Qualitrol-Iris Power

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DIAGNOSTIC NEWS

January 2012

What About Film-Backed Mica Paper Insulation?

By: Greg Stone

There is one big difference between the stator winding insulation used in motors and small generators made in North America and the insulation made outside of North America. That difference is the backing material of the mica paper tapes needed to support the mica. In North America, most machine OEMs tend to produce coils that use a Dacron™ and fiber glass woven material as the tape backing material. In Europe and Asia, the OEMs tend to use a plastic film (usually a variation of polyester) to support the mica paper. Originally, all mica paper tape was backed by a woven material. However in the 1970s coil manufacturers started using a film-backed tape for some very good reasons:

- The dissipation factor is usually lower
- Most importantly, there is a more uniform thickness to the tape, and thus the tolerance on the total groundwall insulation thickness is smaller. The result is that designers do not have to build as large a safety factor into the groundwall thickness, just in case the tapes are on the thin side of the specified thickness. Thus, using one or two extra layers of tape is not needed, "just in case".

There are a few disadvantages to the film-backed tape. One is that a film backed tape is less permeable to the uncured epoxy resin during the VPI process as compared to a woven backing material. Thus adjustments are needed for the impregnation time, pressure, etc. Perhaps more critically, there is a perception amongst motor and small generator users that there is a greater tendency for the groundwall to have voids and/or delaminate. The feeling was that it is much harder for epoxy to bond to film than it is to bond to the woven tape.

This perception was first apparent in the 1970s when the premature failure of many

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UPCOMING EVENTS 2012

Energy Generation Conference	Bismarck, ND Jan 24-26
EPRI-TGUG Users Group	Scottsdale, AZ Jan 30-Feb 2
Middle East Electricity Show	Dubai, UAE Feb 8-10
501 F&G Users Group Meeting	St. Petersburg, FL, Feb 13
NETA Power Test	Ft. Worth, TX Feb 27-Mar 1
Western Turbine Users	Pasadena, CA Mar 18-21
Australian Major Component Reliability Workshop	Brisbane, Australia Apr 12-14

QCMC/IRMC 2012

June 25-28, 2012

For the first time, the Iris Rotating Machine Conference will be held in Las Vegas, NV! For this 15th annual conference the program has changed to provide attendees with parallel sessions on Rotating Machines, Gas Insulated Switchgear, and Transformers. This conference will be devoted not just to presentations on condition monitoring tools, but also to educating attendees on the practical aspects of implementing condition-based maintenance in transformers, switchgear, large motors and generators. There will be ample time for participants to take in the local sites as well as network with colleagues.

Renaissance Las Vegas Hotel
3400 Paradise Road
Las Vegas, NV 89169

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What About Film-Backed Mica Paper Insulation?

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global VPI stators was blamed in part on the film-backed mica paper tape. As a consequence, many large utilities in the USA and Canada changed their purchase specifications to disallow film-backed mica paper in motor and generator stator windings. The North American OEMs complied and thus machines intended for the North American market rarely were made with film-backed mica paper tapes.

In contrast, most European manufacturers have continued to use film-backed mica paper tape since it was first introduced. Although initial problems with its introduction undoubtedly occurred, changes to the GVPI process, and perhaps the use of surface treatments to the film to promote adhesion with epoxy, reduced the incidence of poor impregnation and/or delamination after thermal cycling. Until recently this dichotomy between North America and the rest of the world regarding the mica paper tape persisted. However at the 2011 IEEE Electrical Insulation Conference, GE Energy presented a paper where they described a new insulation system that used a polyester (PET) film-backed mica paper. Knowing the likely reaction of some large North American utilities, they presented accelerated aging and other data that indicated the bonding between film-backed mica paper tapes was as good as the conventional backing materials. Presumably GE will be selling motors with their new insulation system to users in Canada and the USA. Other manufacturers can be expected to follow suit. It will likely take a decade or two to determine if the film-backed insulation system will have as good a service experience.

