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Condition Monitoring of High Voltage Transformer using Dissolved Gas Analysis Methods

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Abstract: Power transformer plays a significant role in the entire power transmission network; thus, transformer protection requires more attention for fault free electric supply. when the mineral oil and insulation inside the transformer is subjected to high thermal and electrical stresses, gases are created by the decay of mineral oil and cellulose. Different gases create different faults, Identification of faults inside the power transformer before they occur reduces its failure rate during its service period. For Knowing the fault condition of power transformer, Dissolved Gas Analysis (DGA) is proven to be as accurate method based on combination of concentration of gases like CO, CO2, H2, C2H6, C2H4, C2H2 etc., Dissolved gas analysis is the most important test in determining the fault condition of a transformer and it is the first indicator of a problem and can identify deteriorating insulation and oil, overheating hot spots, partial discharge and arcing. For developing this DGA Techniques, the MATLAB GUIDE interface can be used for making easy interaction between the user and software developed. This software is designed using some conditional statements and logical functions to get the type of faults in transformers based on the concentration of gases in transformer oil. The faults in transformer using dissolved gases analysis are detected using methods such as key gas, Roger's methods, IEC ratio, Doernenburg ratio, Duval triangle and the Combined DGA methods. In this paper, these four methods of dissolved gas analysis (DGA) are presented and explained briefly.
Keywords: Power transformer, Gas formation, Thermal faults, electrical faults, DGA, Key gas method, Roger's ratio method.

I. INTRODUCTION

The Transformer is a very important electrical equipment which plays significant role in transmission of electrical energy. For getting reliable power supply from it, the utmost care must be taken during its operation period, otherwise some incipient fault developed in transformer unknowingly, damage transformer completely and also causes consumers and utilities to face the complete outage until the transformer get repaired. Hence for getting reliable supply from transformer it should be continuously and regularly monitored, maintained and tested.

During the Normal operation of transformer, several gases like acetylene, hydrogen, Carbon monoxide, Carbon dioxide, ethane, ethylene, methane were release at lower concentration. This will not affect the operation of transformer because these were at normal level. But During some abnormal condition these gases concentration become more than the normal values and slowly degrade the performance of transformer.

If there is any identification of combination of gases regularly in transformer oil, this is the first accessible sign mal operation of transformer. if these gases were not identified then transformer will get damaged. This is not encouraging thing because Failure of power transformers lead to a major problem affecting the power system network connected to it. Further, an unexpected failure of power transformers not only cause an outage to the consumer, but also it can cause the loss of millions of dollars for industrial failure costs, utility companies, and also indirectly to the national security. Hence the better option is to identify the problem in the transformer before the fault actually occurs in it.

A. Objective

The basic objective is to here to increase the life of the transformer by finding the fault condition in a transformer before it actually occurs. This can effectively achieve by using the dissolved gas analysis techniques which helps in finding out the type of fault that will going to occur in transformer based on the concentration of gases in the oil of it. The DGA mainly consist of Five traditional methods like key gas, Roger's ratio, doernenburg ratio and duval triangle methods. These methods individually not so accurate because they were not able to predict each and every fault that will occur in transformer. Hence some combined method can be developed which can predict almost all the faults and having highest accuracy in checking condition of fault in an oil filled transformer. In this paper, the IEC ratio method, Doernenburg ratio, Duval Triangle and Combined DGA methods were briefly reviewed.

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II. FORMATION OF GASES IN TRANSFORMER OIL

Transformer faults generally result from the long-term degradation of oil and paper due to the combination of heat, moisture, and air. Due to electrical and thermal stresses that power transformer experiences, oil, and paper decomposition occur resulting in various gases depending upon the causes of the faults. Gases produced due to oil decompositions are hydrogen (H2), methane (CH4), acetylene (C2H2), ethylene (C2H4), and ethane (C2H6), while paper decompositions mainly produce carbon monoxide (CO) and carbon dioxide (CO2). The characteristics and concentrations of the gases dissolved in transformer oil vary according to the nature of the fault and hence can be used to identify the type of fault. However, the analysis is not always straightforward as there may be more than one fault present at the same time.

