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Shaft Grounding Ring Application Notes:

Subject: Maximizing the effectiveness of conductive microfiber shaft grounding ring (AEGIS SGR™) on NEMA/IEC and above NEMA/IEC frame motors

1. Introduction

Motors with variable frequency drives (VFD) are subject to high frequency (HF) bearing currents that are caused by the common mode voltages that are inherent with pulse width modulation (PWM) VFD's . In recent years conductive microfiber shaft grounding rings were successfully applied on VFD motors of all sizes to economically solve the problem of the premature bearing failure.

2. Review of inverter induced bearing currents

A voltage source inverter presents a high frequency voltage source in the common mode circuit when PWM drives are used to control electric motors. The generated common mode voltage contains high frequency components that interact with capacitances inside machine that have not been of influence at line operation. As a result, different inverter induced bearing currents can occur that can be classified as follows.

a. Discharge bearing currents (commonly referred to as EDM bearing currents)
b. High frequency circulating bearing currents
c. Bearing current due to rotor ground current (If the frame of the motors is well grounded, this bearing current may not occur)

The first one (a) is related to the influence of the high frequency common mode voltage on the voltage across the bearing. The last two are caused by high frequency common mode currents that result from the interaction of common mode voltage with high dv/dt and the capacitance between stator winding and motor frame.

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3. Small Motors - shaft current mitigation with application of SGR on motors below 150kw/200 HP (shaft diameter less than 50mm/2")

For motors with shaft diameter less than 50mm/2", one shaft grounding ring (SGR) is sufficient to divert the harmful bearing currents.

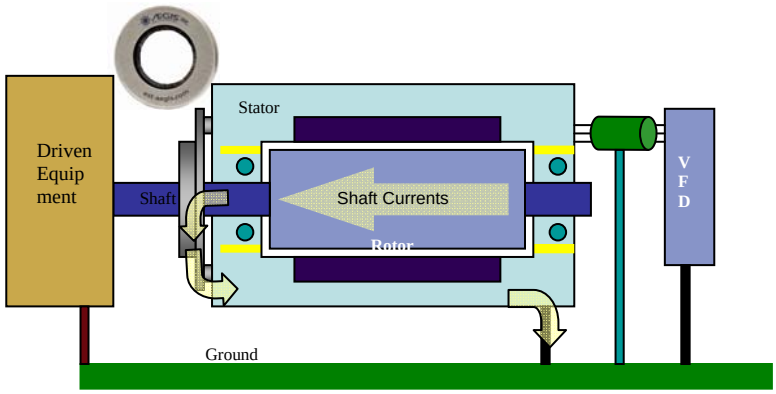

Figure 1

In these motors, the first bearing current type is the primary cause (type a. above) of electrical discharges in the motor's bearings. The discharge bearing currents also known as electrical discharge machining (EDM) currents are related to the influence of the high frequency common mode voltage on the voltage across the bearing.

4. Large motors - shaft current mitigation with application of SGR on the large frame motors above 150kw/200 HP (usable shaft diameter 50mm/2")

With large motors above the shaft diameter of 50mm/2", the bearing currents are more complex than with smaller motors. The large frame motors have not only the EDM currents but also circulating currents [1]. In this note, a practical installation of conductive microfiber shaft grounding ring is described to maximize the effectiveness of the SGR on a large frame motors.

Three cases will be described and the appropriate recommendations presented to apply the shaft grounding rings to best protect the motor's bearings from premature failure.

a. Case 1: General application with two ball bearings
b. Case 2: When it is not possible to install SGR on NDE of the motor or when roller or sleeve bearing is on DE
c. Case 3: Critical application

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Case 1: General application with two ball bearings

If neither bearing of the motor is insulated, bearing currents will circulate through the bearings and the bearings will be under severe electrical damage. The following procedures are recommended.

a. The frame of the motor must be well grounded and common with the ground of the VFD.
b. Install SGRs on the each end of the motor, i.e., DE and NDE. Please see the Figure 2 for illustration. By installing two SGRs, the bearing currents will be diverted to the SGRs instead of bearings.
c. SGR may be used instead of insulating sleeve to divert shaft currents through away from the bearings. This avoids potential problems with the insulation on the bearings breaking down because of stress or contamination.
d. Shaft surface on which SGR is riding should be polished to remove any oxide build-up and make the surface as smooth as possible.

