MINISTRY OF ELECTRICITY & WATER
Transmission Electrical Network Sector
Primary Substation Maintenance
Department Transformers Section

A Study Report of Transformer no. (1) 300 MVA located in ALAHMADI "W" MVA

Abstract:

Transformer no. (1) Of 300MVA located in ALAHMADI ''W'' is one from the important "26" electrical transformer which is connected to the DGA analyzer in the electrical grid. DGA analyzer triggers a caution alarm in the software, if some of the dissolved gases reached the caution limit in the transformer.

According to the figure (1), there was no concern in the transformer from 6th.October 2020 to approximately 24th.October 2020 in the light green zone. Then it jumped to the yellow zone from 25th.October, 2020. After 28th.October 2020 there was a significant decrease in the transformer index (3) in the yellow zone to transformer index (2) in the light green zone. Therefore, it was stable during the study period from 29th.July 2020 to 1st November 2020. After that it jumped again to the yellow zone during the last study period. This reports will demonstrate all the increase rates reasons of the dissolved gases in the electrical transformer during the study period (5/9/2020-5/11/2020).

Figure (1): Risk index of the transformer under study

Overall DGA Analysis

A nine weeks of the dissolved gases data were analyzed and collected from the DGA analyzer under the study period (5/9/2020-5/11/2020). The data was calculated by the average calculation for each gas for the nine weeks as indicated in table no (1). Basically, if one of the dissolved gases are in the acceptable limits, the DGA analyzer will test the transformer automatically every eight hours and the rate of the sampling will change into every two hours, if the one of the dissolved gases reached the caution limit.

Gases	Value Week1	Value Week2	Value Week3	Value Week4	Value Week5	Value Week6	Value Week7	Value Week8	Value Week9	Expected value week10	unit	L	CL
H_2	48.55	50.50	48.40	51.54	50.19	46.81	46.30	47.12	49.75	174.1	ppm	<50	>150
O_2	59.95	63.26	59.40	67.61	73.60	80.49	81.93	87.96	93.97	328.9	ppm	----------	
CO_2	2235	2231.2	2219.1	2239.9	2235.9	2196	2164.4	2139	2122.4	7428.6	ppm	<3800	>14000
CO	85.90	85.82	85.97	85.70	86.03	86.17	85.72	85.70	85.29	298.5	ppm	<400	>600
C_2H_2	0.163	0.089	0.08	0.06	0.19	0.08	0.11	0.19	0.11	0.39	ppm	<2	>20
C_2H_4	6.63	6.63	6.47	6.46	6.66	6.30	6.30	6.12	6.22	21.7	ppm	<60	>280
C_2H_6	221.03	220.85	222.18	221.42	218.59	223.70	220.1	216.2	217.18	760	ppm	<20	>90
CH_4	44.04	44.28	44.45	44.8	43.78	45.16	45.35	44.45	44.58	156	ppm	<30	>130
H_2O	4.55	4.23	4.07	4.72	4.22	3.3	3.02	2.70	2.55	3.7	ppm	<20	>30