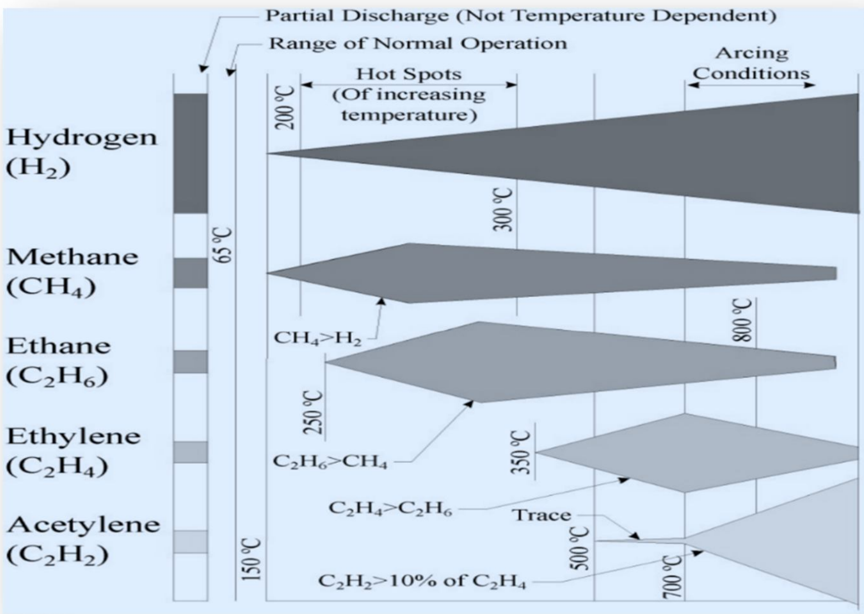

Fig. 1 Gas Generation chart

Gases (in PPM)	Normal	Caution	Abnormal	Danger	Type of fault
Hydrogen	100	101-700	701-1800	>1800	Partial discharge in oil
Methane CH4	120	121-400	401-1000	>1000	
Acetylene C2H2	35	36-50	51-80	>80	Arcing in oil
Ethylene C2H4	50	51-100	101-200	>200	Overheated oil
Ethane C2H6	65	66-100	101-150	>150	
Carbon Monoxide	350	351-570	571-1400	>1400	Overheated cellulose
Carbon Dioxide	2500	2501-4000	4001-10000	>10000	
TDCG	720	721-1920	1921-4630	>4630	

Table 1 Limits of concentration of Gases

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III. DGA FLOW CHART

The Steps Involved in DGA Is Shown in Following Figure

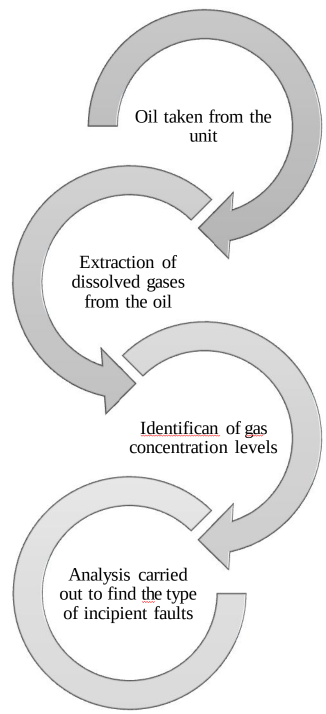

Fig. 2 Flow Chart of DGA

From above flow chart, the first step involved in process of DGA is collecting the oil sample from the transformer unit. After that, Oil is subjected to Gas chromatography to extract the dissolved gases from the collected oil sample. The next step involved in this process is to identify the concentration levels of gases in oil sample by using suitable methods like flame ionization, thermal conduction detector etc., and finally analysis for the faults using the suitable diagnostic methods like key gas, Roger's ratio methods etc.,

IV. IES RATIO METHOD

IEC ratio method is derived from Roger's Ratio method. In this method, the ratio C2H6/CH4 was dropped as it revealed only a partial temperature range at the time of decomposition inside the transformer. Following Table 2 shows the IEC Ratio codes with gas ratio range and its code(0-2).

Sr. No	Gas Ratios	Ratio Codes	Range	Code
1	CH4/H2	I	<0.1	1
			0.1-1.0	0
			>1.0	2
3	C2H4/C2H6	K	<1.0	0
			1.0-3.0	1
			>3.0	2
4	C2H2/C2H4	L	<0.1	0
			0.1-3.0	1
			>3.0	2

Table 2 IEC Ratio Codes

Sr. No	i	k	L	Diagnosis
1	0	1	0	Normal ageing
2	1	0	>0	Partial discharge of lowenergy density
3	1	0	1	Partial discharge of highenergy density
4	0	1-2	1-2	Discharge of low energy
5	0	2	1	Discharge of highenergy
6	0	1	0	Thermal fault(<150°C)heating
7	2	0	0	Thermal fault (150°C -300°C)
8	2	1	0	Thermal fault (300°C - 700°C)
9	2	2	0	Thermal fault(>700°C)follows through

Table 3 Different faults based on IEC Ratio

A. *IEC Ratio Method Software Implementation*

The below figure 2 shows the IEC Ratio method software implementation using MATLAB GUIDE (A Graphical User Interface Development Environment) Which provides a graphical display of entire method at one window. This window contains the nine boxes which will take the nine gases as inputs in ppm and read their concentration level for checking the fault condition. This method diagnoses the fault with the help of three gas ratios generated at the time of the fault. The three gas ratios are CH4/H2, C2H4/C2H6 and C2H2/C2H4.

