

A rapidly increasing concern for all Engineers in South Africa

In recent years the cost of electricity combined with a greater need for South African companies to compete internationally is placing a lot of pressure on engineers and financial managers.

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Reliability, efficiency and cost are a factory's biggest concerns. One of the major costs to industry is electric motors, both in their maintenance and their cost of electrical consumption. One of the solutions has been to introduce Variable Speed Drives (VSDs) into factories, thereby reducing motor failures as well as electrical consumption costs.

VSDs protect and increase electric motor reliability, as well as reduce energy consumption but have a huge side effect in the form of capacitive currents and high shaft voltages, which damage electric motor bearings. This stops companies from realizing the full benefits of their Variable Speed Drives (VSDs).

VSDs are the largest single source of bearing failures in the world today. There is a 57% increase in bearing failures worldwide,

which is due to the introduction of IGBT Variable Speed Drives.

Older VSDs operated at a lower switching frequency and did not create many bearing problems, with the advent of the newer IGBT VSDs, the higher switching frequencies have created more unbalance and thereby creating higher shaft currents that increase motor failure.

Variable Speed Drive problems, as a scenario, are very similar to vehicle problems. When you own 4 or 5 vehicles, you believe they are quite reliable and you do not experience many problems. But as soon as you have a fleet of 200 vehicles, you start to experience an increase in problems, which is logical, but like VSDs; you also start to experience problems you never knew even existed. This is the same as our scenario in South Africa, whereby factories are starting to experience problems they

never knew existed, and in most cases factories are not even aware that these new problems exist.

These problems are often disguised as standard industry failures such as contaminated grease, low grease levels and normal bearing failures and the true cause of failure is never identified.

VFD INDUCED SHAFT CURRENTS

So what are these high shaft currents and how do they damage bearings? Damaging voltages are induced on the shafts of AC and DC motors controlled by Variable Frequency Drives (VFD). The extremely high on/off switching speeds of the Pulse Width Modulation (PWM), generated by the Insulated Gate Bipolar Transistors (IGBT), induce damaging voltages onto the motor shaft through parasitic capacitive coupling between the stator and rotor. This common mode shaft voltage seeks a path

to ground, usually through the motor's bearings.

Damaging currents arc through the di-electric oil film between the rolling elements and the bearing race. This is known as Electrical Discharge Machining (EDM) effect.

EDM causes fusion craters, severe pitting, and eventually bearing fluting (a washboard-like pattern in the bearing race) which results in premature bearing failure.

One of the most frequently asked questions is, "Will electrical bearing damage always occur in a VSD application?" The answer is "Yes - with no alternate path to discharge shaft current, pitting of the motor bearing will take place during VSD operation. These discharges will continue and will always seek the path of least resistance - usually through the motor bearings".

Yes, many motors still last for some time on a VSD application but bearing life is drastically reduced by up to 50 percent, even when the problem is not critical.

Bearing current problems are nothing new to engineers, but it is the alarming rate of increase in this problem that is becoming a worry to factories and mines.

SGS, a company in the USA, undertook a survey on 1000 AC motors on Variable Speed Drives. 250 of the motors monitored had bearing faults appearing by month 18, and of motors averaging 24 months production time, 65% had electrical bearing faults appearing.

This problem is termed by many as "The Ghost" as you never know when or how damaging its effects will be, there are many cases in KZN (where the initial research has taken place) where AC and DC motors

have been effected within 2 to 6 months of the motors installation, thereby creating huge and expensive down times. South African companies are going to experience increasingly more of this scenario, unless they protect their motors' against this growing problem.

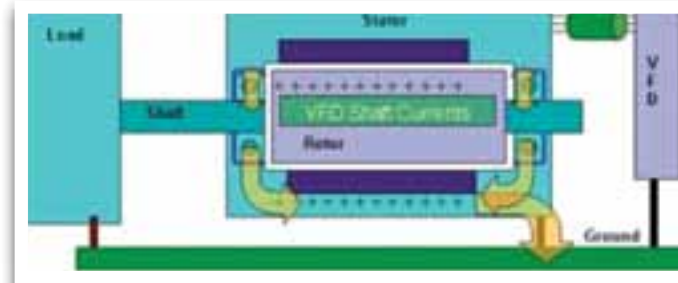
SOLUTIONS TO HIGH SHAFT CURRENTS AND EDM

(electrical discharge machining)

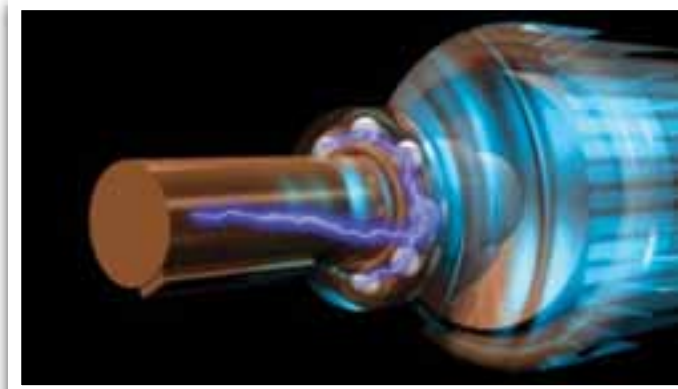
So what are the solutions to this problem? As EDM is brought about by high shaft currents, the most effective way is to reduce these shaft currents. This has been assisted by the use of filters for variable speed drives. This has had mixed results and the research is not conclusive, therefore the filter manufacturers will not guarantee the products solves electrical bearing damage. The next solution is to make sure that the high electrical currents and voltages that are passing the bearings on their way to

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EDM Currents Damage Bearings



Shaft voltages going through bearings on the way to earth.

ground, are redirected so that they do not pass through the bearings. This is the most effective solution, and there are many systems that have been in place over the years that try to solve this problem (mainly in relation to the old Eddy-current problem). None have been 100% effective, and have performance (and/or high cost) problems of their own.

