Making Wind Turbine Operation More Durable and Reliable

The expansion of wind energy remains a key issue when it comes to achieving climate targets, green electricity and energy transition across the globe. Despite various challenges, including politics or the growing global population and demand for power supply, there has been a significant increase in the capacity and size of plants installed over the last two decades.

Today, onshore wind turbines (with a capacity of 6 MW) and offshore turbines (with an enormous capacity of up to 15 MW) are being installed, which can power around 20,000 homes. As wind turbines increase in size and the stress and load on drivetrain components, such as gearboxes and bearings also grow, failure or standstill becomes more likely. Such a breakdown not only results in high downtime costs, but also in a significant loss of generation capacity. To maximise return-on-investment, it is vital that turbines have the best possible uptime, reduced maintenance and replacement costs, and minimised failures and unplanned operation outages.

Historically, wind turbines have had reliability issues, with multiple studies indicating that gear and bearing wear and tear have a significant impact on reliability, which can be critical to the success of a wind energy project and can also result in high costs for operators.

Costs come not just from the need to replace the failed part, but also from the downtime, labour, planning, and logistics. One study estimated the total cost to replace a gearbox can be more than €250,000 without accounting for the additional costs if the gearbox must be sent offsite to be refurbished and then reinstalled at a later date.

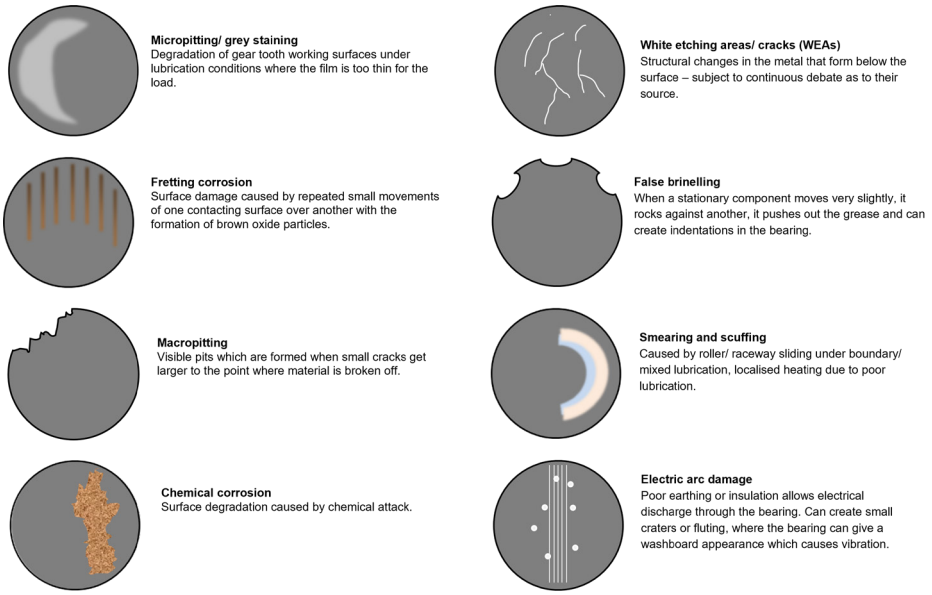
Why wind turbine gears and bearings fail

There are multiple reasons for failures and they can include:

1. High costs of maintenance: One insurer reported that 25 % of all insurance claims are linked to poor maintenance, with excessive costs being cited as a major reason owners / operators skip essential work.
2. Extreme forces within individual components, coupled with massive variations in output, can cause loads to be concentrated on specific areas, putting additional strain on already stressed parts.
3. Environmental factors such as rain and salt contaminate lubricating oils and grease.
4. Extreme temperature changes can alter seal performance.

These factors can cause specific wear damage to the surfaces of gears and bearings, such as micro pitting, false brinelling or standstill damage because of micro vibrations. Figure 1 (above) shows an overview of the most common types of damage to wind turbines.

Figure 1: Some of the main damage and failure modes within wind turbine gears and bearings.