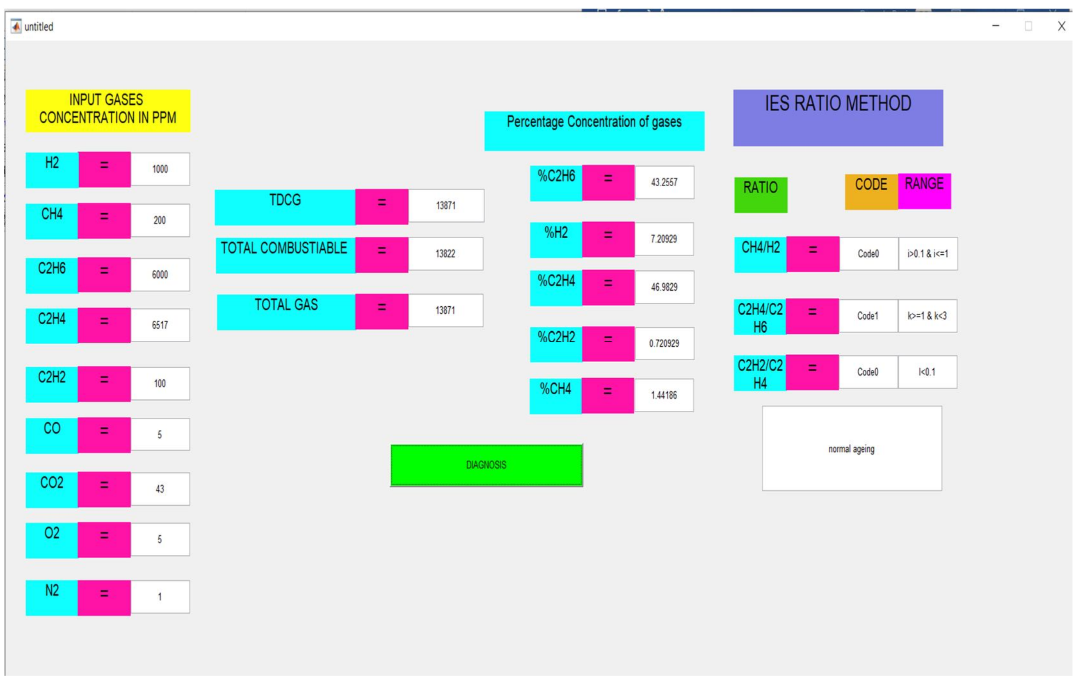

Fig. 2 IEC Ratio Method Software Implementation

B. *IEC Ratio Method Results and observations*

The gases concentration was collected from the transformer oil sample, and entered in given respective input boxes of IEC Ratio Method software window.

Input gases	H2	CH4	C2H6	C2H4	C2H2	CO	CO2	O2	N2
Concentration in ppm	1000	200	6200	6617	100	5	43	5	1

Table 4 Input gases to IEC Ratio Software

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1) TDCG gives summation of total dissolved combustible gases
2) TCG gives summation of total gas concentration without noncombustible gas CO2.
3) The GUI result in Figure 2 given status of the faults, showing Faults found.

By taking the input gas concentrations shown in Table 4. IEC Ratio method diagnosis the condition as "normal ageing". Figure 2 shows the IEC ratio GUI result, taking nine gases concentrations as input, it gives fault condition by moment when diagnosis button clicked. This result also gives each gas ratios range followed by corresponding code.

The GUI result for given sample unit is obtained by

i= CH4/H2=0.2
k= C2H4/C2H6=1.06
l= C2H2/C2H4=0.0151
CH4/H2 gases ratio range is i>0.1, i<=1.0 and corresponding code representation as code0
C2H4/C2H6 gases ratio range is k>=1 and k<3 and corresponding code representation as code1
C2H6/CH4 gases ratio range is l<0.1 and corresponding code representation as code0

Hence from given Table 3, the software will compare obtained codes and display fault condition can be as "normal ageing".

V. DOERNENBURG RATIO METHOD

This technique used four different gas ratios such as C_2H_6/C_2H_2, CH_4/H_2, C_2H_2/CH_4 and C_2H_2/C_2H_4. Taking these gas ratios ranges, its diagnosis the different fault conditions like partial discharge, arcing and thermal faults in various degree of severity. Table 3.4 indicates the minimum level of gas concentrations for key gases used in this method.

Key Gas	Concentration (ppm)
Acetylene(C2H2)	35
Methane (CH4)	120
Ethylene(C2H4)	50
Hydrogen(H2)	100
Carbon Monoxide (CO)	350
Ethane(C2H6)	65

Table 5 Concentration limit for Dornenburg RatioMethod

Fault	CH4 / H2)	C2H2 /C2H4)	C2H2 /CH4	C2H6 / C2H2
Thermal decomposition	>1.0	<0.75	<0.3	>0.4
Partial Discharge (PD)	<0.1	Not significant	<0.3	>0.4
Arcing fault	>0.1 to <1.0	>0.01 to < 0.1	>0.3	<0.4

Table 6 Diagnosis by Dornenburg Ratio Method

A. *Dornenburg Ratio Method Software Implementation*

The below figure 3 shows the Dornenburg Ratio method software implementation using MATLAB GUIDE (A Graphical User Interface Development Environment) Which provides a graphical display of entire method at one window. This window contains the nine boxes which will take the nine gases as inputs in ppm and read their concentration level for checking the fault condition. This method diagnoses the fault with the help of four gas ratios generated at the time of the fault. The four gas ratios are CH4/H2, C2H2/CH4, C2H6/C2H2 and C2H2/C2H4.

