

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

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
H₂	48.55	50.50	48.40	51.54	50.19	46.81	46.30	47.12	49.75	50.9	ppm	<50	>150
O₂	59.95	63.26	59.40	67.61	73.60	80.49	81.93	87.96	93.97	96.3	ppm	-----	
CO₂	2235	2231.2	2219.1	2239.9	2235.9	2196	2164.4	2139	2122.4	2175	ppm	<3800	>14000
CO	85.90	85.82	85.97	85.70	86.03	86.17	85.72	85.70	85.29	87.4	ppm	<400	>600
C₂H₂	0.163	0.089	0.08	0.06	0.19	0.08	0.11	0.19	0.11	0.11	ppm	<2	>20
C₂H₄	6.63	6.63	6.47	6.46	6.66	6.30	6.30	6.12	6.22	6.3	ppm	<60	>280
C₂H₆	221.03	220.85	222.18	221.42	218.59	223.70	220.1	216.2	217.18	222	ppm	<20	>90
CH₄	44.04	44.28	44.45	44.8	43.78	45.16	45.35	44.45	44.58	45.6	ppm	<30	>130
H₂O	4.55	4.23	4.07	4.72	4.22	3.3	3.02	2.70	2.55	2.6	ppm	<20	>30

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

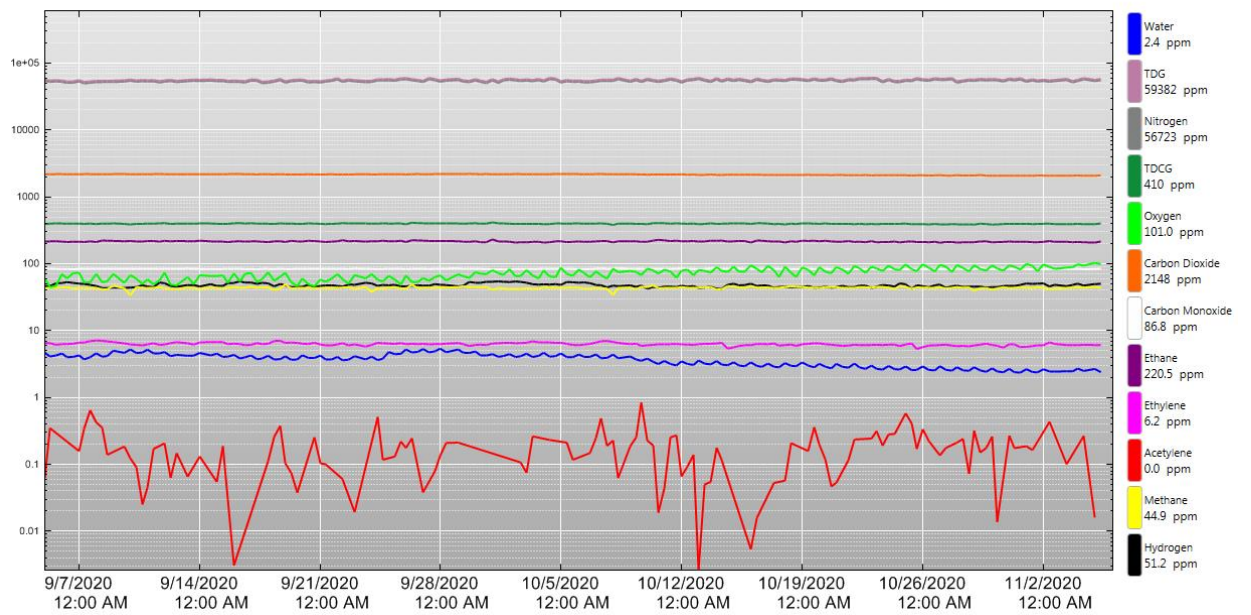


Figure (2): DGA Trend Chart

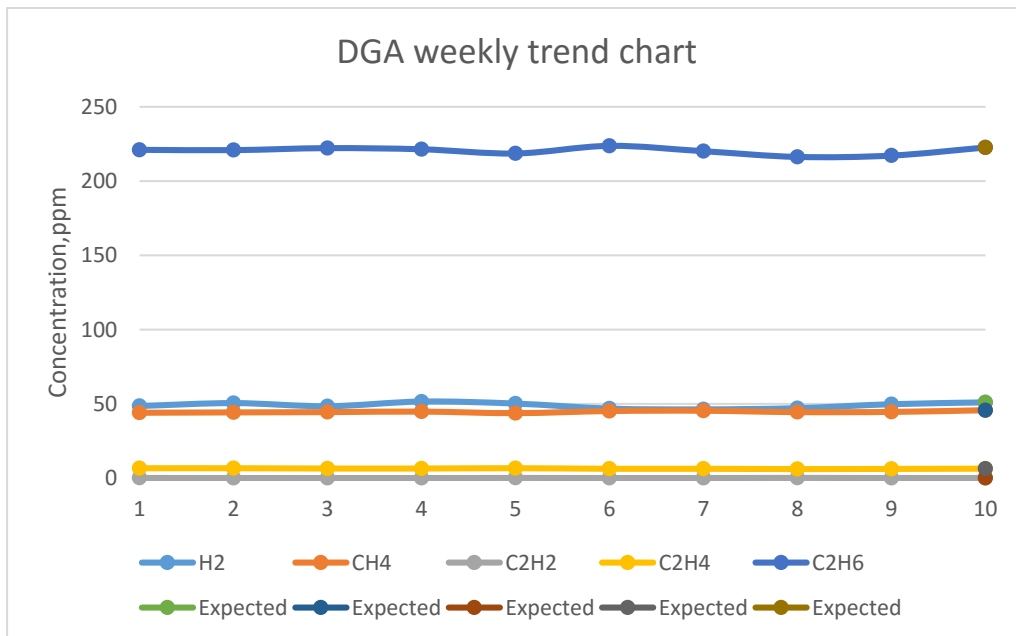


Figure (3): DGA weekly trend chart (key gases)

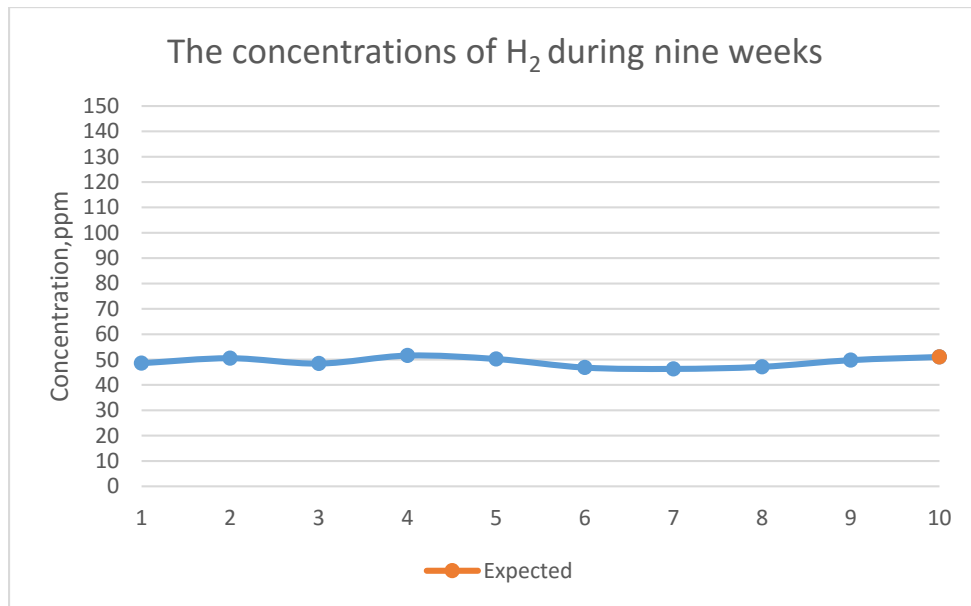


Figure (4): H_2 concentrations

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).