Table (1): Transformer (1) Weekly Data Collected from DGA Analyzer

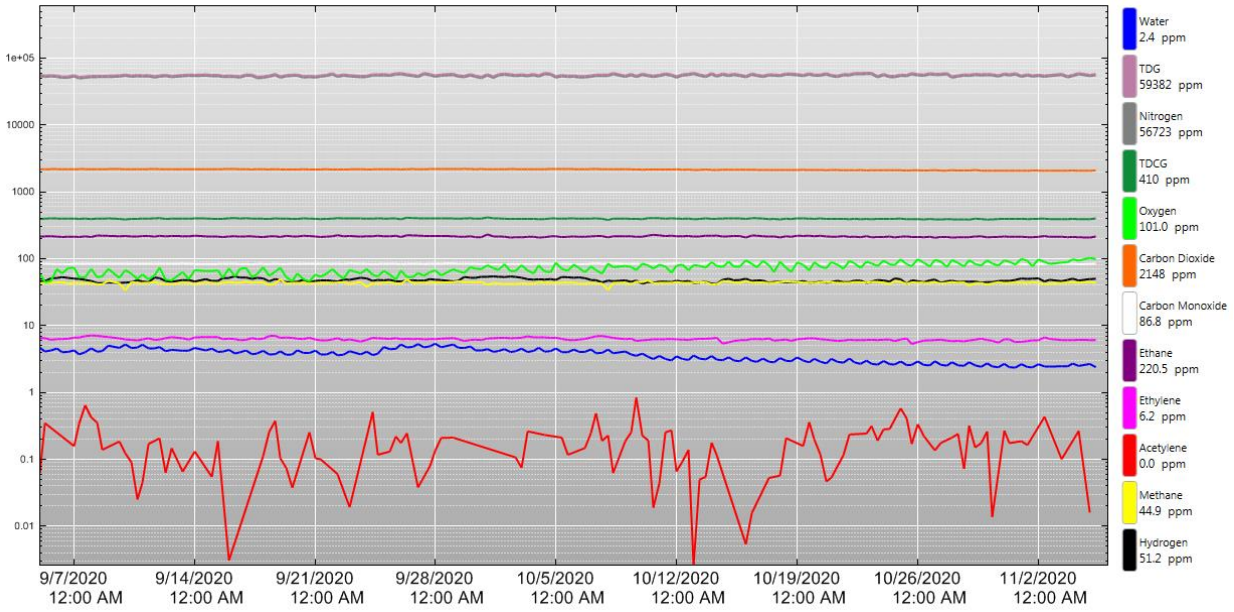

Figure (2): DGA Trend Chart

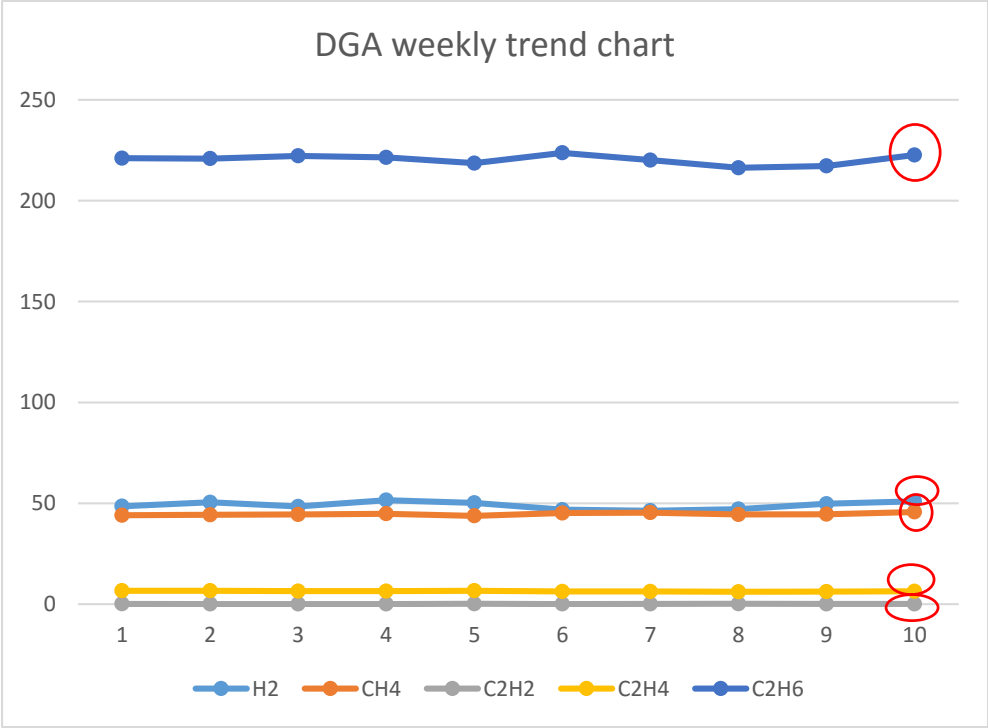

Figure (3): DGA weekly trend chart (key gases)

