

Identification Of Transformer Incipient Faults By Using Fuzzy Logic-IEC Based 3 Gas Ratio Method

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Abstract—The electrical stress and thermal stress such kind of different stresses occurred when power transformer is in operation .Which is subjected to different gases in transformer /mineral oil. To detect the incipient faults ,most useful method is Dissolved gas analysis (DGA). There are number of methods are available to find out gases such as key Gas, Rogers Ratio, International Electro technical Commission (IEC) Ratio, and Duval triangle. Artificial neural network method is also used to detect incipient faults in power transformers. The Analysis of different types of dissolved gases in the insulating oil of transformers is to be done by using different methods .Diagnosis of different gases in transformer oil is reliable and an efficient way by using dissolved gas analysis. However, in some case each method of dissolved gases interpretation can indicate one different type of fault.

Index Terms-- Dissolved gas analysis, fuzzy logic, power transformer, transformer oil , Three-Ratio Method.

I. INTRODUCTION

In a power system Oil immersed power transformer is a major apparatus which is useful to reduced outages. It is also useful to monitoring of its in-service behavior as well as it is necessary to avoid catastrophic failures. Internal faults are occurred in transformer which is to be done at the protection zone side. The internal faults are classified into two types:

internal short circuit faults and incipient faults. In Internal short circuit faults consists turn-to-turn short circuit or turn-to-earth short circuit in transformer windings. The fast action by protective devices is required which is useful to disconnect the system from transformer.

In power system Power transformers is one of the most expensive and important equipment. If Any kind of fault in power transformer is occurred this may lead to the interruption of the power supply to consumers at the utility side. Consequently, it is most important to detect incipient fault as early as possible in power transformer. The Dissolved gas analysis (DGA) has been widely used as an effective technique to detect the incipient fault of the transformer. Because of electrical and thermal faults in power transformer more main gases are formed as a Hydrogen (H₂), Ethane (C₂H₆), Methane (CH₄), Ethylene (C₂H₄), Acetylene (C₂H₂), Carbon dioxide (CO₂), Carbon monoxide (CO). Recently, to get the correct diagnosis based on DGA data the artificial intelligence techniques have been used. This paper is aimed at applying fuzzy inference system based on IEC to determine the incipient fault of power transformers. Inside the power transformer when an overheating or discharge fault is occurred, it will produce corresponding characteristics of gases in the transformer oil. So that dissolved gas-in-oil analysis (DGA) is the mostly used method to diagnose power transformer faults. We have to analysis the concentrations of dissolved gases, the ratios of certain gases, and their gassing rates by using DGA method. By DGA method we can determine the fault type of transformer which is to be done inside the power transformer.

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II. CONVENTIONAL IEC THREE-RATIO METHOD

IEC three-ratio method is most commonly used in transformer fault diagnosis, but because of the number of fault is less than the code combination, at that time there is no matching occurs of fault diagnosis. At the time of multiple fault condition, the gases from different faults are mixed up and resulting in confusing ratios between different gas components. This could only because of more sophisticated analysis method such as the fuzzy three-ratio method.

TABLE 1
THE CODING RULE OF THREE-RATIO METHOD

Ranges of gas ratio	Codes of different gas ratios		
	C_2H_2 / C_2H_4	CH_4 / H_2	C_2H_4 / C_2H_6
<0.1	0	1	0
0.1-1	1	0	0
1-3	1	2	1
>3	2	2	2

TABLE 2
CLASSIFICATION OF FAULT TYPE THROUGH IEC THREE-RATIO METHOD

No	Fault type	Codes of the ratios		
		C_2H_2 / C_2H_4	CH_4 / H_2	C_2H_4 / C_2H_6
1	No fault	0	0	0
2	Partial discharge of low energy density	0	1	0
3	Partial discharge of high energy density	1	1	0
4	Discharge of low energy	1or2	0	1 or 2
5	Discharge of high energy	1	0	2
6	Thermal fault of low temperature <150 C	0	0	1
7	Thermal fault of low temperature 150~ 300 C	0	2	0
8	Thermal fault of medium temperature 300~700 C	0	2	1
9	Thermal fault of high temperature >700 C	0	2	2

III. TYPES OF FAULTS

The internal faults occur within the transformer protection zone. The internal faults can be divided into two types internal short circuit faults and internal incipient faults. In transformer winding's turn to earth short circuits or turn-to-turn short circuit faults takes place in case of internal short circuit faults. Internal incipient transformer

faults usually consist of Insulation deterioration, often the result of moisture, overheating, vibration, voltage surges, mechanical stress created during transformer through faults, are the major reason for winding failure.

IV. DESOLVED GAS ANALYSIS

The gas ratio range is also affected by number of factors such as loading factors, Transformer construction, manufacturer, weather conditions and oil volume. Here chemical and dielectric properties of oil is irreversible due to aging effect. Consequently, transformer oil may act as an information carrier with the help of this we will get the condition of the power transformer and as a result we can determine the type of incipient fault in power transformer. Dissolved gas analysis (DGA) is a reliable and very sensitive technique to identify the incipient faults in power transformers. The main advantage of DGA method is that the analyzing and sampling procedures are really very simple and inexpensive and are carried out without de-energizing the transformer from service. Different kind of techniques have been reported to predict the incipient faults such as IEEE standard's Roger's, Doernenburg's ratio codes, IEC ratio codes Key gas method and Duval triangle.

TABLE I
FAULT TYPES USED IN THE ANALYSIS

Fault Type	Code
Partial discharge	PD
Discharges of low energy	D1
Discharges of high energy	D2
Thermal faults $T < 300$ °C	T1
Thermal faults $300 < T < 700$ °C	T2
Thermal faults $T > 700$ °C	T3

According to table no. I here number of faults are given and there codes are also given. For partial discharge PD code is

considered same for other type of faults.