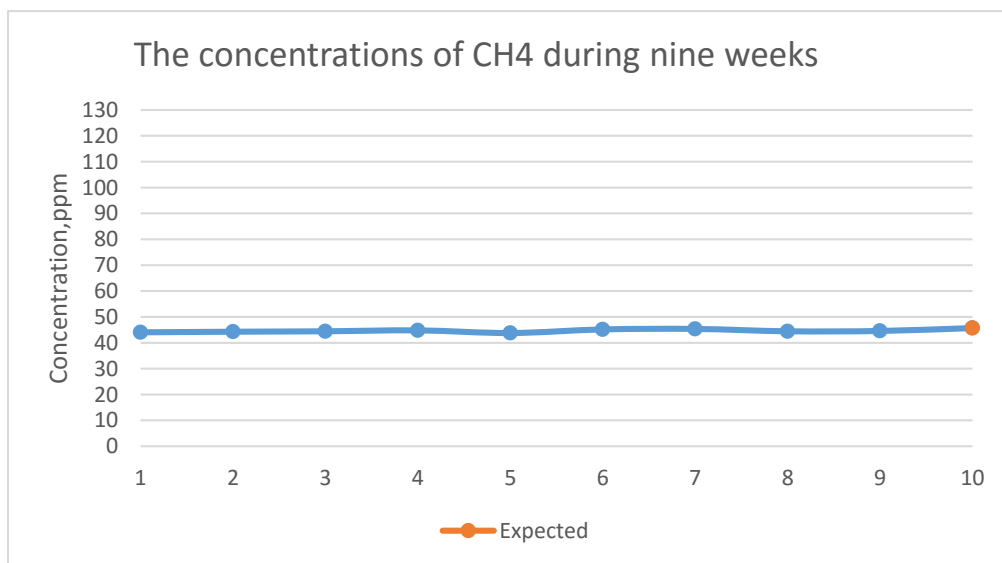


Figure (5): CH_4 Concentrations

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).

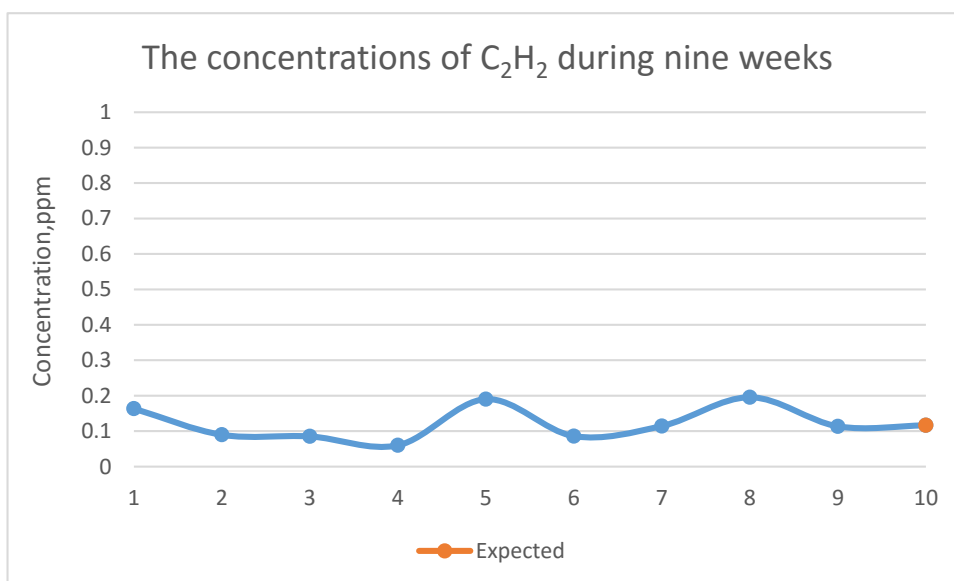


Figure (6): C₂H₂ Concentrations

The graph above shows the behavior of acetylene gas C₂H₂ during nine weeks. There was an increase from week4 to week5 and from week7 to week8 are almost equal to (3.1%). However, it did not reach the caution limit during the study period (5/9/2020-5/11/2020).

