

DIAGNOSTIC NEWS

December 2010

Your Source for Monitoring the Reliability of Electrical Equipment

Recent Developments for Off-Line Testing of Stator Insulation

By: Greg Stone

When high partial discharge (PD) activity is detected in an on-line test, endusers usually want to verify that there is a problem by performing a visual inspection and/or doing some off-line testing. The traditional off-line DC tests are the insulation resistance (IR) and polarization index (PI) tests, as described in IEEE 43. In addition, AC tests such as the off-line PD test or the dissipation factor (power factor) tip-up test can also be done. All these tests are well understood and have been employed for decades. However, in the past few years a relatively new off-line diagnostic test has been applied to machine insulation. The test goes by various names, but the polarization-depolarization current (PDC) test seems to be the most widely used. It is a variant of the IR and PI tests, but it seems to be sensitive to more failure processes than IR and PI alone.

In the PDC test, a stable, high voltage DC voltage (up to 10 kV) is applied to the isolated stator winding (the complete winding or a single phase). The voltage is applied for 1000 to 2000 seconds – while recording the current. Then the stator winding is shorted to ground via the

PDC test device, and again the current is measured. During the voltage application, the insulation is said to be polarizing, that is, charge is moving to the interfaces between insulation tape layers and polar molecules are reorienting in the applied electric field. This is much the same as occurs in the well-known polarization index test, as described in IEEE 43. During the discharge cycle, a reverse current flows and the molecules gradually become disoriented and the space charge dissipates. This is referred to as the depolarization cycle. The relatively long time while both the voltage is applied and the winding is discharged, allows the current to “probe” the molecular condition of the insulation system. Of course the long time for application and discharging also implies that the test instrument must be sensitive to very small currents.

Although PDC measurements have been researched for many years, in the past decade there has been considerable attention in its application to rotating machine insulation diagnosis.

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UPCOMING EVENTS 2011

Energy Generation Conference	Bismark, ND Jan 25-27
EPRI TGUG Users Group	Houston, TX Jan 17-21
QCMC	Dubai Feb 6-8
Middle East Electricity Show	Dubai Feb 8-10
NETA Power Test	Washington, DC Feb 21-24
501F&G User Group	San Diego, CA Feb 23
Western Turbine User Group	Palm Springs, CA Mar 20-23
Hydrovision	Russia Mar 28-30

Iris Power News

By: Joseph Mbuyi

It is my pleasure to report to our clients and partners around the world that we have completed the key milestones of the integration action plan making us part of the Qualitrol team. Qualitrol, a Danaher Company, has a lengthy history of success and growth over the past decade, and Iris is now a significant component of the strategic initiative to bring leading technological solutions to condition assessment of large electrical apparatus, be it in Generation, or in the Transmission & Distribution side of

the business. In the past 6 months we continued to deliver on our growth targets and we have aligned our processes to meet the needs and objectives of the group, furthermore we have been the fortunate to be immersed in learning and participating in the implementation of Danaher Business System tools that will help us achieve the operational and commercial excellence so that we can deliver better products and services to our customers globally.

In the months and weeks to come you will learn of our ex-

panded commercial and technical presence that will help us support you better within your geography, and in the short term this is manifested in a new regional conference that will take place in February in the Middle East, specifically Dubai. This conference is called the Qualitrol Condition Monitoring Conference (QCMC 2011) and will include papers and training pertaining to condition monitoring of transformers, switchgear and rotating machines.

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Bhumiwat, David et al and Pinto have all presented research to indicate that different failure processes have different characteristic PDC plots [1-4]. For example, endwinding contamination is easily detected by PDC, as one would expect considering the ability of the IR and PI tests to find this problem.

Since surface leakage currents will not flow during the depolarization cycle (since no voltage is applied), any difference between the P and D currents implies that the difference between the plots is due to contamination of the stator endwinding. Of greater interest, damaged stress relief coatings or thermal deterioration leading to insulation delamination can also apparently be identified by the nature of their PDC plots. If verified by further research, this will allow owners of machines to obtain confirmation of the presence of particular stator winding problems using a completely different approach than used by the on-line partial discharge test. Two completely different test methods leading to the same conclusion will greatly increase confidence that a specific problem is occurring, even before one opens up the generator for a visual confirmation.

As an example see the PDC plot in Figure 1, which was published in a conference paper by Prof. Eric David [2]. It shows the charging and discharging current as two different plots on a graph of current versus time. The time is the number of seconds since the voltage was applied for the polarizing cycle, and the time since a short was applied for the depolarizing cycle. Typically the depolarizing current is assigned a positive current, even though it is really the opposite polarity to the polarizing current. This facilitates the comparison of the polarizing and depolarizing current. If the P and D current plots are essentially the same, the stator winding insulation is apparently clean, dry, well bonded and the stress relief coatings are not damaged. Figure 2 shows a PDC plot for a properly cured coil and poorly cured coil, showing a much higher current, especially after about 1000 s.

