Shop "Tech Talk" August 2008

Motor Bearing Currents

The use of variable speed drives with ac motors induces electrical currents on the motor shaft. In a small fraction of electric motor applications this can lead to premature bearing failure! In this article we will learn (a) How to recognize this problem and (b) what are the possible solutions to this problem and finally (c) what I think is the best of the most recent solutions.

How To Recognize The Problem:

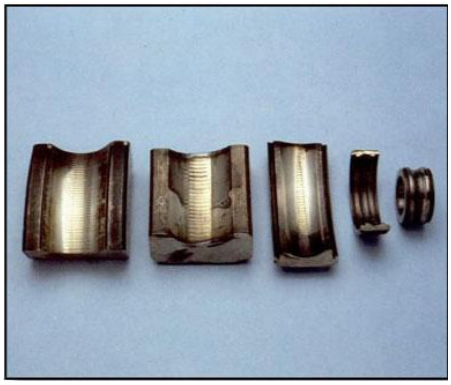
If we are using an AC drive with a motor and we are experiencing reduced bearing life i.e. from a couple of months to a couple of years, then I am suggesting it would be reasonable to think that the drive may be causing the problem. Obviously we should try and rule out all other possible causes like poor alignment, V belt tension beyond suggested practices, improper installation of replacement bearings and there are more I am sure.

If you can carefully cut the failed bearings apart, with a torch, so that you can see clearly the races of the bearings where the balls have run, then if you see anything like the photos below you can feel pretty certain that you have in fact damaging bearing currents.

Black discolored grease grease affected by current discharges

Fluting or washboard in raceway

The dull surface of the ball is a sign of micro-cratering called frosting



Electrical currents that pass through a bearing cause small pits to be burned into the bearing races. This can form a pattern known as "fluting" which is shown in the photograph

Fusion craters in a bearing race from Scanning Electron Microscope image

Notes:

Frosting is a name given to the damage caused by electrical discharge fusion craters. This damage begins as pitting and these fusion craters increase in number and size as each cycle of induced voltage discharges through the bearings to the frame and ground. Soon the entire race is covered with millions of pits. As new fusion craters form over old ones, eventually a "frosted" surface visible to the naked eye appears.

Fluting occurs when the operational frequency of the VFD (Variable Frequency Drive) causes concentrated pitting at regular intervals along the bearing race wall, forming a washboard pattern. This pattern results in vibration and noise and in a HVAC system can be transmitted throughout a facility via the air ducts.

The Possible Solutions To This Problem:

Here we will look at the various ways that have been designed to reduce and in some cases eliminate this problem.
There are 4 approaches used to reduce high frequency bearing currents.
All these methods are designed to decrease the bearing voltage to values that do not induce high frequency bearing current pulses at all or damp the value so that there is no effect on bearing life.

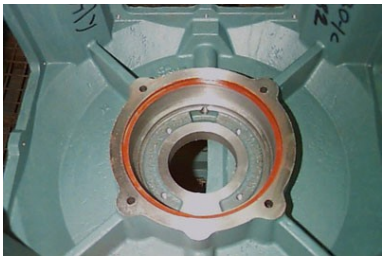
1.A proper cabling and grounding system. Where possible use only symmetrical multicore motor cables such as Belden VFD drive cable , 29500 series. Use also a high frequency bonding connection of braided copper strap as a ground wire between the motor ground and the drive ground. This strap should be in the range of 50 to 100 mm wide. This will provide a lower inductance path than round wires

2.Breaking the current loops The current loops are broken by insulating the bearing construction.

SKF INSOCOAT® Rolling Bearings

Insulated bearing showing the insulation layer

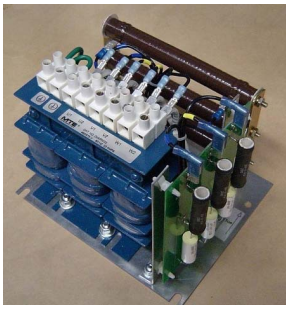
EMQ-Insulated Sleeves



Insulated bearing.

The bearings can be insulated using bearings and sleeves as per the photos above.

3.Damping the high frequency common mode voltages coming from the drive This is accomplished by using dedicated filters.



