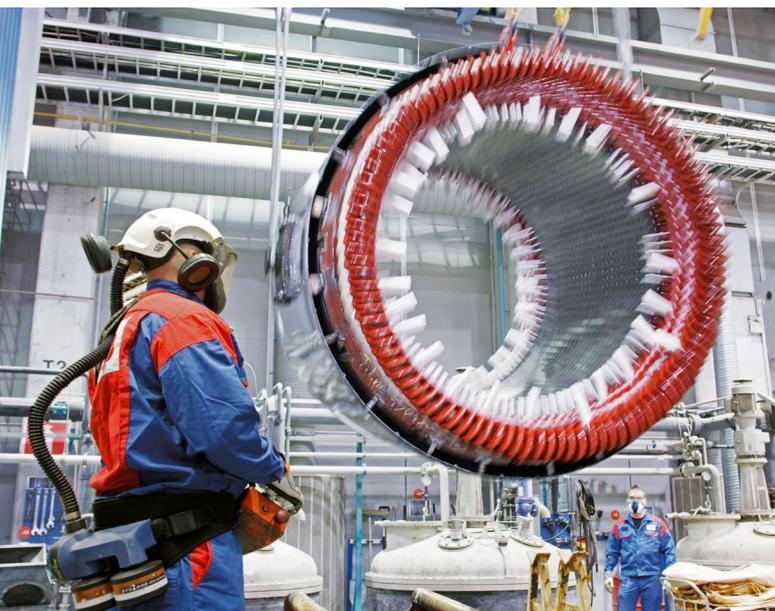


High voltage motors and generators

Approaches to control partial discharge phenomena

The MICADUR* Compact Industry insulation system used by ABB is extremely durable against the detrimental effects of partial discharges (PDs). ABB has supplied thousands of high voltage (HV) motors and generators with no premature failures due to PD. Various approaches are available to monitor winding condition and minimize the effects of PD. Two enhancements are available for winding design: Insulation+ for further improved PD durability and Lifetime+ to maximize lifetime. ABB can also provide various solutions for on- and offline PD measurement.

* Trademark of General Electric Company



What is PD?

PD is a kind of small spark that occurs due to a high electrical field. It typically arises inside the main insulation, between the coil and slot, or in the coil overhang. A PD generates a short-lived plasma burst which stresses the insulation. PDs release energy that can be detected by various methods, typically based on measuring electrical current pulses, ozone levels, sound, light or other high frequency radiation. If PD is neglected, in the worst case it can result in a stator failure, which can put the generator or motor offline.

Partial Discharge is a known phenomenon in HV motors and generators. It is taken into consideration in ABB's design, manufacturing and service processes. ABB is a safe choice for customers who are looking for the most viable solutions to minimize the effects of PD. For ABB motors and generators normal periodic maintenance is sufficient to manage PD.

During any project procurement phase, the most essential decision is to select a motor or generator supplier with a proven track record. In HV motors and generators the electrical stress can be several kilovolts per millimeter. Therefore it is vital that the workmanship is extremely accurate, and that the most suitable materials and designs are selected.

For industries where very long lifetime is crucial, ABB can provide the Insulation+ design which offers an extended

insulation service cycle. To meet even longer lifetime expectations, ABB supplies Lifetime+ motors and generators that benefit from reduced temperature stresses and have an extended design lifetime. Achieving a long lifetime requires that maintenance is performed according to the User's Manual and assumes that the operation profile is typical for the industry in question.

ABB can also provide solutions for customers who choose PD level tracking using PD couplers. The most systematic approach to PD level tracking is to decide on PD measurement equipment supplier before the motor or generator is manufactured. ABB does not have own PD measurement equipment. ABB can perform fingerprint measurements already during Factory Acceptance Testing (FAT).

