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BY USING FUZZY THREE-RATIOFINDING OF POWER TRANSFORMER FAULTS

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ABSTRACT

To detect transformer initial faults, DGA (Dissolved Gas Analysis) is one of the procedures which are most likely used. Among the different and diverse techniques of DGA, in this paper we have used IEC three-ratio method irrespective of not accurately diagnose in different conditions like no matching, multiple faults etc. also in conventional three-ratio method has different drawbacks like as the ratio crosses the coding boundary, codes change harshly, but in actuality the boundary should be fuzzied. Based on this opinion, this paper initially proposes the fuzzy membership functions for different codes. In this paper proposed System performance was studied via simulation results.This simulation results validated the satisfying operation of the proposed System.

***Indexterms:*Power transformer, fuzzy logic, DGA (Dissolved Gas Analysis), Three-Ratio Method**

I.INTRODUCTION

PoWER TRANSFORMER IS MAJOR COMPONENT OF POWER SYSTEM WHICH HAS NO SUBSTITUTE FOR ITS MAJOR ROLE [1]. A TRANSFORMER MAY WORK OUT WELL EXTERNALLY WITH MONITORS, WHILE SOME INCIPIENT DESCENT MAY OCCUR INTERNALLY TO CAUSE TERMINAL PROBLEM IN LATER DEVELOPMENT WHILE APPROXIMATELY 80 % OF FAULT RESULTS FROM INCIPIENT DETERIORATIONS. HENCE, FAULTS SHOULD BE RECOGNIZED AND AVOIDED AT MOST PRIMITIVE POSSIBLE STAGE BY SOME EXTRAPOLATIVE MAINTENANCE TECHNIQUE. LIKE ANY DIAGNOSIS PROBLEMS, DIAGNOSIS OF AN OIL-IMMERSED TRANSFORMER IS A SKILLED TASK. DISSOLVED GAS ANALYSIS (DGA) IS UNSWERVING SYSTEM, TO DETECT INCIPIENT FAULTS IN OIL FILLED POWER TRANSFORMER.

SO ON THIS BASIS, THE FAULTS OCCURS IN TRANSFORMER IS DIVIDING MAINLY INTO TWO TYPES, FIRST IS AN INTERNAL INCIPIENT FAULTS AND OTHER IS AN INTERNAL SHORT CIRCUIT FAULTS [3]. THE MAJORITY OF FAULT OCCURS IN POWER TRANSFORMER IS INCIPIENT FAULTS IT WILL AFFECT ON TRANSFORMER & REDUCES LIFE SPAN OF TRANSFORMER. IN DIFFERENT SERVICES, TRANSFORMERS ARE USED FOR ELECTRICAL AND THERMAL STRESSES, WHICH CAUSED THE DEGRADATION OF THE INSULATING MATERIALS AND THEN THIS DEGRADATION LEADING TO THE FORMATION OF SEVERAL GASES [2]. THUS,

BASED ON THE FORMATION OF THE GASES FOR THAT TEMPERATURE, USING ON DISSOLVED GAS ANALYSIS (DGA) THE FAULT IN TRANSFORMER CAN BE PREDICTED[3][4]. THE QUALITATIVE AND QUANTITATIVE ANALYSIS OF DISSOLVED GASES IN TRANSFORMER OIL MAY BE OF GREAT IMPORTANCE IN ORDER TO ASSESS FAULT CONDITION AND FURTHER OPERATING RELIABILITY OF POWER TRANSFORMERS [5][6]. IN SOME CASES, CONVENTIONAL FAULT detection methods, such as Roger's, fail to give diagnosis. Dissolved Gas Analysis (DGA) is an important tool for online monitoring oftransformers of transformers [1-3].Different standards are available such as the IEC 599 ratio codes, Rogers's ratio and Triangle ratio [1-3]. These ratio methods are efficient and simple to use. But there are some limitations in this method. In this method some of the faults are left unrecognized. Through the combination of fuzzy logic and IEC three ratio methods, can overcome the problem of ratio method. The below section shows the overview of DGA system with different methods.

III.DISSOLVED GAS ANALYSIS (DGA) IN TRANSFORMER OIL

Most of power transformers are full with oil that aids several purposes. The oil is a dielectric medium which acts as insulator and as heat transfer agent. The initial faults happening in transformers give evidence as early in their improvement stages through transformer oil gas analysis [7]. These faults can lead to the thermal degradation of the oil and paper insulation in the transformer. The composition and quantity of the gases generated depend on the types and severity of the faults, and regular monitoring and maintenance can make it possible to detect incipient flaws before damage occurs.

