INDUCTION ABSORBERS for PROTECTING BEARINGS

Can an Old Technology Actually be Repurposed for Eliminating Electrically Induced Motor Bearing Damage?

A few years ago, DP&A Sales and Shaft Grounding Systems, Inc. noticed that an old technology, once thought to be able to eliminate electrically induced motor bearing damage, appeared to be in the process of making a comeback. Our initial reaction to induction absorbers being marketed again for use as a method for eliminating electrically induced bearing damage was to wait and see what would happen. Our early testing of this technology nearly 30 years ago definitively showed that it had almost no impact on shaft-to-frame voltages and therefore had no appreciable effect on eliminating electrically induced motor bearing damage. Despite these findings from decades ago, we were surprised to see induction absorbers taking hold in the market with claims of being able to eliminate electrically induced motor bearing damage.

This article about induction absorbers was further inspired by a recent conversation we had with a Midwest engineering firm whose mechanical contractor seemed to be pushing its customers away from proven shaft grounding solutions and towards the use of induction absorbers. The engineering firm expressed some concern regarding the actual effectiveness of this technology which led to a long discussion about shaft grounding principals and a review of the reliability testing methods used by the mechanical contractor in their effort to prove the induction absorbers they installed actually work. The following is a synopsis of that conversation and is an effort to educate the public about dubious marketing claims that induction absorbers are effective at eliminating electrically induced motor bearing damage.

Brief Review of Motor Shaft Grounding Principals

Put simply, electrically induced motor bearing damage is solely the result of a shaft-to-frame build-up of electrical potential that eventually overcomes the bearing grease (dielectric) and hits the bearing. That voltage, which carries a small current, will burn off a piece of bearing material. That process is known as electrical discharge machining. Discharge of current through the bearing occurs millions of times and results in the characteristic fluting and frosting patterns associated with electrically induced bearing failure.

Shaft-to-frame build-up of electrical potential is a very localized event inside the motor and is caused by the variable frequency drive's (VFD) gated switching process. When current leading to the motor is switched on and off several thousand times per second (carrier frequency) in a system with rotating metal parts (shaft), a voltage potential is created between the rotating parts and the motor frame. Electrical current does one thing very well; it always finds the path of least resistance. In the case of an induction motor, that path is through the bearing. The continual switching on and off of current traveling to the motor induces a shaft-to-frame potential. That potential is trying hard to find the path of least resistance. If the potential builds to approximately 3 volts, then the dielectric properties of the bearing grease are exceeded and the potential is discharged through the bearing.

In order to eliminate the shaft-to-motor frame potential, a better path of least resistance needs to be established away from the bearing. Tying the motor shaft back to the frame of the motor is the only way to route the potential away from and around the bearing so that the bearing is protected from the harmful effects of shaft currents.

Brief Review of Induction Absorbers

Induction absorbers have been around a very long time. They have been used in industry for the purpose of decreasing line noise that may interfere with sensitive equipment. Induction absorbers are simply a core of wound wire. These cores are installed around power cabling and are designed to filter out electrical noise by dissipating it to thermal energy.

Copyright © 2020 DP&A Sales

In the case of an induction motor, the leads coming out of the VFD and leading to the motor are wrapped with an induction absorber. What is advertised by a leading induction absorber company is the absorber has the ability to eliminate shaft-to-frame potentials and therefore eliminating electrically induced motor bearing failure.

Let's further parse out the above claim. We know that shaft-to-frame voltages are caused by the inherent nature of the VFD's rapid gated switching process called the carrier frequency. That current switching process **causes** the build-up of a potential between a motor's rotor (shaft) and the frame of the motor. The only way to fundamentally eliminate the shaft-to-frame potential in the system is to not allow the switching on and off of current to happen. Eliminating the gated switching process means not using a VFD. In short, the gated switching process is a fundamental attribute of the VFD and creates the benefits associated with VFD usage such as power savings, process control, etc.

Induction absorbers claim to clean up the power leading from the VFD to the motor. That is not a false claim. As mentioned above, induction motors will filter out noise that can interfere with sensitive equipment by dissipating that noise via thermal energy. What is misleading, however, is the notion that cleaning-up the power coming from the VFD somehow overcomes the fundamental physics involved in rapidly switching on and off the current to the motor that causes shaft-to-frame potential.

