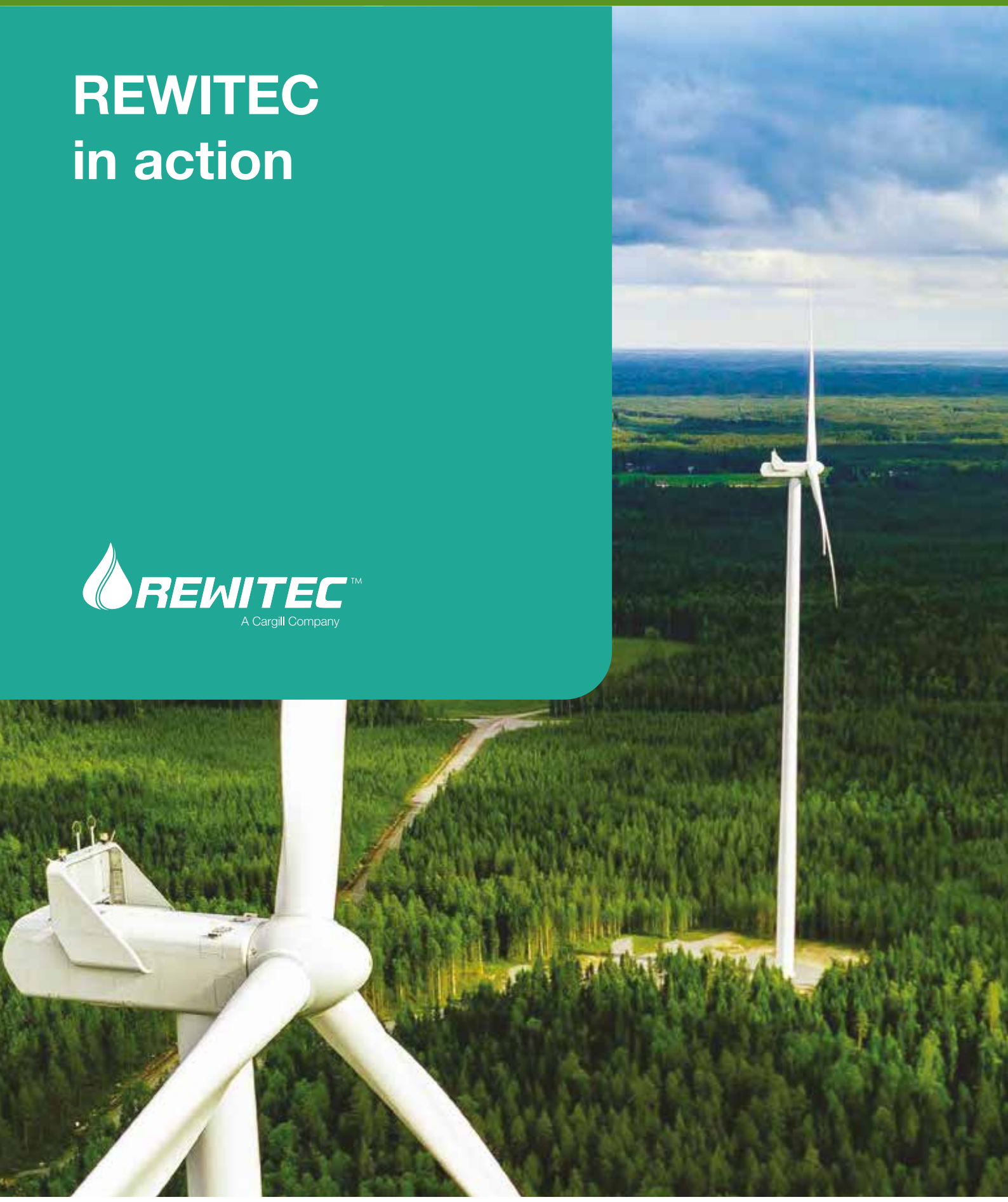

Before and after REWITEC application

The photographic examples in this section show the positive effects that REWITEC can impart onto damaged metal surfaces. Figure 14 shows micropitting and corrosion before an application with the surface treatment additive REWITEC Duragear W100.

Figure 14 Micropitting and corrosion before the REWITEC application

Figure 15 Micropitting after the REWITEC application

In Figure 15 you can see the same location **after six months** of operation and the dramatic improvement in surface finish and appearance. These pictures exemplify the reparative nature of REWITEC

Figure 16 shows grooves on a roller bearing element of a planetary bearing. The image on the left is before the application of REWITEC, the image on the right is 7 months after REWITEC was applied.

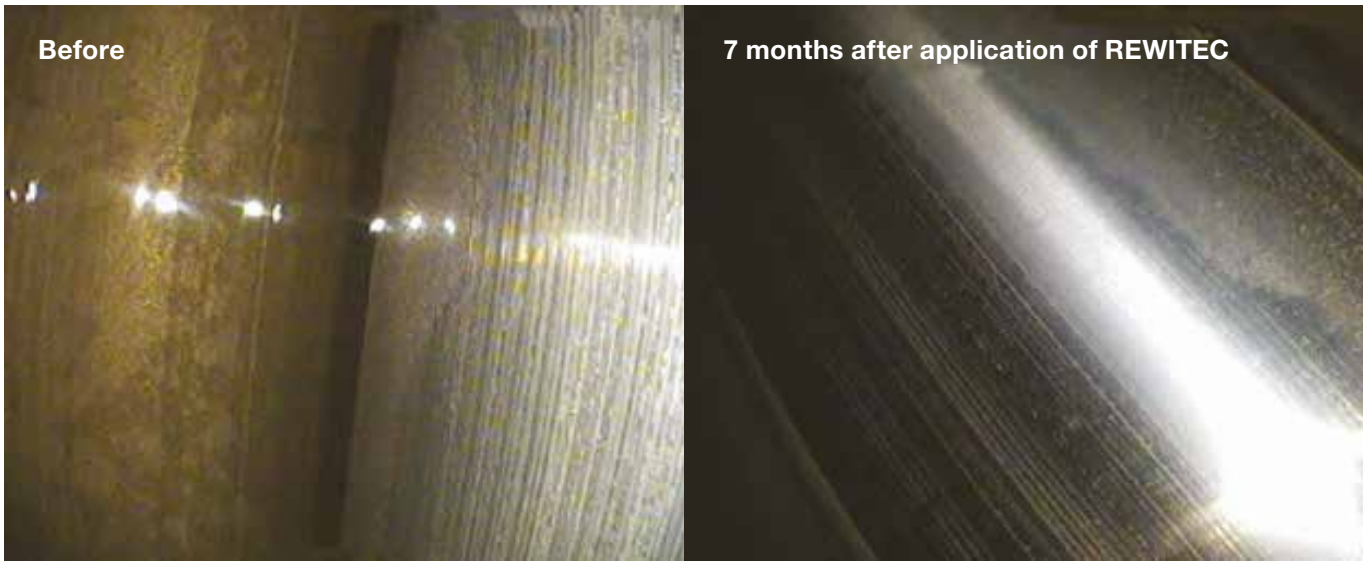

Figure 16 Surface grooves at planetary bearing before and after the application of REWITEC