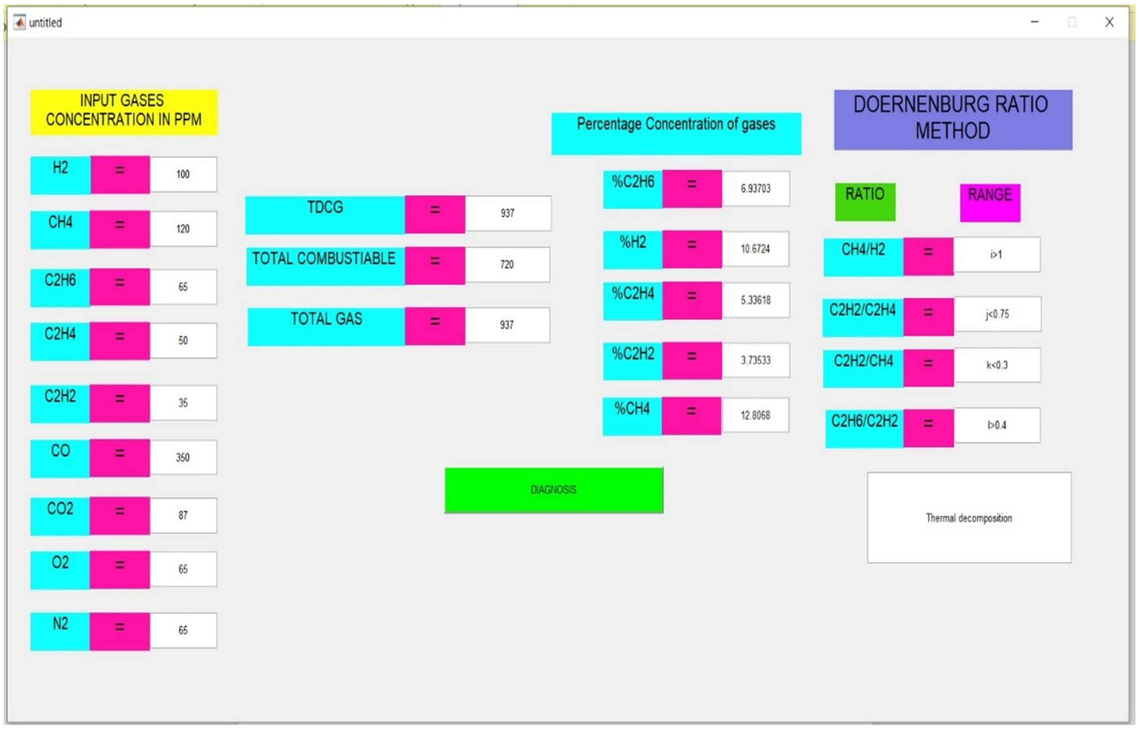

Fig. 3 Doernenburg Ratio Method Software Implementation

B. Dornenburg Ratio Method Results and Observations

The gases concentration was collected from the transformer oil sample, and entered in given respective input boxes of Dornenburg Ratio Method software window.

Input gases	H2	CH4	C2H6	C2H4	C2H2	CO	CO2	O2	N2
Concentration in ppm	100	120	65	50	35	350	87	65	65

Table 7 Input gases to Rogers's Ratio Software

1) TDCG gives summation of total dissolved combustible gases
2) TCG gives summation of total gas concentration without noncombustible gas CO2.
3) The GUI result in Figure 3 given status of the faults, showing Faults found.

By taking the input gas concentrations shown in Table 7 Dornenburg ratio method diagnosis the condition as "thermal decomposing". Figure 3 shows the Dornenburg ratio GUI result, taking nine gases concentrations as input it gives fault condition by moment when diagnosis button clicked. This result also gives each gas ratios range followed by corresponding code.

The GUI result for given sample unit obtained by

i= CH4/H2=1.2
j= C2H2/C2H4=0.7
k= C2H2/CH4=0.291
l= C2H6/C2H2=1.87
CH4/H2 gases ratio range is i>1
C2H2/C2H4 gases ratio range is j<0.75
C2H2/CH4 gases ratio range is k<0.3
C2H6/C2H2 gases ratio range is l>0.4

Hence from given Table 6, the software will compare obtained codes and display fault condition can be as "Thermal decomposition"

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VI. DUVAL TRIANGLE METHOD

Duval Triangle method is one of the most accurate methods when compared to the other four methods. This method is based on three gases CH4, C2H4 and C2H2. The problem exists only if at least one of the hydrocarbon gases or hydrogen is greater or equal to the L1 level. The gas generated must at the rate of G1 & G2 as shown in Table 9.

Symbol	Fault code	Examples
PD	Partial Discharge	Cold plasma discharges(corona), voids
D1	Discharge of low Energy	Partial Discharges of sparking type like carbonized punctures, pinholes
D2	Discharge of High Energy	Discharges in oil or paper,
T1	Thermal Fault <300^0C	Evidenced by paper turning brownish
T2	Thermal fault 300^0C-700^0C	formation of carbon particles, Carbonization of paper discharges of low energy pinholes
DT	Electrical and Thermal faults	-
T3	Thermal fault (>700°C)	-

Table 8 Codes for Faults in Duvel Triangle

If the above conditions as mentioned in Table 8 are satisfied then the problem exists. The percentage of each gas with total gas (CH4 + C2H4 + C2H2) is calculated. This percentage of each gas is plotted on the triangular chart which is subdivided into six fault zones. The fault zone where the point is located indicates the type of fault produced in the transformer as shown in figure 4.

Let say CH_4=a, C_2H_4=b and C_2H_2=c

- First, calculate the summation of three key gases concentration as a+b+c
- Calculate the relative percentage of each gas by using the following formulas

$\%CH_4 = (a / (a+b+c))*100$

$\%C_2H_4 = (b / (a+b+c))*100$

$\%C_2H_2 = (c / (a+b+c))*100$

By considering three gas percentages, draw a parallel line to the corresponding sides of the triangle. It indicates only one point inside the triangle that shows the fault zone.

S. No	Gas	L1 Limits	G1 limits(ppm per month)	G2 limits(ppm per month)
1	H2	100	10	50
2	CH4	75	8	38
3	C2H2	3	3	3
4	C2H4	75	8	38
5	C2H6	75	8	38
6	CO	700	70	350
7	CO2	7000	700	3500

Table 9 L1 limit and gas generation rates for DuvalTriangle Method

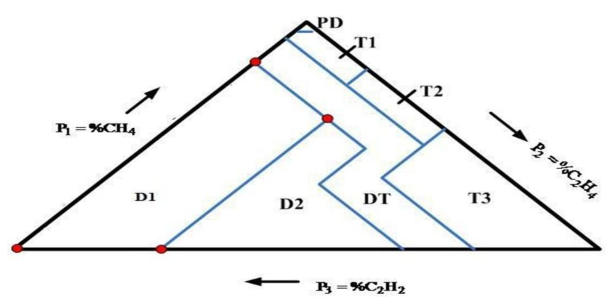

Fig. 4 Duvel Triangle

A. Duvel Triangle Method Software implementation

The below figure 5 shows the Duvel Triangle method software implementation using MATLAB GUIDE (A Graphical User Interface Development Environment) Which provides a graphical display of entire method at one window. This window contains the three boxes which will take the nine gases as inputs in ppm and read their concentration level for checking the fault condition. This method diagnoses the fault with the help of Duval triangle in which point of fault located at the moment when the diagnosis button pressed after entry of concentration of gases in respective boxes provided in software window as shown in Figure 5. Software coding can be done such that it gives visual display of all type of fault zones with different color. This method uses only three gases, they are C2H4, C2H2 and CH4.

