A Discussion of Practical Partial Discharge Methods

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Abstract: A wide variety of partial discharge detection methods are available in the modern marketplace. Benefits and drawbacks for certain techniques are discussed. Concepts such as Partial Discharge Inception Voltage, Partial Discharge Extinction Voltage - versus certain test methods will be presented.

1. Introduction:

Corona, as it relates to electrical insulation was first mentioned in the literature in the early 1900's. The crackling, hissing blue electrical discharge could be seen visually and audibly. For history's sake - observations of the corona electrical discharges could be said to go back to the times of Benjamin Franklin.

During the early 1900's widespread, worldwide deployment of high voltage AC generation and transmission techniques was partially responsible for the rapid development of knowledge in this arena. As a result, the limits of test technology were rapidly expanding.

How could engineers determine the presence of Corona or lack thereof?

In the early 1900's there were relatively few methods available to check the quality of electric insulation. The Insulation Tester from Evershed and Vignoles was one of the means available, and the AC High Potential test was another. The AC test set was where the early work related to partial discharge occurred. As mentioned above, it is possible to detect corona or partial discharge visually and audibly. A test could have been performed on an electrical winding, whereby high voltage AC was applied, and by careful listening or observation – the source of the electric discharge could be determined.

(Author's note: During my time in the electrical test equipment industry, when performing calibration\repair\debugging work of high voltage testers, it was sometimes necessary to take equipment into a very dark room. Wait in the dark for 5-10 minutes, for eyes to adjust to the dark. Then, raise the power supply voltages in the equipment. Once the corona inception voltage was attained, a flickering blue electric discharge could be seen with the naked eye. It would be present at a joint, damaged insulator, or exposed metal connection. The discharge would be accompanied by a crackling or hissing or gentle popping sound. Using this technique to locate the damaged area, steps could then be taken to repair or replace the damaged insulation. I have also used this technique for electric motors and windings. Today, EASA members might recognize this technique as the "blackout" test. – G. Frey)

It must have soon become apparent to the engineers that this method had significant limitations. If one considers the construction of the 3 phase AC stator, stator iron and coil slots, it is not too difficult to understand why. The areas of greatest voltage differential are often in two locations (when they are excited with an AC test voltage or operating with mains voltage present)

A) Between the electric coils and the stator iron
B) Between the phase-phase ends of the electric coils.

Certainly, these areas are not easily viewable, or in the case of the locations in the stator slots, are entirely hidden from view. Compounding this reality is the fact that the coil windings were almost always coated or impregnated with varnish, types of gum or shellacs. This provided great rigidity to the windings, a definite requirement for reliability. But, this sealing treatment could also hide certain electrical defects from visual or audible detection.

One can understand why research and development began towards further, more advanced test techniques. By the 1920's a test technique was developed by Harald Schering in Germany. The device was named the Schering Bridge in his honor. This apparatus allowed sensitive measurement of both capacitance, and the effects of dielectric loss. This effect was called dissipation factor. This technique was documented in the literature as early as the 1920's.

Further discussion of practical detection methods will be published in Q1, 2012.

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George Frey
Application Engineer
EDE Electric Motor Testing
1545 Reeves Drive
Fort Collins.CO
George.frey@ieee.org