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~ Transformer Oil Testing ~

"Transformer oil testing? " "Oil testing can wait for now!" We all may have heard these words. But can it wait?

On December 16, 2002, a refinery in Texas City was shut down by a fire resulting from

Profits Up in Smoke
Texas City Fire Department File Photo

what the newspapers reported as a "transformer explosion". This was the second time within the year that a shut down occurred at this facility as a result of a situation repeating itself. Both times management had to file a downward revised earnings projection with the Securities and Exchange Commission.

Could this fire and its associated lost opportunities have been prevented? YES! Well documented is the benefit of dissolved gas analysis on transformer oil in preventing this kind of unscheduled outage. The best known references are *2001 Transformer Maintenance Guide*, published by S.D. Myers, Inc., of Talmadge, Ohio, and *Maintenance Testing Specifications-2001*, published by the International Electrical Testing Association of Morrison, Colorado. The IEEE *Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers Std.C57.104-1991* is also a good reference.

Implementation of a baseline and follow-up gas and liquid sampling plan provides information invaluable for a facility's maintenance and reliability program.

In the past, dielectric liquids such as PCB's, and, more recently, silicones and high-molecular-weight (HMW) oils have been used with the intent of reducing flammability. The rationale has been, "If we let the transformer blow up, at least it won't burn us down".

Silicone and HMW oils are used because insurance companies and code making authorities have allowed transformers with lower flammability liquid fills to be placed closer to each other and to buildings. Conventional liquid fills can be used with similar spacings, but the user assumes the burden of preventing transformer explosions, and fighting any fire that could result. Dissolved gas analysis methods have been developed for silicones, HMW's, and remaining PCB's. (The use of dielectric PCB's has been replaced with other mediums.)

Most power distribution transformers used in industrial plants have voltages below 25 kV, paper insulation, and are filled with ten centipoises (10C) mineral oil manufactured by Exxon, Texaco, and Mobil. Consequently, most interpretations of dissolved gas analyses are directed to this type of liquid. Listed below are the limits used by the U.S. Government Bureau of Reclamation.

Gas	Level	Indicates
Acetylene	<15 ppm	Arcing
CO_2	<11,000 ppm	Normal aging
CO	<750 ppm	Normal aging
Ethane	<75 ppm	Overheating
Ethylene	<175 ppm	Corona discharges
Hydrogen	<500 ppm	Heat and arcing
Nitrogen	large amounts	Good blanket
Oxygen	large amounts	Case leaks

Small changes in the presence of key gases can be expected, but a rapid rise in gas concentration can indicate a problem. I am familiar with one transformer in which the acetylene increased from a few parts per million to over six percent in a few months. The operating manager was very reluctant to shut down the transformer (and his process unit) because every thing was acceptable — to all appearances. After lengthy discussion with the manager, the unit was shut down. A short investigation revealed that the source of the arcing was loose bolts on a bus connection. During the next unit outage, a similar problem was found in a companion transformer (same manufacturer and consecutive serial number).

Several times, acetylene was generated by loose contacts in no-load tap changers. This leads to the question: why continue to purchase transformers with tap changers? If no-load tap changers are needed why not use internal bolted connections?

Sampling oil from transformers protected by sudden pressure relays has been a problem. Discharging the gas blanket by those inexperienced with proper sampling techniques is one problem. Hammering on stuck sample valves may be another. Personnel familiar with proper methods and experienced with numerous manufacturers' equipment are essential to a successful dissolved-gas-based maintenance program. An additional benefit of liquid sampling is the identification to remove condensed water from the transformer tank which will reduce the oil's dielectric strength.

Transformer explosions and fires injure people, and equipment, and impacts the environment and profits. Having to tell stockholders twice in one year that profits have been revised downward can easily justify the maintenance costs for prevention. The oil testing technology has been in use for over fifty years, is well proven, and is economical. Guidance during establishing or reviewing a current maintenance program may be beneficial because of the large volume of information that must be processed.

Believing in the results of the tests and taking action can be "gut wrenching" and without the accolades one usually receives for rapidly repairing a spectacular fault. The alternative can be another Texas City-size fire. ▲

Author: George House, EE

Editor's Note: Transformer oil testing is an important part of an overall best practices plan. In addition, transformer reliability starts with proper sizing of the transformer to support the intended loads. Overloading the transformer quickly decreases the life and increases the failure risk. Also, the utilization of quick operating protective relaying schemes such as differential relays and sudden pressure devices can limit the amount of energy during a transformer fault. Contact us today to assist in resolving your transformer reliability issues.