Here is a picture of an MTE series A dv/dt filter.
MTE Series A dV/dT (rate of change of voltage with respect to time) filters are designed to protect AC motors from the destructive effects of peak voltages facilitated by long cable runs between the inverter and motor. Depending on the switching time of the power semiconductor used in the inverter and the size of the motor, cable lengths as short as eight feet can result in motor peak voltages that exceed the rating of the motor's insulation system. However, the longer the cable the greater the problem. The MTE dV/dT filter is guaranteed to meet its maximum peak motor voltage specification (150% of bus voltage) with up to 1,000 feet of cable between the filter and the motor. It is also

4. Diverting away the harmful bearing currents.This can be accomplished by the use of a suitable shaft grounding brush(es) or by the use of conductive microfiber shaft grounding ring(s).

A metal brush contacting the motor shaft is a more practical and economical way to provide a low-impedance path to ground, especially for larger NEMA-frame motors. However, these brushes pose several problems of their own:
a. They are subject to wear because of the mechanical contact with the shaft.
b. They collect contaminants on their metal bristles, which destroys their effectiveness.
c. They are subject to oxidation buildup, which decreases their grounding effectiveness.
d. They require maintenance on a regular basis, increasing their cost.

4.Diverting away the harmful bearing currents continued.....

This last product solution is also the product that I most heartily recommend!

These devices are part of the range offered by a company called Aegis and they are called collectively Shaft Grounding Rings (SGRs).

Inside the bore of each of the SGRs below are rows of conductive microfibers that provide a reliable, very low impedance path from shaft to frame, bypassing the motor bearings entirely. The ring's patented Electron Transport Technology™ uses the principles of ionization to boost the electron-transfer rate and promote extremely efficient discharge of the high-frequency shaft currents induced by VFDs.

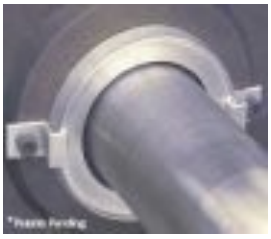
The patented shaft grounding ring design ensures that there is a high density of discharge points provided by the Conductive MicroFiber™ all around the shaft to discharge the unwanted shaft currents to ground.

The AEGIS SGR™ is maintenance free and there is nothing to wear out.

The AEGIS SGR™ is designed to be effective when oil, grease or contamination is present on the shaft surface. When excessive particles, dirt or dust are present, an "O" ring or slinger should be installed to prevent ingress of materials.

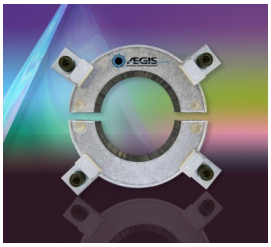
The patented technology design of the AEGIS SGR does not use applied pressure friction for the fibers and therefore there is no direct frictional wear applied to the fiber tips. The SGR will literally last for the service life of the motor.

In Wear tests carried out the measured wear was less than 0.001 inch per 10,000 hours continuous operation. There was also zero fiber breakage after 25 million direction reversals.
The expected life of Aegis SGR is 200,000 + hours. ".....lasts for the service life of the motor"



This is a Standard Mounting Bracket. Quick and easy installation to most surfaces. Same shaft sizes as below.

This is a Press Fit Mounting. Clean dry 0.102mm press fit. Custom sizes available. Same shaft range as below.



This a Split Ring Assembly suitable for shafts from 0.311 to 6.02 inches dia.Includes 4 to 6 mounting brackets, screws and washers.Installs without decoupling motor.

This is a Bolt Through Mounting. Same shaft range. M3 x 14 socket head cap screws and lock washers. Two mounting holes up to 99mm shaft, 4 mtg holes for larger sizes

This is a Nema/IEC Mounting Adaptor to facilitate installation of the device on AC motors with shaft shoulders, slingers, bearing caps, or end-bell protrusions. Designed for use on any NEMA or IEC motor frame, the adaptor consists of a mounting plate to support the SGR and standoffs to provide clearance for bearing housings or slingers. Available for Nema 56 thru 449T frames and 80 frame thru 355M frame IEC

*****These SGRs are also available for shaft diameters greater than 6 inches, in solid or split design.**
The Aegis iPRO has been designed for High Current Bearing Protection (120 amp continuous,3000v peak) for large Motors and Generators and is available in sizes up to 30 inches diameter****

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