The following two examples show a rolling element in a planetary bearing within the gearbox of a GE 1.6 SL wind turbine. The rolling element had considerable surface damage. The maintenance team recommended that the gearbox be replaced within six months of the date of the “before” image. The operator searched for a temporary solution before replacing the whole gearbox and decided to use REWITEC DuraGear W100. The gearbox ran for an additional two years without failure, before being replaced.

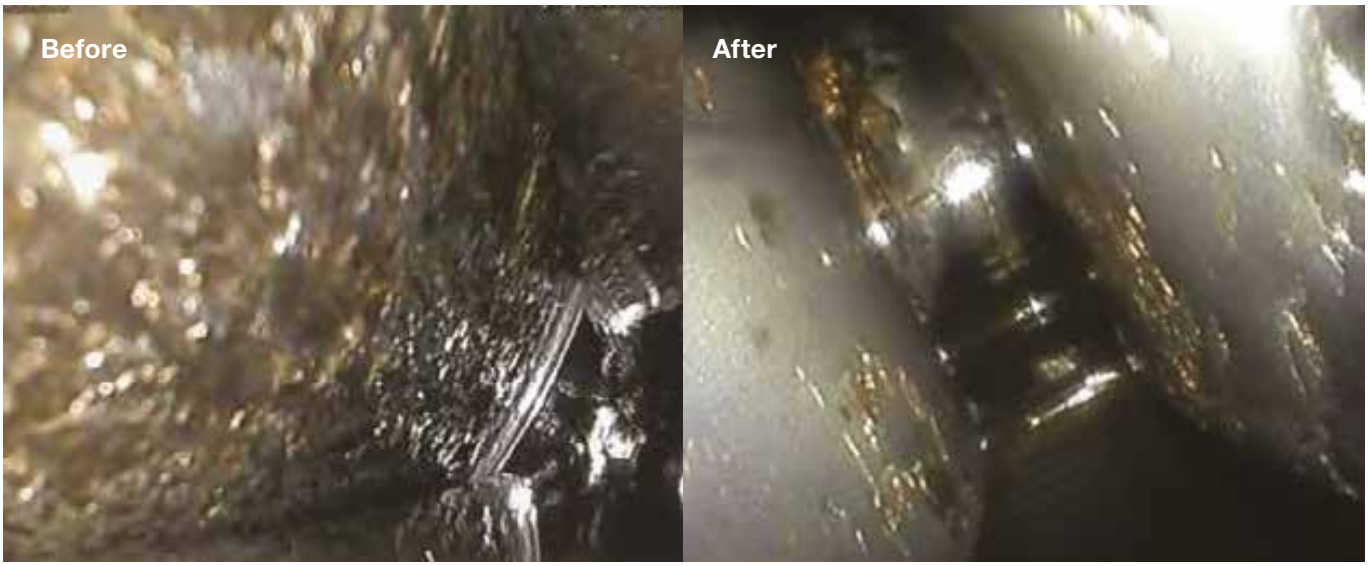

Figure 13 Figure 17 Rolling element in a planetary bearing, before and after the application of REWITEC

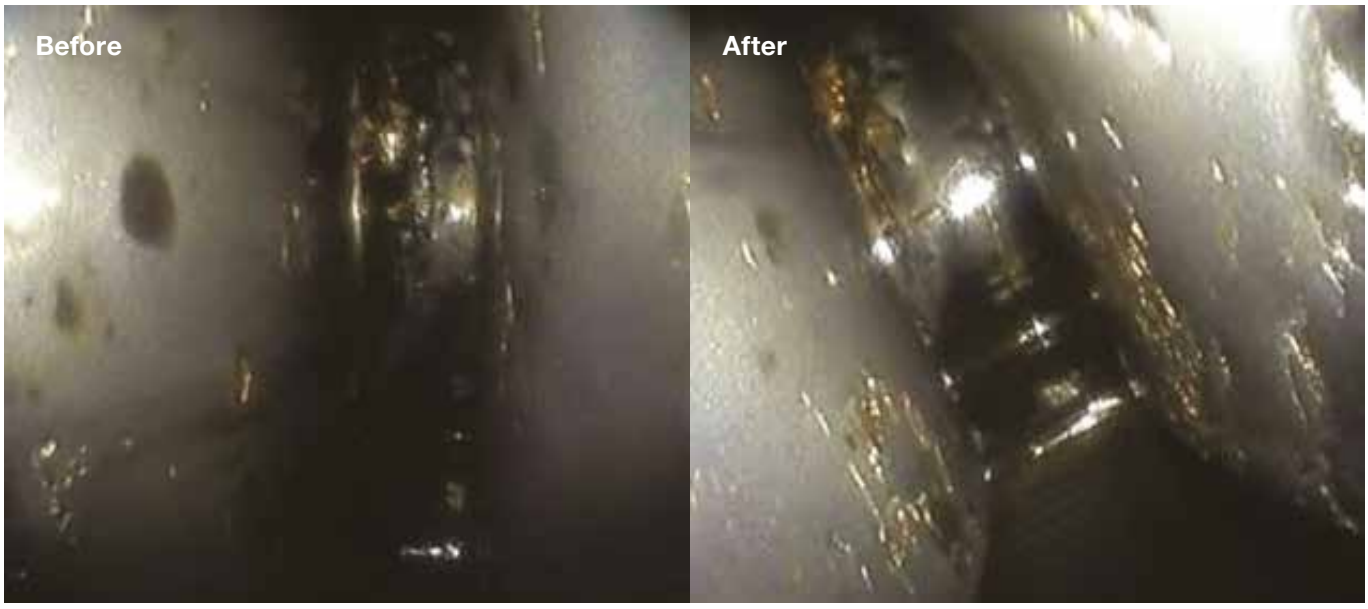

Figure 18 Rolling element in a planetary bearing, before and after the application of REWITEC

In Figure 19 you can see micropitting on a cylinder roller bearing before and after REWITEC application. The images were taken from an endoscopy report.