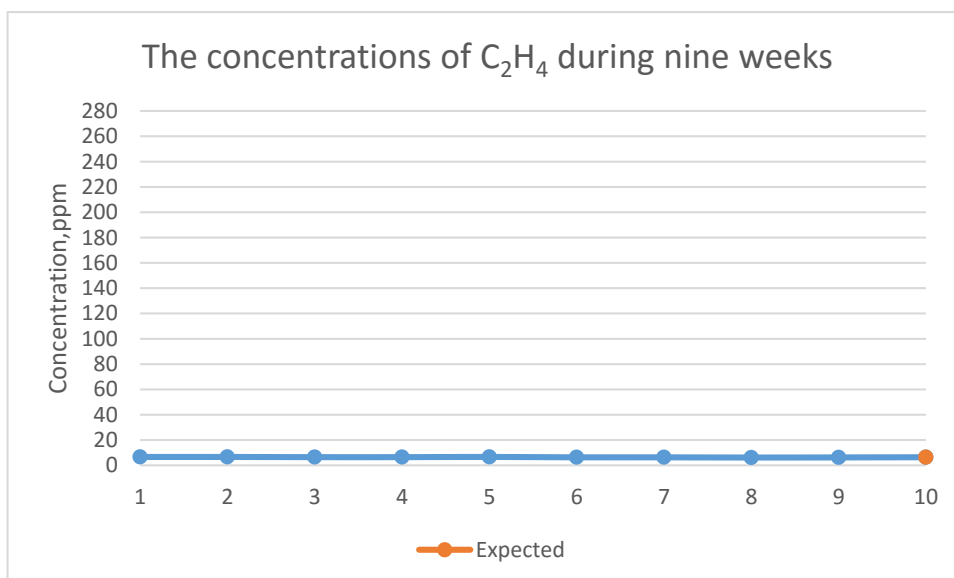


Figure (7): C₂H₄ Concentrations

The graph above shows the behavior of ethylene gas C₂H₄ during nine weeks. It did not reach the caution limit during the study period (5/9/2020-5/11/2020).

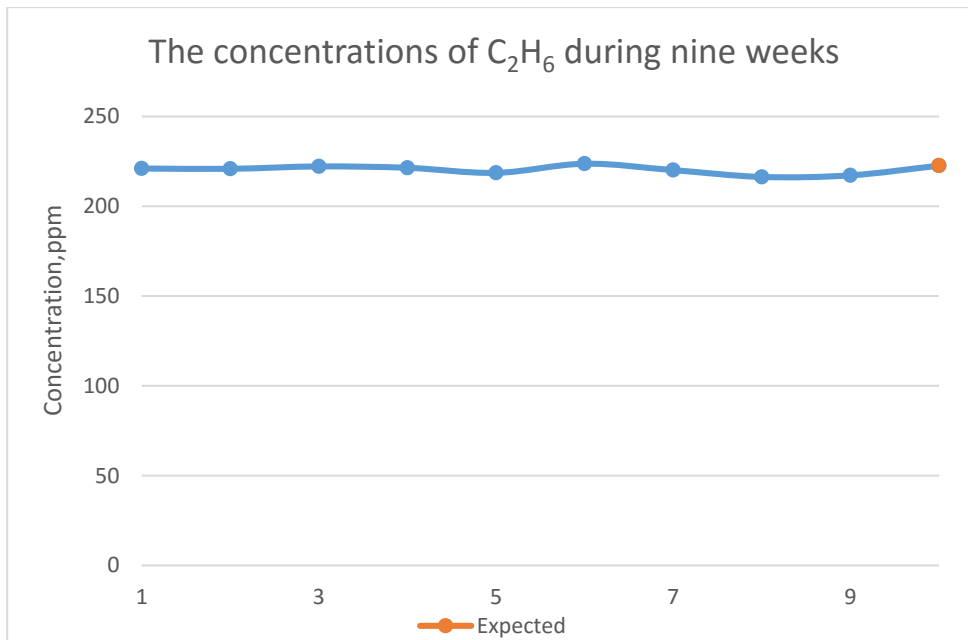


Figure (8): C₂H₆ Concentrations

The graph above shows the behavior of ethane gas C₂H₆ during nine weeks. Although It reached the caution limit (above 90ppm) during the whole study period (5/9/2020-5/11/2020), the increase of the gas is normal because because the transformer is Japanese (Toshiba).