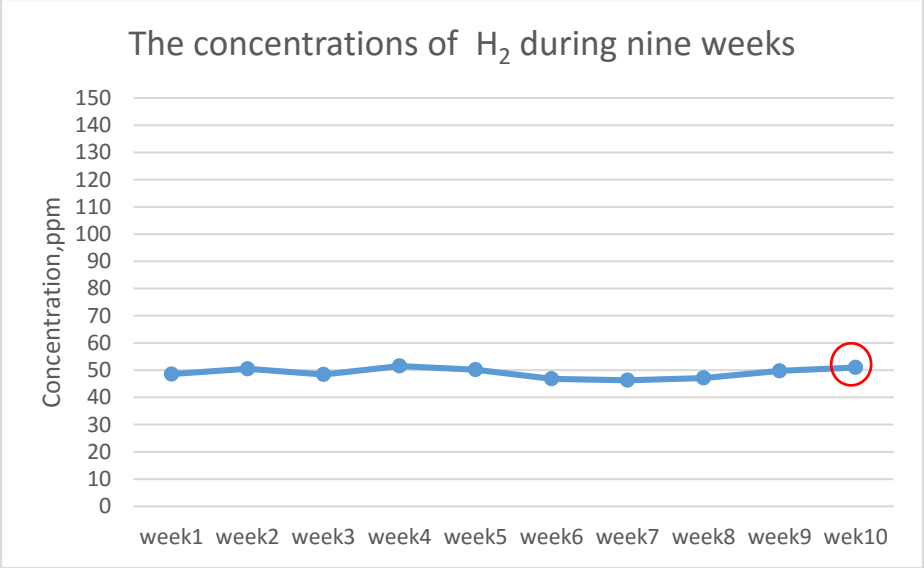

Figure (4): H_2 concentrations

The graph above shows the behavior of Hydrogen gas H_2 during nine weeks. It did not reach the caution limit during the study period (5/9/2020-5/11/2020). The red circle indicates the expected average value for week 10.

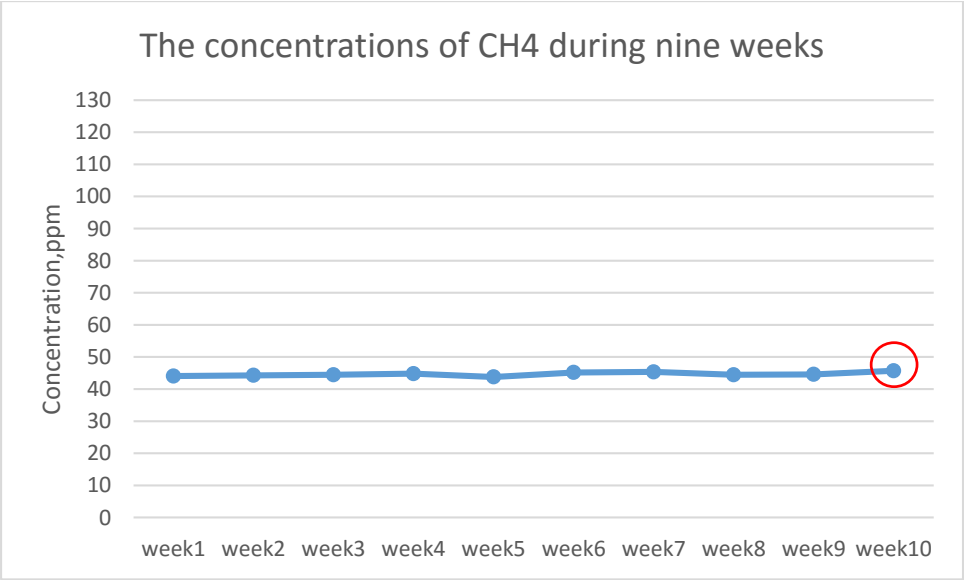

Figure (5): CH_4 Concentrations

The graph above shows the behavior of methane gas CH_4 during nine weeks. It did not reach the caution limit during the study period (5/9/2020-5/11/2020). The red circle indicates the expected average value for week 10.

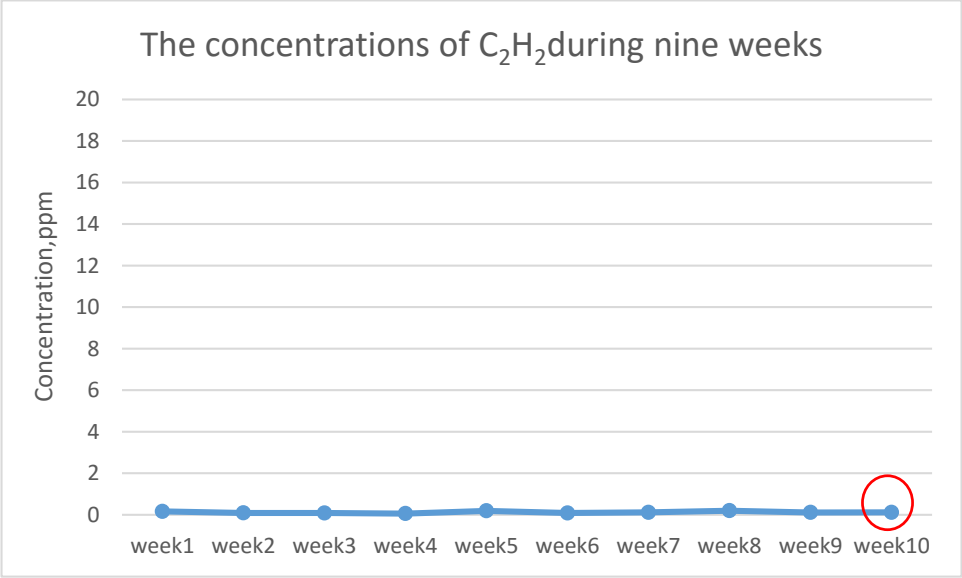

Figure (6): C_2H_2 Concentrations

The graph above shows the behavior of acetylene gas C_2H_2 during nine weeks. It did not reach the caution limit during the study period (5/9/2020-5/11/2020). The red circle indicates the expected average value for week 10.

