WEAR CHECK®
Condition Monitoring Specialists

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Transformer Oil Testing: An overview

Power transformers are expensive and are a critical part of power systems, playing a significant role in the transmission and distribution of electricity. As with all equipment, transformer failures do occur, and there are many degradation mechanisms operating in components and sub-systems that will ultimately limit the useful operating life.

WearCheck's transformer fluid analysis data is analysed by experts who provide recommendations on remedial action based on relevant standards and expert knowledge.

The diagnosis is dependent on a number of factors that include the following: trend, ratio, type of transformer, make, age, type of industry etc., and the type of oil.

There are three main types of oil:

- Mineral oil (uninhibited / inhibited)
- Ester oils
- Silicone oil

Dissolved Gas Analysis (DGA, electrical faults in transformer)

The DGA analysis tests for the following gases: Hydrogen, Oxygen, Nitrogen, Carbon Monoxide, Carbon Dioxide, Ethane, Ethylene and Acetylene. The test values and ratios are indicative of an electrical fault in the transformer, and each type of gas - which is a hydrocarbon - will indicate a specific electrical fault at certain temperature ranges in a transformer.

This is possibly due to the high solubility of the gases in transformer oil - Hydrogen starts at 7% and Acetylene is the highest at 400%, with the other gases' solubility measurements somewhere between these two gases.

Oil Quality (Cooling and insulating properties)

Moisture Content

The moisture content can have a direct influence on the insulating properties of transformer oil. This value can increase or decrease, depending on the temperature and load. In the case of an electrical unit with paper insulation, this is even more evident. There is always an equilibrium between the moisture in the oil and the moisture in the paper insulation. In time, more oxidation can occur within the mineral oil, and this results in the mineral absorbing more moisture.

Acidity Content (TAN, Total Acid Number)

The mineral oil will deteriorate over time with oxidation, temperature and load playing key roles. If left untreated, the oil will form carboxylic acids, and this can, in turn, cause sludge in the unit. The TAN testing goes hand-in-hand with the Metal Particles tests. The presence of metal particles in the oil acts as a catalyst, accelerating the

deterioration of the oil and rendering a higher TAN result. The by-products of the natural deterioration of the oil reduce the insulating properties. Sludge forms and can cause blockages in the unit, accelerating the paper deterioration, which is difficult to remove.

Dielectric Strength

This test determines how well the transformer oil can withstand electrical stress. There are a few important contaminants that can influence this directly: water (moisture), sediment, particles, cellulose paper breakdown and conducting particles (metals in oil). Dielectric strength is an absolutely critical function of the transformer, and the test value should be as high as possible to prevent flash overs. The industry experiences load-shedding on a regular basis, and this value - in combination with the water content - is critical for energising the transformer after a power down.

PCB (Polychlorinated biphenyl) – Please also see Stockholm Convention.

This is purely a health and environmental test, as PCB has been banned world-wide. There are three aroclors found in mineral oil: aroclor 1242, aroclor 1254, and aroclor 1260. These three components are tested by a laboratory and are reported as a single value on the report. The PCB should be tested on a yearly basis or if any work and/or oil changes have been done.

Furans

The paper in a transformer will break down over time, it can't be stopped, but it can be managed. The paper in a transformer will generate fural (five types) in the oil. This allows the laboratory to test the transformer for fural compounds and, through a calculation, can report a Predicted DP value. A Furanic test means the client won't have to do an intrusive test, such as taking an actual paper sample, but test the Predicted DP from the oil. The test is very accurate, but there are a few rules: the transformer must be energised, and no oil changes or purification should have been done in past 12 months. The test result will be influenced by any work done on the oil, but as in the case of DGA, a trend can be established. This Predicted DP value should be seen in conjunction with trend, DGA and other oil results.

Corrosive Sulphur (yearly test)

The sulphur present in transformer oil is refined as sulphur-contained molecules. The amounts will depend on the degree of refining and type of crude oil. If there was poor refining, reactive compounds will cause corrosion in the transformer. In some cases, the conditions in a transformer can cause the oil to become corrosive. This corrosive component can cause immense damage in a transformer, which can't be reversed. The oil can either be treated with a passivator or the oil must be replaced with new oil.

Metals in Oil (ICP Test – Inductively Coupled Plasma instrument)

The laboratory will do a full ICP test on the oil, but only the metals are reported on: Zn, Pb, Fe, Cu and Al. There are no limits or standards for the ICP test. The trend of the metals in the oil are used for diagnosis. Any important additional information, such as the results of a DGA and TAN test, are helpful, as metals in oil can act as a catalyst.

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Tan Delta (yearly test)

The oil in a transformer does have a limited lifespan. Checking for any changes in the levels of contaminants in the oil is a very sensitive test and it is possible that tests like TAN indicate normal values, yet the oil is at the end of its life. Contaminants have an influence on the power factor and/or insulation resistance.

Sampling

It is important to always use a clean, new container, and it is critical that sampling is done correctly, as it directly impacts the results and, ultimately, could cause the incorrect diagnosis to be given if the sampling is done incorrectly. This could result in unnecessary down-time and potential unnecessary maintenance spend for the client.