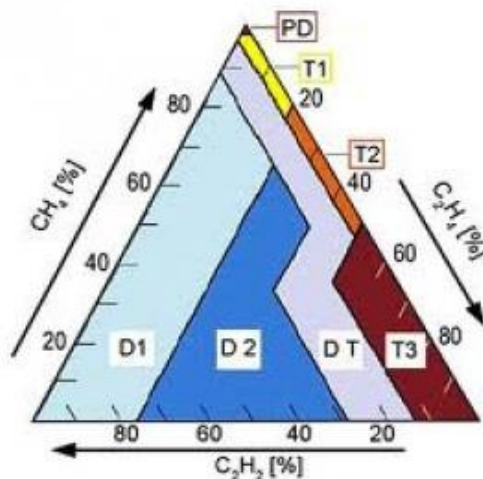


Figure (9): Duval triangle

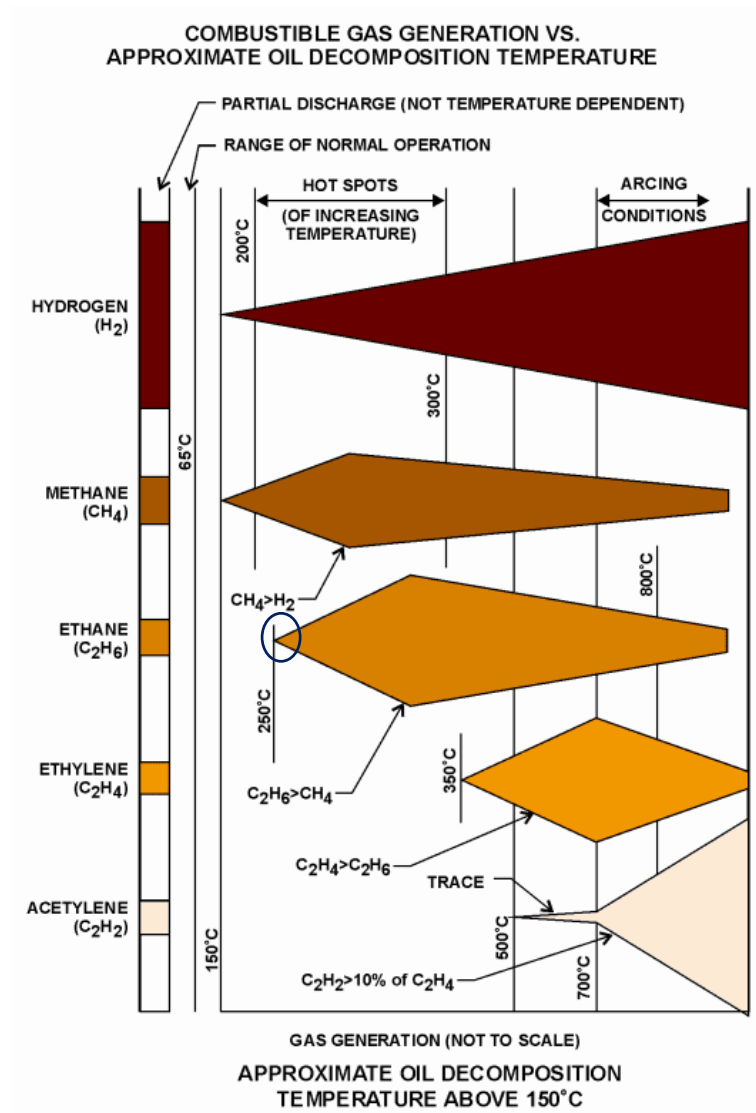


Figure (10): Gas generation chart: Combustible Gas Generation vs. oil Decomposition temperature

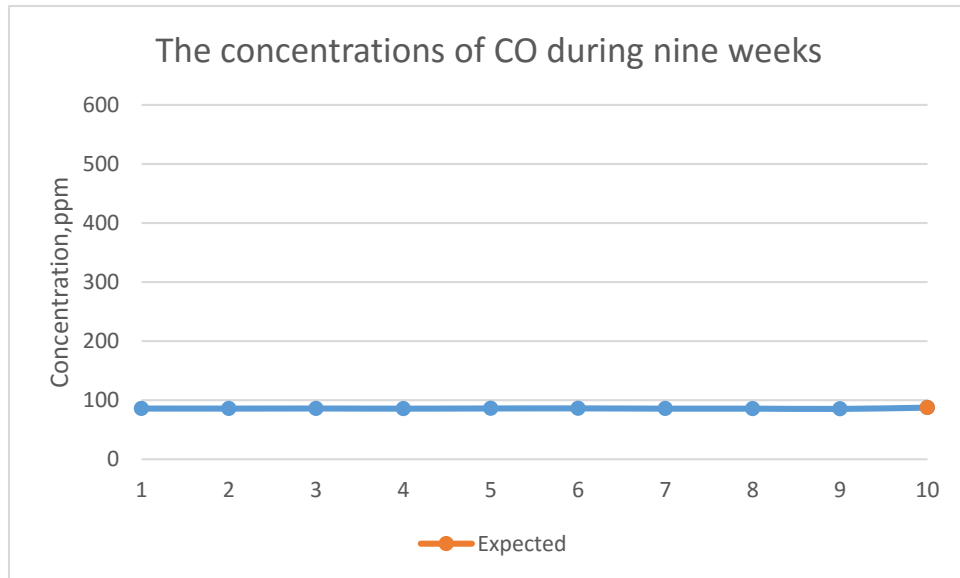


Figure (11): The concentrations of CO

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).