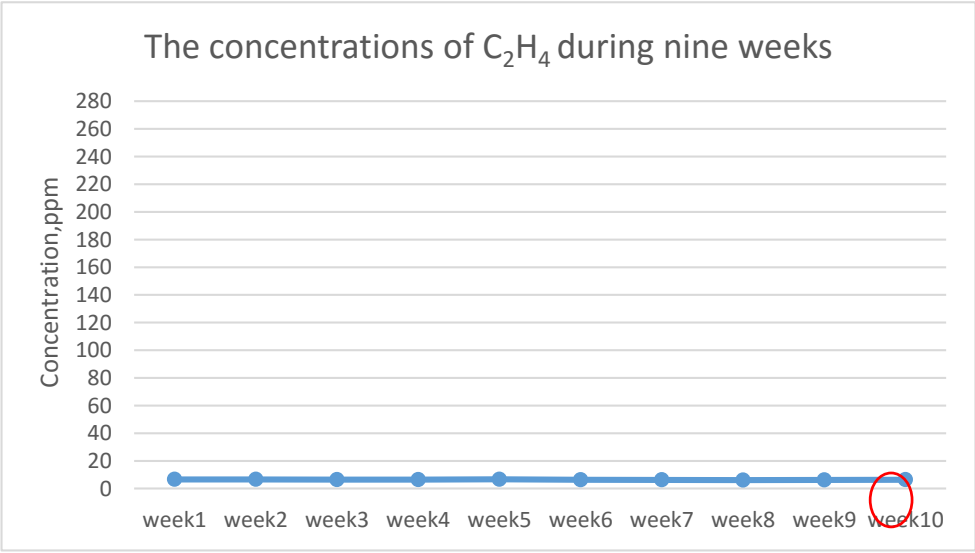

Figure (7): C_2H_4 Concentrations

The graph above shows the behavior of ethylene gas C_2H_4 during nine weeks. It did not reach the caution limit during the study period (5/9/2020-5/11/2020). The red circle indicates the expected average value for week 10.

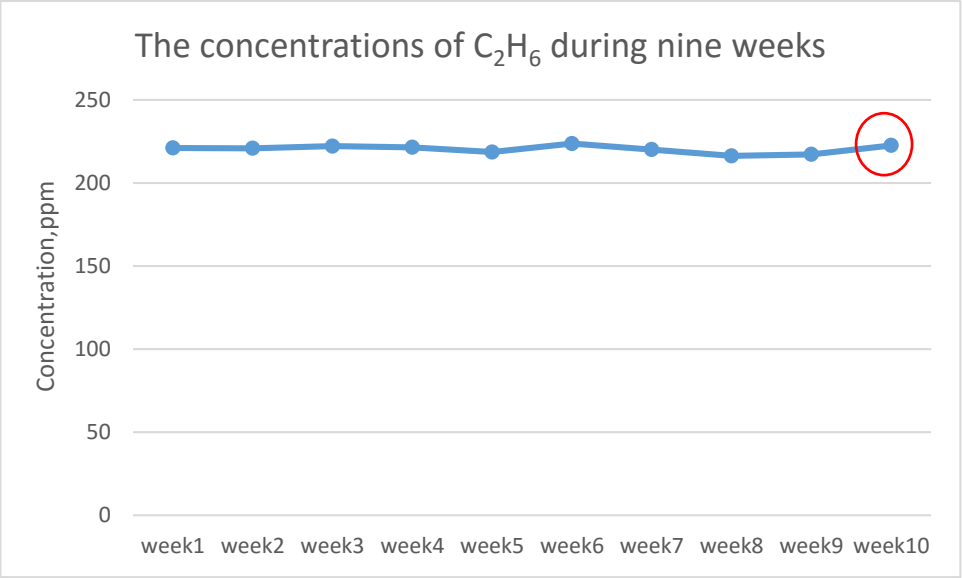

Figure (8): C_2H_6 Concentrations

The graph above shows the behavior of ethane gas C_2H_6 during nine weeks. It reached the caution limit during the whole study period (5/9/2020-5/11/2020) .However, there was a light increase from week5 to week6 (1.27%). The red circle indicates the expected average value for week 10.

