Identification of Internal Fault in Distribution Transformer using DGA

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Abstract— Distribution transformer insulation aging diagnosis is necessary for all the situation assessment Dissolved gas analysis (DGA) is one of the mainly helpful techniques and tools to detect the incipient faults in large oil filled transformers. DGA is most helpful condition monitoring technique as primary diagnosis method for detecting the incipient fault in oil filled transformer in this paper used MATLAB programming to detecting present transformer condition according to Dissolved gasses in transformer oil as per IEC and IEEE Gas ratio code. It also describes the structure and specific features of transformer insulation aging diagnosis base IEC codes and Rogers's ratio technique. MATLAB programs using these two methods were developed to automate. As well this paper present three fault category, partial discharges (PD), arc discharges, and thermal faults and winding circulate current.

Key words: Acetylene Methane, Carbon Monoxide, Carbon Dioxide, Dissolved Gas Analysis, Ethylene, Ethane, Key Gasses, Hydrogen

I. INTRODUCTION

The transformer is the static electromagnetic device. From the day of this equipment in service, special stresses like the electrical, mechanical, chemical and environmental effect the condition of the transformer. At the initial stages, Degradation of insulation quality occurs gradually. But this deterioration multiplies in due course of time and leads to ending crash of the transformer. So, to overcome this condition, the continuous monitor of the condition and preventive measures is required for correct maintenance of the transformer. This can be achieved by providing the condition monitoring of transformer to be done at before stages via online or through offline. Like major equipment in a power system, the power transformer is vital to the system process. Technique for diagnosis and incipient fault detection is valuable. A transformer is subject to electrical and thermal stresses which could break down the inculcating materials and free gaseous decomposition products. Condition monitoring of any transformer can only be doing well if it is possible to have early fault detection. The dissolved gas analysis (DGA) of transformers can present an insight view related to thermal and electrical stresses during operations of oil immersed distribution transformer. DGA is accustomed to detect elementary faults in the transformer. It is found that the abrupt changes in concentration and ratio of a variety of gasses interpret the healthiness of transformer. So to improve the transformer health it is required to constantly monitor all the gasses. Gasses are necessary to be monitored at every instant as every gas contribute either in some parameter or will be the reason of rising of any additional gas. The two stresses could break down insulation materials and discharge gaseous decomposition products. Overheating, corona and arcing are three main causes of fault related gasses. Principally, the fault related gasses commonly used is hydrogen, carbon monoxide, carbon dioxide, methane, acetylene, ethane, and ethylene. The study of dissolved gasses is a powerful tool to diagnose developing fault in distribution transformer. Early detection of faults is very important for saving transformer starting some catastrophic failure so condition monitoring of transformer must be required for early detection of fault and obtain the necessary preventive action to keep away from the total failure of the transformer.

II. DISSOLVED GAS ANALYSIS

DGA is a diagnostic method for detecting and evaluate of incipient faults in oil immersed transformers. A fault is caused abnormal dissipation of energy inside the transformer. While a fault occurs in the transformer, the insulation arrangement will undergo chemical degradation which leads to a production of various gasses that dissolve in the oil. These gasses are frequently referred to as key gasses, and from their concentrations, we can identify dissimilar types of the fault occurring in the transformer. Study Dissolved gases-in-oil analysis (DGA) is mainly helpful technique in transformer fault diagnosis. Electrical insulation such as mineral oils as well as cellulosic materials degrades under extreme thermal and electrical stresses, forming byproduct gasses which can serve as indicators of the category of stress and its severity. Dissolved gas-in-oil concentrations, the relative proportion of gasses, with gas generation rates (gasses rates) are used to approximation the situation of a transformer. Usually, used gasses include hydrogen, methane, acetylene-ethylene, ethane, carbon monoxide, and carbon dioxide. These gasses are extracting from the oil under high vacuum and analyzed in Gas Chromatograph to get each gas attention individually.

III. PROCEDURE OF DGA

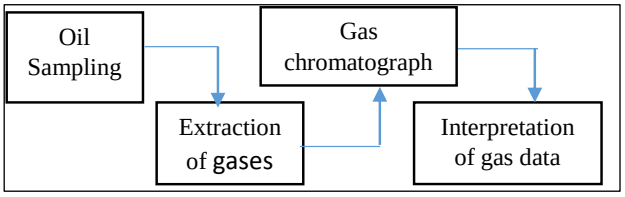

Fig. 1: Methods for Interpretation of Gas data

The standards IEC [4] and IEEE [5] present guidelines for interpretation of DGA. Into these standards, one can use for example find graphical interpretations of gas ratios and numerical tables for typical gas concentration within oil immersed transformer in a process.