The ability to confirm the severity and nature of different insulation aging problems as found by on-line PD testing will be an important advancement in machine condition assessment. This will enable more certain prediction of the insulation condition, even before the machine is disassembled and a visual examination can occur. To that end, Iris is proud to offer a PDC instrument called the DRA-3 (Figure 3) to its customers. The DRA-3 was developed by Dr. Bernd Fruth of PDTech in Switzerland. PDTech and Iris Power are now part of the Qualitrol organization.

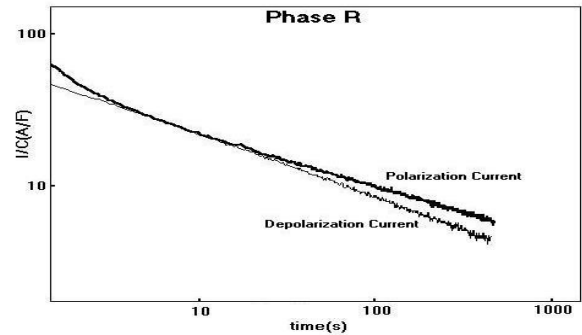


Figure 1: Polarization and depolarization measurement on one phase of an air-cooled turbine generator stator winding (from Reference 2).

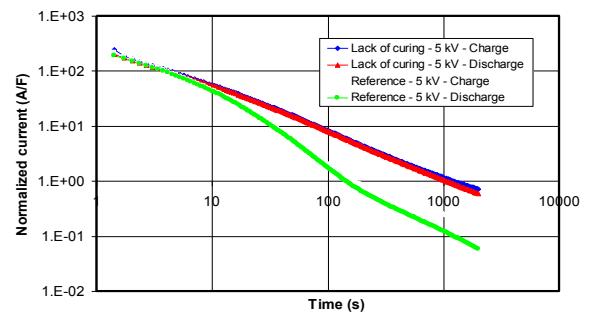


Figure 2: PDC measurements on two coils – one which is properly cured, and one which is poorly cured (from Reference 3).



Figure 3: DRA-3 which can perform PDC tests up to 10 kV

References:

1. S. Bhumiwat, "Field Experience in Insulation Diagnosis of Industrial HV Motors Using Dielectric Response Technique", Proc IEEE Electrical E. Insulation Conference, May 2009, pp 454-459.
2. G.R. Soltani, E. David, "Condition Assessment of Rotating Machine Winding Insulation by Analysis of Charging and Discharging Currents", Proc IEEE ISEI 2006, pp 336-339.
3. E. David, L. Lamarre, D.N. Nguyen, "Measurements of Polarization/Depolarization Currents for Modern Epoxy Mica Bars un Different Conditions", Proc IEEE Electrical Insulation Conference, Oct 2007, pp 202-206.
4. C. Pinto, "An Imporved Method of Detecting Contamination of HV Stator Windings in the Field", Proc IEEE Electrical Insulation Conference, Oct 1991, pp 55-59.

Iris Power News— continued from page 1

We cordially invite you and your colleagues to attend and meet our own experts, and our new colleagues who have demonstrable leadership for condition monitoring of other asset classes.

As markets around the globe recover incrementally after the recent economic crisis, we are well positioned to help you test and monitor your large machines. Over the last 2 years we continued to invest in R&D to ensure our current instrumentation and newly released products can work seamlessly with data you have gathered in the past. Furthermore, at Iris we are adding new tools and techniques for on-line assessment of all major components of your rotating machine, unified under a single interface and providing flexibility in moving data across multiple communication platforms. More importantly, we continue to make breakthroughs in our assessment and interpretation techniques of on-line data which will result in more timely information for decisions by maintenance and plant personnel. In September we celebrated 20 years since Iris Power came into existence, and we are extremely grateful for your confidence in support of our technical solutions. We will continue to strive to meet your expectations in terms of innovation, value and technical services for years to come.

FluxTrac//™ Rotor Winding Monitors Released

On-line rotor flux monitoring is a tool for predictive maintenance of synchronous machine rotors by detecting shorted rotor turns. FluxTrac// is the continuous line of products for on-line rotor flux monitoring that complements the existing RFA// line of portable instruments. After successful implementation in beta sites, the FluxTrac// monitors have been commercially released. The following part numbers are now available:

M1011—FluxTrac//-R monitor for one round rotor machine

M1012—FluxTrac//-R enabling for one additional machine (up to four machines per monitor)

M1015—FluxTrac//-S monitor for one salient pole machine

M1016—FluxTrac//-S enabling for one additional machine (up to four machines per monitor)

Typically round rotors are used in 2 and 4 pole machines such as turbine generators, and salient pole rotors are used in 6 or more pole machines such as hydro generators, diesel generators and

most synchronous motors.