Figure 19 Micropitting on a bearing element before and after the application of REWITEC

Figure 20 shows wear damage on the sun pinion. In the after picture you can see a matt surface with diminished passages.

Figure 20 Sun pinion wear, before and after the application of REWITEC

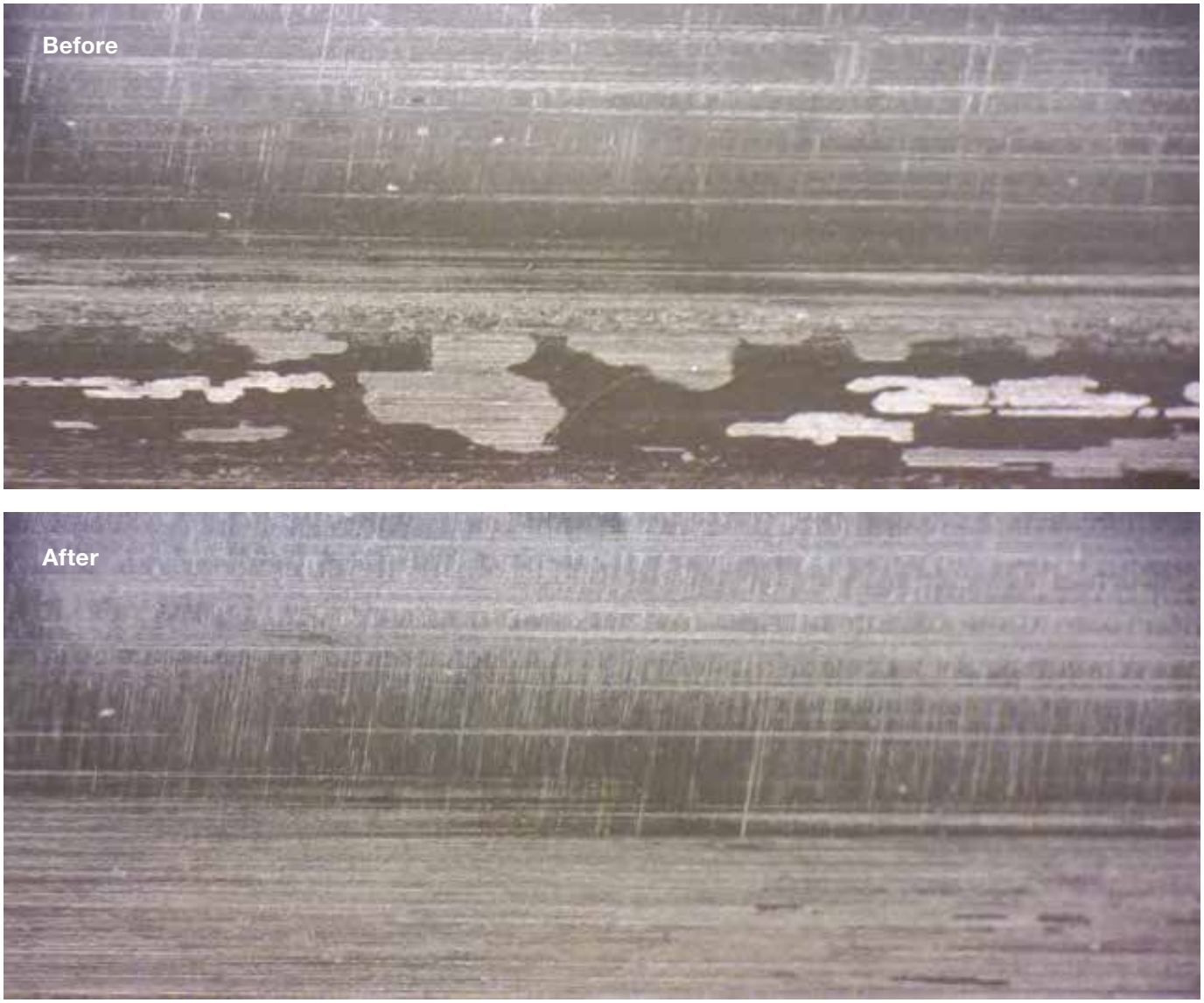

Figure 21 Comparision of micropitting damage, before and after application of REWITEC. Analysis was carried out using REWITEC replica set imprints and light microscopy

Surface analysis

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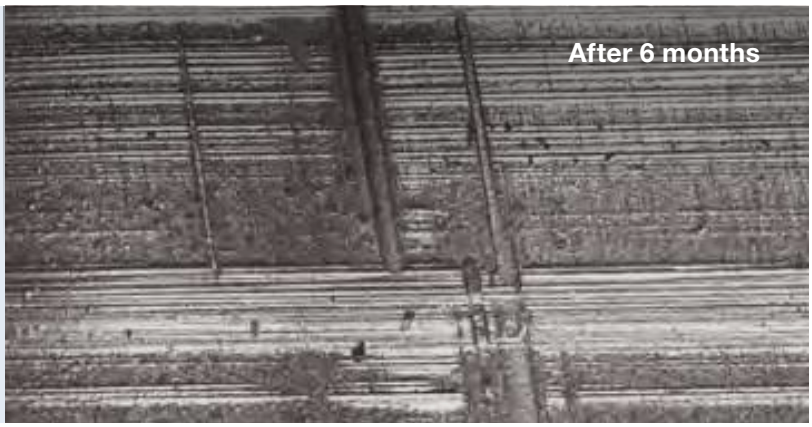
Under the microscope

Laser confocal microscopy (20-fold magnification) was used to evaluate the gear tooth of a GE 1.5 SL wind turbine. The impressions were taken at the same point on the gear tooth over a period of two years.