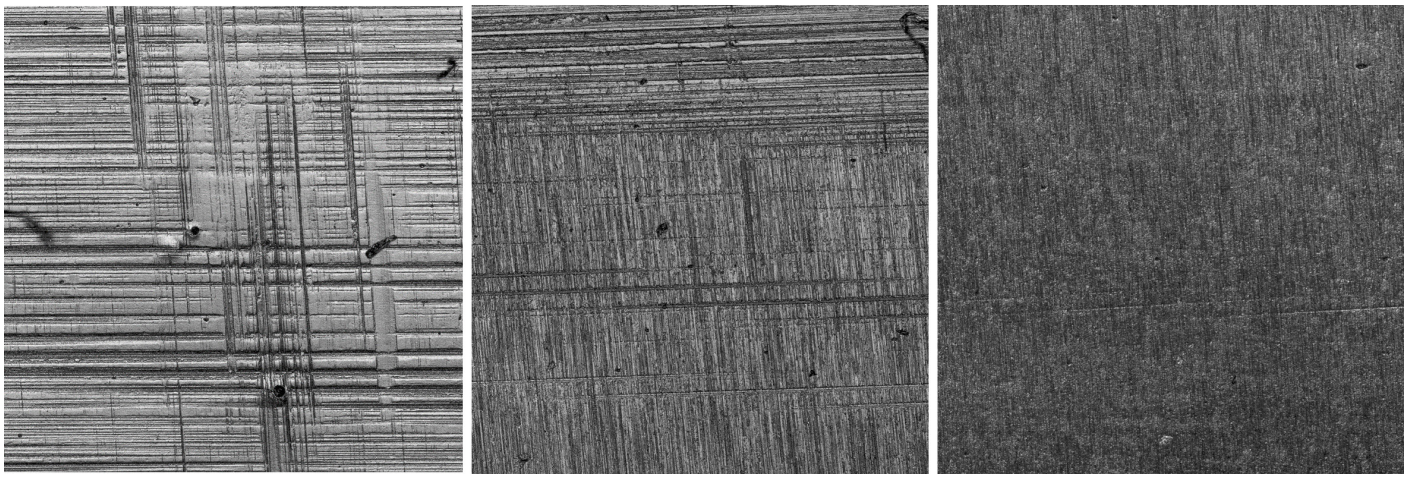


Figure 2: Gear tooth wear development over a period of two years, left: before the REWITEC application, middle: one month after the application, right: Two years later after a second REWITEC application.

But what are the options to repair equipment once potential or actual damage has been identified? One solution that has been proven with thousands of wind turbines globally is to use REWITEC to repair and preventively protect the equipment from downtime or take the wind turbine out of service completely.

REWITEC™ surface technology

REWITEC – a lubricant concentrate that is added up-tower, directly to the existing wind turbine oil or grease, which improves reliability, performance and extends the life of the turbines drivetrain.

The patented repair technology creates a protective layer on the surface of lubricated components, smoothing the surface, reducing friction, wear, surface roughness and temperatures. This translates to higher efficiency and extended life of gears and bearings for both onshore and offshore wind turbines. The technology can be used in all lubricated moving parts of a wind turbine, and also in combustion engines as well as a wide variety of heavy machinery applications, including marine, automotive, steel, cement and mining.

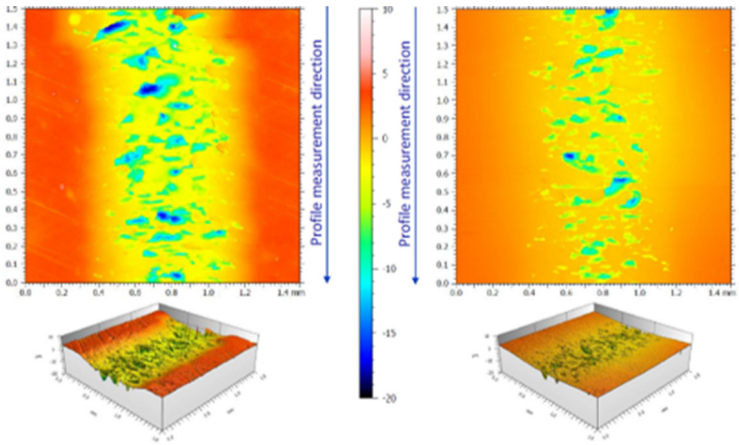
REWITEC products have been extensively tested by independent third parties, like the University of Mannheim and Giessen. Treatments for the gearbox oil, as well as the greases used within all wind turbine bearings are available. REWITEC can also be used preventively: the reduction in friction and the resulting smoothing of the surfaces prevents damage and increases service life even in new or nearly new drivetrains.