TABLE II
DIAGNOSIS USING THE RATIO METHOD (IEC 60599)

Fault type	C_2H_2/C_2H_4	CH_4/H_2	C_2H_4/C_2H_6
PD	<0.1	<0.1	<0.2
D1	>1	0.1 – 0.5	>1
D2	0.6 – 2.5	0.1 – 1	>2
T1	<0.1	>1	<1
T2	<0.1	>1	1 – 4
T3	<0.2	>1	>4

From table no.2 we can say that there are three ratios which are considered according to their ranges we will get fault type.

TABLE III
Targeted outputs of ratios

Input	Targeted output
1- C_2H_2/C_2H_4	1- No fault
2- CH_4/H_2	2- Partial discharge
3- C_2H_4/C_2H_6	3- Discharges of low energy
	4- Discharges of high energy
	5- Thermal faults $T < 300^\circ C$
	6- Thermal faults $300 < T < 700^\circ C$
	7- Thermal faults $T > 700^\circ C$

From table no. III we can say that from different type of input (gas ratios) we will get output (Identification of type of fault).

V. FUZZY LOGIC METHOD

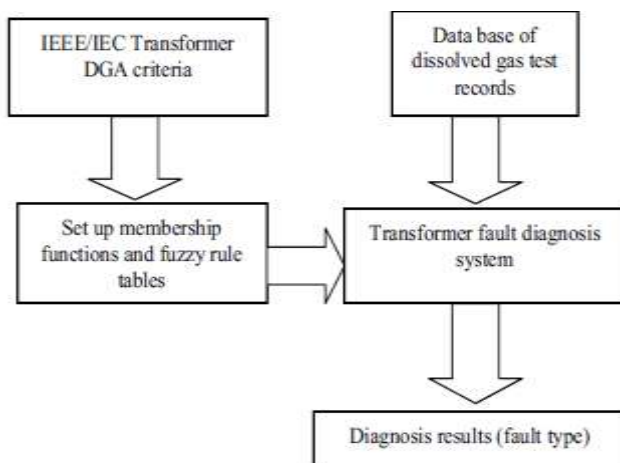


Fig. Fuzzy logic model flow chart

Here fuzzy logic model is given to estimate the transformer critical ranking based on DGA results. Input is considered as 7 key gases and according to input we will get output transformer ranking. Fuzzification of input variables is to be done which is given to AND or OR operators in this block antecedent is takes place. The output of gate is forward for

implication process and after that we are doing aggregation of that consequents. After aggregation the consequents are given to Defuzzification, we can identify transformer fault and finally we will get output. By using the fuzzy diagnosis method, the detailed information about the faults which is takes placed inside a transformer can be easily obtained. Due to the more realistic representation of the relationship between the dissolved gas levels and fault type with fuzzy membership functions.

A. Key gas method

The transformer condition depends upon the temperature, as temperature increases the paper insulation of transformers damaged and causes faults. Because of temperature the decomposition of gases in oil is takes place.

With the help of percent certain gases we can find out Various faults occurred. It also mention fault types, in that case overheating of oil and cellulose, arcing, and corona

In oil. With the help of key gases we can qualitatively determined types of fault, these key gases are generated in oil filled transformers.

B. Ratio methods

The most widely used technique is ratio method. The Roger's, Doernenburg's and IEC ratios are all widely used by utilities. Typically, three or four ratios are used for sufficient accuracy. The original Roger's ratio method uses four ratios (CH_4/H_2 , C_2H_6/CH_4 , C_2H_2/C_2H_4 , C_2H_4/C_2H_6) to identify incipient fault conditions As well as normal condition.

VI. CONCLUSION

Through study and analysis, we can diagnose the transformer incipient faults by using fuzzy method. Dissolved Gas Analysis (DGA) is the most effective diagnostic technique for power transformer incipient faults detection. A novel fuzzy logic approach is used to identify the transformer critical ranking based on DGA of transformer oil. Many conventional DGA schemes have been developed to determine transformer condition. The limitations of conventional DGA methods with frequent non-decisions are

addressed by fuzzy-logic based diagnosis for power transformer incipient faults.

VII. REFERENCES

- [1] Mostafa. M. Ibrahim, M.M. Sayed, E.E. Abu El-Zahab. Diagnosis of Power Transformer Incipient Faults Using Fuzzy Logic-IEC Based Approach[IEEE] ,2014.
- [2] Balint Nemeth, Szilvia Laboncz, Istvan Kiss, Gusztav Csepes. Transformer condition analyzing expert system using fuzzy neural system [IEEE],2010.
- [3] Deepika Bhalla , Raj Kumar Bansal, and Hari Om Gupta. Transformer Incipient Fault Diagnosis Based on DGA using Fuzzy Logic[J].
- [4] Hongzhong Ma, Zheng Li, Jingdong Han, Limin Zhang. Diagnosis of Power Transformer Faults Based On Fuzzy Three-Ratio Method.
- [5] CS Chang, CW Lim, Q Su. Fuzzy-Neural Approach For Dissolved Gas Analysis Of power Transformer Incipient Faults [J]. 2004
- [6] C. H. R. Martins, M. A. Araujo Araujo and R. A. Flauzino ,Power Transformer Fault Diagnosis using DGA and Group Decision Making with Intuitionistic Fuzzy Preference Relations[IEEE], Electrical and Computer Engineering Department ,2015.
- [7]Cristina CIULAVU, Elena HELEREA, Power Transformer Incipient Faults Monitoring [J],2008