Continuous on-line flux monitoring with FluxTrac// monitors has the following advantages:

- ◆ Reduce testing costs
- ◆ Avoid visits to remote plants
- ◆ Automated flux collection at different loads
- ◆ Alert relay: activated once a shorted turn is detected
- ◆ Rationalize available resources: maintenance efforts can be focused in machines with alerts
- ◆ Plant and diagnostic monitoring systems integration capability: Ethernet port for LAN communication using RotorFluxPro software and Modbus TCP/IP for third party applications
- ◆ Compatible with portable RFA// portable instrument
- ◆ Stand alone operation
- ◆ Support from Iris Power, the first company offering continuous flux monitoring when we introduced FluxTrac in 2000.

Iris Launches New PDTrac//™

After a year of development and months of laboratory and field verification, Qualitrol – Iris Power is preparing to launch a second generation product for continuous PD monitoring of motors. The PDTrac// instrument incorporates many advanced features that users of the earlier MotorTrac and PDTrac products have asked for. The PD data collected is compatible with the 220,000-record Iris database and now includes 3D phase-resolved plots reducing the need for supplemental portable instrument testing to diagnose the particular winding problem when a high PD level alert is detected.

The PDTrac// is a continuous on-line instrument constantly acquiring PD data and comparing it to alert thresholds that are automatically configured based on the Iris database and machine name-plate data. The instrument is “auto-ranging” and will adjust the sensitivity as PD conditions change. Up to 2 years of phase resolved PD data is archived in a FIFO fashion every 3 hours.

The PDTrac// supports several communications schemes for data retrieval and configuration. These include a local USB or remote Ethernet port for computer connections, or a USB Master port for automatic retrieval of archived data to a memory stick without the need for a laptop computer. The instrument can also be configured to periodically push data to a remote computer via FTP, eliminating the need for any local user intervention.

The base configuration includes inputs for temperature and humidity from standard probes. In addition, the PDTrac// includes numerous digital

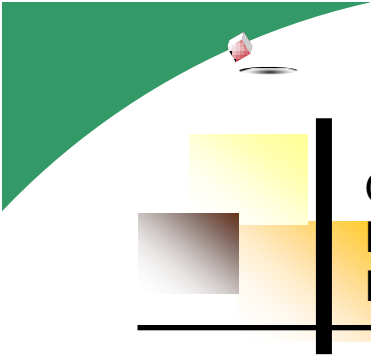
and analog input and output options. Modbus over Ethernet is built in, and allows operating data to be input from a remote system for archiving along with the PD data, or conversely PD summary data to be output to a remote system. Using optional third party protocol converters, other industry standard protocols like OPC™ or PI can be supported.



The PDTrac// also optionally supports local or remote (rack mounted, Modbus over Ethernet enabled) Analog Signal Inputs and Outputs to acquire machine operating data and to provide PD summary numbers to external PLC's or plant computers via analog signals. Alerts on PD levels can also be interfaced in this fashion.

The PDTrac// utilizes PDTracPro software for configuration, data downloads, and data analysis. The new PDTracPro is fully backwardly compatible with existing PDTrac instruments.

Housed in a slightly larger Nema 4X enclosure than the original PDTrac, the PDTrac// is designed to be field upgradeable with a second future motor monitoring technology such as flux monitoring for rotor shorted turns detection on Salient Pole rotors, or Current Signature Analysis technology for squirrel cage induction motors. Contact your Iris sales representatives for complete details on the PDTrac//.



QCMC 2011 February 6-8, 2011 Hyatt Regency Dubai



The first annual Qualitrol Condition Monitoring Conference (QCMC) will be held in Dubai February 6-8, 2011. The QCMC will concentrate on condition monitoring of the key electrical assets in electric power utilities and industrial plants: switchgear, power transformers and rotating machines. Over the past decade, equipment condition monitoring has become an essential tool to plan maintenance, extend the time between outages and turnarounds, minimize maintenance costs and delay equipment replacement. However, condition monitoring can only be effective if owners of electrical equipment have a sound understanding of the design of the equipment, know its failure processes as well as the repair options. Thus the QCMC is 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 as well as large motors and generators. This technical conference offers both in-depth half-day courses on condition monitoring methods and papers on state-of-the-art aspects of electrical equipment design, failure and repair. This information will be provided in a non-commercial environment by world-class experts offering a range of points of view. The QCMC will be an excellent opportunity to network with peers in different organizations. We have also arranged the date and location of the conference to enable participants to visit the Middle East Electricity trade show immediately after the QCMC.

The Conference will take place at the Hyatt Regency Dubai in Deira. To download the event Program and registration form, please visit www.irispower.com or for further information email Ms. Resi Zarb at resi.zarb@qualitrolcorp.com.



Iris Power will be hosting the 14th annual Iris Rotating Machine Conference (IRMC) June 20-23, 2011 in San Antonio, Texas. This annual conference is attended by industry professionals from around the world. The conference will take place at the Sheraton Gunter San Antonio Hotel.

Visit www.irispower.com for more information or email Karen Howard at khoward@qualitrolcorp.com.



Training Courses 2011

- ⇒ ACE EL CID Course, Toronto, March 15-17 and September 13-15
- ⇒ Hydrogenerator Maintenance Course, Vancouver, BC, March 15-17
- ⇒ Partial Discharge Course, Orlando, FL, December 6-8