Winter 2002

DIAGNOSTIC NEWS

The Newsletter on Monitoring the Reliability of Electrical Equipment

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Why Semiconductive and Stress Control Coatings are Needed in Stator Windings

By Greg Stone

Stress relief coatings are important insulation system components in stator windings operating at 6 kV or above. These coatings are present to prevent partial discharges (PD) occurring on the surface of the stator bars or coils. They prevent PD from occurring in any air gap that might be present between the coil/bar surface and the stator core, or in the endwinding near the end of the stator core. PD gradually degrades the groundwall insulation, and can create significant amounts of ozone. The coating in the slot is usually a black paint or tape and is often referred to as a partly conductive or semiconductive coating or shield. The stress control coating on the endwinding area just outside of the slot is often grey or red in color (although it is often not visible since it is overcoated with an insulating varnish). This coating is often called the silicon carbide coating.

SLOT SEMICONDUCTIVE COATING

The reason PD may occur between the coil and the core is similar to the reason PD can occur in air pockets within the groundwall. Since coils and bars are fabricated outside of the stator core, they must be thinner in the narrow dimension than the width of the core's steel slots, otherwise, the coils/bars cannot be inserted into the slot. Thus an air gap between the coil/bar surface and the core is inevitable. (The global VPI process may fill in much of the gap with epoxy or polyester between the coil surface and the core, and thus in theory does not require stress relief coatings. However, because of thermal cycling considerations most machine manufacturers will still use a semiconductive coating with global VPI stators.)

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Iris Announces Several New Appointments:

Joseph Mbuyi has been appointed to the position of Executive Vice President with responsibility for the company's overall operations and support functions. Joseph started with Iris in 1996 as an Applications Engineer in Sales and was Vice President of Sales and Marketing for the last 2 years.

Paul Magder has been promoted to Vice President of Sales and Marketing. Paul has spent the last 2 of his 8 years with Iris as the General Manager - Production.

Claude Silveira has been appointed Manager of Manufacturing after 6 years as a Supervising Technologist. Claude has been with the company for 8 years.

Please join us in extending them congratulations!!!

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NEW ISO QUALITY MANAGEMENT SYSTEM

Iris has begun the process of upgrading its Quality Management System from the ISO 9002:1994 Standard to the new ISO 9001:2000 Standard. This new Standard emphasizes customer needs, and the continuous review of our quality system. In order to accomplish the transition seamlessly and efficiently, Resi Zarb has returned to Iris to pilot the conversion. With Resi at the helm, we expect to have ISO 9001:2000 Certification by Spring 2003.

Angela Wong has been appointed Management Representative for Iris and will assume responsibility of maintaining and improving our Quality Management System in February.

The ISO 9001:2000 Standard encompasses each facet of our operation from design to delivery so that we can continue to offer our customers the quality products they have grown accustomed to. Iris continues to focus on customer needs and our objective is to fulfill those needs to the best of our abilities.

PREDICTIVELY SPEAKING
Internal Infrared Inspection of High-Voltage Electrical Equipment

Infrared imaging of plant apparatus has proven to be a powerful tool for detecting incipient problems in outdoor electrical equipment. Thermal imaging enables maintenance personnel to implement predictive maintenance as problems are identified and corrected before failure occurs.

To allow thermal imaging to be applied to energized electrical equipment contained within enclosures in switchgear, MCCs and motor terminal boxes, the SpyGlass™ lens port has been developed. Once this port is installed, thermal imaging equipment can view the inside of the enclosure or terminal box through the port - without having to open access panels or doors, or having to de-energize the apparatus.

Infrared Surveys, a sister company to Iris, can provide safe and reliable inspection of your energized high voltage equipment without risk to your personnel and without shutdown of the equipment. If you would like additional information on Infrared Surveys' thermography services please contact Iris Power Engineering at marketing@irispower.com.

PDTrac

The new ***PDTrac™*** is a cost effective instrument providing automated, continuous PD measurements for motors, generators, switchgear and dry-type transformers. ***PDTrac*** provides maintenance professionals with an opportunity to continuously monitor their machines for emergent problems. ***PDTrac*** will automate measurements and store recorded data for up to 2 years. ***PDTrac*** uses Sensor Input Modules to ensure a reliable and repeatable measurement each time. Testing under consistent operating conditions is extremely important when trending PD levels. ***PDTrac*** can be completely controlled from your office. You can easily configure it, perform tests on your machines, and receive an alarm when the PD levels you established have been breached - all from your office!

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Figure 1 shows the gap that can occur in the slot, adjacent to the coil surface, since the coil is undersized. An equivalent circuit, only slightly different from the groundwall case, is shown in Figure 1. A surprisingly large percentage of the applied voltage will appear across the air gap. If the electric stress (E = V/d) in the air gap exceeds 3 kV/mm, PD will occur, at least in an air-cooled machine. This PD will eventually erode a hole through the groundwall, causing failure. Discharges on the coil/bar surface are sometimes referred to as slot discharge, since they can be seen in the slot. Under practical conditions, most stators rated 6 kV or more will experience this PD on the coil/bar surface.

To prevent PD on the coil or bar surfaces, manufacturers have long been coating the coil/bar in the slot area with a partly conductive coating. The coating is usually a carbon-black loaded paint or tape. This coating is likely to be in contact with the grounded stator core at many places along the length of the slot. With a sufficiently low resistance (say a few kilohm), this coating is essentially at ground potential because of the contact with the core. Thus the voltage across any air gap is zero. PD cannot occur in the gap, because the electric stress will never exceed 3 kV/mm. The result is that the semiconductive coating prevents surface discharges in the slot. Note that the coating cannot be highly conductive, since this will short out the stator core laminations.

