Wind energy with no downtime

AEGIS® shaft grounding for wind turbines

Along with solar power, wind power is the fastest growing source of renewable energy. However, inverter-induced voltage can damage the bearings of wind power generators and lead to downtime. One solution to this problem is using AEGIS® Shaft Grounding Rings to reliably prevent such damage through effective grounding.

Wind turbines convert wind energy into electrical energy by using the wind to turn a generator shaft. The generators use a gearbox and an inverter drive (a.k.a. VFD) to match the frequency of the generated electrical energy to the mains frequency of 50 or 60 Hz. Most also use inverters to excite the generator itself, while others use permanent magnets.

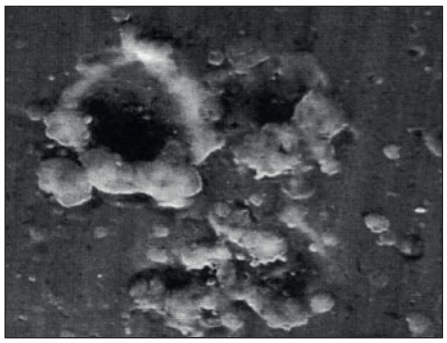
However, inverter drives also induce voltage on the generator shaft. This voltage discharges to the ground via any existing low-impedance current path. These current paths usually lead through the generator or gearbox bearings. The discharge through these moving parts causes cumulative damage due to electric discharge machining. The resulting damage is referred to as fluting or tiger-striping. It can lead to generator failure, which leads to costly repairs and downtime.

Most generators have hybrid or insulated bearings that are resistant to electrical damage. However, coupled components such as gearboxes and tachometers are at risk. Wind generators are therefore also equipped with rotor grounding intended to reduce the risks to these components. Inverter-excited generators generally use carbon brushes for grounding the shaft, but versions with permanent magnets sometimes use rollers on the brake disc. Both methods offer a low-resistance path for low-frequency current and direct current. These otherwise damaging currents thus flow through the carbon brushes or rollers without causing any further damage.

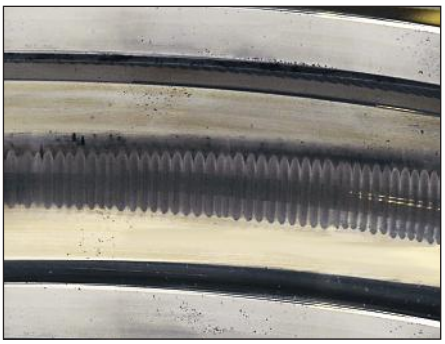
Risk of high-frequency currents

However, the shaft voltage contains high frequencies as well as low, and carbon brushes and rollers have high impedance (resistance) to high-frequency currents. This means that, even with carbon brushes or rollers, there's still the risk that the system will be electrically damaged. Wind turbines therefore also require shaft grounding with low impedance for high frequencies.

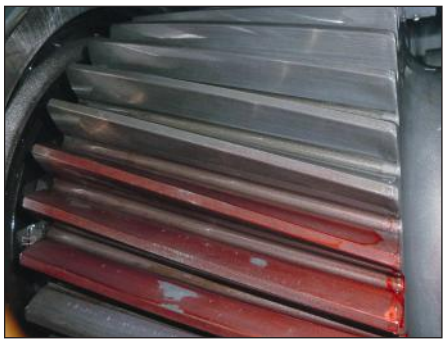
The technical solution for this requirement is AEGIS® Shaft Grounding Rings. The rings of the AEGIS® WTG and PRO Series enclose the shaft with hundreds of thousands of conductive microfibers. Overall, these fibers have a large surface area, which gives them a low impedance for high-frequency currents. For large shafts, they can be manufactured in segments to allow easy installation. With hybrid bearings to block circulating currents, a roller or carbon brush for the transmission of direct and low-frequency current, and an AEGIS® grounding ring for high frequencies, the system is completely protected against electrical bearing damage.



Localized corrosion (pitting) in a bearing shell (magnified) as a result of spark erosion when shaft voltage is discharged through the bearings, leaving behind small melt craters.



Bearing with fluting formation.



Gear with tiger-striping.

Measurements on wind turbines

Electro Static Technology, the manufacturer of AEGIS® Shaft Grounding Rings, recently performed measurements on a wind turbine for a generator manufacturer on a 140 m high turbine with a 135 m rotor blade diameter and a permanently excited generator with VFD control.

The generator has rollers on the brake disc for low-frequency grounding and also has shaft grounding in the form of a "violin bow" for high-frequency voltage.

Without any shaft grounding, the high-frequency shaft voltage was a dangerous 20 volts peak to peak. With the "violin bow," the voltage could be reduced to slightly more than 4 volts. Below 5 volts is a safe level for the shaft voltage, but the "violin bow" showed heavy wear. Because these components are pressed, under tension, against a spinning shaft, they can quickly wear through.

Shaft voltage lowered to a safe level

After installing AEGIS® PRO Ring segments, the residual shaft voltage decreased to a safe level of less than one volt. In addition, the fibers of the AEGIS® segment are not under tension. They only touch the slip ring lightly and are therefore much more durable than other grounding systems.

With their long service life and low impedance at high frequencies, AEGIS® Shaft Grounding Rings and segments are currently the most effective grounding system for high-frequency shaft voltage in wind turbines.

Wind power expert Jens Leipner at the generator level of the wind turbine on which the measurements were performed.

After installing the AEGIS® PRO ring, the shaft voltage could be reduced to less than one volt.

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