Gas Ratios	Range of gas ratio code	Range of code / IEC code
$\frac{C_2H_2}{C_2H_4}$	<0.1	0
	0.1–1.0	1
	1.0–3.0	1
	>3.0	2

$\frac{CH_4}{H_2}$	<0.1	1
	0.1–1.0	0
	1.0–3.0	2
	>3.0	2
$\frac{C_2H_4}{C_2H_6}$	<0.1	0
	0.1–1.0	0
	1.0–3.0	1
	>3.0	2

Table 1: IEC Ratio Code

The ratios of the dissimilar gasses and its range according to analyze the value of ratio the following table provide the codes according to the gas concentration. With from this codes combination we can classify which types of fault occurrence in a transformer.

Fault categorization according to IEC Codes:

The following table shows the grouping of codes and according to this codes it classify the type of fault indicate by transformer oil.

$\frac{C_2H_2}{C_2H_4}$	$\frac{CH_4}{H_2}$	$\frac{C_2H_4}{C_2H_6}$	FAULT TYPE
0	0	2	Partial discharge of low energy
0	1	1	Thermal Fault of low temperature $150-300^0C$
0	1	2	Thermal Fault of low temperature $<150^0C$
1	0	0	Flashover, Intermittent sparking
1	1	1	Thermal Fault of low temperature $150-300^0C$
1	1	2	Thermal Fault of high temperatures $>700^0C$
1	2	0	Core and tank circulating currents.
1	2	1	Winding Circulating currents.
1	2	2	Core and tank circulating currents.
2	0	0	Partial discharge of high energy density, Corona
2	0	1	Discharge of high energy, Arcing.
2	0	2	Discharges of low energy, Continuous sparking
2	1	0	Partial discharge of high energy density, Corona
2	1	1	Discharge of high energy, Arcing.
2	1	2	Discharges of low energy, Continuous sparking
2	2	0	Severe arcing, Overheating of oil. $>1000^0C$
2	2	1	
2	2	2	

Table 2: Fault Classification

IF the ratio CO/CO2>0.1 Transformer shows High temperature then Normal in Insulation.

IV. MATLAB PROGRAMMING

From the analysis of key gases concentration in the transformer oil and its ratio according to Rogers's method & IEC code. I have prepped MATLAB program for which type of fault in the transformer may occurs in future.

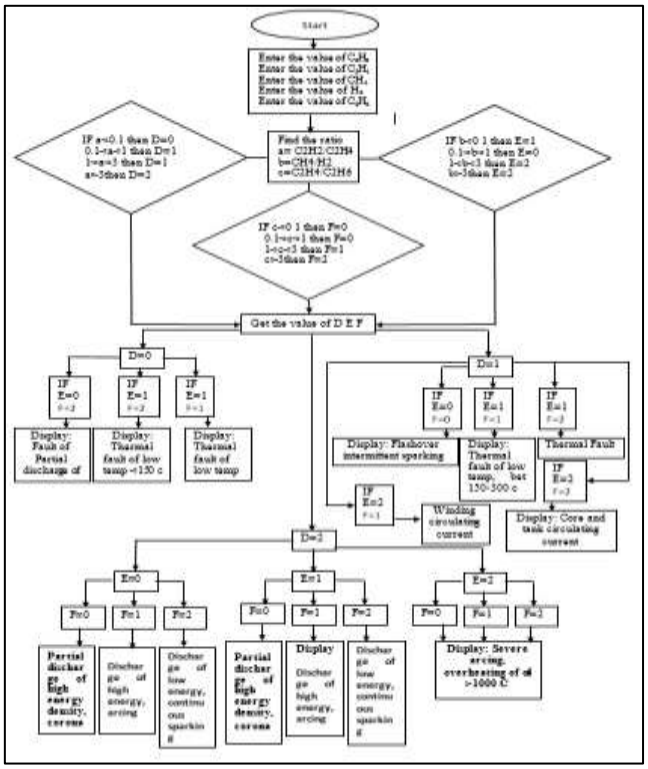

Fig. 1: Flow chart of program

By the ingoing the rate of concentration of gages in oil in MATLAB program input we obtain the resultant fault according to IEC standard.

A. Case Study on DGA

Rating of Transformer: 100 MVA 220/66/11 KV
Full load current: HV-262.4 Amp
IV-874.8 Amp
TV-1749.5 Amp

H2	O2	N2	CH4	C2H2	C2H4	C2H6	CO	CO2
19	9892	33927	6	7	12	3	15	239

Table 3: Gas Level in PPM

Impedance Z%: 12.661%
Result: Thermal fault of low temperature between150-300^{0}C.
CO/CO2 = 0.1040, Sows insulation overheating
Gas concentration after maintaining transformer:

H2	O2	N2	CH4	C2H2	C2H4	C2H6	CO	CO2
1708	3700	47849	1502	34	1528	652	106	1019

Table 4: Gas level in PPM

Result: Winding circulating current

V. CONCLUSION

Analyze insulate oil in use from transformers is a primary way of identifying problems occurring inside a transformer. Through identifying and quantifying the gasses found in transformer oil, the state of the transformer can be monitored. If faults are found to be occurring, outages can be planned and the fault can be rectified previous to major harm can occur. This sample should use properly and further records can be maintained.

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