Effects of REWITEC™ on wind turbine components

The positive effect of REWITEC has been measured by analysing component surfaces directly up-tower. To quantify the effect, surface imprints are taken at the same location; allowing the roughness and damage of the metal surfaces of a component to be analysed separate from the wind turbine, thus offering a before and after treatment comparison.

Figure 2 (bottom left, previous page) shows an imprint of a gearbox surface of a GE 1.5 SL turbine before the REWITEC treatment and one month after the REWITEC treatment. It is clearly visible that the roughness of the damaged surface has been refilled and thus repaired. What's more is that result after two years and a second application displays the gearbox surface in an almost fully restored condition.

Figure 3: Main bearing surface of a 1.5 MW wind turbine before and 6 months after REWITEC application.



The same imprint technique was used to analyse a main bearing. Figure 3 (above) shows how REWITEC improved the condition of the surface of a 1.5 MW wind turbine main bearing. Roughness has been reduced by more than 50 %; the surface is more uniform, which leads to better load distribution and reduced stress on the component. Thus, improving reliability and extending the life of the main bearing.

Effects of REWITEC™ in laboratory-based tests

In addition to the field analysis, laboratory tests have also been tested REWITEC performance in a controlled environment. The 2-disc test bench is an industry standard testing system that allows extremely high loads to be applied to moving metal surfaces, replicating the extreme forces experienced by wind turbine gears and bearings.

The test bench was set up to replicate the forces experienced in a wind turbine gearbox with an industry standard wind turbine gear oil. Figure 4 (below) illustrates how applying REWITEC to the system resulted in friction reduction of up to 40 %.

Conclusion

While gears and bearings may not be the least reliable components in a wind turbine, when they do fail, they cause significant downtime and repairs can be extremely expensive.

REWITEC lubricant concentrate products are simple and quick to apply as they are added directly to the existing wind turbine oil or grease, up-tower. Through surface modification, roughness is significantly reduced, which leads to lower local loads and stresses on lubricated components. Using REWITEC products can help repair existing damage in wind turbine gears and bearings and also protect the system and extend its life. •

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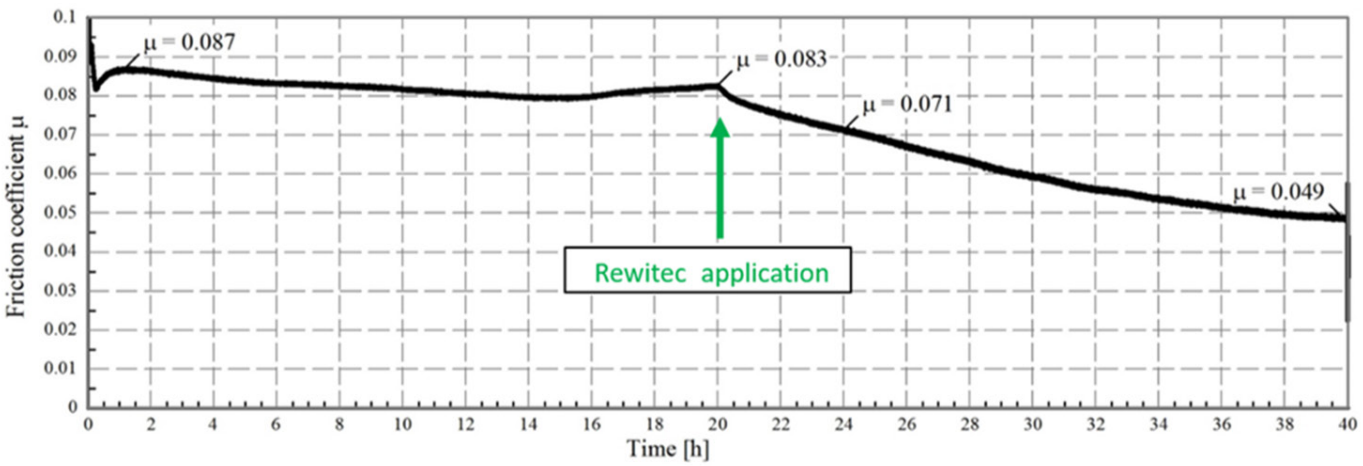

Figure 4: Friction measurement in industry standard wind turbine gear oil with REWITEC added after 20 hours using a 2-disc test rig.