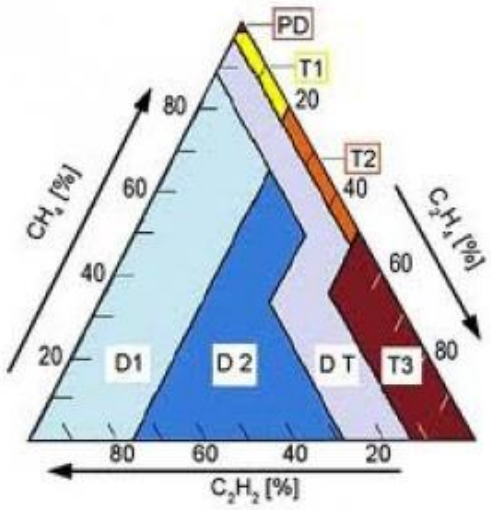

Figure (9): Duval triangle

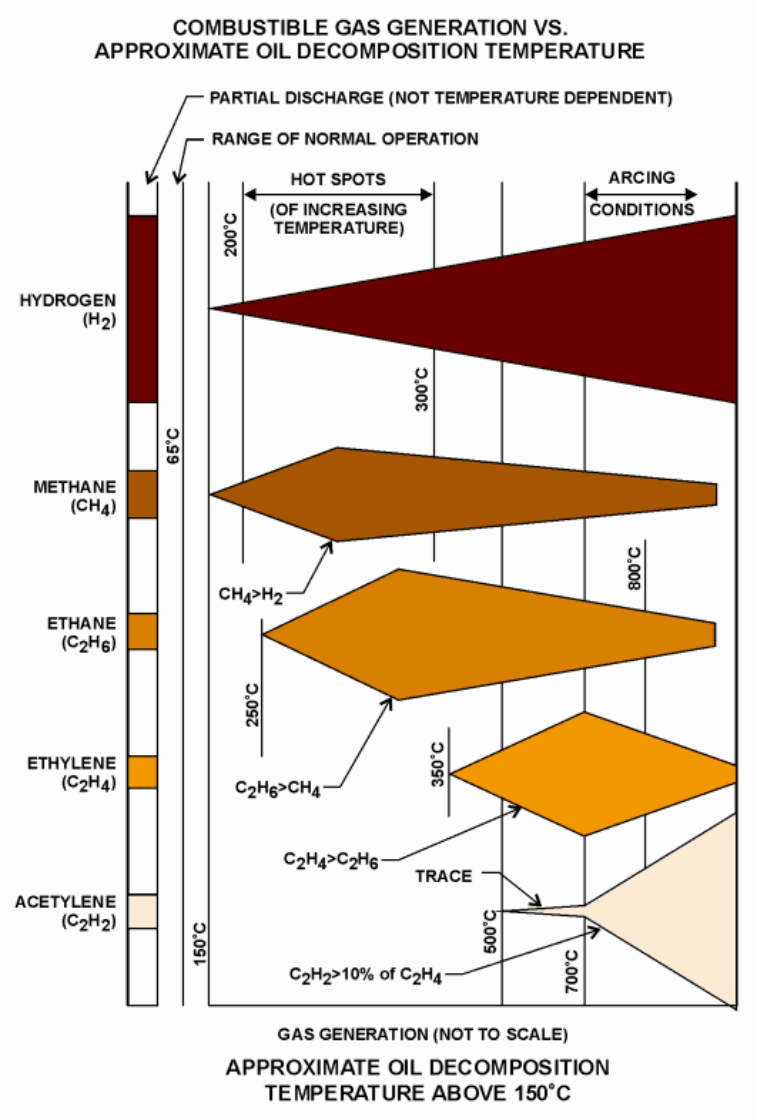

Figure (10): Gas generation chart: Combustible Gas Generation vs. oil Decomposition temperature

