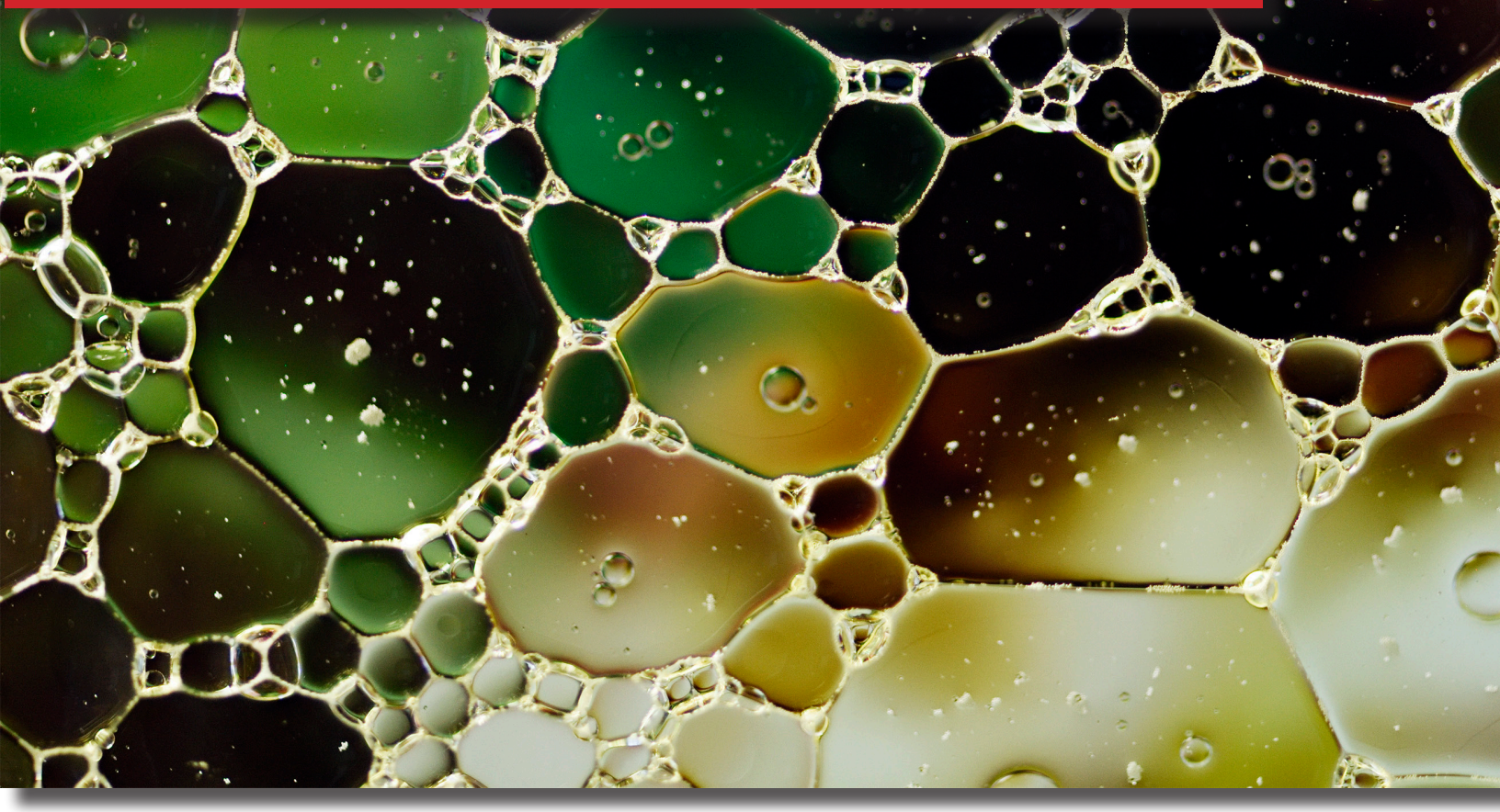
DANI Transformer Oil Gas Analyzer

APPLICATION NOTE - AN169



Introduction

Transformers are electrical devices used for energy transfer by electromagnetic induction between two or more circuits. Large oil filled transformers are found in all power and switching stations, as well as many large buildings.

Like all electrical devices, faults also happen in transformers which may have catastrophic consequences. One failure can cause many problems. A simple fault at the distributing end can cause black-out of power to a large area. The fault can also be very dangerous as the transformers contain large quantity of oil in direct contact with high voltage components. This increases the risk of fire and explosions due to failures.

Different faults are caused by different reasons, which all have different impacts on the power system.

When a fault in a transformer occurs, certain gaseous products appear. The relationship between the amounts of the various compounds and the various types of fault is generally understood, so an early diagnosis by performing a routine TOGA analysis results as a prevention of future failures.