The four main types of transformer faults are,

a) Arcing or high current breakdown,

b)Low energy sparking, or partial discharges,

c) Localized overheating, or hot spots, and

d) General overheating due to inadequate cooling or sustained overloading.

III.DISSOLVED GAS ANALYSIS (DGA)

Dissolved gas analysis (DGA) is a test which used as a diagnostic and maintenance tool for oil-filled apparatus [6]. Under normal conditions, the oil present in a transformer will not decompose at a faster rate. However, thermal and electrical faults can increase the rate of decomposition of the dielectric fluid as well as the solid insulation. Gases produced by this process are of low molecular weight and include hydrogen, methane, ethane, acetylene, carbon monoxide, and carbon dioxide, and these gases get dissolved in the oil experience accumulated throughout theworld to diagnose incipient faults in transformers. The below figure 1 shows overview of a DGAsystem,

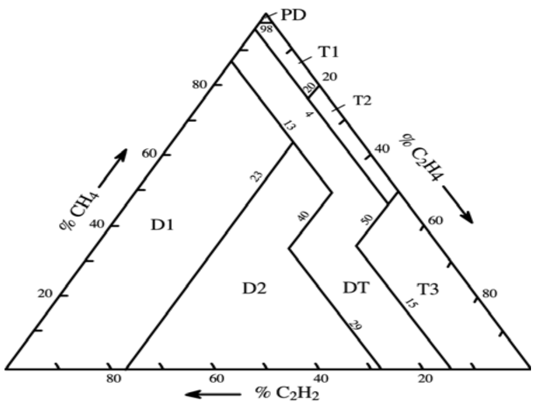
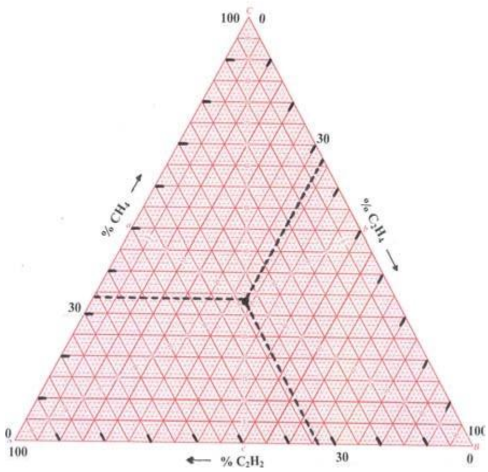


Figure 1: DGA.

It uses three hydrocarbon gases only (CH4, C2H4 and C2H2). These three gases correspond to the increasing



levels of energy necessary to generate gases in transformers in service. The Triangle method is indicated in Figure 1. In addition to the 6 zones of individual faults mentioned in Table 2 (PD, D1, D2, T1, T2 or T3), an intermediate zone DT has been attributed to mixtures of electrical and thermal faults in the transformer.

2.1 Methods of interpreting fault using DGA

1 .Key Gas method:-

In this method the concentration and gassing rates of the key hydrocarbon gases is monitored. The key gases analyzed are, hydrogen (H2), methane (CH4), ethane (C2 H6), ethylene (C2 H4), and acetylene (C2H2), carbon monoxide (CO), and carbon dioxide (CO2). The concentrations are expressed in ppm (parts per million).

2. Ratio method:

This method is the most widely used method for the fault interpretation. In this method ratio of gas concentrations are used for the interpretation purpose. Roger ratio method, Dorrenburg ratio method, and IEC ratio methods are used by the utilities. IEC ratio method is used as an industry standard.

III. PROPOSED WORK

This good performance of the Triangle with CH4 might be related to the fact that H2 diffuses much more rapidly than the hydrocarbon gases from the oil through gaskets and even metal welds. Therefore, gas ratios using H2 are probably more affected by the loss of this gas than those using hydrocarbons gases only, which have much lower and comparable diffusion rates.

The three sides of the Triangle are expressed in triangular coordinates (X,Y,Z) representing the relative proportions of CH4, C2H4 and C2H2, from 0% to 100% for each gas.

In order to display a DGA result in the Triangle, one must start with the concentrations of the three gases, (CH4) = A, (C2H4) = B and (C2H2) = C, in ppm.

First calculate the sum of these three values: (CH4 + C2H4 + C2H2) = S, in ppm, then calculates the relative proportion of the three gases, in %:

X = % CH4 = 100 (A/S), Y = % C2H4 = 100 (B/S), Z = % C2H2 = 100 (C/S).