A Field Example of Efficacy Testing Induction Absorbers

As mentioned above, the creation of this article is partially due to a Midwest engineering firm contacting DP&A Sales to discuss induction absorbers that they've been sold. During the conversation, the gentleman made mention of having a testing report showing their installed induction absorbers were working as intended. He was kind enough to forward the report. The report revealed the use of a Rogowski coil placed on the leads between the VFD and the motor as their methodology for determining if the motor bearing was protected against electrical bearing damage. Let's dig a little deeper into this testing methodology.

Rogowski coils are designed to measure current in a wire. The coil is wrapped around the motor leads coming out of the VFD. The oscilloscope readings, in this case, showed the peak voltage without the inductive absorber installed to be between 1.5v and 2.3v across two separate readings. The inductive absorbers were installed and using the Rogowski coil method, two oscilloscope voltage readings showed a dropped to 0.5 and 0.59, respectively. Results! Lower voltage readings must mean the inductive absorbers are working as advertised. That is to say, they must be eliminating electrical bearing damage. Pretty convincing result if we don't consider the root cause of electrical bearing damage. Let's quickly review what we know about how electrical bearing damage occurs. Shaft-to-frame voltage potentials are created by the VFD's gated mechanism switching on and off. Building up enough potential between the shaft and the frame causes the current to find the path of least resistance for discharge (the bearing) leading to electrically induced bearing failure. It's that gated switching that causes shaft-to-frame voltages to build-up inside the motor on the motor's rotating parts (shaft). That is an irrefutable, well known fact and is accepted by not only the field in general, but also OEM motor manufacturers. With that knowledge, we can begin to challenge the concept of using inductive absorbers and the testing methodology used to confirm a conductive absorber is working.

Inductive absorbers make the erroneous assumption that by cleaning up the noise between the VFD and the motor, this affects shaft-to-frame potentials located inside the motor. Inductive absorbers used for bearing protection also wrongly assumes that if the voltage readings on the line between the VFD and the motor are slightly decreased, then this must have a substantial positive affect on the shaft-to-frame potentials leading to electrically induced bearing failure. Remember, it's the VFD's gated switching that causes the shaft-to-frame voltages inside the motor. Does an induction absorber eliminate the VFD's gated switching? Of course not. That would completely defeat the purpose of the VFD.

Copyright © 2020 DP&A Sales

www.shaftgroundingsystems.com | sales@dpa-sales.com | 541-997-4068 (USA)

Another key point to consider when looking at the induction absorber testing report is the testing methodology. As mentioned prior, voltage readings were taken with a Rogowski coil on the leads between the VFD and the motor. The claim being made was that the bearing was being protected via a minimal voltage drop reading that occurred outside the motor's environment. Again, shaft-to-frame potentials are a localized event that occur inside the motor. Beyond pulling a bearing and actually seeing the condition of that bearing, the only effective way to test for whether or not a bearing is exposed to potentially harmful shaft currents is to test for shaft voltages on the motor shaft itself. The induction absorber testing method as described in the report is akin to testing a car's gasoline to determine the car's emissions performance. Measuring one will not really tell you anything about the other.

Testing Induction Absorbers via Shaft Voltage Testing

Shaft Grounding Systems, Inc. set out to once again test the effectiveness of induction absorbers on shaft voltages. They purchased several absorbers from a leading manufacturer and installed them per the induction absorber's manufacturer instructions. The following are a series of photos showing that testing.

Photo 1 is a shaft voltage reading taken with a Fluke 199C Scopemeter 200MHz 2.5GS/s without induction absorbers installed. The scope was set to 20ms with 10 volts per division. The testing probe is custom-built and designed to minimize environmental effects on scope readings. Shaft voltage readings show 48 volts peak-to-peak on the shaft. Photo 2 shows the Allen-Bradley VFD used for this test. Photo 3 shows the leads from the VFD.