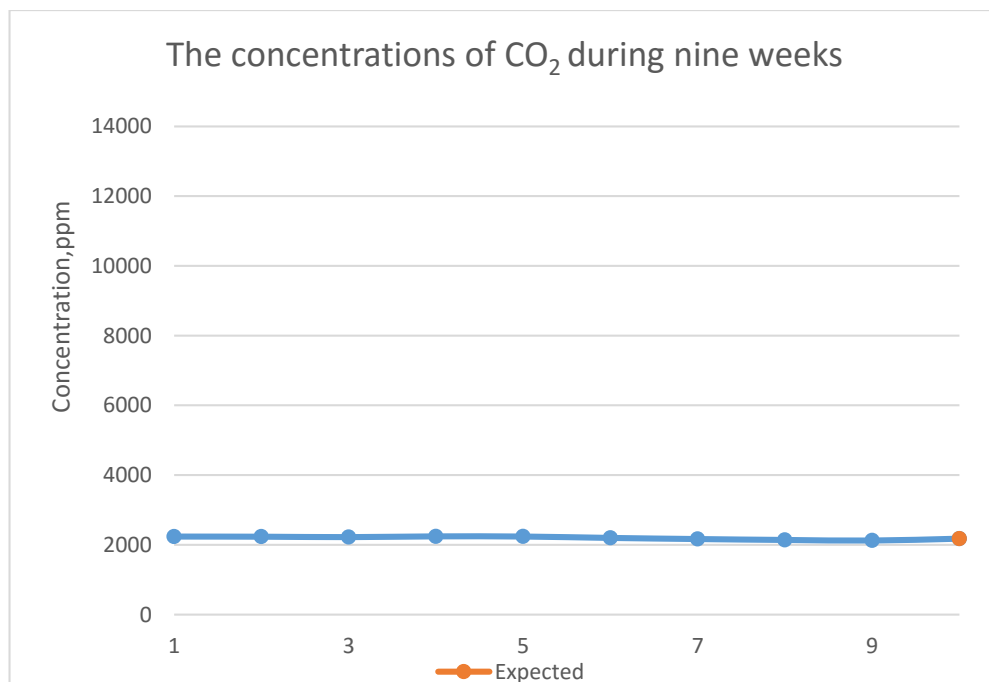


Figure (12): The concentrations of CO₂

The graph above shows the behavior of carbon dioxide gas CO₂ during nine weeks. It did not reach the caution limit during the study period (5/9/2020-5/11/2020).

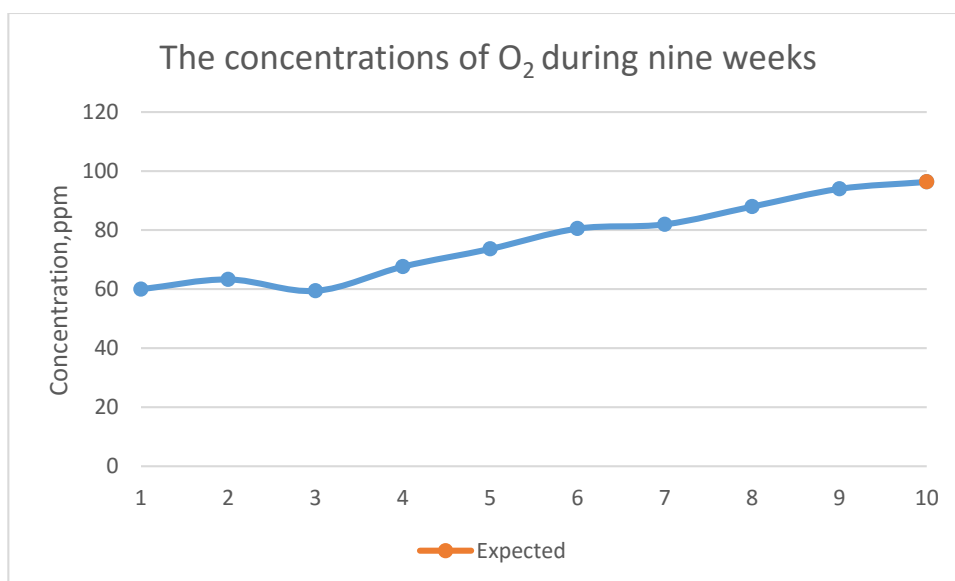


Figure (13): The concentrations of O₂

The graph above shows the behavior of Oxygen gas O₂ during nine weeks. There was a significant increase in gas concentrations of O₂ from week3 to week9 due to the leakage.