Surface wear on gear tooth of GE 1.5 SL wind turbine

Surface roughness

- R_a = 7.606 µm
- R_z = 238.547 µm



Surface roughness

- R_a = 3.464 µm
- R_z = 133.443 µm

Reduction of the surface roughness (Ra) up to 54%

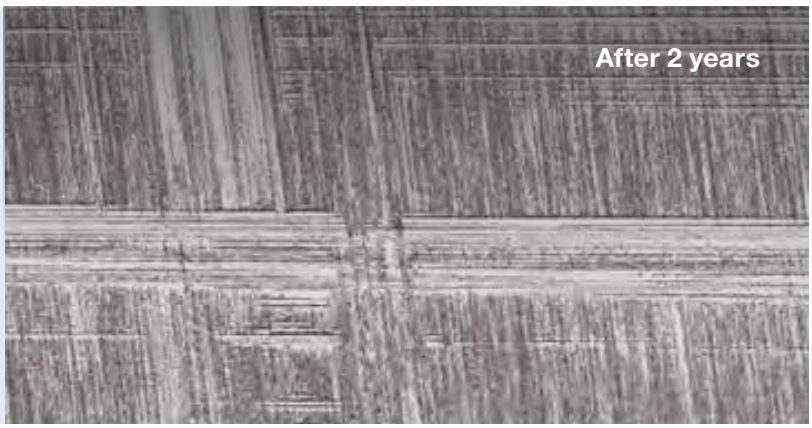


Figure 22 Surface roughness evaluations before and after the application of REWITEC

Wear development on a Bosch-Rexroth gear tooth over a period of two years

Laser confocal microscopy (10-fold magnification) was also used to evaluate wear on a Bosch-Rexroth gear tooth over a period of two years.

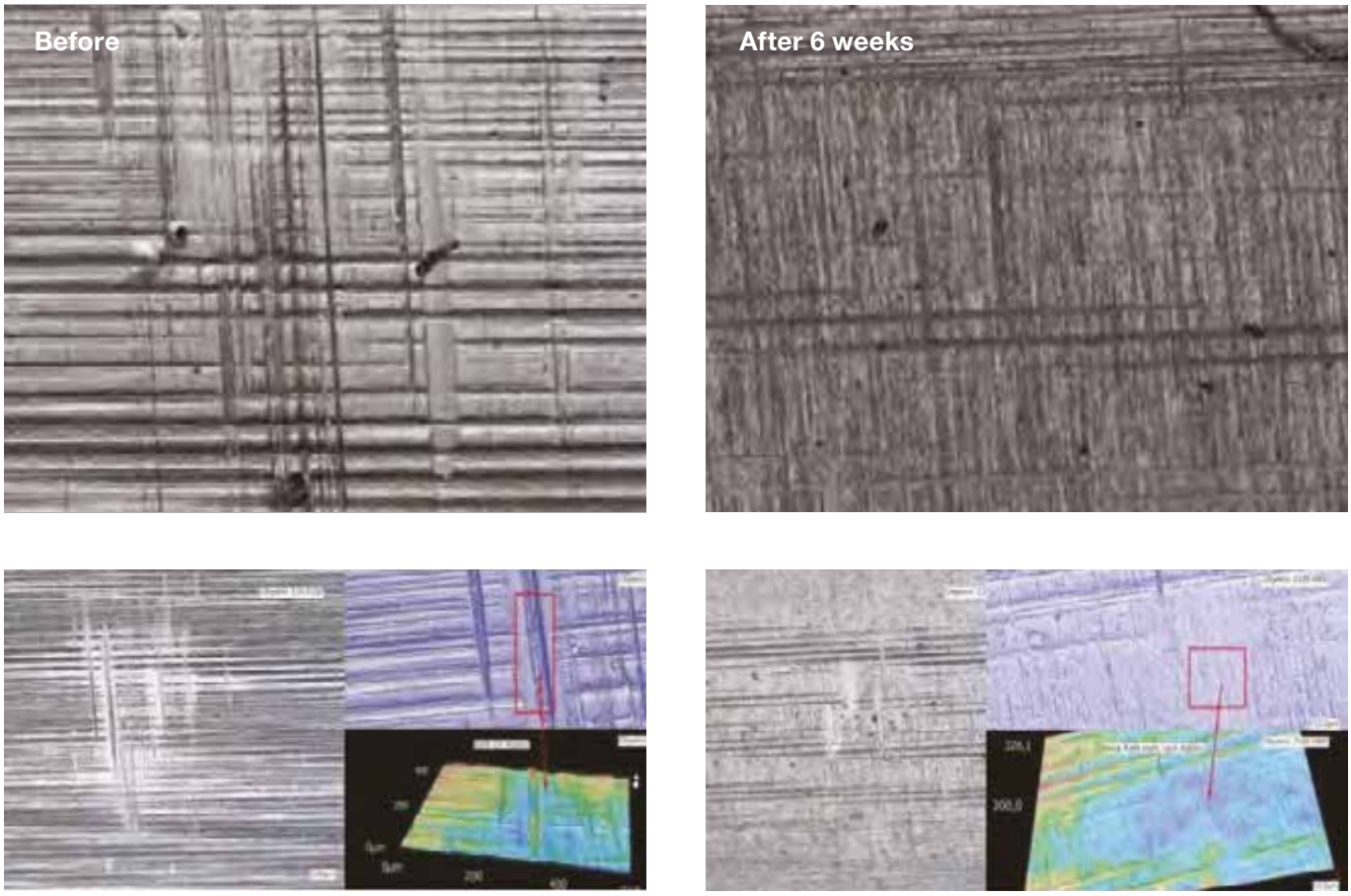
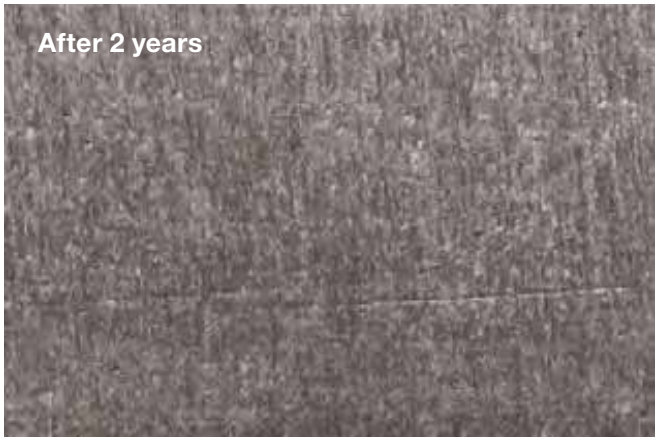