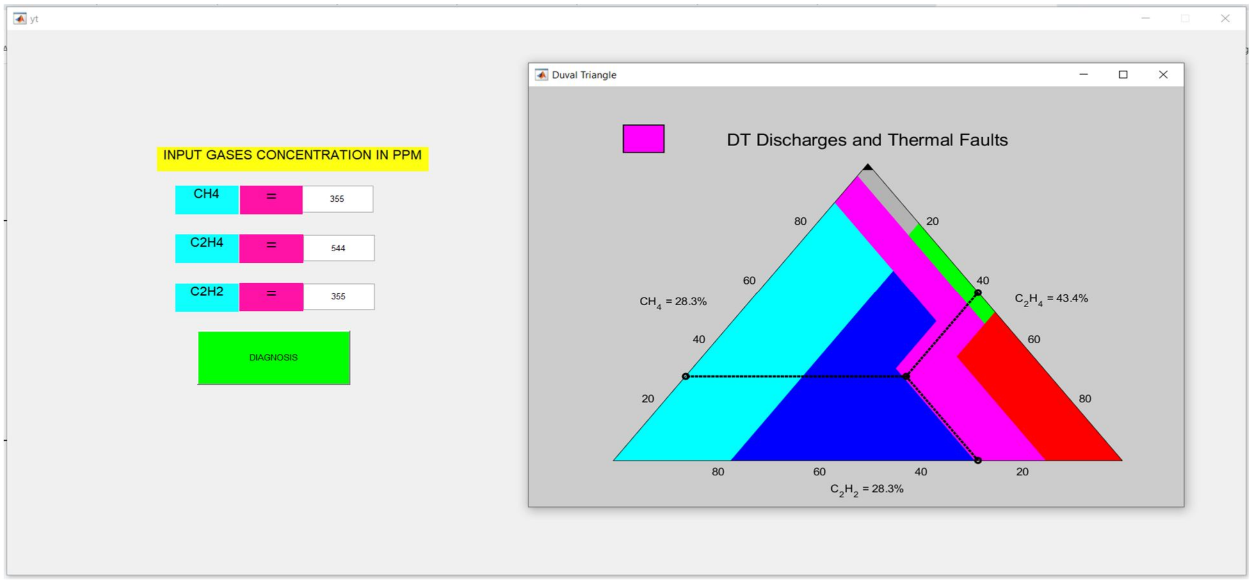

Fig. 5 Duvel Triangle Software implementation

B. Duvel Triangle Method Results and Observations

The gases concentration was collected from the transformer oil sample, and entered in given respective input boxes of Duvel Triangle Method software window.

Input gases	CH4	C2H4	C2H2
Concentration in ppm	355	544	355

Table 10 Input gases to Duvel Triangle Method Software

- %CH4= (CH4/ (CH4+ C2H4+ C2H2)) *100
  = (355/355+544+355) *100
  =28.3
- %C2H4= (C2H4/ (CH4+ C2H4+ C2H2)) *100
  = (544/355+544+355) *100
  =43.4
- %C_2H_2= (C_2H_2/ (CH_4+ C_2H_4+ C_2H_2)) *100
  = (355/355+544+355) *100
  =28.3

The software developed for duvel triangle method will locate trinary co-ordinates of the percentage of gases in triangle and fault condition was indicated at top of triangle with some colour indication.

By taking the input gas concentrations shown in Table 10, Duvel Triangle Method diagnosis the condition as "Discharge and thermal faults". Figure 5 shows the Duvel Triangle Method GUI result, taking three gases concentrations as input and it gives fault condition by moment when diagnosis button clicked.

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VII. COMBINED DGA ANALYSIS

In this DGA combined Method considering the merits all individual diagnostic methods except duval triangle method and finally diagnosis actual incipient fault. Hence by combines the four classical Techniques, diagnosis of all type faults is possible such as Partial Discharge of with and without arcing, Thermal Faults with various range (300*C-700*C), Discharge of High Energy, Arc with Power follow Through, Arcing and Combination of Electrical and Thermal faults. Finally, by using MATLAB GUIDE software all diagnostic results of individual method and Combined DGA method results displayed at one window.

Figure 6 Shows the process for combined dissolved gas analysis by all the five methods which we have discussed, based on the percentage of fault diagnosed by each method the fault is concluded. The result of the combined analysis is displayed on MATLAB GUIDE. The above codes are incorporated to provide the incipient fault based on the percentage of the fault data of gases was analyzed for DGA by comparing the results with individual methods and combined DGA analysis.