Endwinding Vibration Monitoring

By Blake Lloyd

Endwinding design, construction, and maintenance is critical to the longevity of a turbine generator stator insulation system. Online failure in the endwinding can cause considerable collateral damage since it often results in phase to phase faults or broken copper conductors that open under load.

The principle purpose of the endwinding is to allow safe electrical connections to be made between series bars and connections to other parallels. Generally, the higher the voltage rating of the machine, the longer the endwinding extension. If not suppressed, endwinding vibration will occur because the stator winding current in each bar creates a magnetic field that will interact with the fields produced by adjacent bars resulting in both radial and circumferential vibrating forces at 2X AC line frequency. In addition, core and frame vibration can result in once-per-revolution vibration of the stator endwinding.

Support rings, blocking and bracing are needed to prevent movement of the endwinding. Another consideration in endwinding design, especially for large two and four pole generators, is the growth of the coils in the slot and the endwinding as a result of high operating temperatures. As a stator goes from no load to full load, the copper conductors heat, and grow in length. The endwinding support system must be able to compensate for this growth, otherwise the support system and even the bars can become distorted.

As stators age, the insulating blocking and bracing material can shrink or loosen resulting in increased endwinding movement. Also large fault currents due to system disturbances can lead to sudden relative movement of the stator bars – causing loosening of the support system, allowing increased vibration in normal service. Design can also play a factor when inadequate endwinding support is utilized to reduce cost or when the design has resonances at the key forcing frequencies of 60 Hz and 120 Hz (or 50 and 100 Hz).

Endwinding vibration issues can be detected on-line utilizing specialized fiber optic vibration sensors, or offline through visual inspection or “bump testing”. During suitable maintenance outages and after endwinding repairs, it is prudent to perform bump testing to make sure there is no shift in resonant frequencies to the 60 Hz and 120 Hz regions, or changes to the damping factor, are occurring.

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2012 Training Courses

- Large Turbine Generator & Motor Maintenance Course, Honolulu, HI
  March 20-22
- EL CID—ACE Course, Iris Power, Mississauga, Canada
  March 27-29
  September 25-27
- HydroGenerator Maintenance Course, Nashville, TN
  September 25-27
- Partial Discharge Course, Long Beach, CA
  November 27-29

For more information, contact: khoward@qualitrolcorp.com

IEEE-PES Materials Subcommittee Meeting

On November 1-3, 2011, Qualitrol - Iris hosted the fall meeting of the IEEE Power and Energy Society's Rotating Machine Materials Subcommittee. The Materials Subcommittee is chaired by Stefano Bomben of Ontario Power Generation, and Iris's Greg Stone and Ian Culbert have long been active members. Prior to the Subcommittee meeting there were 8 standards working group (WG) meetings held to create new or update old IEEE standards for the testing of electrical insulation in motors and generators. Such meetings are held twice per year, usually in conjunction with an IEEE conference. At its June meeting, the Materials Subcommittee decided to meet at Iris, since there was no suitable conference for the WGs to co-locate with. Originally the WG meetings were to be held at Iris's Mississauga office, adjacent to the Toronto airport. However when the number of attendees swelled to about 35 people, the meeting was beyond the capacity of largest meeting room at Iris. Fortunately we were able to move to a meeting room across the street in the Sheraton Four Points hotel.

The series of meetings were very productive, with progress made on updating many test standards, some to the point that they will be formally voted on in 2012.

Message from the Business Leader

By Joseph Mbuyi

Iris Power has completed its first full year of operation as part of the Qualitrol Corp team, and we are happy to report a year of positive growth around the globe. Our team has helped our users deal with their maintenance and diagnostic needs on hundreds of motors and generators this year; for example, we produced close to a 1000 data interpretation reports for our clients which helped them assess the health of their key assets. We have also launched a number of new product offerings, i.e. the on-line report generator for those clients looking for efficiency in managing their data, more options for continuous rotor monitoring of large generators and synchronous motors (flux monitoring), as well as a number of off-line electrical testing tools under the PDTech brand in some unaddressed markets (tan delta and low frequency off line PD measurements). We continued to expand in all geographies adding new local representatives as well as direct Sales and Field Service associates in Asia, Latin America and Europe to drive service to be more responsive to the needs of the global energy sector.