Figure 23 Surface before/after

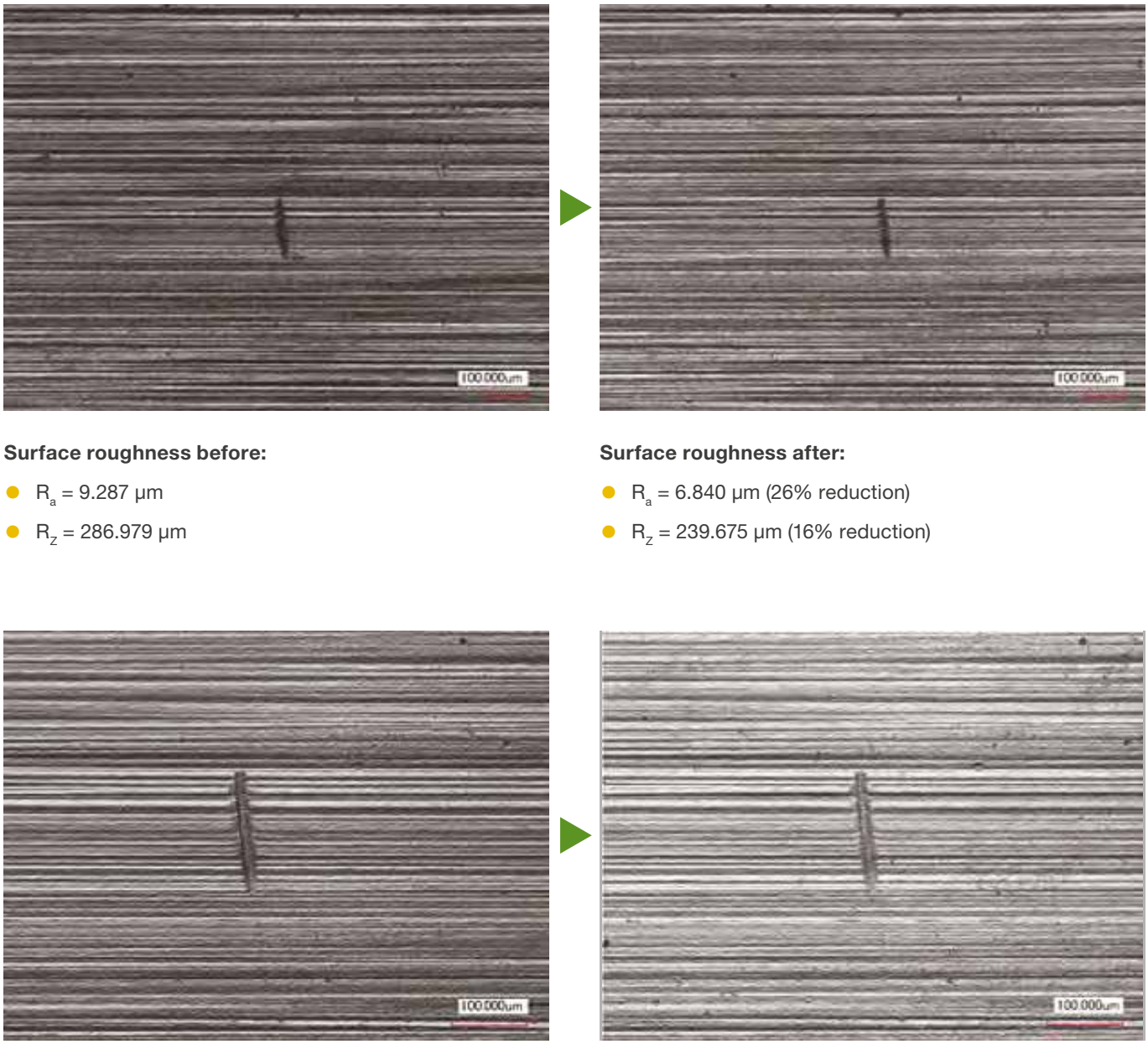
Run through marks could be clearly observed on the tooth flank and were monitored after 6 weeks and two years. The application of REWITEC was able to provide:

- Reduction of the surface roughness and friction force
- Improved load contact pattern
- Less stress for the tooth flank



Wear development on a Bosch-Rexroth gear tooth

Further surface roughness calculations were carried out on the impressions shown below in Figure 24.



Surface roughness before:

- R_a = 9.287 µm
- R_z = 286.979 µm

Surface roughness after:

- R_a = 6.840 µm (26% reduction)
- R_z = 239.675 µm (16% reduction)

Figure 24 Surface before/after

Analysis of a GE 1.5 MW turbine main bearing

Figure 25 Before wind turbine was treated with REWITEC

R_a = 0,556 µm (within the track)

Figure 26 5 months after wind turbine was treated with REWITEC

R_a = 0,403 µm (within the track)

Figure 27 12 months after wind turbine was treated with REWITEC

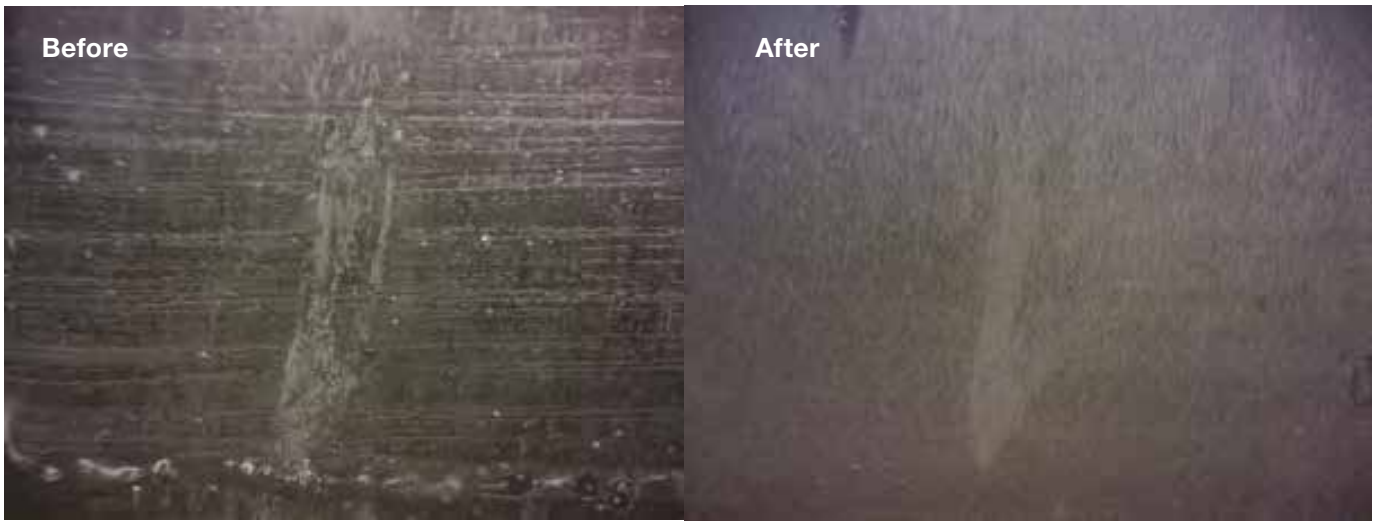
R_a = 0,225 µm (within the track)