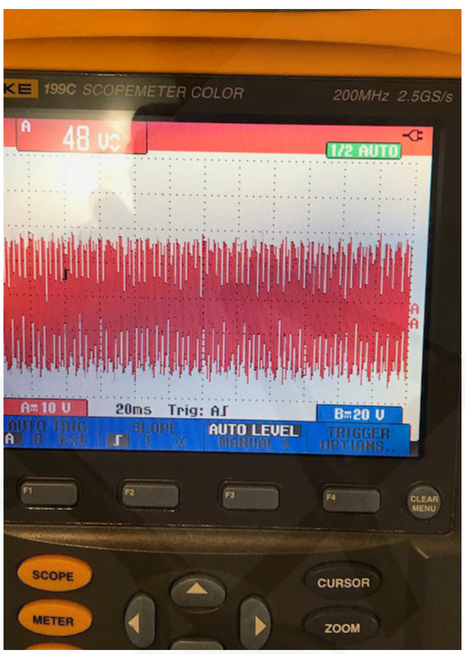

Photo 1

Photo 2

Photo 3

Copyright © 2020 DP&A Sales
www.shaftgroundingsystems.com | sales@dpa-sales.com | 541-997-4068 (USA)

Photo 4

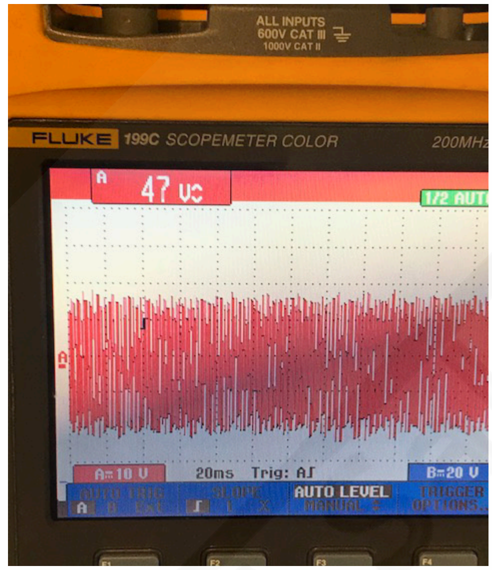

Photo 5

Photo 4 shows the inductive absorbers installed onto the motor leads. Photo 5 is a shaft voltage reading with the induction absorbers installed per the manufacturer's instructions.

As you can see, the shaft voltage readings with and without the induction absorbers installed are virtually the same. More importantly, in order to prevent break over to the bearing, the shaft voltages need to be approximately 3 volts or less. With the induction absorbers installed and 47 volts on the shaft, this motor's bearing is not at all protected from harmful shaft currents.

The Takeaways

Firstly, having a good understanding of the root cause of electrical bearing damage is critical when considering different methodologies for eliminating electrically induced motor bearing damage. Knowing that this type of damage is a result of the inherent nature of the VFD's gated switching mechanism and the fact that that switching mechanism causes a localized event to occur inside the motor and on its rotating parts, will allow for a better critique of a device's ability to eliminate electrically induced bearing damage. Induction absorbers cannot fundamentally alter the very characteristic of the VFD (gated switching) that is responsible for electrically induced bearing damage (shaft voltage\current).

Secondly, knowing that the damaging mechanisms of the VFD's gated process occur inside the motor, we can better understand why it's necessary to actually test the motor's internal environment for those mechanisms (shaft voltage testing). Testing the motor leads can not tell the story that is occuring inside the motor. However, testing the motor's shaft for shaft voltages will accurately determine if a bearing is protected or not.

Lastly, once the realization is made that to eliminate electrically induced motor bearing failure requires establishing a path of least resistance for current to flow between the shaft and motor frame, then a discussion can begin regarding devices that actually divert those shaft currents away from the bearing. There are several devices on the market that take this approach, including SGS™ shaft grounding systems. To learn more about SGS™ shaft grounding systems, please don't hesitate to call to discuss in greater depth. You will quickly learn that not all shaft grounding systems are created equal, especially when considering industrial grade applications and the special demands that environment puts on a shaft grounding device's long-term performance.

Copyright © 2020 DP&A Sales
www.shaftgroundingsystems.com | sales@dpa-sales.com | 541-997-4068 (USA)