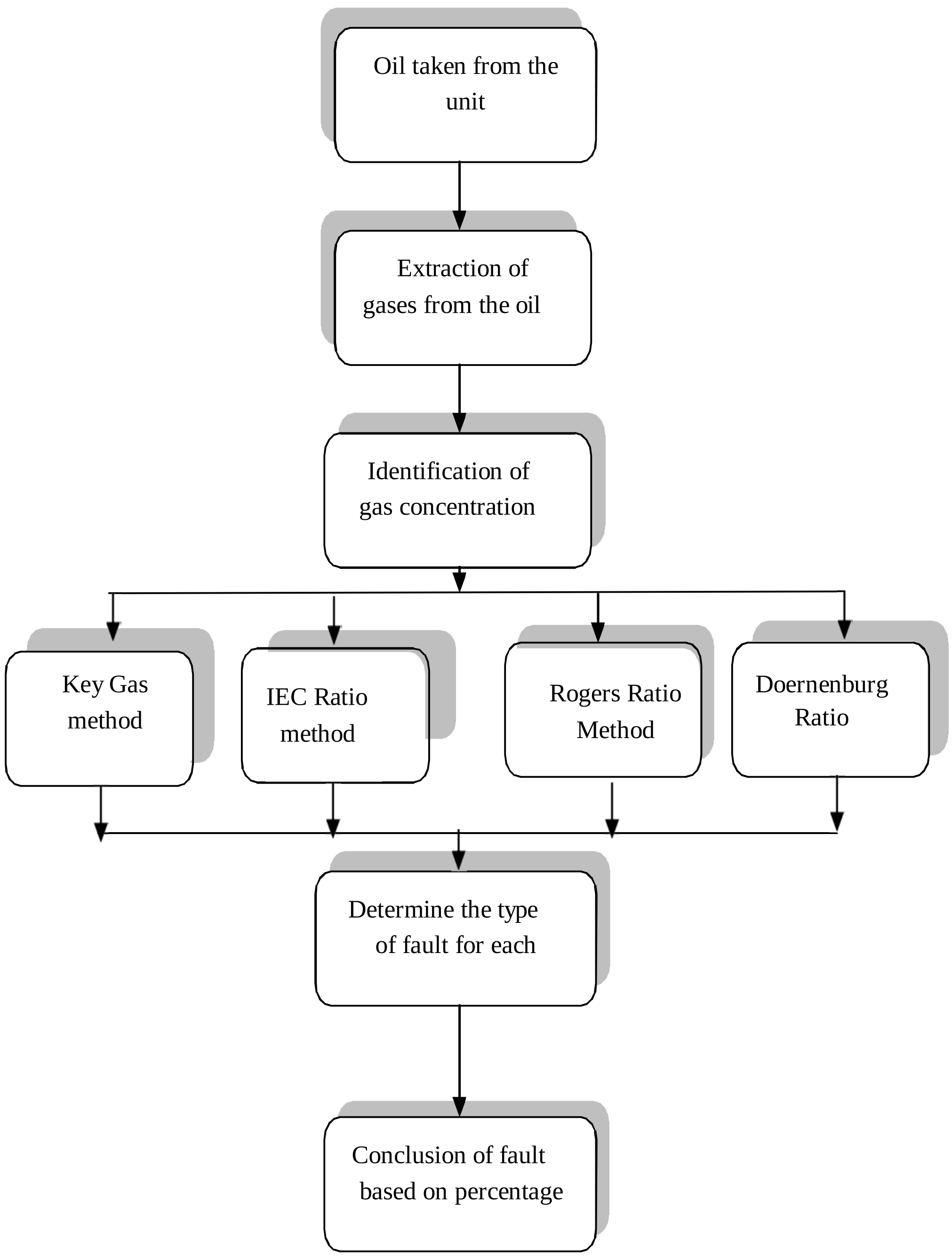

Fig. 6 Block diagram of Combined Dissolved Gas Analysis (DGA)

A. Mapping Process of Faults to each Individual Diagnostic Method

The fault names shown by these individual methods were different for similar types of fault, hence for given sample concentration of gases, this software of combined DGA method will not able recognize similar faults in all individual methods. Thus, in order avoid such problem some fault codes were assigned to faults which were come under same category in all individual diagnostic methods. For example, Rogers Ratio and Key gas Method diagnosis the condition as “Arc with power follows through” and ‘Arcing in oil” simultaneously and it is mapped with fault code is F2. The entire codes for the faults are shown in table below.

Type of fault in key gas method	Type of fault in Roger’s ratio method	Type of fault for IEC ratio method	Type of fault for Doenenburg ratio method	Final fault to be considered in combined DGA method	Fault Code
Partial discharge in oil	Partial discharge, Partial discharge with tracking	Partial discharge of lowenergy density, Partial discharge of highenergy density	Partial Discharge (PD)	Partial Discharge	F1
Arcing in oil	Arc with power follow through, Flash over without power follow through	Discharge of high energy	Arcing fault	Arcing with follow through	F2
Overheated oil, Overheated cellulose	Overheating(200C-300°C), Overheating(150C-200°C), General conductor over heating	Thermal fault (150°C - 300°C)	Thermal decomposition	thermal fault with General conductor overheating, decomposition in Oil and Cellulose (150°C to 300°C)	F3
-	Core & circulating currents (300C-700°C)	Thermal fault (300°C-700°C), Thermal fault(>700°C)follow through	-	thermal fault with circulating currents (300°C to 900°C)	F4
-	Slight overheating(<150°C)	Thermal fault (<150°C)heating	-	Slight overheating (<150°C)	F5
Normal condition	No fault. Normal deterioration	Normal ageing	-	normal detoriation with aging	F6
-	-	Discharge of low energy	Discharge of low Energy D2	-	F7
-	Winding circulating currents	-	-	-	F8
-	Continuous sparking to floating potential	-	-	-	F9
-	No fault detected	No fault detected	No fault detected	-	F10

Table 11 Fault codes for individual methods in Combined DGA method

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B. Combined DGA Method Software Implementation