Images show the surface of a main bearing within a GE 1.5MW wind turbine. The white arrow on each image shows the same track is evaluated over time.

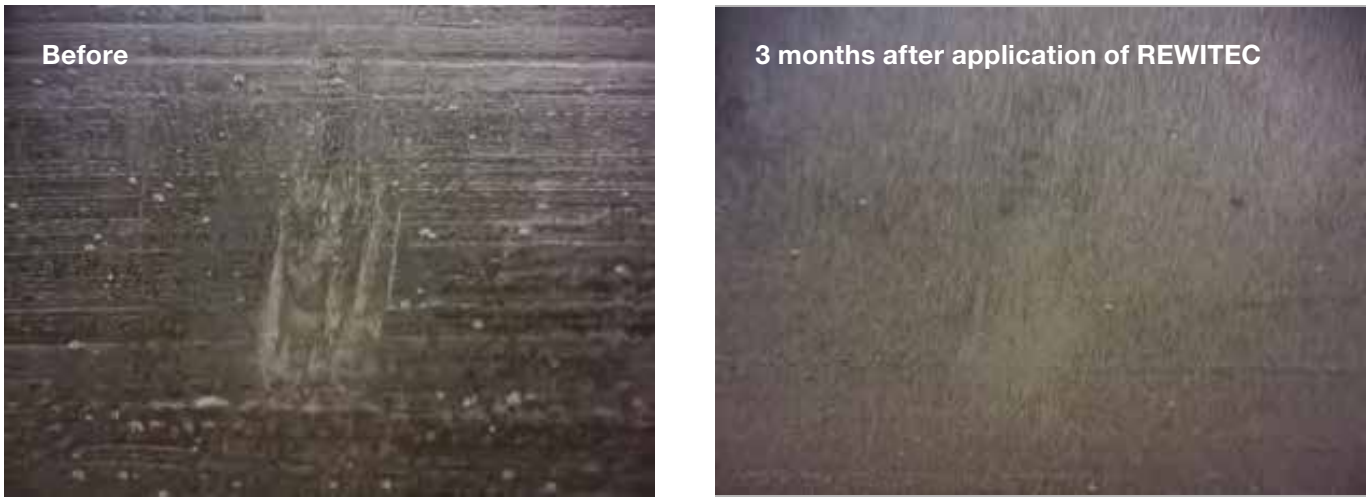
Surface roughness was quantified before and after REWITEC was applied in the field, demonstrating a reduction of over 50%.

Analysis of a Ebara 1.5 MW high speed shaft tooth flank showing run through marks

Area 1



Area 2

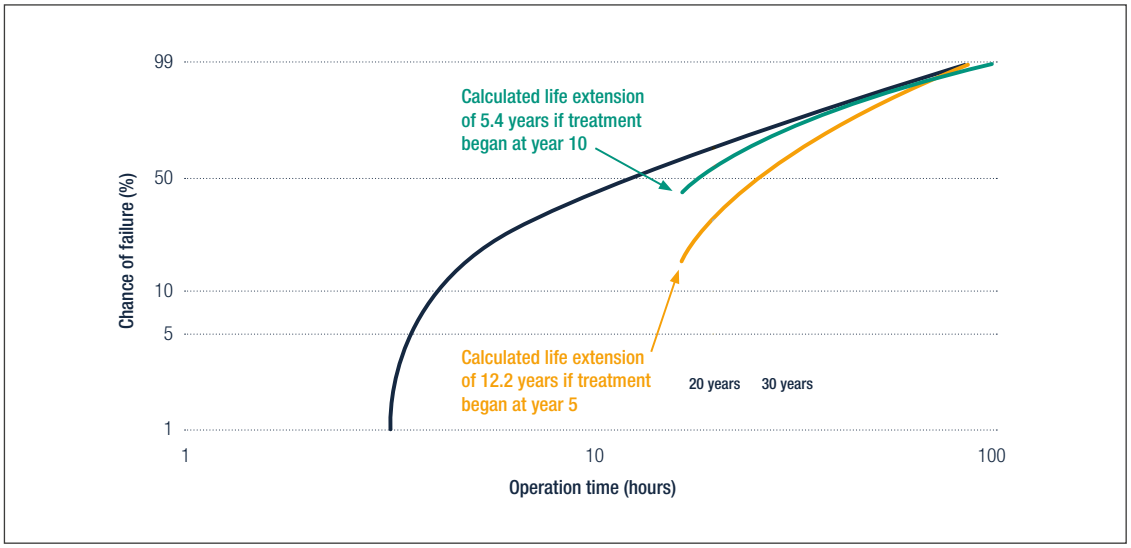


In both cases, in both areas of evaluation, a reduction in the appearance of run through marks could be observed as well as reduced roughness and a restoration of the surface.