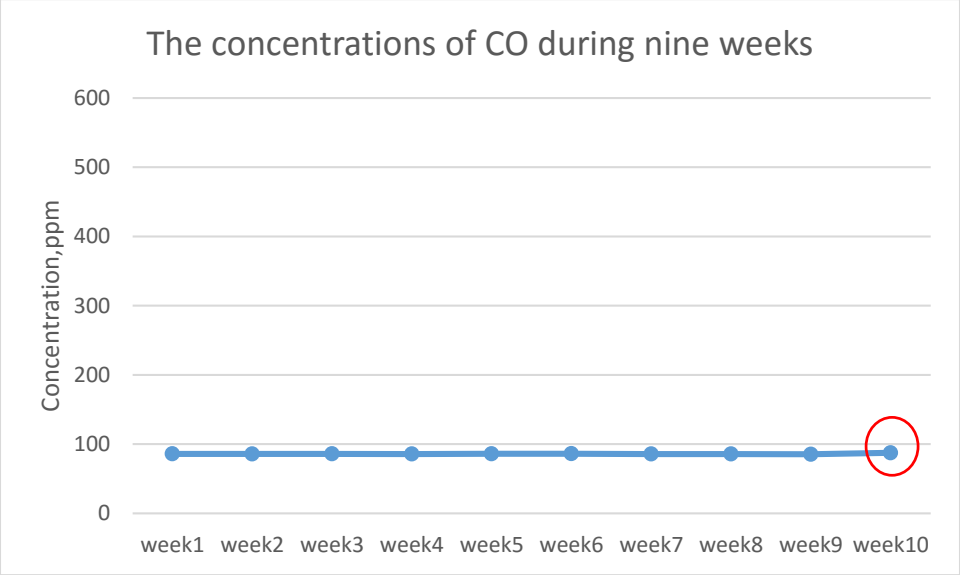

Figure (11): The concentrations of CO

The graph above shows the behavior of carbon monoxide gas CO during nine weeks. It did not reach the caution limit during the study period (5/9/2020-5/11/2020). The red circle indicates the expected average value for week 10.

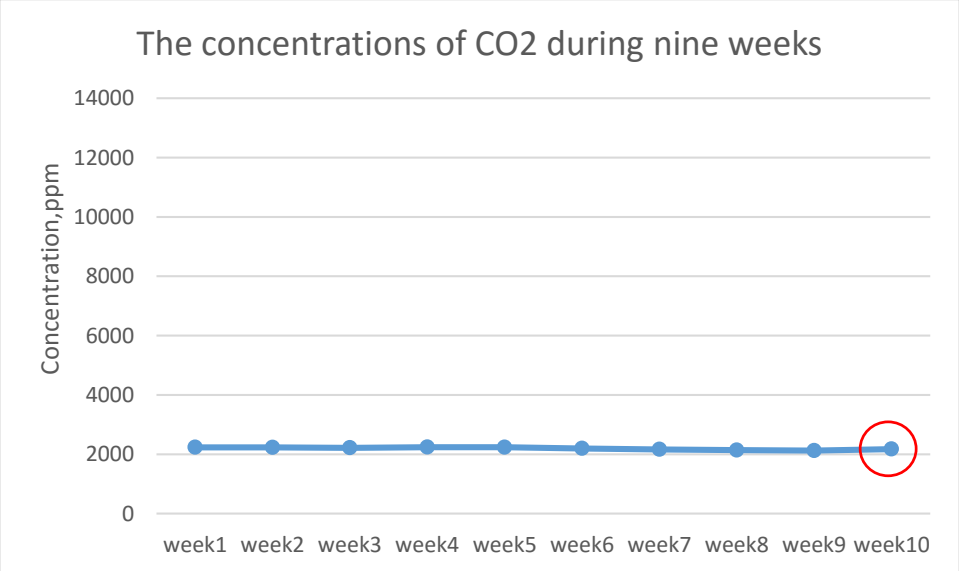

Figure (12): The concentrations of CO_2

The graph above shows the behavior of carbon dioxide gas CO_2 during nine weeks. It did not reach the caution limit during the study period (5/9/2020-5/11/2020). The red circle indicates the average value expected for week10.

