

## Basics of Transformer oil DGA

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Dissolved Gas Analysis (DGA) of transformer oil reveals internal electrical failures of transformer

(i) The dissolved gas products in transformer oil where DGA will show deterioration of oil and clues where the failure occurred or where it is about to happen.

It is done only in Power transformers. Winding turns ratio, winding insulation tests, insulation power factor will all give indications and should confirm the DGA results.

(ii) DGA results indicate burning of insulation which appears as discoloration or carbonisation of cellulose.

The more important factor of DGA gases is not only the ppm but mainly, the trending whether upward or downward.

Apart from monitoring the hydro carbon gases on individual basis, the Gas Ratios viz. Roger, IEC, Doremberg, Duvel may be utilised for best results.

(iii) The organic products in a transformer degrade over time and finally they lose the capability to withstand the stresses, a transformer might see in daily life short circuits, energising, vibration, etc.

(iv) It is possible to reverse the ageing of mineral oil through oil

reclamation which can restore the material properties close to the values when new. Ageing of paper insulation however is an irreversible process and is considered one of the life-limiting processes of a transformer.

(v) The lifetime of the combination of mineral oil and paper in a transformer is very much dependent on the operating temperature, oxygen content, acidity of the oil and the moisture content in the insulation.

(vi) Moisture is accumulated within the paper insulation of the transformer and has different sources. Hence utmost care must be taken to prevent the moisture entry inside the transformer in all possible ways inclusive of online monitoring and removal of moisture which should be less than 35 PPM.

(vii) Temperature is mainly dependent on the transformer design, the loading, the cooling facilities, and the ambient temperature. There are a number of aged transformers in utilities working for more than 25 years which may be identified and condition monitoring such as Frequency Response Analysis (FRA), HFCT (High Frequency Current Transducer), Infrared thermography, etc. shall be carried out and actions to be taken accordingly. Also, such aged transformers may be derated and operating temperature restricted even by 10 deg. C to that of rated temperature till permanent remedy is taken.

(viii) The nine gases examined are:

Atmospheric gases:

Nitrogen and oxygen, oxides of carbon (carbon

monoxide and carbon dioxide). Upper Limits: CO<500.  
CO<sub>2</sub><10,000.

Hydrocarbons:

Acetylene<15.

Ethylene<20.

Methane<25.

Ethane< 10.

Hydrogen<500 PPM.

The gases extracted from the sample oil are injected into a gas chromatograph where the columns separate gases which are injected into the chromatograph and transported through a column. The column selectively retards the sample gases and they are identified as they travel past a detector at different times. A plot of detector signal versus time is called the chromatogram. The separated gases are detected by thermal conductivity detector for atmospheric gases, by flame ionisation detector for hydrocarbons and oxides of carbon.

A methanator is used to detect oxides of carbon by reducing them to methane, when they are in very low concentration.

The total gas content of the sample oil should not exceed 15% .

High CO,CO<sub>2</sub>: Thermal overheating.

High Acetylene( C<sub>2</sub>H<sub>2</sub>):Arcing.

Roger's Ratio of CH<sub>4</sub>/H<sub>2</sub>:

0.1 TO 1.0.

CO<sub>2</sub>/CO:25-OK.

Other Tests on transformer oil:

Dielectric oil test.

Moisture content.

Karl Fisscher.

Oxidation Inhibitor,

Power factor<0.05%.

H<sub>2</sub> high content alone will not indicate any fault but only combined with other gases.