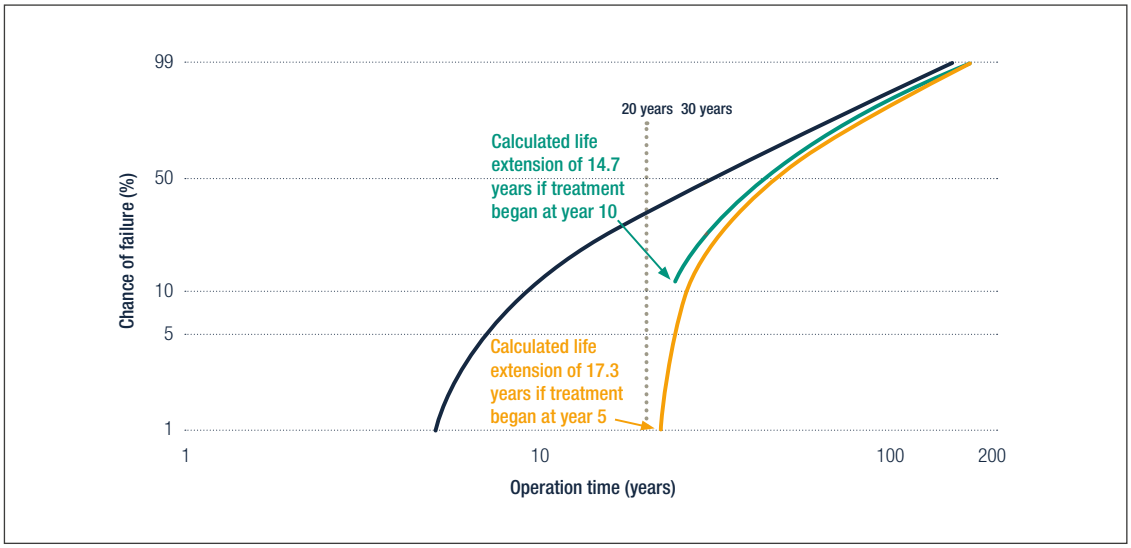
Demonstrating asset lifetime extension using REWITEC and Sentient Science DigitalClone® Software

Sentient Science developed a digital model using DigitalClone for Engineering (DC-E) software. Two wind turbine main shafts were modelled, using data including stress levels, surface roughness and friction force. The effect of adding 2% REWITEC GR400 grease additive to the lubricant was calculated.

Treatment of a main bearing with REWITEC significantly improved its calculated lifetime in a wind turbine. After treatment, main bearing lifetime was extended by up to 17.3 years, depending on the age and type of bearing.



Calculated lifetime improvement for an SKF 23188 inner ring generator-side raceway after treatment with REWITEC.



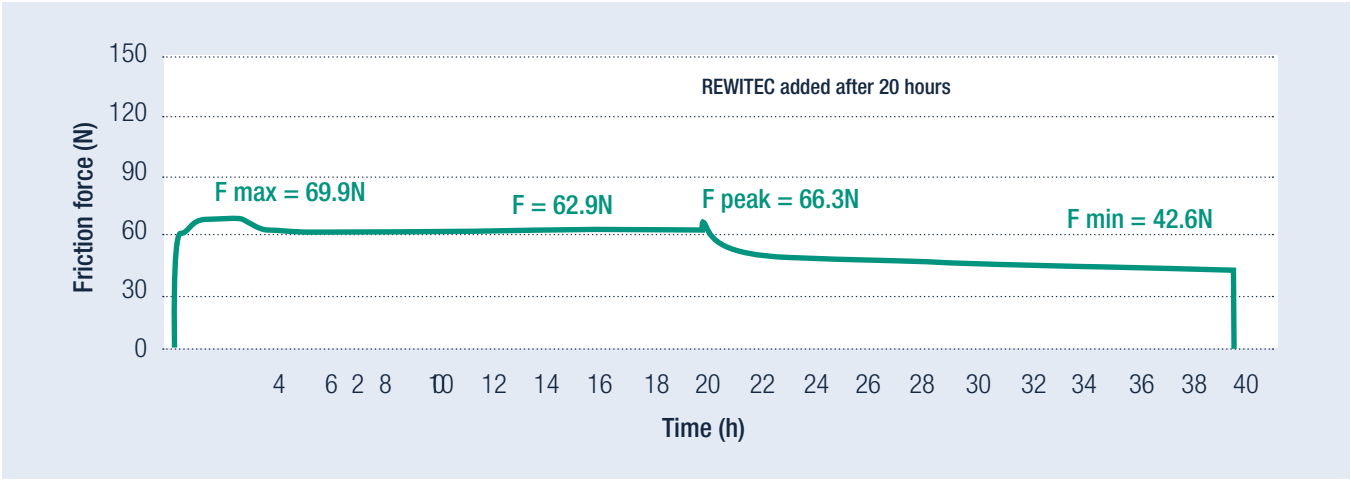
Calculated lifetime improvement for an SKF 23188 inner ring generator-side raceway after treatment with REWITEC.

Tribometer 2-disc test rig

The Competence Centre of Tribology at the University of Mannhelm evaluated REWITEC products using the 2-disc tribometer. The tribometer is suitable for testing the friction of high-load lubricated rolling contacts, replicating the conditions present in wind turbine gears and bearings.

REWITEC DuraGear was added to range of commercially available ISO 320 gear oils after 20 hours of monitoring the performance of the standard lubricant formulation on the test rig.

As observed in figures below, friction was reduced by up to 55% after the addition of DuraGear, which was maintained after the initial application in all ISO 320 oils.



	Oil Grade	Castrol Optigear Synthetic X320	Mobilgear SHC XMP 320	Klubersynth GEM 4-320N	Kluberbio EG 2-150	Fuchs Unisyn CLP 320	Amsoil PTN 320	Shell Omala S4 GX 320
Measured data	R_1 before (µm)	0.22 µm	0.22 µm	0.22 µm	0.22 µm	0.22 µm	0.22 µm	0.22 µm
	R_1 after (µm)	0.129 µm	0.123 µm	0.100 µm	0.133 µm	0.109 µm	0.180 µm	0.165 µm
	R_1 reduction (%)	41%	44%	54%	40%	50%	18%	25%
	R_1 before (µm)	2.00 µm	2.00 µm	2.00 µm	2.00 µm	2.00 µm	2.00 µm	2.00 µm
	R_1 after (µm)	1.52 µm	1.18 µm	0.91 µm	1.04 µm	1.02 µm	1.51 µm	1.42 µm
	R_1 reduction (%)	24%	41%	55%	48%	49%	25%	29%
	Friction force before	62.9 N	63.3 N	73.5 N	120.0 N	69 N	81.8 N	81 N
	Friction force after	42.6 N	41.0 N	44.0 N	54.0 N	44.0 N	44.0 N	47.0 N
	Reduction friction force	33%	35%	40%	55%	36%	46%	412%

Figure 29 Overview reduction of the surface roughness of the wind turbine oils

REWITEC products for wind turbine gears and bearings

DuraGear™ W100

A surface repair concentrate for wind turbine gears

- Reduction in friction in bearings and gears of up to 55 %*
- Reduction in roughness on metal surfaces up to 60 %*
- Decrease in temperature in bearings and gears of up to 20 %*
- Significant optimisation of primary material properties
- Reduction in wear and abrasion, as well as reconditioning of frictional metal surfaces
- Surface finishing during operating (without downtime)
- Recommended to use 1 litre per 100 litres of oil.