Method and Experimental

This method covers the procedure for extraction and measurement of gases dissolved in electrical insulating oil having a viscosity of 20cSt or less at 40°C, following the ASTM D 3612-C Method.

The gases to be measured include Hydrogen (H_2), Oxygen (O_2), Nitrogen (N_2), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Methane (CH_4), Ethane (C_2H_6), Ethylene (C_2H_4), Acetylene (C_2H_2), Propane (C_3H_8) and Propylene (C_3H_6).

The analytical method consists of the extraction of the dissolved gases by mean of the Headspace sampling technique. A portion of the headspace phase in equilibrium with the oil is sampled and automatically introduced into the Master GC equipped with two detectors and a methanizer. The non-destructive Thermal Conductivity Detector (TCD) is used for the analysis of H_2, N_2 and O_2.

CH_4, CO, CO_2, C_2H_6, C_2H_4, C_2H_2, and are detected through the more sensitive FID and the Methanizer.

A CarboBOND column, specific for CH_4, CO, CO_2, C_3H_2, C_2H_6, or C_3H_8 is located in the GC oven, while a Molsieve column for H_2, O_2 and N_2 is located in the auxiliary oven.

A 6-port valve, also located in the auxiliary oven, switches flows in the different analytical path.

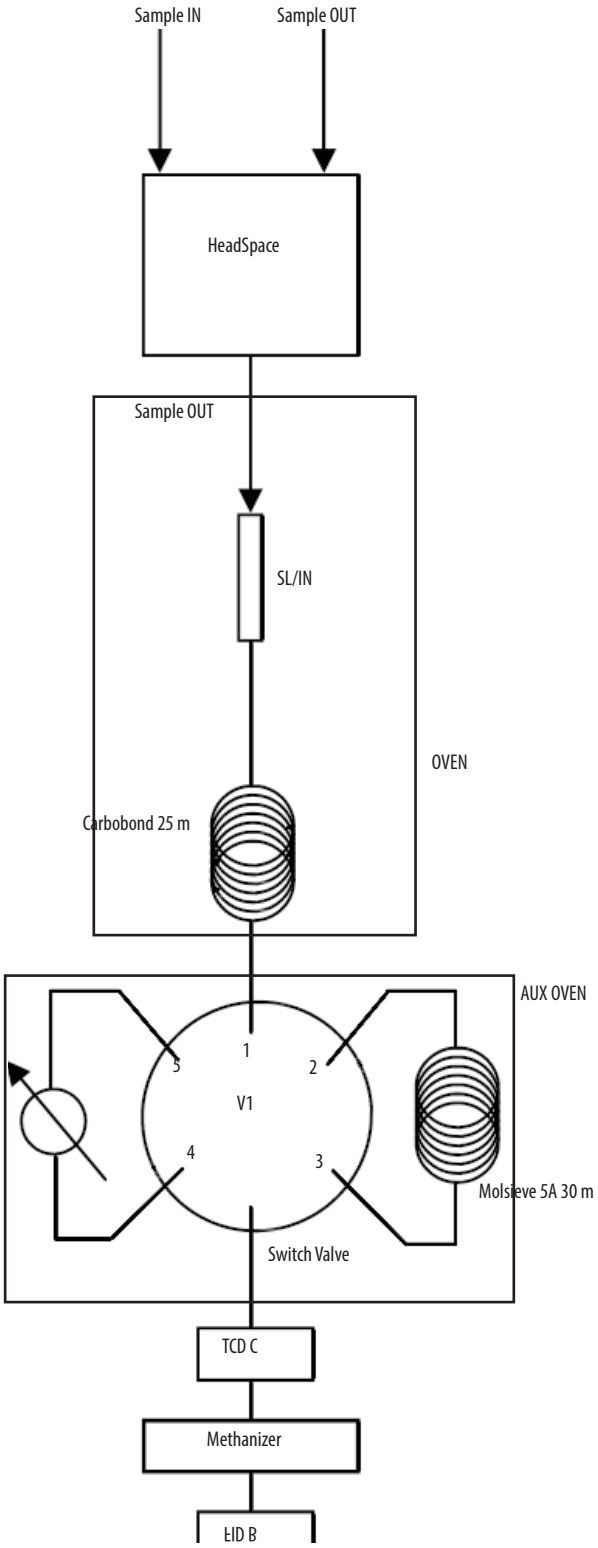