The most popular solutions South African companies have used in solving Eddy-current problems, which are similar, but are not the same as VSD capacitive currents are the following:

- Insulated bearings
- Insulated bearing housings
- Carbon block brushes
- Copper or bronze metal brushes

INSULATED BEARINGS: These are effective but are not guaranteed against EDM by the bearing manufacturers. They also do not stop the bearing currents going into the driven equipment machinery (gearboxes, pump casings etc.), which can transfer the problems to other areas in which problems had not previously been experienced. With shaft voltages unable to escape through the motor bearings, there is a massive increase of current through the motor shaft. This can lead to the higher risk of ionization in hazardous areas. The initial, and on-going cost of ownership of insulated bearings in South Africa is also very high.

INSULATED BEARING HOUSINGS: Since normally only one insulated end shield is fitted, this solution is not 100% effective when used to protect the motors bearings against VSDs. In addition the capacitive currents differ from Eddy-currents, and the use of only one insulated housing would just increase the shaft currents in the other bearings. This method, of using two insulated housings per motor, is also very expensive as well as increasing the currents diverted to the driven equipment, and the associated risks involved.

CARBON BLOCK HOUSINGS: Conventional shaft grounding brushes need frequent maintenance and become less effective over time. They rely on the spring tension to press the brush against the rotating shaft. This causes the brush material to wear - sometimes in as little as 3 months as it rubs on the shaft. In addition, oil, grease, dirt or oxidation will break the conductive path and reduce or will reduce or prevent conventional brushes from discharging shaft currents.



Damaged grease & Bearing fluting, "washboard" pattern on bearing race

COPPER OR BRONZE METAL BRUSHES:

These brushes are very abrasive, wear out faster, and are therefore not maintenance free. These need constant monitoring to prevent the build up of contaminants.

THE SOLUTION FOR SOUTH AFRICA

With the advent of more and more VSDs becoming used in South Africa, what is the most effective and economical solution?

The answer is earthing rings, or Bearing Protection rings. – These rings consist of very thin micro-fiber that redirects shaft currents and provides a reliable, very-low-impedance path from shaft to frame, which by-passes the motor bearings entirely. The earthing ring is attached to the electric motors bearing housings. Once installed, the earthing rings require no maintenance. Unlike conventional shaft grounding brushes, its conductive microfibers work with virtually no friction or wear. They are unaffected by dirt, grease, or other contaminants, and last for the life of the motor, regardless of motor speed. In overseas trials the results show surface wear of less than 0.001 in. per 10,000 hr of continuous operation, and no fiber breakage after 25 million direction reversals.

For almost a decade these earthing rings have been extensively used in USA, UK and more recently Australia. There are thousands of case studies that show the positive effects of using these rings. The rings are seen as a solution to these problems, as well as an insurance against unforeseen problems. During changes in load conditions and during adjustments to their drive parameters it was found in KZN that many motors exhibited increased shaft currents after their most recent repair.

This is why it is termed "The Ghost", since it can never be determined when its effects will drastically increase and rapidly destroy bearings. It is of utmost importance that industry protects itself against this so called "Ghost", especially in regard to their critical motors.

You may wonder, "if these earthing rings are so effective and popular, why are they not extensively used and sold in South Africa". There are a number of reasons for this: - (1) High costs, due to high patent costs as well as the exchange rate in South Africa. (2) Lack of support and education to factory's, these newer EDM faults disguised as old standard industry bearing problems (3) Long Delays in supply time (especially for older or non standard motor shaft sizes, of which SA has a lot.).

These problems have been solved with the launch of South Africa's very own manufacturer in KZN. Due to local patenting costs and no ill effects of exchange rates the cost of the product has been reduced and is in line with our SA market. All Support is local, combined with education and training.

Earthing rings of both standard and custom designed sizes, can be manufactured and supplied anywhere in the country within 24 to 48 hours. Due to extensive research this South African company will also be the first company in the world to manufacture this product for approval in motors in flammable locations.

Due to the massive increase in the use of Variable Speed Drives (VSDs), shaft current bearing failures are one of the fastest growing problems on electrical motors in the world. **wn**



Earthingrings Combo



"Two of the largest factories in South Africa have just specified the earthing rings, as a requirement on all new motors purchased."

"Testing in a number of government departments have been confirmed for 2013 and testing has commenced."

For more information, contact Wyko Industrial on Tel: 031 461 4411 | Fax: 031 461 4450