Critical decisions

Customers who choose to utilize PD level tracking as a condition monitoring tool need to take two important decisions at an early stage:

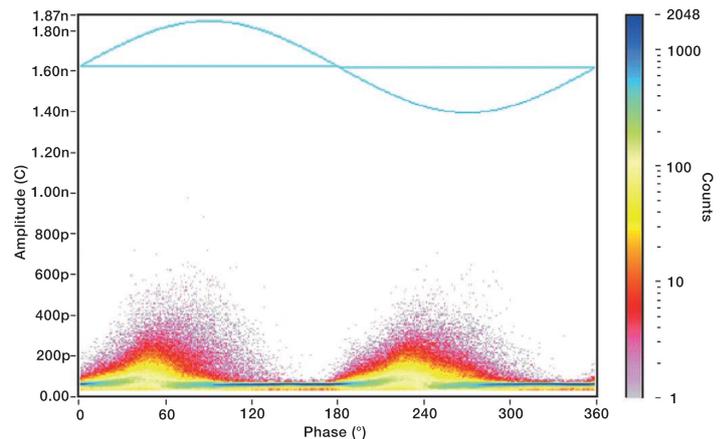
1. Specific expertise is required to perform the measurements and analyze the results of PD level tracking. Should the necessary skills be developed in-house, or will an external service provider be used? These skills are required because the results of PD level tracking are motor/generator specific and there are no standards to support their evaluation. The results are also expressed in many different terms. A service provider may have a preference for certain hardware, which means that the provider should be selected as early as possible.
2. Will the PD measurements be done on a stand-alone basis or in combination with other tests? Will they be done on- or offline? All the variants have benefits and drawbacks. ABB LEAP is a service that includes a number of electrical measurements – such as tan delta, polarization index etc. – in addition to PD, and the measurements are done offline. The results produced by ABB LEAP are more stable than PD measurement results, as each measurement is enhanced by the other measurements and a large database of earlier tests is used while creating reports. Continuous online measurements require permanent mounting of couplers into the terminals and can be performed at any time, but online measurements are prone to disturbances and the necessary investment is higher.

Pitfalls of PD level tracking

PD level tracking faces challenges that need to be evaluated when planning to use PD measurements as a condition monitoring tool. These challenges include:

- Results are very sensitive to the equipment, environment, measurement set-up, external noise and calibration.
- Evaluation of PD measurement values is complicated. Detail interpretation is typically based on pattern recognition that is not quantitatively supported by any standard. Therefore absolute PD magnitude is often used as an evaluation criteria. However due to sensitivity of the results, IEC standards and ABB's own guidelines recommend using trended PD measurements instead of giving limits for absolute PD magnitudes.
- PD measurements give indications only about the winding condition. They do not reveal anything about the condition

Example about the partial discharge distribution as a function of phase voltage



of mechanical parts, cleanliness, cracks, or auxiliaries, for example. Therefore PD measurements are no substitute for conventional inspections. PD measurements also give a one-sided view of the condition of the winding based mainly on electrical aging.

- At best, PD measurements can give an indication of a potential problem that can be used as a trigger to perform a visual inspection. By contrast, systematic calendar based inspection and more traditional predictive maintenance and service activities, will reveal the same potential problems, enable immediate corrective action and in addition reveal other issues that are not visible in PD results.
- The correlation between PD and lifetime is not unambiguous. Primary HV insulation materials are resistant to PD and are therefore designed to operate under varying levels of PD activity, even for very long periods of time. The combination of electrical, thermal, mechanical and ambient stresses appearing during motor or generator operation determines the performance and lifetime of the insulation system. There is therefore no unambiguous correlation between service lifetime and PD magnitude, since electrical stress alone may not be the dominant aging factor.
- It is costly to maintain the required measurement and analysis expertise. Achieving useful results requires a long-term commitment to equipment and expert personnel.

For more information please visit:

abb.com/motors&generators

We reserve the right to make technical changes or modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars shall prevail. ABB does not accept any responsibility whatsoever for potential errors or possible lack of information in this document.

We reserve all rights in this document and in the subject matter and illustrations contained therein. Any reproduction, disclosure to third parties or utilization of its contents – in whole or in parts – is forbidden without prior written consent of ABB. Copyright© 2019 ABB. All rights reserved.