Paper condition

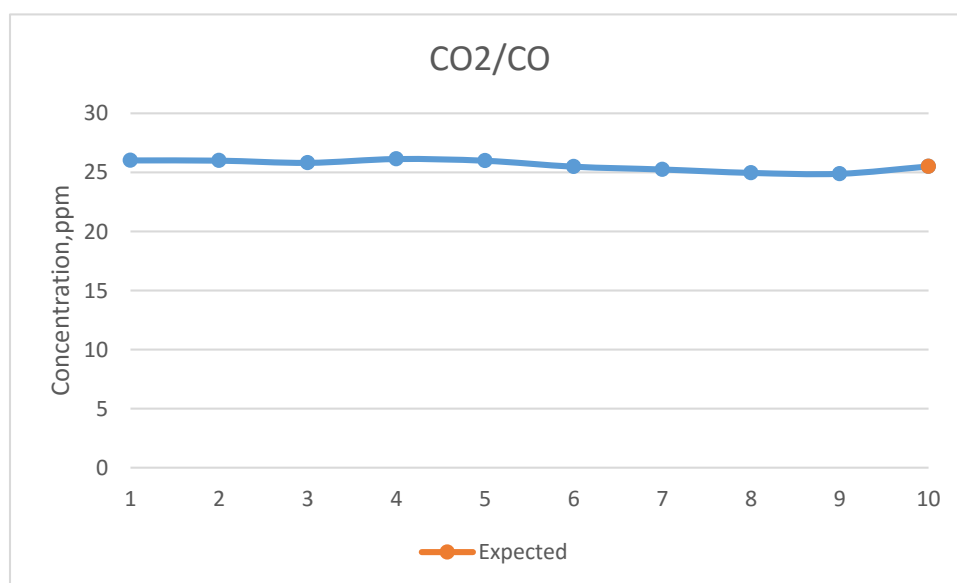


Figure (14): CO₂/CO

The graph above shows the paper condition. There was a very slight decrease from week5 to week6 then it was constant again at the end of the study period.