A MATLAB user friendly Graphic User Interface Development Environment (GUIDE) is used in this work to represent results of key gas, Roger's ratio, IES ratio, Doernenburg ratio methods at one window. GUI needs only input data of gas concentrations in ppm. Algorithm divide into different modules to visual display and in which programming calculations were done to find the faults as already programmed. If click on the Diagnosis button on GUI window, all the incipient faults and fault codes of each individual method displayed and type of common fault is displayed with fault code using Combine DGA Method. The result from every technique is the submitted go into the main project program of DGA combine method outline that interfaces the four calculations. The DGA Combine program interface will focus the fault examination analysis classification by using a single fault analysis to find the common fault result

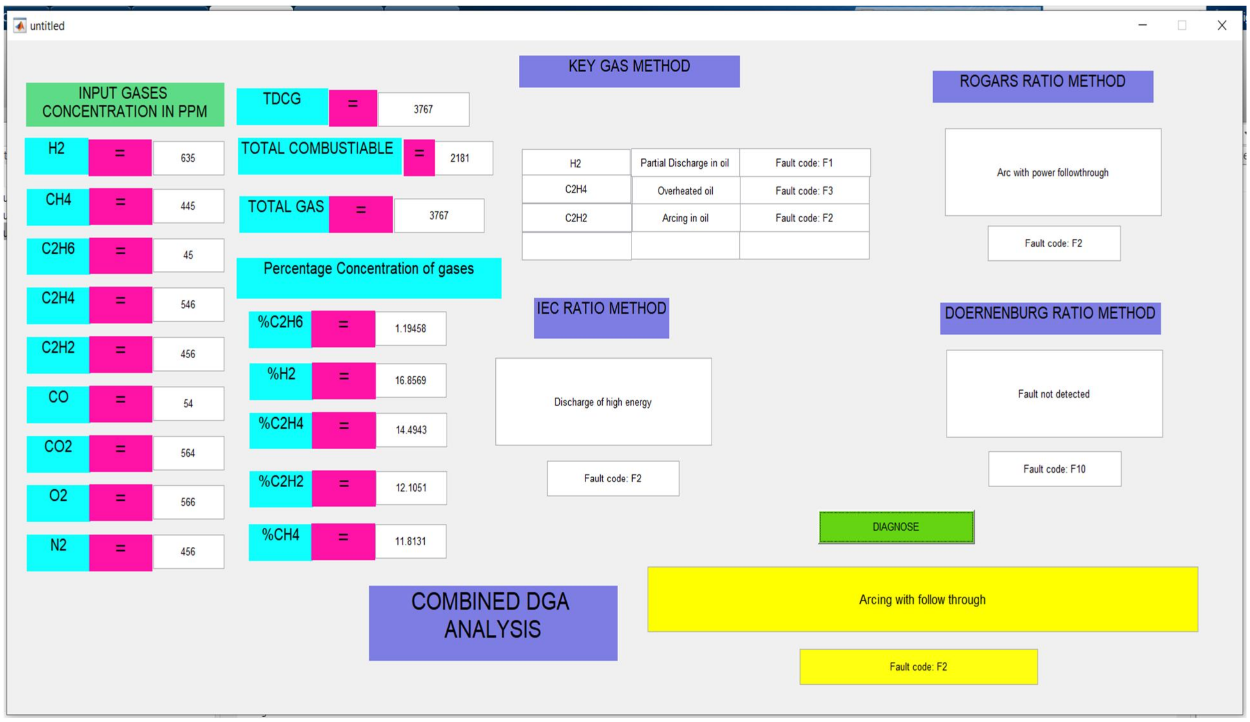

Fig. 7 Combined DGA Analysis method Software Implementation

C. Combined DGA method Result and Observations

The gases concentration was collected from the transformer oil sample, and entered in given respective input boxes of Combined DGA Method software window.

Input gases	H2	CH4	C2H6	C2H4	C2H2	CO	CO2	O2	N2
Concentration in ppm	635	445	45	546	456	54	564	566	456

Table 12 Input gases to Combined DGA Method Software

1) TDCG gives summation of total dissolved combustible gases
2) TCG gives summation of total gas concentration without noncombustible gas CO2.
3) The GUI result in Figure 7 given status of the faults, showing Faults found.

All the individual methods result will be displayed on the Software window separately with the fault code assigned to them as shown in the Figure 7. DGA Combine Method taking the diagnosis results of all individual methods and submitted back into the main program to diagnosis the final fault and it gives final fault by considering the repetition of faults in individual methods.

By taking the input gas concentrations shown in Table 12, DGA Combine Method diagnosis the condition as "Arcing with follow through". Figure 3.6 shows the DGA Combine Method GUI result, taking nine gases concentrations as input it gives final fault condition by moment when diagnosis button clicked.

VIII. CONCLUSION

The results from different cases under study reveal that the proposed techniques are reliable to use as a diagnostic tool to detect the fault in the transformer in its early stage. The conclusions from the real cases explain that the nature of the insulating materials involved in the fault and the nature of the fault itself affect the distribution of dissolved gases. Based on the results fromthe software code and the lab results, we see that the software code is reliable to diagnosis the transformer fault based on the gas concentrations. The results from the software code have a good agreement with the previous conventional methods for fault detection intransformers.

