

**Black oxide: Reducing the probability of premature bearing failure due to white etching cracks.**



The bearings in wind turbine gearboxes endure demanding conditions: exposure to dynamic loads and speeds, shock loads or too low load, as well as varying temperatures, moisture, and chemicals. This combination of stresses can reduce the life time of the bearing and can lead to cracking, including white etching cracks ([WECS](#))

### What are white etching cracks?

White etching cracks are cracks within the microstructure of bearing steel. They are decorated by white etching areas on the steel surface. White etching refers to the white appearance of the altered microstructure of a polished and etched steel sample. The affected areas consist of ultra-fine, nano-recrystallized, carbide-free ferrite, or ferrite with a very fine distribution of carbide particles. These areas appear white under an optical microscope due to their low-etching response to the etchant. White etching areas around cracks are 10%-50% harder than the surrounding unaffected microstructure.

Bearings in wind turbine gearboxes are large bearings and require a good running-in behaviour. Black oxide will allow to do a fast (chemical) running-in which will protect the bearing against several special operating conditions.

### **Benefits**

- Enhanced protection to corrosion
- Improved resistance against smearing
- Enhanced protection against hydrogen that could enter the bearing material and cause cracking.
- Improved performance in low-lubrication conditions (micropitting and wear)
- Limit the risk of fretting.
- Reduced risk of damage from aggressive oil additives
- Reduced downtime and maintenance costs

For one, they can boost performance in poor lubrication situations because the oxide layer improves lubricant adhesion and enhances smearing resistance. The coating also limits the risk of fretting, micropitting and cracking. Enhanced resistance to corrosion and chemicals mitigates the effects of moisture and aggressive oils. Finally, they improve friction behaviour and reduce wear, especially under the mixed friction conditions and high roller slip conditions commonly found in wind gearboxes.

Black oxide treatment improves reliability and performance in highly demanding applications, especially under low load conditions, marginal lubrication conditions and vibrations. It is recommended for all gearbox positions, but mandatory for tapered, cylindrical, full complement and four-point contact ball bearings on the high speed, high intermediate speed, and first planetary stage.

Black oxide bearings can be used for new installations or to replace untreated conventional bearings and are an affordable way to boost gearbox uptime. One wind gearbox manufacturer saw failure rates more than 50% in standard cylindrical roller bearings over a two-year period. After switching to black oxide bearing, the failure rate fell to 0.1% over the same period.

The process can currently be applied to bearings up to 2.2m in diameter and 1,000kg per component, which is covering current bearing sizes used in wind turbine gearboxes.