Oil Diagnostics - Test Information

EA Technology offers a wide range of analytical specification tests coupled with expert interpretation and reporting systems. Typical testing on transformer units includes:

- **Dissolved Gas Analysis (DGA)** IEC 60567

  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.

  It is normal practice to measure nine gases in an oil sample. Nitrogen, oxygen, carbon monoxide, carbon dioxide and the five hydrocarbon gases hydrogen, methane, ethane, ethylene and acetylene. The five hydrocarbon gases and carbon dioxide and carbon monoxide can be formed as a result of a thermal decomposition of oil. These therefore provide the opportunity for identifying the presence of faults or developing faults which give rise to heating in the transformer. The relative amounts of the different gases generated change with changing temperature, therefore providing the possibility of identifying different types of faults by the relative concentration of the different gases. For each of the gases the absolute value is considered and then the ratio of various gases is looked at in order to give information on the nature and severity of a potential fault.

- **Oil Quality**
  - Moisture IEC60814
  - Acidity IEC 62021
  - Breakdown Voltage Strength IEC 60247

  This includes moisture, acidity, and electrical breakdown strength. These parameters are primarily intended to give information on the condition of the oil, although indirectly they also provide some information on the condition of the transformer. The moisture content is particularly relevant to transformer condition. Maintaining acceptable oil quality is critical in preventing premature aging of the transformer and therefore can assist in determining appropriate life enhancing measures.

- **Furan Analysis (Paper Insulation Assessment)** IEC 61198

  Furan detection has become accepted as a means of monitoring the degradation of paper insulation in transformers. Paper consists of cellulose molecules which have very long carbon chains. As the paper ages the carbon chains are progressively broken into shorter lengths with the subsequent reduction in the mechanical properties of the paper. Bi-products of the chain breakdown are organic compounds known as the furanic (furans) family.

  This information is extremely useful in determining the condition of the paper insulation and therefore the transformer as a whole. Generally once the paper insulation has reached the end of its life the transformer can also be considered to be at the end of its life. This information can assist in making informed decisions regarding the replacement strategy for transformers.

- **PCB Analysis** IEC 61619

  Polychlorinated biphenyl (PCB) content of the oil is purely an environmental issue. The presence (at any level) of PCB has no significance for the condition or performance of a transformer, PCB is a very effective insulating liquid and is entirely compatible with oil. Therefore the significance of the measured levels is determined by the local environmental regulations. 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)** IEC 60247

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

- **Interfacial Tension (IFT)** ASTM D971

  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 (varnishes, 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** IEC 60422

  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.

- **Density (Specific Gravity)** ASTM D1524

  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** ASTM D1500

  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.

- **Inhibitor Content (DBPC)** IEC 60666

  Inhibitors are added to the oil to replace the natural oxidation inhibitors. The inhibitors increase the resistance to the oxidation of the oil and assist in preventing degradation. As the oil is exposed to oxidation the oil is protected by the inhibitors and they are used up in the process. Once the inhibitors are depleted the oxidation and degradation of the oil will occur at a faster rate. Monitoring the inhibitor content allows this degradation to be prevented by topping up the inhibitor as required before it reaches depletion.

- **Corrosive Sulphur Assessment** IEC 62535

  Copper in direct contact with the oil and at a high temperature, can cause a corrosive reaction. From this the by-product copper sulphide will be formed, which will float in the oil and deposit between the windings. Copper Sulphide will reduce the electric strength of the insulation causing inter-turn faults.

- **Passivator Content – Dibenzyl Disulfide (DBDS)**

  Dibenzyle Disulfide (DBDS) is one of several sulphur compounds known to cause copper corrosion in transformers under certain circumstances. Remedial processes such as absorbents, absorbents and oil change-out have been known to reduce the concentration of DBDS in the oil. However, if not destroyed or removed below several mg/kg (ppm), breakdown of the DBDS can still cause corrosion of the copper and the formation of copper sulphide.

- **Additional testing is also available**

EA Technology can also offer an additional range of more bespoke testing such as Filtration, Particle assessment, Flash Point and Pour Point to build up a testing programme to meet the specific requirements of individual clients.

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