

Power Transformers Seminar

Argonaut Hotel
San Francisco, California
June 8-10, 2009

Course Content:

It is often said that the life of a transformer is defined by the life of the insulation. Transformers are designed to operate for twenty years fully loaded. Most transformers exceed this design life, often lasting for twice this value. This course is designed to give the attendee a basic understanding of Power Transformer design, manufacture, operation and maintenance from a perspective of maximizing transformer life. By understanding the insulation system, operations and maintenance personnel can make informed decisions for purchasing, operating, maintaining and replacing power transformers on their system.

Special Session: Mobile Substation Design and Manufacture

Marion Jaroszewski - Delta Star West

George Reitter – George Reitter Consulting

Contingency planning strategies for large utilities often include Mobile Substations. The art of Mobile Substation design is to make the substation as versatile as possible from a voltage transformation, and power standpoint while keeping the unit as light as possible from a transportation perspective. Included in this seminar will be a presentation on the design and manufacture of Mobile Substations by Delta Star, a leading manufacturer of Mobile Substations in North America.

Included with this course will be a guided visit through Delta Star Inc. a manufacturer of power transformers and mobile substations. * Participation in the factory tour is at the sole discretion of Delta Star*

Transformer Design and Manufacture

H. Jin Sim - Waukesha Electric Systems

Power transformers are designed according to the specification provided by the purchaser and must include the manufacturer's design practice, and manufacturing capabilities. Typically each power transformer has its own unique design. In this presentation Mr. Sim will review the transformer design process including examples from his experience as a transformer designer. He will discuss the basics of transformer design and the effect on the insulation system. Insulation design criteria such as cooling and dielectrics will be discussed.

Transformer Insulation

Thomas A. Prevost – Weidmann Diagnostic Solutions

The insulation system is a critical component of a Power transformer. In this presentation Mr. Prevost will review the basic functions which the insulation system must perform in a power transformer. Manufacturing practices will be reviewed which if followed will maximize the integrity of the insulation system over the life of the transformer. Insulation aging mechanisms will be reviewed so that they can be incorporated into operation and maintenance practices in order to maximize transformer life.

Alternate Fluids

C. Patrick McShane – Cooper Power Systems

While mineral oil has been the common dielectric fluid used in Power Transformers there are alternative fluids available. In this presentation Mr. Rapp will focus on Natural Ester fluid as an alternative to mineral oil.

High Temperature Insulation Systems

Rick Marek – DuPont

Cellulose insulation in Power Transformers is the limiting material from a thermal perspective. In this presentation Mr. Marek will discuss high temperature insulation systems. These insulation materials can be used with mineral oil or with high temperature dielectric fluids depending on the application.

Factory Inspection

Ron Barker – Power Transformer Consulting

Many transformer purchasers visit the manufacturer to inspect their unit in process. In this presentation Mr. Barker will review the critical manufacturing processes in regard to what should be inspected to assure that the manufacturer is meeting the purchaser's expectations. Critical areas such as winding clamping, dielectric clearances, electrical connections, and proper mechanical support will be discussed with examples and photos included for illustration.

Shipping and Acceptance

Troy Kabrich – Waukesha Electric Systems

Transformer acceptance testing is performed to determine the condition of the transformer as it arrived on site. These include the repeat of some of the factory tests as well as a detailed review of the seismic shipping record. Acceptance testing also establishes a baseline of electrical and mechanical characteristics that can be compared with for the life of the transformer. In this presentation Mr. Kabrich will review specific test procedures which should be included in an acceptance test program.

Transformer Loading

Don Platts – PPL Electric Utilities

David J. Woodcock – Weidmann Diagnostic Solutions

Transformers are designed to last at least thirty years under normal operating conditions. In this presentation Mr. Platts will review loading philosophies and practices which have a direct influence on transformer insulation life. Many loading algorithms today depend on data generated during factory acceptance testing. The instructors will demonstrate how to find it and how it is used in the temperature calculations. Thermal limits on loading based on the phenomenon of bubble evolution and other criteria will be discussed.

Transformer Operation and Maintenance

John Stead – Altalink Management Ltd.

In order to maximize the life of a transformer a purchaser must be involved in every aspect of the process from writing a proper specification, selecting an appropriate factory through design and manufacturing verification. After the purchaser has accepted shipment of the unit it is through his operation, maintenance and monitoring practices. In this presentation Mr. Stead shares his experiences with transformer life enhancement from protection to maintenance and monitoring. Several case histories are presented which illustrate his points.