* Tested at the Competence Centre of Tribology at the University of Mannheim, Germany using a “2disk” test rig.

GR 400

A grease for bearings, incorporating REWITEC’s patented additive technology to repair previous damage and optimise metal surfaces

- Reduction in friction in bearings
- Prevention of pitting and grey staining
- Reduces operating temperatures
- Reduction in roughness of metal surfaces
- Significant optimisation of primary material properties
- Very good adhesion and water resistance
- Reduction in wear and abrasion
- Surface finishing during operation (without downtime)
- 1:1 grease replacement

GR 400 +5 and GR400 +10

A high-performance concentrate treatment for existing bearing grease

- Reduction in friction in bearings
- Prevention of pitting and grey staining
- Reduces operating temperatures
- Reduction in roughness of metal surfaces
- Significant optimisation of primary material properties
- Very good adhesion and water resistance
- Reduction in wear and abrasion
- Surface finishing during operation (without downtime)
- Top treatment for 5kg/10kg grease

Partners in the field

Surface analysis with the help of imprints

In order to evaluate the surface of gears and bearings, we use various measurement methods and analysis to provide constant proof of the added value and benefits of our products. To support our customers, we are able to carry out some of these measurements directly up-tower, without needing long downtime.

Substantial information about the quality of the application is provided by our surface analysis. To do the surface analysis, we create an impression of the tooth flank or bearing surface with the REWITEC replica set.

To create a tooth flank impression, a visual inspection of the surfaces is first carried out by one of our qualified service technicians. It is cleaned and marked with an oil-resistant paint and then the surface impressions of the tooth flanks or bearing surfaces are taken in order to evaluate them microscopically later. The corresponding REWITEC product is added or applied. After approximately 500 operating hours, the entire process is repeated for the before and after comparison.

The resulting surface imprints are analysed and evaluated by light microscopy, laser microscopy and confocal microscopy. Thanks to the REWITEC replica set, roughness depths with a resolution of up to 0.1 microns can be analysed. In addition to the surface analysis, depending on the application, vibration, temperature or comparative compression measurements can be obtained.

These are documented and finally compiled and reported to you, the customer.

Figure 29 Overview reduction of the surface roughness of the wind turbine oils

Summary

Scientifically proven, practically tested.
The future for gears and bearings is here.

Our innovative technology is ideally suited to the needs of the wind industry and protects drives effectively against wear and tear. Well-known manufacturers and owners apply REWITEC products. The unique particle-based surface treatment additives show their convincing effect in all types of gearboxes and bearings. The refining process is initiated from the first moment of operation.

REWITEC is based on proven experience from various application areas of wind power companies. Based on this, we have developed REWITEC specifically to meet the needs of wind turbine users.

As a result, you can bring your gears and bearings close to brand new.
Less friction means less wear, longer life and less downtime.

Glossary

ABRASIVE WEAR
Gradual removal of material from one or more surfaces caused by abrasion.

CORROSION
An oxide layer caused by a chemical reaction with a metal surface.

DLE MARKS
Continuous ripples in the distance between the roller bodies on the running tracks or the tooth flank. They are caused by vibration-induced micromotions of the rolling element / tooth flank at the static bearing.

FAILURE
Fault or damage, which prevents a transmission or bearing from fulfilling its actual purpose.

FATIGUE
Damage (structural changes) of the material caused by damage accumulation in the steel metallurgy or a material defect causing the material to be in contact with the contact surfaces.

FRACTURE
Spread of a crack up to a complete separation.

FRICTION
The resistance force which acts when two objects move relative to each other under load.

IMPURITIES
Solids particles or liquids which penetrate the system and impair its function.

MICROPITTING
Micropitting is a wear phenomenon in areas of highly stressed metallic components. It happens predominantly on gears and bearings. Micropitting occurs when high sliding speeds as well as low lubricant film thicknesses are present in the highly stressed contact between two components.

MOISTURE CORROSION
Chemical reaction occurs when water / moisture or another chemical substance evaporates on a metal surface and can thereby oxidize with oxygen.

PITTING
A general term for a kind of local damage occurring in the form of small holes, craters or cavities. The causes of pitting include surface fatigue, corrosion and indentations by impurities.

WEAR
The gradual removal of material from a surface.

References

Literature Index

ANSI/AGMA 1010-F14 Appearance of Gear Teeth - Terminology of Wear and Failure

DIN 50320:1979-12 (Note: This draft has been withdrawn) Wear; Terms, Systematic Analysis of

Wear Processes, Classification of Wear Phenomena

Figures no. 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 & 17 kindly provided by Deutsche Windtechnik Service

GmbH & Co. KG; Pictures Title/Back, P.23: Shutterstock

ISO 10825:1995 Gears - Wear and damage to gear teeth - Terminology

ISO 15243:2004 Rolling bearings - Damage and failures - Terms, characteristics and causes

Who are we?

The Energy Technologies business in Cargill Bioindustrial creates, makes and sells specialty chemicals and additives for the global energy market. Working in close collaboration with our customers, we apply sustainable concepts and deep scientific expertise so that together we can efficiently power the world of tomorrow.

At our core, we are experts in synthetic ester and polyalkylene glycol chemistries, taking products from lab scale through to full manufacturing. Investing in the development of new chemistries allows us to support our customers in meeting new industry challenges.

For those who dare to imagine a brighter future, we establish long lasting relationships and create bespoke industry solutions through our integrated research & development and global manufacturing capabilities. Being both global and local, you have direct access to our network of technical experts. We look forward to talking to you.

Further information

Cargill Bioindustrial sales and distribution are coordinated through an extensive worldwide network of technical and commercial experts. For further information or guidance please contact us:

energy_technologies@cargill.com

Cargill®