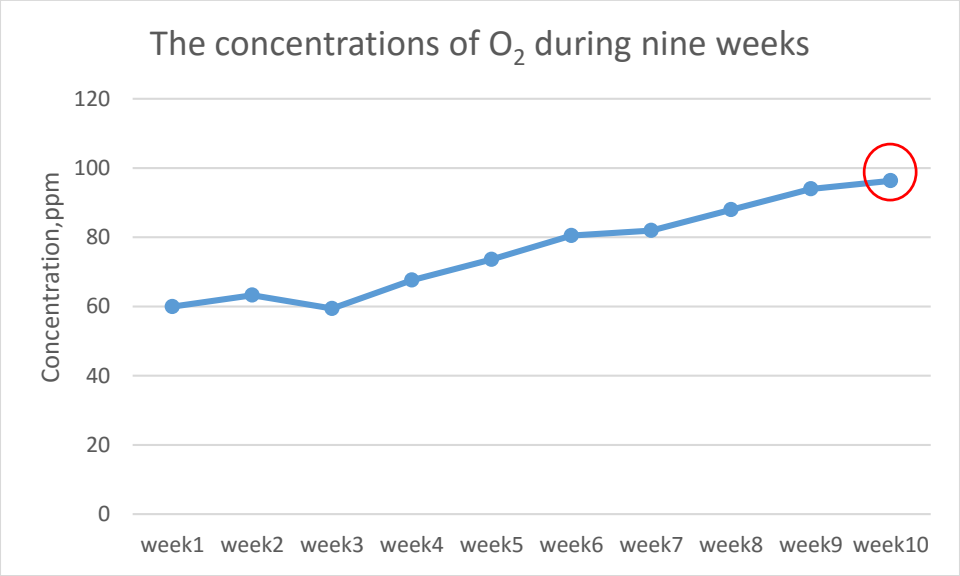

Figure (13): The concentrations of O_2

The graph above shows the behavior of Oxygen gas O_2 during nine weeks. There was a significant increase in gas concentrations of O_2 from week3 to week9. This increase due to leakage. The red circle indicates the expected average value for week 10.

Paper condition

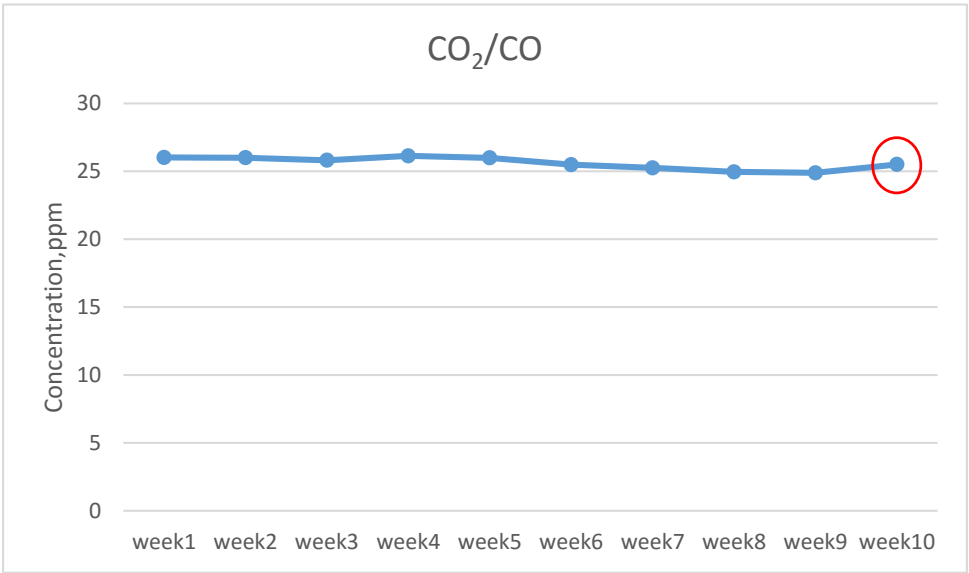

Figure (14): CO_2/CO

The graph above shows the paper condition. There was a very slight decrease from week 5 to week6 then it was constant again during the rest of the study period. The red circle indicates the expected average value for week 10.