Field Processing of Power Transformers

Derek Baranowski – Baron USA

Whether due to atmospheric contamination or the byproducts of aging, the water content of transformers will increase with age. At some point it may be desirable to remove this moisture as well as any particles from the transformer oil. Mr. Baranowski will discuss the pros and cons of different methods of field processing transformers.

Transformer Retrofill

Troy Kabrich – Waukesha Electric Systems

There are several situations in which the transformer owner may decide to retrofill his equipment with a replacement fluid. Retrofill with a higher temperature fluid such as Natural Ester is becoming more frequent. This presentation will discuss the critical issues of transformer retrofill including the benefits of retrofilling as well as the impact on performance.

Transformer Condition Assessment

Rick Ladroga - Doble Engineering Company

Whether because of service age or abnormal operation, it is often necessary to assess the current condition of a power transformer. The information obtained by such an assessment can be used to decide whether to change the operation of the equipment (reduce load), perform maintenance or field upgrades, remanufacture, or replace the equipment. In this presentation Mr. Ladroga will review condition assessment methodology including the various tests which are typically included in condition assessments and what can be learned from these tests.

Transformer Repair or Rebuild

Bruce Forsyth – Southwest Electric Company

In many cases a transformer can be remanufactured so that it will have a life expectancy similar to a new unit. This is not always the case however. In this presentation Mr. Forsyth will review the remanufacture and renewal process. He will cover those critical areas which must be reviewed in order to determine if your transformer can be remanufactured so that it is as good as new.

Transformer Fluid Diagnostics

Argonaut Hotel

San Francisco, California

June 11, 2009

Course Content:

OIL QUALITY ASSESSMENT

Bruce Pahlavanpour – Nynas Naphthenics

Mineral Oil Composition

Dielectric Fluid Requirements

Chemical and Physical Evaluation of Dielectric Fluids

Over ninety percent of transformers are filled with mineral oil based dielectric fluid. Typical transformer fluid is a complex organic mixture that contains over 3600 different molecules. The role of any dielectric fluid is to transfer heat, provide insulation between components and to quench any arcs. The ability of a dielectric fluid to meet these requirements can be determined with a series of chemical and physical measurements.

Chemistry of Furans and Interpretation

One of the most significant parameters used to ascertain remaining life of transformer insulation is a measurement of the Degree of Polymerization (DP) of the insulation. This test is invasive, requires de-energization of the unit and removal of a test specimen. Determination of furans in oil has been developed as a non-invasive alternative to the DP measurement. Furans result from the partial degradation of cellulose insulation. They are soluble in oil, can be extracted from an oil sample and be quantitated. The concentration of furans can be approximately correlated with the important DP value.

CORROSIVE SULFUR

Bruce Pahlavanpour – Nynas Naphthenics

Sulfur Compounds found in Mineral Oil

Testing for Corrosive Sulfur Compounds

Preventive Measures

Corrosive sulfur compounds in transformer oil have become a significant concern for system asset managers. Failures due to the presence of corrosive sulfur have occurred in several countries. The nature of corrosive sulfur compounds and their determination will be discussed. Proposed mechanisms for failures due to corrosive sulfur compounds will be reviewed. Also the mitigation of the corrosive sulfur problem with passivators will be explained.

ALTERNATIVE FLUIDS

Bruce Pahlavanpour – Nynas Naphthenics

Types and Chemistry of Alternative Fluids

Polychlorinated biphenyls (PCBs) have been controlled compounds since PCB production was halted in 1979. Alternative dielectric fluids that have higher flash points than mineral oils were required as PCB replacements. Biodegradability is also a very desirable fluid property. Natural ester dielectric fluids meet both of these requirements. The chemical, physical and environmental properties of natural ester fluids will be reviewed in detail.

DISSOLVED GAS ANALYSIS (DGA)

Fredi Jakob – Weidmann Diagnostic Solutions

Insulation Decomposition

History of DGA

Laboratory Procedures

On-line DGA

DGA Data Interpretation

Case Histories

During the last thirty years Dissolved Gas Analysis has emerged as the single most useful tool to assess the condition of transformers and other oil filled electrical equipment. The theoretical basis of DGA will be described. Laboratory and on-line DGA methods will be discussed. Interpretation of DGA data will be thoroughly reviewed. Case histories will be examined to illustrate the application of various diagnostic protocols.

LTC and OCB Diagnostics

Fredi Jakob – Weidmann Diagnostic Solutions

DGA principles for newer applications such as LTC and OCB diagnostics will be presented.