

FILTERALL LIMITED

During the service life of transformer oil, deterioration of the oil occurs as a result of many conditions. The oil may be exposed to air, varying temperatures and catalysts such as copper or iron, which all cause an increase in the rate of oxidation.

The products of oxidation are acidic compounds which can lead to the formation of sludge. Other contaminants from within the transformer are varnish and insulating papers. Moisture within the oil must also be limited.

To safeguard the integrity of oil-filled electrical apparatus, a strict routine of oil sampling and analysis should be followed. This will ensure that suitable measures can be taken **before the equipment is subject to the risk of failure.**

However, a single test result is only as reliable as the sample taken. It is recommended that sampling is undertaken at specified periods in order that variation of the oil between these periods may be monitored and conclusions regarding cause of variations made with some reliability.

It is important that oil samples are taken using approved containers and in such a way as to avoid the ingress of moisture and other contaminants that may affect the test results.

Tests which are recommended on in-service transformer oil are:

- **General Condition BS5730:**

Visual interpretation of oil appearance can often serve as a guide to the condition of the oil. The oil should be clear and bright; if the oil sample appears cloudy this is an indication of the presence of excessive moisture. Does the oil show visual signs of particulate matter such as dirt or fibrous material? Does the oil have an unusual odour or a dark appearance? If any of the above signs of deterioration are evident then further investigation is warranted.

- **Moisture Content BS6725:**

The dryness of the oil has a direct effect on the electric strength of the transformer and is assumed during the design of the transformer. It is essential therefore that the moisture content of the oil is monitored at regular intervals. Moisture levels are detected down to one part per million of moisture using modern coulometric equipment.

- **Neutralisation Value BS2000:**

Acidic products of oxidation within the oil will increase rapidly once present. These contaminants have a very aggressive effect on the materials of the transformer. The neutralisation value of the oil sample will indicate the oil life remaining before it contributes to the deterioration within the transformer. If the acidity increases above a certain level the oil requires replacement / regeneration to prevent deterioration of both current carrying and insulating components within the transformer. The life of a transformer can be no greater than the life of the insulating paper and press board within the transformer. Although limits are set for the neutralisation value, it is

good practice to process oils well before these limits are reached if the transformer is to give long and reliable service.

- **Resistivity BS5737:**

Resistivity is a reliable indicator of the condition of transformer oil, low resistivity values being a sign of oil which contains particulate contaminants and oxidative products.

- **Electric Strength BS5874:**

The electric strength or breakdown voltage is of particular interest when monitoring oil in service. The presence of contaminants such as water and fibrous material, when subjected to electrical stress, can lead to gas bubble formation and subsequent failure. The electric strength is the voltage measurement carried out under test conditions and is a means of assessing the extent of contamination.

- **Dissolved Gas Analysis :**

Dissolved Gas Analysis (DGA) is an important procedure used for monitoring the condition of transformers in service. Under electrical stress conditions, oil will produce various gases which can result in voids within the oil tank - affecting the insulation capability and eventually leading to transformer failure. By extracting these gases from an oil sample and comparing same ratios it is often possible to recognise fault conditions before failure occurs and to recommend action which should be taken to prevent transformer failure. By carrying out periodic DGA it is possible to compare results and changes over known periods; this allows the possibility of diagnosing fault conditions by comparing normal and abnormal ratios.

- **FFAs, Phenol and m-Cresol:**

Furfurals, phenol and m-cresol are produced by the breakdown of the paper and press board used to insulate the transformer. Therefore, an analysis for same provides useful information regarding degradation of solid insulation within the transformer. As with DGA, periodic analysis for FFAs, Phenol and m-Cresol can provide valuable diagnostic trend details which can identify possible fault conditions before these actually occur.

- **PCB Content:**

Polychlorinated biphenyls, (or askarels as they are often known), have in the past been added to transformer oils to improve the durability of the oil. However, findings have proved that such additives are resistant to biodegradation and can have a adverse effect on man. Consequently, this process is no longer allowed and directives are in place to remove same from circulation in a controlled and acceptable manner. This directive also makes the transformer owner responsible for identifying PCB contaminated installations and for actions required to dispose of contaminated oil and equipment. Using modern techniques it is possible to establish the presence of PCB down to levels of one part per million. Under proposed EU legislation, an inventory and plant labelling is required for plant containing PCB. Also, labelled plant must be registered with a licenced disposal company.