IRIS POWER

Iris Power LP
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DIAGNOSTIC NEWS

Your Source For Monitoring the Reliability of Electrical Equipment

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UPCOMING EVENTS

EPRI Turbine Generator Workshop	Aug. 11-14, 2008 Charlotte, NC
CIGRE 2008	Paris, France Aug. 24-29, 2008
EL CID Training	Toronto, Ontario Sept. 9-11, 2008
IEEE PCIC 2008	Cincinnati, OH
Turbo Maintenance Course	San Antonio, TX Oct. 7-9, 2008
Finepoint Circuit Breaker Conference	Pittsburgh, PA October 7-9, 2008
Motor Maintenance Course	St. Petersberg, FL Dec. 2-4, 2008

KEEPING STATOR AND ROTOR WINDINGS CLEAN

Earl Goodeve

One of the most common maintenance tasks in rotating electrical machines of all types and sizes is cleaning to remove contamination and debris from the windings. Most equipment operators perform this task to some degree every 1 to 5 years. If done properly, a significant outage is necessary and thus there is considerable cost. To minimize the cost, cleaning should only be performed when it is needed, and when done, the cleaning should be performed with the most effective methods and materials available.

Sources of Contaminations

Contamination and debris may come from both within or from outside of the machine. Perhaps the most serious source of contamination is from oil released from machine bearings. A leaking bearing results in oil entering directly into the machine and eventual distribution throughout the stator and rotor by centrifugal and ventilation action creating an oily film everywhere. This film then forms the perfect “magnet” for solid contaminants, depending on the type of machine, such as atmospheric dust, carbon dust, brake dust, insects, sand, cement particles, metallic residue from grinding and so on. Open ventilated machines are particularly susceptible to these “floating” contaminants.

Impact of Contamination and Debris on Windings

There are several ways that debris and contamination will affect the life of a rotor and stator winding. The most immediate effect is that it interferes with cooling. By collecting in cooling passages and ducts, air-flows are restricted and operating temperatures increase. In a similar manner, any contamination that collects on winding surfaces provides a thermal barrier to the dissipation of heat generated by the copper. Insulation deterioration increases rapidly as temperatures rise resulting in reduced life.

Contamination also results in films that become partly conductive either as a result of the contaminant itself or through changes in relative humidity. This partly conductive contamination results in tiny power frequency currents flowing over the surfaces of the insulation. These currents degrade the organic components of the insulation, leading to electrical track formation, and eventually fail the groundwall insulation. This problem has a greater probability of occurring in machines with high operating voltage. This mechanism is usually very slow, often taking more than 10 years from the time the winding is contaminated to when it fails.

Oil contamination also tends to “lubricate” the stator winding resulting in possible coil movement during operation. The resulting movement causes insulation erosion and, left unchecked, eventual and relatively rapid failure.

Detecting Contamination and Debris

When a machine has been completely or partly disassembled, it is usually easy to detect that there is severe contamination which may lead to any of the above problems. Cooling ducts will be partly or completely plugged, the spacing between the endwindings may be closed off, and/or there is an oily film over the endwindings and, there may be evidence of the formation of electrical tracks.

Detection of contamination or debris without disassembly would be more cost effective. An insulation resistance and polarization index (PI) tests can be performed as described IEEE Standard 43-2000. A low insulation resistance or low PI suggests that there are partly conductive films over the stator endwindings or rotor windings.

Another non-invasive technique way of detecting contamination, especially where debris is partly or completely blocking the cooling system, is to trend the stator winding temperature and the rotor winding temperature (where fitted) over time. Under the same load and ambient cooling water/air conditions, the winding temperatures should not vary more than 1C or so. (Since there are generally multiple temperature sensors, a rise is generally observed in more than one.) In the past, trending of temperature under the same load/ambient conditions was tedious. However, with the modern computer systems now used in many plants, this data is archived. A simple selective database search can often easily uncover any gradual increase in temperature.

Another powerful method to detect stator (not rotor) winding contamination/debris without shutting down is on-line partial discharge (PD) detection. Thermal deterioration of insulation, electrical tracking and loose windings all generate PD signatures that can be analyzed to determine the probable source. The actual cause (contamination/oil) may not always be obvious but the result (increasing PD) will be.

