Oil-Filled Transformer testing & analysis

Oil Diagnostics
by EA Technology

Assessing the internal condition of oil-filled transformers to improve reliability and assist in determining appropriate asset management decisions

Transformer oil holds critical information on the condition of the transformer from thermal and electrical faults to contamination and degradation of the oil which can reduce the life of a transformer.

Transformer oil analysis provides a highly accurate indication of the internal condition of a transformer. Diagnostics tests, including oil quality, dissolved gas analysis and furfuraldehyde levels, offer insights into abnormal electrical or thermal activity and other effects of transformer aging, including the condition of paper insulation – the primary indicator of potential transformer failure. Information on the condition of the transformer and where it is in its lifecycle, allows for cost-effective and efficient maintenance planning, refurbishment and replacement.

Oil-filled transformer testing & analysis

EA Technology's extensive experience shows that oil analysis is the most cost-effective way to assess the internal condition of oil-filled transformers. We therefore carry out the following tests:

Oil quality

Measuring moisture, acidity, solid contamination and breakdown strength of the oil gives a good indication of the overall condition of the oil and internal components. The quality of the oil is also critical in preventing premature ageing of the transformer and extending service life.

Dissolved gas analysis (DGA)

The essential purpose of dissolved gas analysis is to detect gases generated due to thermal degradation of insulation components within the transformer. In particular the aim of gas analysis is to provide prior warning of a developing thermal fault i.e. local overheating, discharge activity or arcing and sparking within the transformer.

Furfuraldehyde analysis (Paper insulation assessment)

Furfuraldehyde analysis gives a highly accurate indication of the condition of paper insulation. The furfuraldehyde content is correlated to the degree of polymerisation of the paper. When furfuraldehyde levels reach specific values, we know that the insulation has effectively broken down and the probability of failure is very high.

PCB analysis

PCB is a very effective insulating liquid and is entirely compatible with oil. Polychlorinated biphenyls were widely used as a fire retardant and insulator in the manufacture of transformers and capacitors. This was due to their ability to withstand exceptionally high temperatures. Because of their classification as a human carcinogen, the Environmental Protection Agency (EPA) banned their use in 1979. It should be noted that PCB content in HV transformers is stable and only one test is required on the oil.

Dissipation Factor (Power Factor)

The Dissipation Factor measures the leakage current through the oil, which can assist in understanding the presence of contamination or deterioration of transformer within the oil.

Interfacial Tension (IFT)

The interfacial tension between oil and water provides a means of detecting soluble polar contaminants and products of degradation. This characteristic changes fairly rapidly during the initial stages of ageing but levels off when deterioration is still moderate. A rapid decrease of IFT may also be an indication of compatibility problems between the oil and some transformer materials (such as varnishes and gaskets), or of an accidental contamination when filling with oil. However, oils with interfacial tension values at or near the lower limit value may or may not need to be investigated further and is highly dependent on the Oil Quality results.

With overloaded transformers, the deterioration of materials is rapid and IFT is a tool for detection of deterioration.

Viscosity

Oil viscosity is an important controlling factor in the dissipation of heat. Ageing and oxidation of the oil tend to increase viscosity. Viscosity is also affected by temperature, such that in a cold climate it is important that the viscosity is sufficiently low to enable adequate oil circulation.

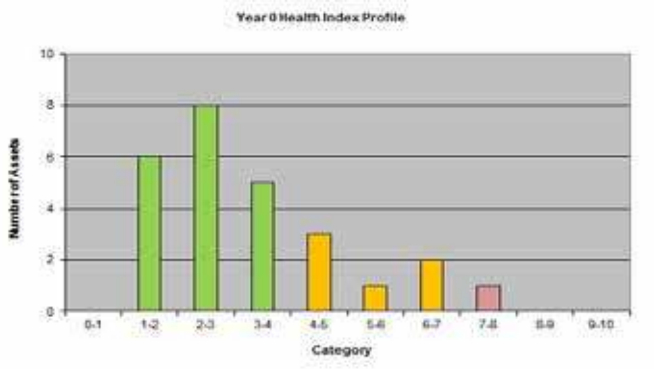
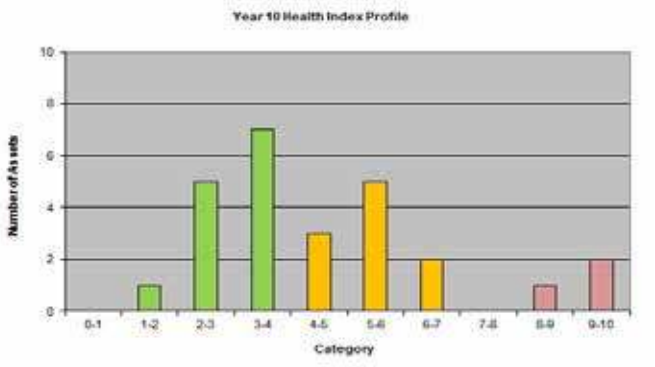


Image above illustrates the Year 0 Heath Index profile against the number of assets. While the image below illustrates the Year 10 health index profile



Density (Specific Gravity)

The Density (Specific Gravity) of the oil is the ratio of the weights of equal volumes of oil and water. A high density indicates the oil's ability to suspend water and in extremely cold climates this can be used to determine whether ice will float on the oil, potentially resulting in flashovers.

Colour & Appearance

The Colour and Appearance of the oil indicates the level of contamination caused by deterioration of the oil or insulating materials. The colour of the oil is compared to a specified spectrum of colours.

Additional testing is also available

EA Technology can also offer an additional range of more bespoke testing such as Corrosive Sulphur, Inhibitor content, DBPC, Flash Point and Pour Point. This allows EA Technology to build up a testing programme to meet the specific requirements of individual clients.

Oil-filled transformer health indices

The oil analysis provides a very good understanding of the internal condition of a transformer, including the condition of specific components.

The oil analysis results are used in combination with relevant background information to create a Health Index for the asset, expressed as a numerical value on a scale of 1 – 10 from which a Probability of Failure (PoF) and estimated end of life are determined. In addition the application of an ageing algorithm enables the future performance and condition to be evaluated. This is particularly valuable for prioritising the maintenance and replacement of multiple assets and is the foundation of CBRM.

Benefits

- Tests provide an accurate assessment of internal condition of the transformer
- The condition data in conjunction with other information such as operational duty, transformer history, environment etc. is used to derive a Health Index
- Probability of failure and end of life are calculated
- Identifies degradation of specific components BEFORE they lead to failures
- Enables operators to develop effective maintenance and replacement strategies based on the condition of the transformer
- Identifies transformers that could benefit from life extension measures
- Low cost test process

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