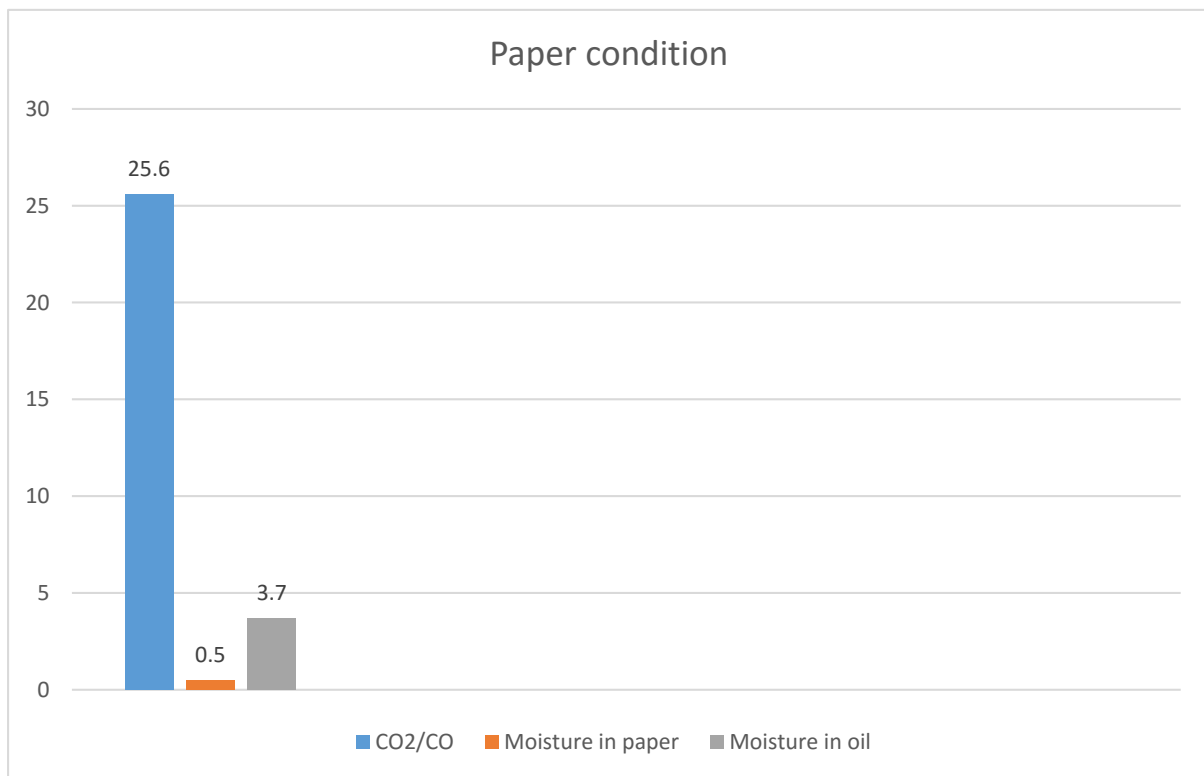


Figure (15): Paper condition chart

Water content

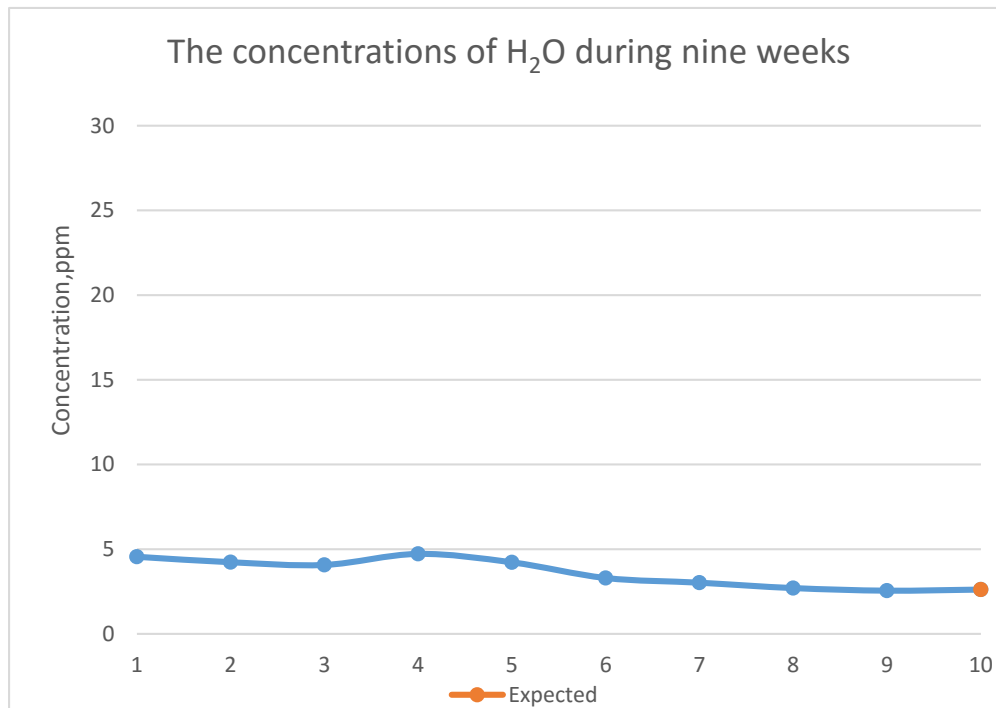


Figure (16): The concentrations of H₂O

The graph above shows the behavior of water H₂O (water content) during nine weeks. It did not reach the caution limit during the study period. However, the water concentration decreased significantly from week 4 to the end of the study period.

Evaluation

After analyzing the data, there was no concern with the dissolved gases such as Hydrogen H_2 , methane CH_4 , acetylene C_2H_2 and ethylene C_2H_4 . However, there was concern with C_2H_6 gas because it reached the caution limit as it shown above in table (1). This leads to the thermal stress (overheating) inside the transformer. With regards to the figure (9)&(10), duval triangle is not applied to this case study because methane CH_4 , acetylene C_2H_2 and ethylene C_2H_4 are in the normal limit. However, gas generation chart is applied to this case study because of the high increase of C_2H_6 gas. According to the figure (11) & (12) 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 normal range (3-10), it was above 10 (25.6%) which is 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 the study period especially from week 3 to the end of the study period. 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 the study period (5/9/2020-5/11/2020) because of the winter season (low temperature).

Recommendation

Continue taking new sample for DGA to stop the high increase rate of the dissolved Gases.

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11.11.2020

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