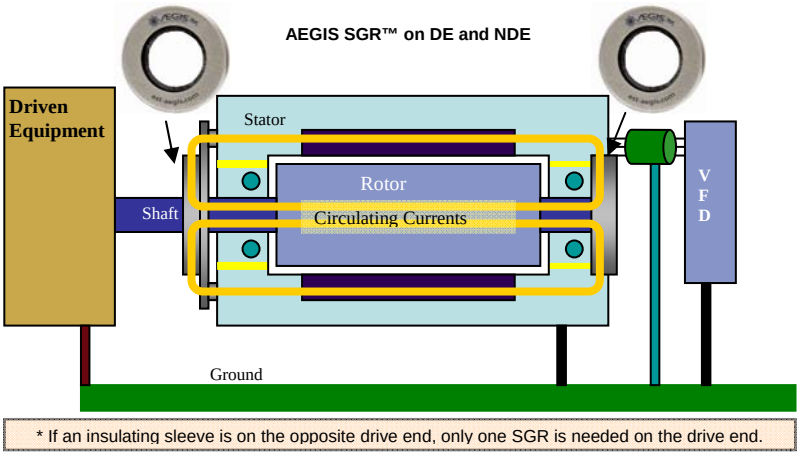

Figure 2

e. Service Shop Bearing installation tip: The effectiveness of SGR will be increased if the resistance across bearing is increased due to the parallel circuit of SGR and bearing. In order to increase the bearing resistance, the outer bearing surface and the bearing seat are recommended to be coated by Teflon. The Teflon coating can be achieved by spraying Teflon aerosol on the surface. Apply at least two coats if possible. It is also recommended to polish the bearing outer surface and the bearing seat as smooth as possible to remove any sharp asperity that may puncture the thin Teflon coat. The Teflon coat will not hamper the normal bearing installation procedure.

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Case 2: When it is not possible to install SGR on NDE of the motor
Or when Roller or sleeve bearing is on DE Case

There are situations where the installation of SGR on NDE is very difficult due to encoder application or fan and other special circumstances. In this case, please follow the procedure below.

a. Insulate the ODE bearing with insulated sleeve or use a Hybrid or ceramic bearing on NDE. It may be possible that the hybrid bearing may not be available in a practical delivery time or the price can be too high. Insulated sleeve can be an alternative although it requires machining of the ODE end bell.

b. If the insulation of the bearing is not practical, investigate the possibility of installing SGR on the bearing cover inside the motor.

c. Install one SGR on DE according to installation instruction.

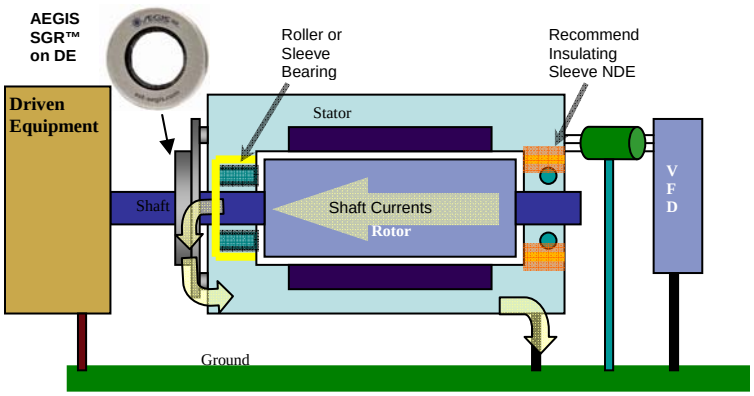

Figure 2

The case 2 installation method is a common method adopted by the industry in the past and is often applied by the motor manufacturer. The circulating bearing current is blocked or cut off by the insulation of NDE bearing and the EDM current is discharged to the frame through SGR.

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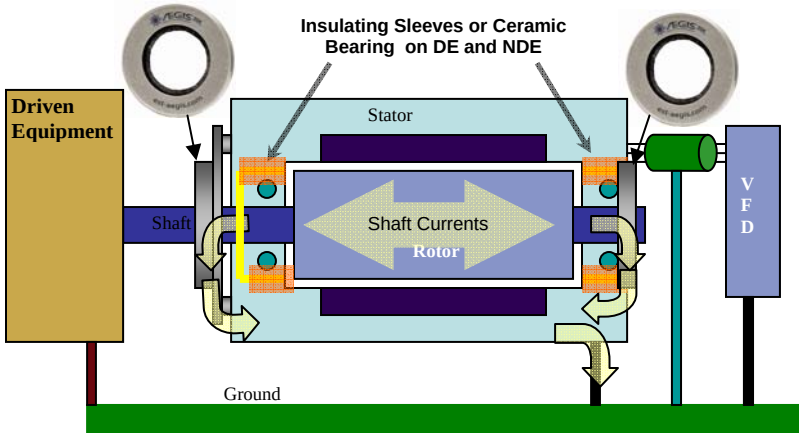
Case 3: Critical application

Insulating both bearing can not prevent the EDM current that will be discharged through connected equipment or the bearing itself if the bearing has steel balls in it. Please refer to the literature about the circulating current that still goes through the bearings with insulated layers around bearings because of HF nature of the current[1]. Therefore, two SGRs are required even with two insulated bearings to prevent the bearings from electrical bearing failure completely.



1) Install SGR on DE and NDE of the motor.

By using two SGRs and insulating both bearings of the motor, the electrical failure of bearings will be completely prevented. This application method provides the best possible solution available to eliminate the electrical damage of the bearings.

References

1. A. Muetze, A. Binder, “Calculation of Circulating Bearing Currents in Machines of Inverter-Based Drive Systems,”IAS2004, pp. 720 – 726, 2004
2. S. Chen, T.A. Lipo, D. Novotny, “Circulating Type Motor Bearing Current in Inverter Drives,” IEEE-Industry Application Society Annual Meeting, vol. 1, pp. 162-166, 1996
3. P.J. Link, “Minimizing Electrical Bearing Currents in ASD Systems,” IEEE Industry Applications Magazine July/August 1999, pp. 55-66.
4. H. William Oh, A. Muetze, “Application of Static Charge Dissipation to Mitigate Electric Discharge Bearing Currents,” IEMDC 2007, IEEE