Figure 1: Schematic Diagram of DANI DGA 5 TOGA Analyzer

Master GC	
Oven	@ 5 min from 35°C to 200°C @ 15°C/min
SLIN INj	
Temperature	250°C
Carrier Gas	Argon
Split Ratio	1:1
Flow	10 mL/min
FID detector	
Temperature	300°C
AUX Gas Flow	25 mL/min
H2 Flow	40 mL/min
Air Flow	280 mL/min
AUX gas type	Nitrogen
TCD detector	
Temperature	200°C
Voltage	7 Volt
Polarity	Positive (+)
Max Current	180 mA
Filament Safety	Injector B
Filament Safety	TCD Aux
Auxiliary Temeprature	
Aux Temp 1 - Methanizer	380°C
Aux Temp 2 - Auxiliary Oven	100°C
Auxiliary Pressure	
Aux Gas 2 - Ar CHN 2 TCD	0.70 bar
Aux Gas 1 - H2 methanizer	0.10 bar
Columns	
Column1	CarboBOND (25m, 0.53 mm ID, 10 µm)
Column2	Molsieve 5A (30m, 0.53 mm ID, 15 µm)

Table 2: Master GC Analytical Conditions

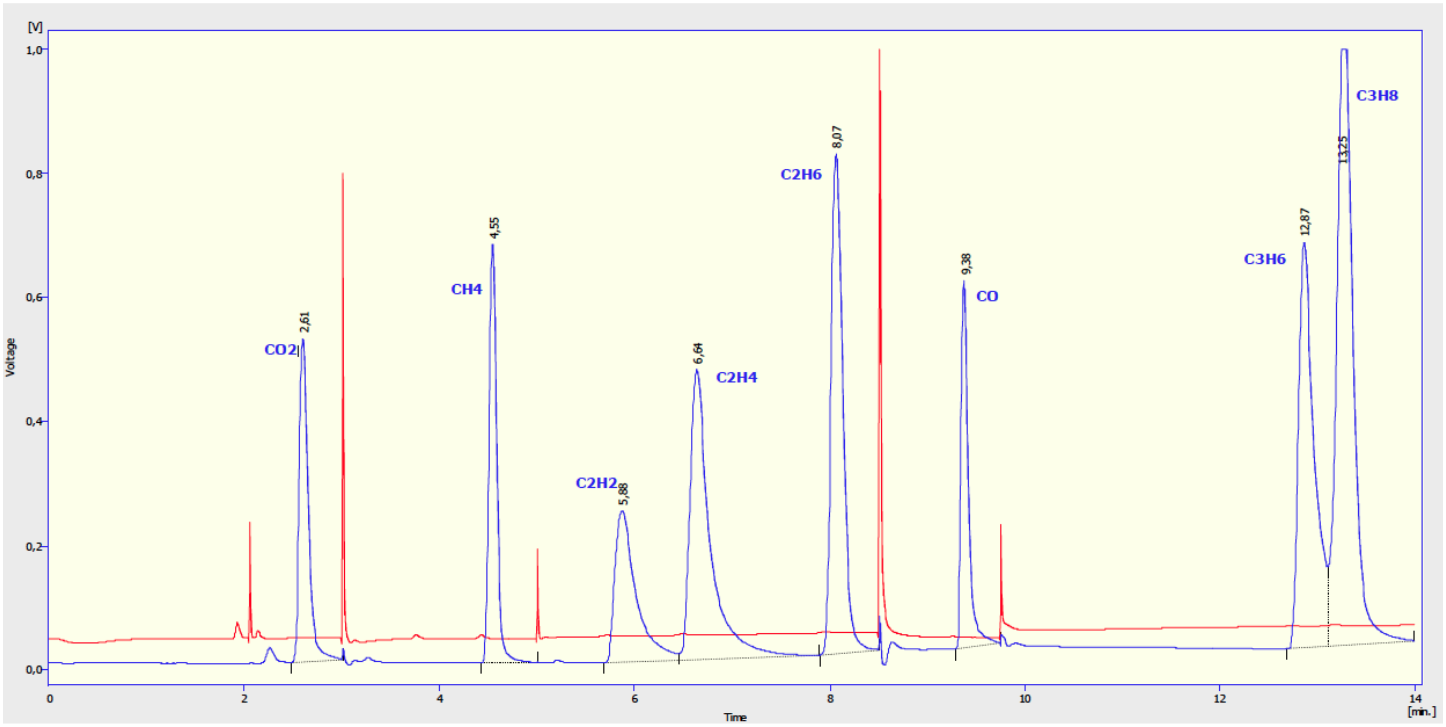
HeadSpace Conditions	
Oven temperature	100° C
Manifold temperature	110° C
Transfer Line temperature	110° C
Pressure Mode	Pressure
Carrier Pressure	0.97 bar (read on GC)
AUX gas Pressure	1.00 bar
Pressure Eq. Time	0.2 min
Vial Equilibration Time	Gas Samples: 2 min - Oil Samples : 30 min
Shaking	YES
Loop Fill Mode	Standard
Loop Fill Time	0.2 min
Loop Eq. Time	0.2 min
Injection Time	0.5 min
Injection Mode	Standard
Vial Venting	ON
Vials Volume	20 mL
Sample Volume	10 mL