X, Y and Z are necessarily between 0 and 100%, and (X + Y + Z) should always = 100 %. Plotting X, Y and Z in the Triangle provides only one point in the Triangle.

For example, if the DGA results are A = B = C = 100 ppm, X = Y = Z = 33.3%, which corresponds to only one point in the centre of the Triangle, as indicated in Figure 2.

Figure 2: Example of triangular graphical plot

The zone in which the (X,Y,Z) point falls in the Triangle in Figure 1 allows to identify the fault responsible for the DGA results. The example of Figure 2 would indicate a fault D2 (when transferred in Figure 1).Plotting the (X,Y,Z) point in the Triangle can also be done manually, preferably using a triangular graphical paper such as in Figure 2 for better precision.

IV. RESULTS ANALYSIS

The accuracy of DGA diagnosis, whatever the diagnosis method used, depends greatly on the accuracy and reliability of the DGA results coming from the laboratory. Note that, by convention among chemists, accuracy is represented by the difference with actual value (the analytical error in %), so that higher (better) accuracies are represented by a smaller number in %.

A few laboratories worldwide provide very accurate results, with an accuracy higher (or error lower) than ±5% at routine gas concentration levels (typically, above 10 ppm for hydrocarbon gases). Some others are known to provide very inaccurate results (±50%). In-between, the average accuracy of laboratories worldwide has been evaluated by CIGRE TF11 as ~ ±15% at routine levels. The average accuracy worsens rapidly to ~ 35% at lower concentration levels (between 2 and 10 ppm for hydrocarbon gases), and even more so (to 100% and more) as concentrations approach analytical detection limits.

This is illustrated in Figure 3, where the diagnosis uncertainty corresponding to the various DGA cases of Table 1 is represented by the coloured polygons 11. The more inaccurate the laboratory results, the larger the uncertainty on the diagnosis, as illustrated in Figure 4

Table 1: Examples of DGA cases (concentrations in ppm)

Fault	CH4	C2H4	C2H2
PD	99	1	0
	9.9	0.1	0
D1	38	12	50
	3.8	1.2	5
D2	15	50	35
	1.5	5	3.5
T2	69	30	1
	6.9	3	0.1
T3	20	75	5
	2	7.5	0.5

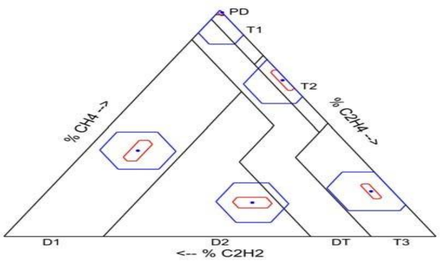


Figure 3: Uncertainty on diagnoses for cases of Table 1

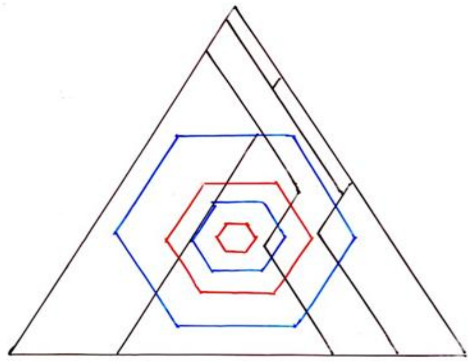


Figure 4: Diagnosis uncertainties corresponding to laboratory analytical accuracies of ± 15, 30, 50 and 75 %

When a polygon crosses two or more zones, a wrong or uncertain diagnosis may result. This may have serious consequences for the equipment if for example an arcing problem is mistakenly diagnosed as a less severe thermal fault. In order to get good reliable diagnoses, laboratory accuracy should below ±10%. Between ±10% and ±40%, diagnoses will likely become more and more uncertain, and above ±40% they are totally meaningless. DGA users are therefore strongly recommended to verify the accuracy of their laboratories, using samples of gas-in-oil standards.DGA users should also always look at inconsistencies in the DGA results, for instance values going up and down within short periods of time for no explainable reason. These are often an indication of a gross laboratory or sampling error rather than just inaccurate results.

IV. CONCLUSION

Dissolved gas analysis (DGA) is widely used to detect incipient faults in transformers. A brief review on the interpretation of DGA in transformers is presented, with a special emphasis on the Duval Triangle method. It is shown how the accuracy of DGA laboratory results can affect the reliability of DGA diagnosis. The minimum gas levels in service above which diagnoses may be attempted are indicated, as well as the gas levels observed before failure.

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