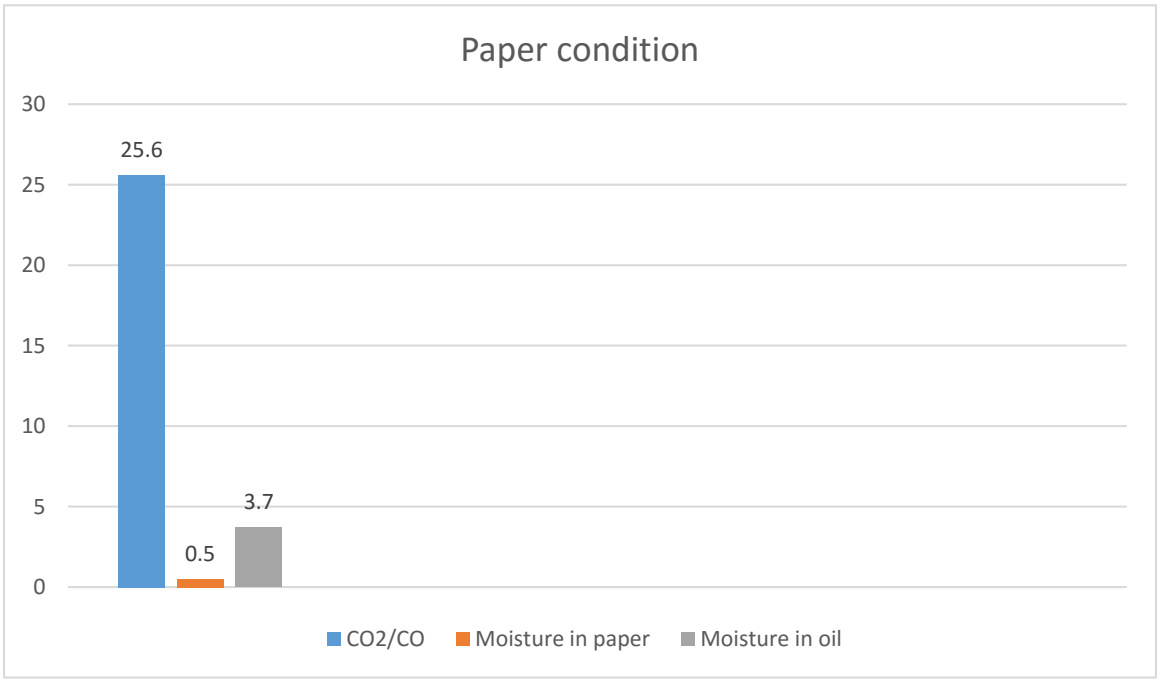

Figure (15): Paper condition chart

Water content

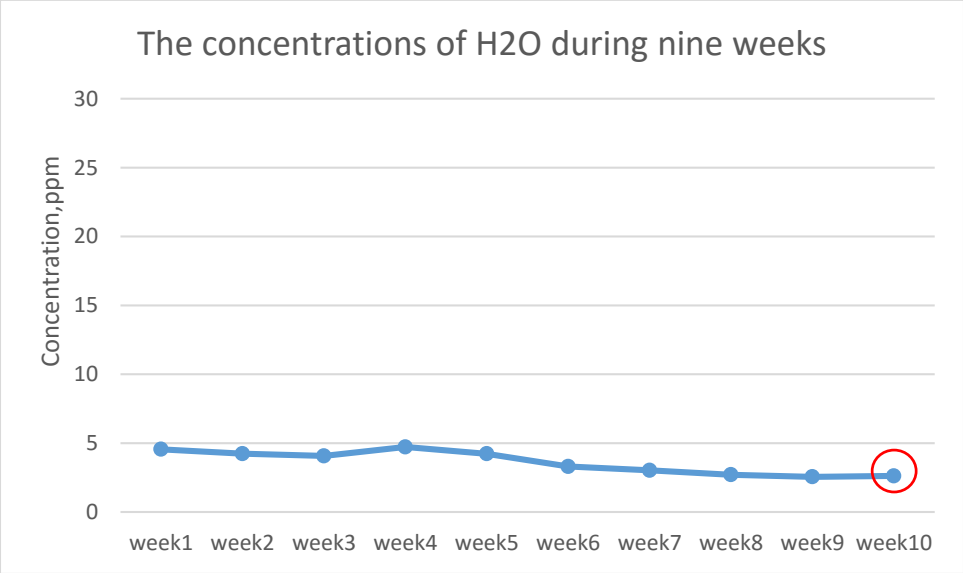

Figure (16): The concentrations of H_2O

The graph above shows the behavior of water H_2O (water content) during nine weeks. It did not reach the caution limit during the study period. However, the water concentration decreased significantly from week4 to the end of the study period. The red circle indicates the expected average value for week 10.

Evaluation

After analyzing the data, there was no concern with all dissolved gases such as Hydrogen H_2, methane gas CH_4, acetylene gas C_2H_2, ethylene C_2H_4 and ethane gas C_2H_6 gas. Nevertheless, Duval triangle in figure (9) is not applied to this case study and also the gas generation chart in figure (10) is also not applied because there was no significant increase with the dissolved gases for all gases but it is applied to the C_2H_6 gas because it reached the caution limit as it shown above in figure (8). This will lead to the thermal stress (overheating inside the transformer). Moreover, there was no concern with carbon monoxide and carbon dioxide (CO& CO_2) as they did not reach the caution limit during the study period. However, the gas concentration of CO_2/CO was not within the range (3-10), it was above 10 and the increase of CO_2/CO was too high. Therefore, there was concern with the paper condition. This will lead to the degradation of insulating paper. There was a significant increase of O_2 gas during study period especially from week 3. This due to leakage in the transformer. The gas concentrations of H_2O did not reach the caution limit. However, there was a significant decrease of H_2O during study period (5/9/2020-5/11/2020) because of the winter season (low temperature).

Recommendation

Continue taking new sample for DGA

Thermal paper degradation

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