

ELECTROSTATIC FILTRATION EXTENDS LIFE OF TRANSFORMER OILS

By Christopher Wilkins

Transformer and circuit breaker insulating oils present their own set of unique problems for utility maintenance engineers. Many high-voltage transformers, load tap changers, voltage regulators and circuit breakers use oil as an insulating medium between contacts. Organizations such as the Institute of Electrical and Electronics Engineers (IEEE) and the Electric Power Research Institute (EPRI) have placed considerable importance on the need to extend equipment life and operational reliability of transmission and distribution (T&D) components.

While no one would disagree that fluid condition and cleanliness has a direct effect on the insulating oil's performance, finding the right proactive approach towards cleaner oil takes an understanding of the causes and effects of oil degradation on the service life of various components. Methods such as Dissolved Gas Analysis (DGA) and various physical and chemical tests can help determine the beginnings of problematic conditions that can lead to component failures.

Many of the tests performed are geared towards identifying the presence of electrically polarized particulates in the oil. Indeed it has been estimated that approximately 75 percent of the failures of high-voltage transformers and components are caused by the breakdown of the dielectric strength of the oil which directly leads to contact arcing and other problems.

The key to controlling the dielectric

strength of the insulating oils in transformers and switchgear is to filter out those electrically polarized particles, as well as moisture and related by-products of oxidation. While the standard procedure of annual oil change out and filtration using conventional methods such as filter press, Fuller's Earth and/or vacuum dehydration can be effective, this does little to control the oil cleanliness until the next maintenance cycle.

REAL-TIME FILTRATION

Electrostatic oil filtration is uniquely suited to the job of maintaining clean oil on a real-time basis. Unlike conventional filtration, electrostatic filtration has the ability to remove sub-micron

sized particulate without the need of expensive absolute rated filtration media. Often described as "one of the best kept secrets in filtration," this patented technology works on the principle of electrostatic and electromagnetic attraction of positively and negatively charged particles for sub-micron cleaning to ISO levels of 10/7/0.

At these levels, the electrostatically filtered oil is cleaner than new oil without the loss originally formulated additives. Coupled with a water filter absorption system, electrostatic oil filtration from ASL Technologies keeps transformer and other oils used in electrical T&D systems, nuclear utilities and

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power generating facilities free from three of the five causes of contamination - particulate, water, oxidation by-products. (The last two causes of oil contamination are air and heat which are best handled by other technologies such as high quality desiccant or particulate air breathers, and heat exchangers or cooling systems). Important to operators of high-voltage transformers and load-tap changers is the ability of electrostatic technology to remove the insoluble by-products of thermal and oxidative oil degradation. Tars and varnishes disappear with the result that contact wear and coking is eliminated. How this happens is illustrated below.

A TRIP THROUGH THE ELECTROSTATIC CELL

An ASL electrostatic filtration system consists of three main components — a power supply, a water absorber and an electrostatic cell. Fluid to be cleaned first enters the cell at the bottom, see Figure 1, where it collects and fills in the expansion area so that the entire cross-sectional area of the cell is effectively exposed to the fluid. As the force of the pump moves the contaminated fluid upward, it immediately encounters the first perforated metal plate, which has a negative charge. Passing through this plate, particulate receiving a charge is repelled upward by the Coulomb force. Many of these charged particles then remain in the voids of the foam media immediately above the plate.

Any particles having a positive charge are attracted by

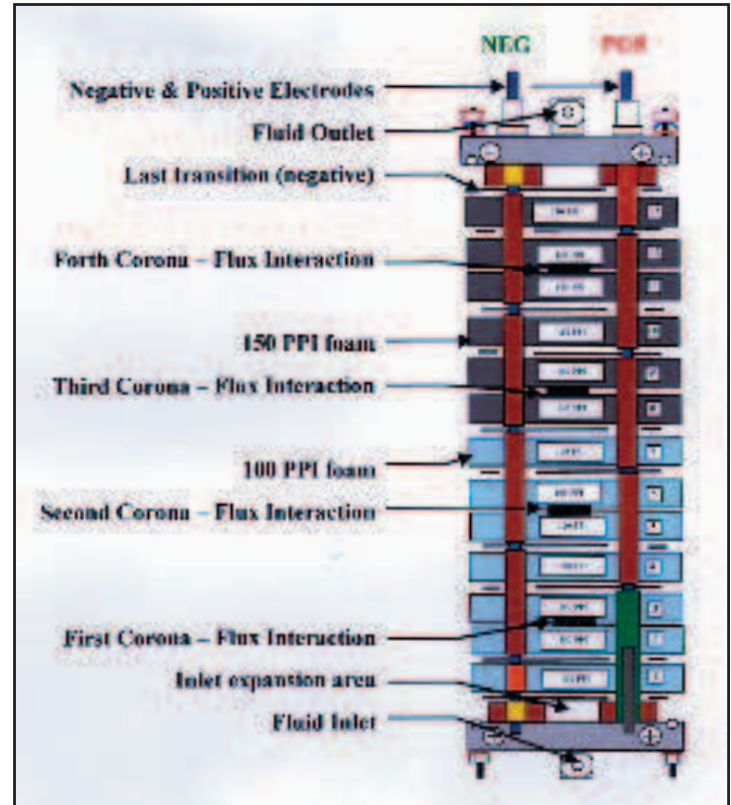


Figure 1: ASL Electrostatic Cell Schematic

on this plate and seek negative particles, eventually becoming large enough to become trapped in the foam. As the fluid advances through the filter, any contaminants remaining in the fluid go through the same process three more times, until finally receiving a negative charge before passing out of the cell and returning to the reservoir. This not only makes entrapment of sub-micron tars, varnishes and oxidation by-products achievable, but effectively doubles the holding capacity of the electrostatic cell. Depending on contaminant ingress, three to five cycles through the cell will usually yield ISO 10/7 or better.

Figure 2 shows an ASL filter system with the covers open and the major components such as power supply, electrostatic cell and water absorber. A micro-ammeter connected to the cell shows the relative amount of power required to hold particulate in suspension. Over time, a gradual rise toward mid-range causes the control system to illuminate a light, indicating back flush is necessary. When power is removed from the cell, contaminant which was held in the electrostatic force field is released, and the cell can be back flushed with compressed air. This removes most of the particulate, and about 1-1/2 gallons of oil for disposal. The cell is then returned to service. Based on 24/7 operation, the cost of cell renewal is less than 4 cents per operating hour.

THE FUTURE IS HERE ARE YOU READY?

Increasingly, 'leaner and meaner' ways of running organizations from manufacturing to power distribution means doing more with less. This attitude and new way of thinking and acting is often the result of a number of small steps working together in search of a common goal. For many American and Canadian companies, reducing the amount of maintenance and the associated costs is one of the recognized goals. Electrostatic filtration has proven itself in thousands of industrial applications where the saying, "There is no such thing as 'too clean' oil", has brought rewards to both the bottom line and equipment uptime.

Christopher Wilkins is the President of EDM Mechatronics, Inc. a manufacturer and distributor of leading edge filtration solutions such as the ASL Electrostatic Finite Particle Removal System (FPRS) for the metalworking, process and electrical distribution industries. ET



Figure 2: Model FPRS S-40