Cleaning Methods

A variety of cleaning methods are available for stator and rotor windings, with varying degrees of effectiveness. The most thorough and rapid cleaning method might be called particulate blasting. This is where materials such as ground-up corncobs, walnut shells or dry ice (frozen CO2) are ‘blasted’ at the winding surfaces at high velocity using special equipment. In essence it is the electrical equivalent of sand-blasting. The idea is to remove the bulk of any debris and surface contamination by the force of the propelled material. Skilled personnel are required for the blasting method since if the nozzle that is blasting particulate is held over the insulation for too long, the coil coating and even the groundwall insulation can be rapidly abraded, creating a weakness in the coil. Dry ice blasting has the advantage that the cleaning particulates do not have to be vacuumed up. However, dry ice does not seem to be as effective at removing oily contamination.

Steam cleaning is common with motors. This can be very effective at removing oil but its use becomes less common on larger machines due to the fact that the large mass of the machine cannot be adequately “heated” to prevent excessive condensation within the stator and hence re-depositing or positioning of the contaminant.

Cleaning with rags and approved solvents is another method used to clean windings. Citrus-based solvents or just detergent and water are common. Care must be taken to ensure the solvent or detergent/water mixture does not degrade the insulation. Also, cleaning with liquids or solvents can “transport” contamination, especially brush carbon and brake dust into areas where it is inaccessible and can cause future problems. Usually most modern insulation systems such as epoxy mica and polyester mica are essentially impervious to common cleaning liquids. It must be appreciated that many areas of the winding cannot be effectively “hand” cleaned because they are essentially inaccessible.

The effectiveness of the cleaning operation can be judged by making use of the guidelines laid out for such purposes. The improvement can be determined by when the insulation resistance increases to the acceptable minimum (100 Megohms for modern windings or a polarization index >2, according to IEEE 43-2000). After returning to service, on-line PD measurements can also confirm the success of the cleaning process.

PULSE WIDTH SPECIFICATION FOR INSTRUMENTS

This article deals with the addition of the pulse width response specification for the Iris PD instruments in addition to the traditional frequency bandwidth specification.

FREQUENCY BANDWIDTH

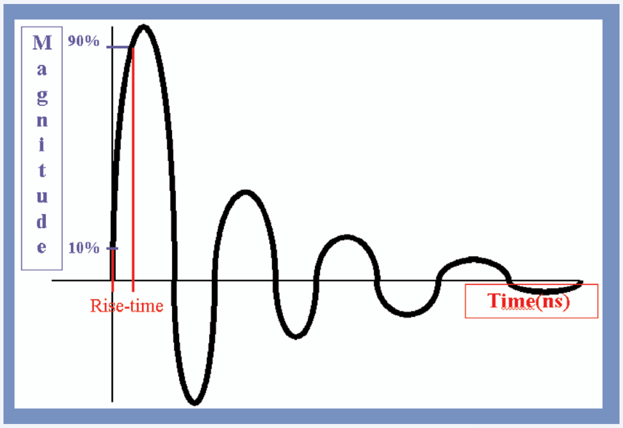


Figure 1

PULSE WIDTH RESPONSE

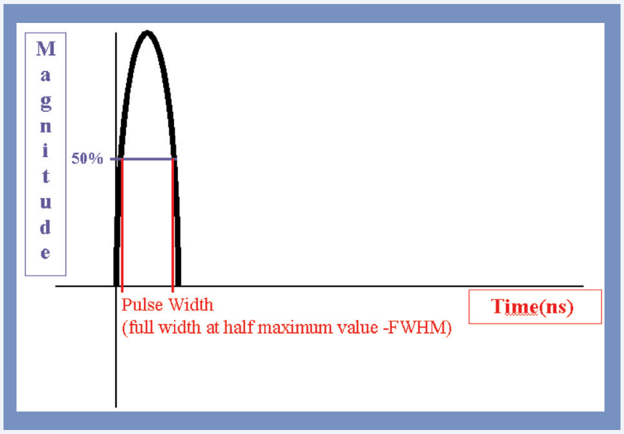


Figure 1

The equivalent period (T) of an initial pulse is approximately four times the rise-time (see Figure 1). As an example, if the rise-time is 1 ns then the period (T) is 4 ns, and the equivalent frequency is 250 MHz (f=1/T). The rise-time of initial pulses of typical PD is 1 to 5 ns, equivalent to frequencies 50 to 250 MHz.
For the past 12 years, one of the critical specifications for the PD test instruments has been the frequency bandwidth. Thus, for the most part, the bandwidth of the PDA and TGA instruments was listed as 0.1 to 350 MHz (3db cutoff), required to detect the fast rise-time initial pulses typical of PD originating in the winding.