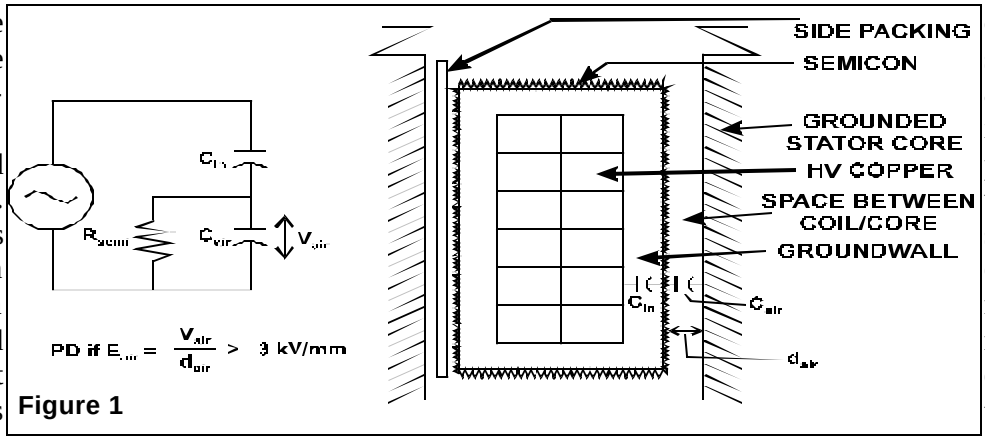

Figure 1

Semiconductive coatings on coils in the slot are not normally needed for stators rated 6 kV or less. Clearly this is because it is unlikely that the critical threshold of 3 kV/mm electric breakdown strength of air will occur at this low operating voltage, even if a substantial gap occurs between the coil and the core. The use of a thin groundwall in 4 kV stators is causing some motor manufacturers to use semiconductive material since it is possible for the 3 kV/mm threshold to occur if the groundwall is thin.

SILICON CARBIDE COATING

The low resistance semiconductive slot coating usually extends only a few centimeters beyond each end of the slot. The thin edge of the coating creates a very non-uniform electric field at the end of the slot coating since the electric stress depends strongly on the inverse of the radius, just as the sharp edge of a knife concentrates the mechanical force in a small area. This field would exceed 3 kV/mm, and PD would occur at the end of the coating. Such PD would eventually destroy the insulation in the vicinity, leading to failure.

Thus, just as for high voltage cables, the end of the semiconductive slot coating must be 'terminated'. The 'termination' method employed today uses silicon carbide. Silicon carbide is a special material that has an interesting property: as the electric stress increases in this material, its resistance decreases. In the past, silicon carbide was used in high voltage surge arrestors to divert to ground high voltage surges from lightning (i.e. have a low resistance state) while being fully insulating during normal operating voltage of a transmission line. When applied to stator coils and bars, the silicon carbide has a very low resistance in the high stress region at the end of the slot semiconductive coating, and gradually increases its resistance further along the endwinding from the core. This varying resistance makes the electric field at the end of the semiconductive coating more uniform. Usually, the stress is reduced to below the critical 3 kV/mm (in air) that would initiate PD.

Silicon carbide is usually mixed into a paint base, or incorporated into a tape that is applied to the coil/bar surface. The length of the silicon carbide surface coating depends on the voltage rating, but 5 to 10 cm is usual.

CALLING ALL PAPERS!

Iris' Sixth Annual IRMC (Iris Rotating Machine Conference)

IRMC 2003
June 16-19, 2003
Santa Monica, California

We are soliciting abstracts for papers discussing recent innovations in machines and testing, as well as papers given by machine users on problems they have experienced and repair methods. The Call for Papers is currently available on hard copy and on the Iris website at www.irispower.com.

The IRMC is one of the few non-commercial conferences dealing exclusively with practical problems in operating and maintaining motors and generators. In addition to the technical program, we also offer several tutorials that educate plant maintenance personnel on predictive maintenance and test methods. Usually over 125 people attend this conference - it is an excellent forum for exchanging ideas.

The 2003 IRMC will be held at the DoubleTree Guest Suites in Santa Monica, walking distance to the promenade and pier and just a short 10 minutes from the LAX international airport in Los Angeles. The 2-day IRMC registration is waived for anyone presenting a paper. (One free registration per paper.)

To submit an abstract or for more information, contact: Kim Zarb at 416-620-5600 X 240 or fax: 416-620-1995 or e-mail: kzarb@irispower.com

UPCOMING TRADESHOWS AND CONFERENCES

January
20-22: EPRI: Buena Vista, FL
27-30: PAPTAC: Montreal
28-30: EXFOR: Montreal
28-30: EGC: Bismark, ND

March
4-6: Electric Power: Houston, TX
23-26: NETA: Buena Vista, FL

April
6-11: Doble: Boston, MA
9-11: Industrial Non-Destructive Control: Moscow, Russia

May
4-7: MARCON: Knoxville, TN
4-9: IEEE-IAS/PCA Cement: Dallas, TX

June
1-4: IEEE-IEMDC: Madison, WI
1-5: ICPADM: Nagoya, Japan
11-13: NORD-IS: Tampere, Finland
16-19: IRMC: Santa Monica, CA
16-20: CIGB-ICOLD: Charleston, SC
29-2July: EASA: Montreal

July
29-31: Waterpower XIII: Buffalo, NY

August
24-26:: IEEE SDEMPED: Atlanta, GA

September
14-17: IEEE-PCIC: Houston, TX
22-25: EIC/EMCW: Indianapolis, IN

October
19-22: CEIDP: Albuquerque
23-24: ETG Kongress: Liepzig, Germany

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