In terms of new initiatives, I am happy to announce that we just completed a Qualitrol Condition Monitoring Conference in Dubai attended by many of our colleagues from the Middle East and Asia. The sessions on transformer, GIS and rotating machine issues were well attended and the participants provided us with feedback that they would like to expand the format of the event moving forward. We are committed to supporting the education, learning and practical exchange of information on these topics as a corporation and we will continue to conduct such events in the region after this 2011 inaugural event. It is also my pleasure to announce that we will be doing a similar event in Asia, specifically China in 2012 and we will be expanding the Iris Rotating Machine Conference in Las Vegas to include seminars and sessions on transformers and GIS.

Finally, this is an opportunity for me to thank all our clients and partners around the globe for their continued business and confidence. We look forward to adding more value to your operations in 2012 and I look forward to meeting you personally at one the QCMC conferences next year.

QCMC 2011

The first Qualitrol Condition Monitoring Conference was held at the JW Marriott Hotel in Dubai, UAE on November 28th and 29th. The QCMC is a technical conference which offered both in-depth half-day courses on condition monitoring methods, as well as presentations on state-of-the-art aspects of electrical equipment design, failure and repair. As with the IRMC, this information was provided in a non-commercial environment by world-class experts offering a range of points-of-view.

Ninety-two people from 18 countries attended the two-day event covering Rotating Machines, Gas Insulated Switchgear, and Transformers. The conference had two parallel sessions each day and all sessions were well attended by maintenance managers, engineers, technicians, designers and executives from 42 different companies.

The QCMC was also an excellent opportunity to network with peers in different organizations and all participants enjoyed the comfortable meeting rooms at the JW Marriott as well as the refreshment breaks, lunch and Monday night reception.

We will soon be releasing information on the QCMCs we are planning for 2012!

Endwinding Vibration Monitoring

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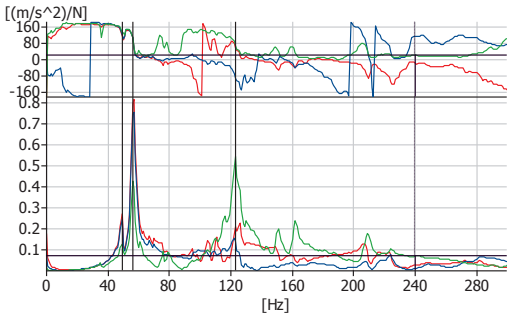
Iris personnel performing a bump test on 200MVA turbine generator

Such testing does require an outage and removal of endshields. The test itself consists of bumping a particular part of an endwinding structure and measuring its overall response with a temporary accelerometer.

The goal of the bump test is to establish a dynamic signature for the structure by doing Fourier analysis to determine the natural frequencies. The natural frequency of an endwinding is independent of the excited frequency so a hammer-accelerometer combination is used to excite the endwinding structure and measure the resulting vibrations. The measurement tries to identify resonances at frequencies that are close to the forcing frequencies where vibration amplification may occur. In service the natural frequencies may drift due to temperature, aging and other variable factors. Thus, a band of concern is defined around 60 Hz and 120Hz which is typically between -5% and +10% of these frequencies.

Bump testing is also critical when applying on-line fiber optic endwinding vibration sensors.



Frequency response plot gathered from a bottom bar. At the "Markers", the resonance frequencies are 49 Hz, 56 Hz, and 123 Hz which is close enough to the forcing frequencies to cause some concern about possible stator winding failure.

Experience indicates that some care is needed to select probe locations to ensure valid results. For best application of on-line monitoring, locations of interest should be tested, including all the jumpers and circuit rings, before the sensors are installed. This will ensure the sensors are not located in positions where natural resonances cannot occur thus invalidating integrity of the on-line monitoring system.

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