IEEE/PES Transformers Committee
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"Water-in-Paper Activity -- a New Concept for Moisture Assessment in Transformers"

-- Technical Presentation --
Monday, October 23, 2006; 4:45 to 6:00 p.m.

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Sponsored by the Insulation Life Subcommittee

1. Abstract

Moisture in a transformer paper-oil insulation complex can be expressed in many different terms. Among the well accepted terms are the water in paper (%), water in oil in parts per million (ppm) and relative saturation (%) to name just a few. It has been shown experimentally that, generally, the water content of paper determined by the well known equilibrium charts is equal neither to the average water content nor to the water content of any particular part of the solid insulation in a real power transformer. Based on numerous tests with different types and thicknesses of paper insulation it has been suggested that the amount of water associated with the level determined by the equilibrium charts corresponds to the amount of water available for exchange between solid insulation and oil, which we call 'active' water.

The concept of **water-in-paper activity (Awp)** explains the discrepancies between theoretically expected and experimentally obtained results. Physically defined as the equilibrium relative saturation, **the water-in-paper activity of a paper-oil insulation system is a good measure of the water available for exchange between the cellulose material and the surrounding oil.**

The authors believe that the introduction of the **water activity concept** into monitoring and diagnostics of electrical insulation will help to better understand and maintain the quality of dielectric materials in general, and electrical insulation in particular.

This technical presentation aims to provide a definition, means of measurement, way of standardization, test procedure and applications of the new concept of moisture measurement and management in transformers.

2. Learning Objectives

The tutorial will provide:

- Discussion on methods available today to estimate moisture content of solid insulation
- Introduction of the Water-in-Paper Activity (Awp) concept
- Instrumentation and methods for the Awp measurement and determination
- Ways of standardization of the Awp
- New research results and their application to practical assessment of moisture in transformer insulation
- Hands-on experience with moisture assessment in transformers; case studies.

3. Learning Outcomes

As a result of attending of this tutorial session members will gain:

- An understanding of a new concept for moisture assessment of a power transformer paper-oil complex
- An appreciation of the benefits of the Water-in-Paper Activity parameter for monitoring, diagnostics and life management of a transformer
- A recognition of usage of different terms describing the water content of a paper-oil insulation complex
- A better understanding of means for solution of the life management problems related to the maintenance of transformer insulation.

4. Presenter's Biographies

Oleg Roizman: Dr. Oleg Roizman is a consultant, providing services to electric utilities, research institutions and manufactures of electrical equipment in Australia and overseas. Earlier he worked as R&D Engineer and Research Fellow at Monash University, Australia. During this period he was involved in various projects related to power quality and power system stability analysis. Since his time at Monash he has been active in research on moisture phenomenon in transformer oil/paper insulation sponsored by EPRI.

He is a member of IEEE, an active participant of the IEEE/PES Transformers Committee, and also a member of the Insulation Life and Insulating Fluids Subcommittees of the IEEE/PES Transformers Committee. He lives in Melbourne, Australia.

Valery Davydov: Dr. Valery Davydov is a Principal Research Fellow with the Department of Electrical and Computer Systems Engineering at Monash University, Melbourne, Australia. Since 1994, he is a Chief Investigator on the EPRI supported research project on power transformers. In 2005, Dr. Davydov established the Centre for Power Transformer Monitoring, Diagnostics and Life Management at Monash University, and was appointed the Centre Director. The Centre is supported by a Grant of the State Government of Victoria, Australia, and a consortium of 15 industrial companies from Australia, New Zealand, Europe and USA.

Before joining Monash University, Dr. Davydov was a Practicing Consultant with the State Electricity Commission of Victoria, Australia. He was involved with the development of a new high voltage testing technique for live line equipment. Prior to this, in 1980's, Dr. Davydov was involved in research and development of the new at the time 1200 kV power transmission technology in Russia. He holds a PhD degree in High Voltage Engineering from Novosibirsk, Russia.

Dr. Davydov is a member of the CIGRE Australian Panel A2 Transformers, CIGRE Working Group "Moisture in Transformers", and IEEE/PES Transformers Committee Task Force "Moisture Estimation in Transformer Insulation". He is affiliated with the Institution of Engineers of Australia and IEEE. He lives in Melbourne, Australia.

Jim Dukarm: Dr. Jim Dukarm is founder and President of Delta-X Research Inc, Victoria BC, Canada. He is the developer of a widely-used software product for management and interpretation of dissolved-gas and oil test data for transformers and related liquid-filled high-voltage equipment. After several years of applied R&D in robotics, speech recognition applications, and industrial expert systems, in the late 1980's Dr. Dukarm began to specialize in problems related to electric power. He was the architect of several successful products, including factory power and switchgear monitoring systems, a major insulation power factor testing product, and a transformer bushing replacement expert system.

Dr. Dukarm is a member of CIGRE, IEEE, and an active participant of the IEEE/PES Transformers Committee. He lives in Victoria, British Columbia, Canada.