In this work, percentage prediction of all five classical techniques and DGA Combine Method was compared. Hence observed IEC Ratio method predicts 65% of total incipient fault cases, Doernenburg Ratio Method predicts 45% of total incipient fault cases and Duval Triangle Method predicts more than 70% cases of total incipient fault conditions. In this work, the condition-based diagnosis system was developed to combine four DGA assessment classical techniques-Keys Gas Method, the IEC Ratio method and Rogers Ratio Method, Doernenburg Ratio methods. The result of this method shows overall DGA accuracy to diagnosis the fault is more than 75% compared to of 70 % the most reliable individual method Duval Triangle

Sl. No	Method	No. of Data tested	Computation		
			Results obtained	No Prediction	% Accuracy
1	IEC	20	13	7	65
2	Doernenburg	20	9	11	45
3	Duval	20	14	6	70
4	Combined DGA Without duval triangle	20	15	5	75

Table 13 Comparing percentage prediction of individualand combined DGA method

VIII. ACKNOWLEDGEMENT

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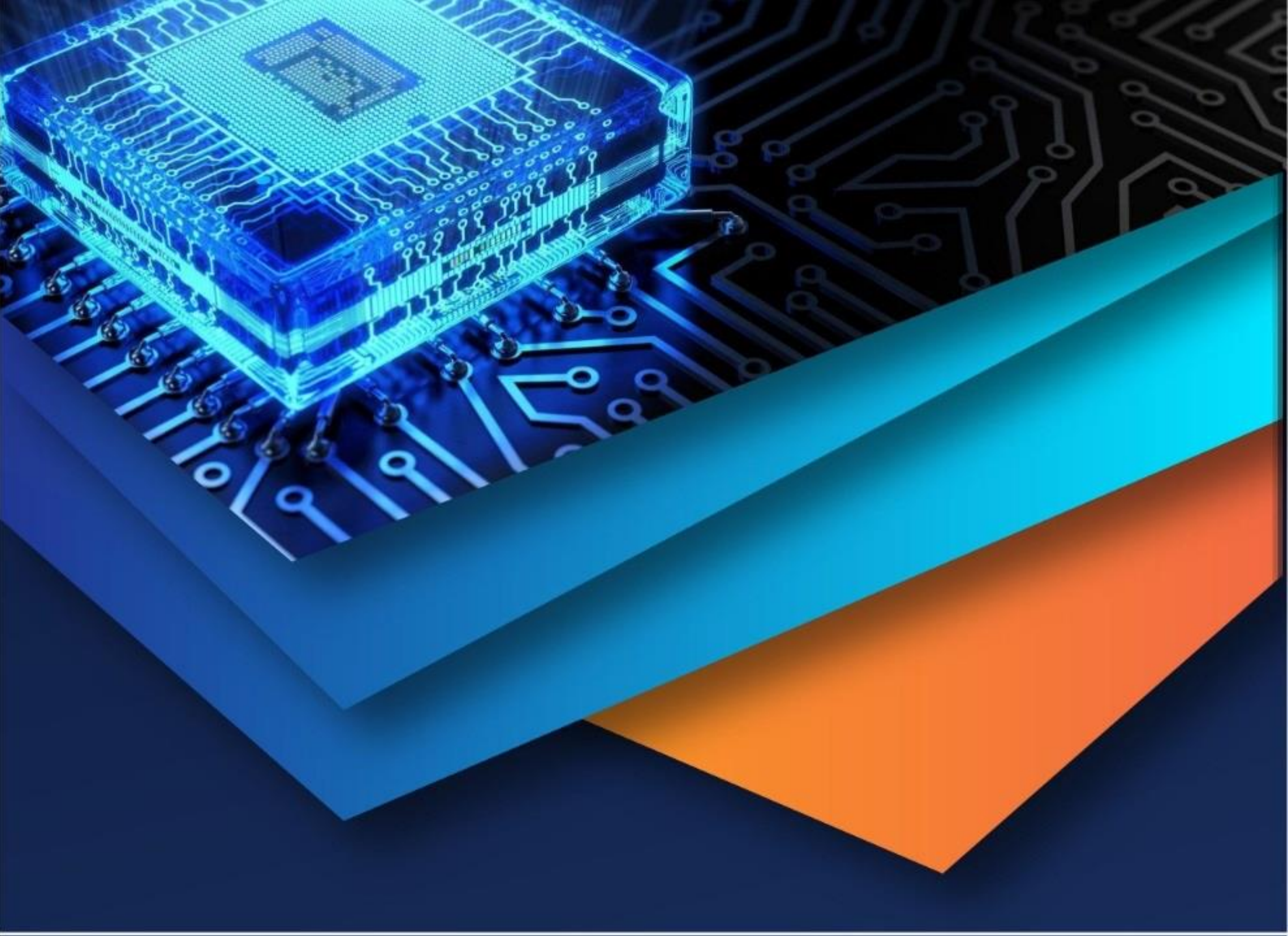
REFERENCES

[1] Simon Babukutty and S.S. Khule, “Combined Dissolved Gas Analysis: A Prescient Methodology for Recognizing Faults in Transformer by MATLAB GUI”, (Volume: 06 Issue: 11), Nov 2019
[2] Y.M.Kim, S.J.Lee, H.D.Seo, J.R.Jung and H.J.Yang, “Development of Dissolved Gas Analysis(DGA) Expert System Using New Diagnostic Algorithm For Oil-immersed Transformers “, IEEE International Conference on Condition Monitoring and Diagnosis.
[3] Sherif S. M. Ghoneim, IEEE Member, Sayed A. Ward, “Dissolved Gas Analysis as a Diagnostic Tools for Early Detection of Transformer Faults”, Advances in Electrical Engineering Systems (AEES), (Vol. 1, No. 3), 2012.
[4] Dawange Manisha Vishnu and Assistant Prof. P.D. Kulkarni, “Analysis of Transformer Oil by Using MATLAB Software”, International Conference Proceeding ICGTETM, Dec 2017
[5] Matlab Guide, “https://in.mathworks.com/help/matlab/creating_guis/about-the-simple-guide-gui-example.html”.



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