

Aegis protects motors from shaft voltages

Variable-frequency drives – commonly used for energy-efficient control of AC motors – can induce shaft voltages which lead to bearing and motor failure. Shaft grounding rings have been proven to protect such motors from damage, says MARTIN DEISS of Electro Static Technology.



Figure 2: Mirror-smooth surfaces of brand new bearing races minimise friction.



Figure 1: Aegis shaft grounding rings.

ALL manufacturers of three-phase alternating-current (AC) motors have motor product lines which are suitable for operation on variable-frequency drives (VFDs). Through precision RPM and torque control of motors with VFDs, at least 30 per cent of energy costs can be saved.

However, VFDs are not without problems and can induce unwanted shaft voltages. Without effective protection, these voltages can result in premature bearing failure and thus motor failure.

Although the National Electrical Manufacturers Association (Nema) and other institutions identify this problem in motors and recommend mitigation methods for motors to be equipped with effective bearing protection, the most frequent cause of bearing failure is still electric current passage. Inverter duty motors include insulation which is designed to meet the latest standards to protect the windings, but the bearings are often neglected.

For an AC motor to be truly suitable for VFD operation, it should have long-term bearing protection. Often, this is not

given sufficient consideration and leads to expensive downtime.

BEARING PROTECTION

In most cases, a reliable and cost-effective way to minimise electrical bearing damage and increase the reliability of VFD-controlled motors and systems is the use of an Aegis shaft grounding ring (combined with an insulated bearing for motors larger than 75-100 kW) [Figure 1]. The Aegis branded products are marketed by Electro Static Technology- ITW, a global manufacturer and designer of static control devices for equipment manufacturers and users.

In contrast to the previously used shaft grounding technology of spring energised carbon brush, Aegis

shaft grounding rings offer far greater efficiency especially in avoiding high-frequency bearing currents. The bearing protection rings consist of highly conductive microfibres, which are secured in the patented FiberLock channel. Scalable to any shaft diameter, the fibres surround the motor's shaft, offering a low-impedance path from the shaft to frame and then to ground thus reliably diverting damaging currents. Since the microfibres work with little or no contact with the shaft, they are not subject to wear like conventional carbon brushes.

RISK OF MOTOR DAMAGE

Damage to windings and bearings can result from the repetitive and extremely fast impulses produced by modern VFDs in motors. This phenomenon is described in terms of harmonic content, parasitic capacitance, capacitive coupling, electrostatic charge and common-mode volt-

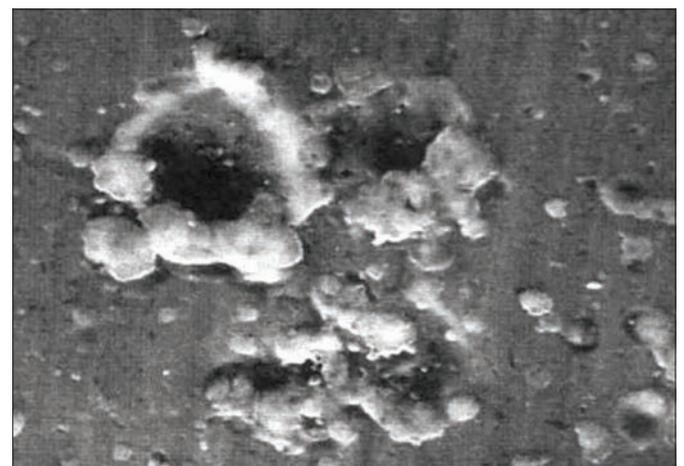


Figure 3: Localised corrosion occurs in a bearing race (magnified) as a result of spark erosion when shaft voltages are discharged through the bearings, leaving behind small melt craters.

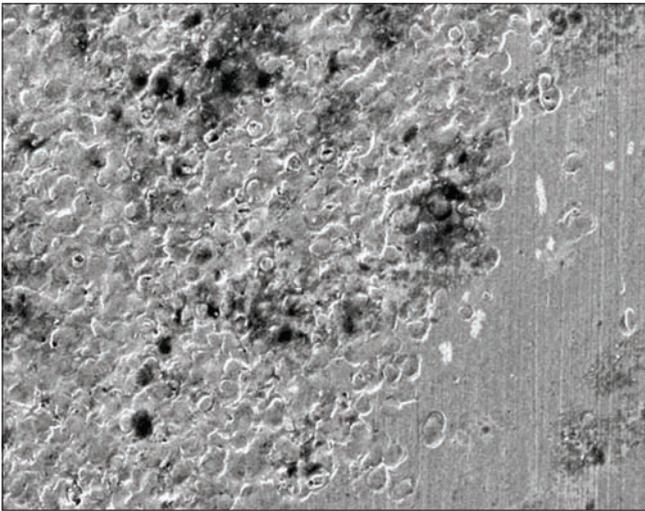


Figure 4: Small melt craters created by localised corrosion have a frosted appearance to the naked eye.



Figure 6: Oscilloscope voltage profile of bearing without shaft grounding (above) compared to bearing with Aegis bearing protection ring (right).



age. Regardless of the name, high voltage peaks and fast clock times can cause damage to insulation, bearings, etc.

If the load impedance is greater than the line impedance, current is reflected back to the VFD and voltage spikes occur in the motor connection which can be twice as high as the intermediate circuit voltage. The damage caused by VFD-induced currents is often overlooked until it's too late to save the motor.

SHAFT GROUNDING RINGS

Bearings, which normally have a mirror-smooth bearing surface [Figure 2], can be damaged by electrical discharges. Without protection, shaft voltages pass through the bearings and cause undesirable electrical discharges. Spark erosion damages the bearing surfaces and leads to

premature failure of the bearing or motor. Within a short time, the bearing surface is strewn with microscopic scale melt craters [Figure 3], giving it a frosted appearance [Figure 4]. Over time, a corrugation (washboard-like surface) forms, resulting in increased bearing noise and vibrations [Figure. 5].

When using insulated bearings, the damaging current will find a different path to ground, usually through connected units such as the gearbox, pump, tachometer, encoder, etc. This, in turn, will damage the bearings of these devices.

PROOF OF EFFECTIVENESS

The effectiveness of Aegis shaft grounding rings can be quantified by simply measuring the shaft voltage by means of an oscilloscope. Without shaft grounding, the voltage profile exhibits high voltage peaks and steep discharge edges. After applying the bearing protection ring, a virtually flat line appears [Figure 6].

Aegis shaft grounding rings have already proven their value in over two million installations worldwide, mainly in North America and Asia. Many motor manufacturers, such as Baldor, WEG, GE, TECO and Regal, use factory-installed bearing protection rings as

standard or as options for certain motor series. This ensures that the operation of the VFD does not have any detrimental effects on the motors.

CONCLUSION

In order to operate an electric motor by a VFD without issues, it is not sufficient to rely exclusively on the statements of the manufacturer. Insulation is designed per the latest standards, but manufacturers often do not pay attention to effective shaft grounding, which protects the bearings against harmful high-frequency VFD currents. Aegis shaft grounding rings (in combination with an insulated bearing for motors larger than 75-100 kW) represent a proven low-cost and effective solution. ■

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Figure 5: Corrugation of the bearing surface caused by localised corrosion results in increased bearing noise and vibrations.



With Aegis shaft grounding rings harmful currents can be dissipated safely.