An inconvenience of the bandwidth specification is that other test instrument suppliers might have wrongly related it to the clock speed of microprocessors inside the PDA/TGA.

In order to provide users with a practical method to assess the capability of test instruments to detect fast rise-time pulses, a specification based on pulse rise-time response of the test instruments will be used in future technical documents.

To determine the new specification, voltage pulses of known magnitude, 1 ns or less rise-time and variable pulse width at 50% of the peak magnitude (Fig. 2) are inputted, and the 2D (pulse magnitude analysis) output plot is used to determine the measured magnitude of the pulses for each pulse width. When the measured Qm dips to 70% of the input pulse magnitude (the 3 db cutoff), this determines the shortest pulse width that can be measured. The shorter the pulse width that can be measured, the more accurately the PD magnitude measured. Thus for the PDA and TGA instruments the pulse width response is at least 2.5 ns, with 3 dB magnitude cutoff.

IRMC 2008 HIGHLIGHTS

The 11th annual Iris Rotating Machine Conference was held this past June in Long Beach, California.

This year's conference boasted a significant international presence, with attendees from China, Japan, Denmark, Colombia, India, Austria, Australia and New Zealand.

In addition to the usual tutorials and user groups, this year we also held a workshop to demo some of our instruments. The workshop was a great success and the feedback very positive. There were also numerous technical papers on various aspects of maintenance, testing and monitoring of electrical apparatus from a vast and knowledgeable field of experts.

We would like to thank all of our attendees for making the 2008 IRMC a success. We look forward to seeing you next year in New Orleans.

Please visit our website at www.irispower.com for more information, as we will be updating regularly.

NEW TELEPHONE AND FAX NUMBERS

As a result of our move to Mississauga, we have been forced to change our phone and fax numbers.

Although we can still be reached at the old phone and fax numbers, this is only temporary, and both numbers will be completely phased out over the course of the next few months.

We would like to take this opportunity to apologize for the inconvenience, and request that you begin using our new numbers. The new phone number is 905-677-4824 and the new fax number is 905-677-8498.

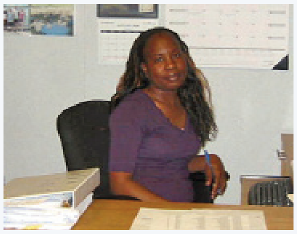
Kindly update your records accordingly, and thanks very much for your assistance during this transition.

SPOTLIGHT ON FIELD SERVICES

Our Field Service Department is ready to assist with your field service requirements. If you need to schedule a visit, or if you require help with data, please contact Shelly Zikovic and Michelle Mathias.

Shelley and Michelle also work closely with our Rotating Machine Technical Specialist team to help facilitate rotating machine maintenance training and services.

Shelly Zikovic, Senior Field Service/RMTS Administrator



Michelle Mathias, Field Service/RMTS Administrator

UPCOMING EVENTS

IRIS ROTATING MACHINE CONFERENCE 2009 (IRMC)

Join us for the 2009 IRMC in
New Orleans, Louisiana
May 11-14, 2008

Venue:

INTERCONTINENTAL®
NEW ORLEANS

InterContinental New Orleans
444 St. Charles Ave.
New Orleans, LA 70130

COURSES

There is still time to register for the Turbo (October 2008) and Motor Maintenance (December 2008) courses.

The Turbo course focuses on large steam and gas turbine driven synchronous generators with cylindrical rotors, rated 11kV and above. Discussion will concentrate on stators and rotors.

The Motor course focuses on large AC Induction and Synchronous Motors rated 2300V and above. Discussion will concentrate on stators (frames, windings and laminated cores) and rotors (shafts, windings and laminated cores). The course is presented from a user's point of view, rather than that of a machine designer.

For more information, or to register, please contact Michelle Mathias at mmathias@irispower.com.