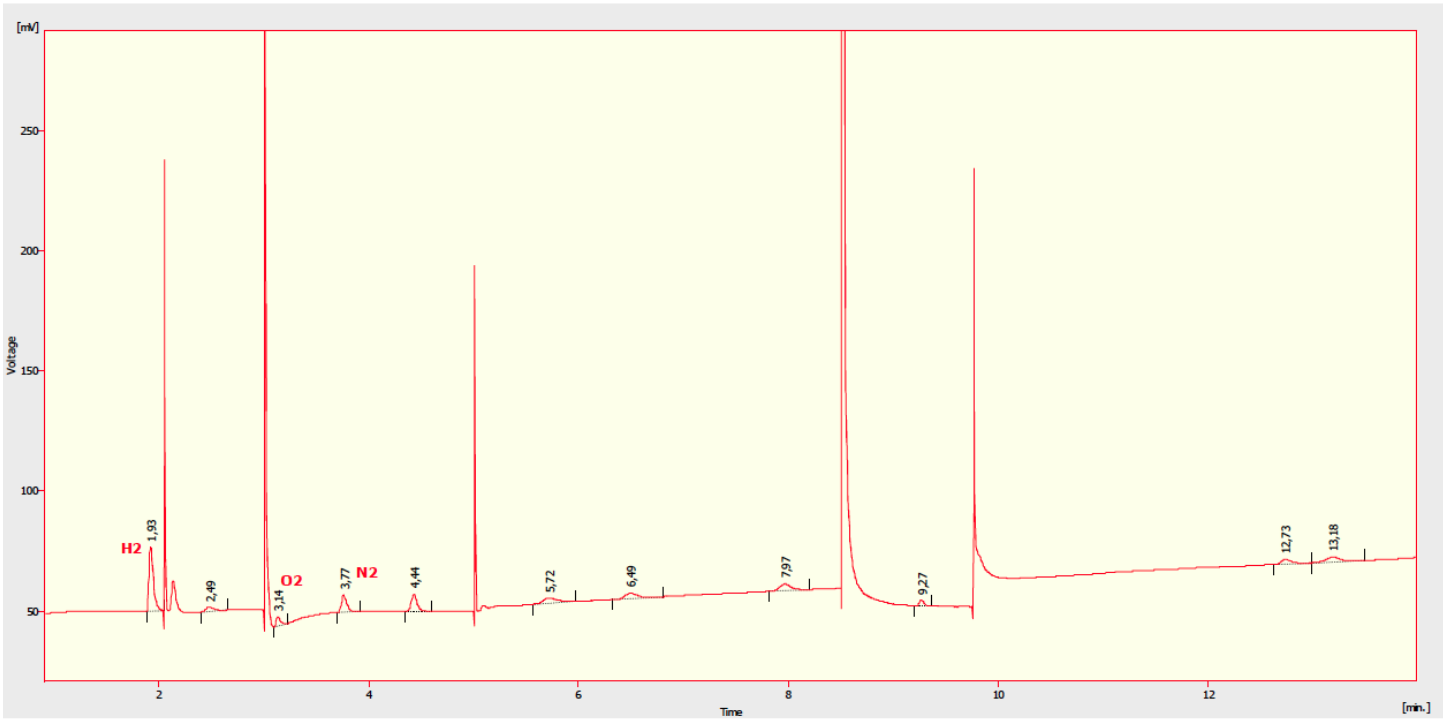
Table 1: Master SHS Analytical Conditions

Oil Standard Mixture (Morgan Schaffer)	
The DANI TOGA Analyzer comes factory-tested. The standard mixture used is composed of:	
H_2	498 ppm*
O_2	16500 ppm
N_2	59100 ppm
CH_4	531 ppm
CO	498 ppm
CO_2	526 ppm
C_2H_4	518 ppm
C_2H_6	506 ppm
C_2H_2	517 ppm

Table 3: Standard Mixture

** milliliters of gas at 273K and 760 torr per cubic meter of oil (+-5%)*





Figures 2 and 3 : FID and TCD chromatograms

CONCLUSION

The DANI TOGA Analyzer, based on DANI Master GC and DANI HS, has been proven to be a pre-configured, fully integrated, tested and guaranteed solution able to meet the ASTM D 3612, Method D requirements.
The system, in fact, performed a fast full separation of all the compounds of interest easily.

REFERENCES

1. ASTM Standard D 3612 - 02 "Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil By Gas Chromatography", Method C. Copyright © ASTM International, West Conshohocken, Pennsylvania, United States.

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