

Transformer Oil Analysis Can Help Prevent Breakdowns

Buildings & Equipment | Program Development



Electrical power transformers are critical pieces of equipment for many businesses. If one fails, it can leave your business without power, which can result in a significant and costly disruption.

For business-owned transformers, a maintenance program is an important consideration. If the utility company owns the transformer, maintenance may not be the responsibility of the business owner. But even when a business does not own its transformer, it should recognize the potential business interruption exposure the transformer represents. A conversation with the utility can reveal how the utility-owned transformer is being maintained, availability of spare parts and expected time to restore service in the event of an outage.

When formulating a predictive maintenance program, a critical component of a business' continuity plan, it is easy to overlook liquid filled transformers because they contain no moving parts. But neglecting this critical solid-state equipment can lead to costly unplanned outages. A suite of predictive maintenance techniques known as transformer oil analysis can help identify abnormal operating conditions and incipient faults before they result in failure and an interruption in service.

In order to understand how transformer oil analysis can help to prevent breakdowns, one must first understand a few transformer basics. A liquid filled transformer consists of copper or aluminum windings around an iron core. These windings are conductors, with electricity flowing through them. The windings are wrapped in paper insulation and submerged in a sealed tank of dielectric fluid, typically mineral oil, which helps to insulate and cool the windings.

Now, with a basic understanding of transformer construction, we can review conditions that lead to transformer failure along with predictive testing techniques designed to help monitor these conditions as they develop.

Over time, and given certain outside influences, the dielectric strength of a transformer's insulating oil can be

reduced, leading to an increased likelihood of an electrical fault within the transformer. The following oil tests should be performed at least annually on liquid filled transformers with a rating of at least 500kVA:

- **Dielectric Strength Test** measures the ability of the oil to withstand electric stress without failure.
- **Interfacial Tension Test (IFT)** measures the presence of soluble contaminants and oxidation products.
- **Neutralization Number** is a measure of the amount of acidic material present in the oil, which indicates oil breakdown.
- **Color Test** is an indication of degree of contamination, deterioration and overall quality of the oil.
- **Karl Fisher Moisture Test** measures the amount of water in the oil, which can lead to oil deterioration.

As a transformer ages the heat generated in the windings during normal operation will lead to a breakdown of the paper insulation. This breakdown of the paper results in the release of carbon dioxide (CO₂) and carbon monoxide (CO), which will dissolve into the transformer oil. If the transformer is overloaded, resulting in overheating, or if partial discharge and/or arcing occurs, other gases, such as Hydrogen, Methane, Ethane and Acetylene, will be released as the paper insulation and oil break down. These gases will also dissolve into the transformer oil.

Because these gases dissolve into the transformer oil, the oil contains a “dissolved gas record” of the history and current condition of the transformer. The following test should be performed annually on liquid filled transformers with a rating of at least 500kVA:

- **Dissolved Gas Analysis** uses gas chromatography to determine the levels of the gases mentioned above that are dissolved in the transformer oil. These gas levels can help to determine the overall condition of the transformer, remaining life, and the presence of any fault conditions that could lead to failure.

Based on the results of the oil analysis techniques mentioned above, actions can be taken as needed to correct deficiencies, further investigations can be conducted to pinpoint the root causes of issues such as overloading or overheating and plans can be made to avoid an unplanned outage.

A facility responsible for the maintenance of liquid filled transformers with a rating of at least 500kVA should have a predictive maintenance program in place. Multiple vendors with qualified personnel and extensive experience with transformer oil analysis are available to help with the development of an effective transformer maintenance program. Travelers has an alliance with United Power Services, a vendor that can perform transformer oil analysis at a special rate for Travelers insureds. They can also help you find answers to your transformer maintenance questions.

All of the above listed predictive maintenance techniques should only be performed by qualified personnel, and in accordance with the equipment manufacturer’s specifications.



Related Resources

[Maintenance Guidelines for Electrical Equipment \(USA and Canada\)](#)

[Electrical Preventive Maintenance Using Infrared Thermography](#)

[Equipment Maintenance and Business Continuity Assessment](#)

[Contingency Planning for Key Equipment](#)

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