A NOVEL TECHNOLOGY FOR TRANSFORMER OIL GAS ANALYSIS USING A STRIPPER COLUMN (ASTM D3612)

Insulating fluids, generally mineral oils, are used in transformers. Under normal operating conditions, there is very little decomposition. However, occasionally localised or general heating of the oil occurs and decomposition products are formed. If the concentration of these dissolved gases reach a critical point, the chances of catastrophic transformer failure increase.

ASTM D3612 describes in detail three different methods for transformer gas analysis. The three different routes for analysis are vacuum extraction, headspace analysis and stripper column analysis. SCION Instruments have developed a novel technology for the analysis of transformer oil gas analysis (TOGA) via a dual channel stripper column configuration.

Instrumental

The oil sample is introduced to the stripper column via a syringe infusion pump. Any dissolved gases are then extracted from the oil sample by sparging carrier gas through the stripper column. The stripper column contains a high surface area bead and separates target compounds from waste/interfering compounds, which are subsequently being backflushed to vent. The target gases are then flushed from the stripper column onto PoraPlot and Molsieve columns for analysis via both FID and TCD detectors.

The analytical system was calibrated using a low-level reference gas mixture sample. Through the use of a syringe infusion pump, an oil sample was injected via two ten-port valves each equipped with sample loops connected to the stripper columns. One channel is equipped with two molsieve columns using argon as the carrier gas. The column is optimised to separate lighter gases such as hydrogen, oxygen and nitrogen. The other channel is equipped with PoraPlot columns with helium as the carrier gas. This channel is used to separate carbon gases including carbon monoxide and carbon dioxide. The schematic configuration of the TOGA analyser (stripper column configuration) is shown in Figure 1 with the analytical conditions detailed in Table 1.

Results

As can be expected, the results obtained from the stripper column configuration are very similar to the headspace configuration. Figures 2 and 3 show chromatograms for the TCD and FID channels of the TOGA analyser.

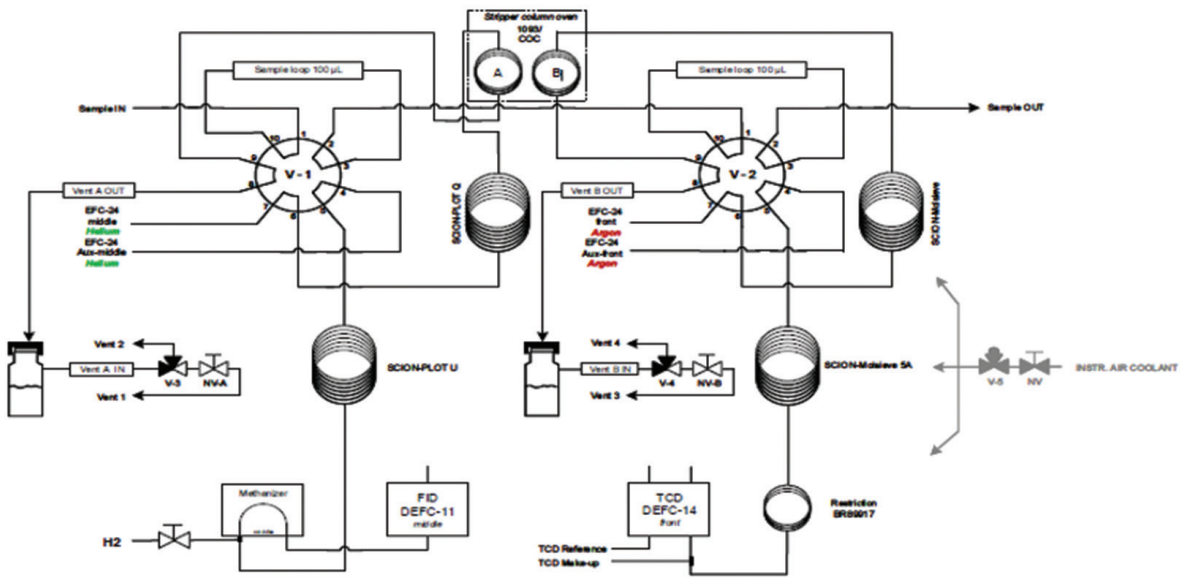

Fig 1. Schematic diagram TOGA analyser with Stripper Column

The lower detection limits (LDLs) of the TCD channel were: hydrogen 4.1ppm, oxygen 32ppm and nitrogen 65ppm (n=20 for LDLs). ASTM D3612 specifies that when using a stripper column configuration, the instrument must be sensitive enough to detect hydrogen at least 20ppm with the atmospheric gases at 500ppm. The Scion TOGA analyser offers greater sensitivity than these minimum requirements.

Repeatability testing was performed using three injections of the same oil sample on both the stripper column analyser and the headspace analyser. A comparison of repeatability values can be found in Table 2.

Repeatability of all components are very similar with all RSD% values meeting specification as required in ASTM D3612. Specification determines that all RSD% values must be <5%.

Table 1. Analytical conditions of the TOGA analyser

Conditions	
Stripper Column Oven	90°C (9 mins), 20°C/min to 120°C (9 mins)
Column 1	SCION PoraPlot 25m x 0.53mm
Column 2	SCION Molsieve 15m x 0.53mm
Oven	25°C (0.1 min), 2°C/min to 30°C (0.5min), 20°C/min to 150°C (8.4 mins), 20°C/min to 25°C (1 min)
Carrier	Helium 35.5 psi, argon 10.4psi
Methaniser	400°C
Detector	TCD 120°C, FID 200°C

Overall, the TOGA analyser as described offers full separation and quantitation of all dissolved gases in transformer oil in compliance with ASTM D3612 specifications.

This novel stripper column technique for TOGA analysis simplifies instrumental configuration by eliminating the headspace sampler. It reduces sample preparation time and cost, is more efficient in both bench space

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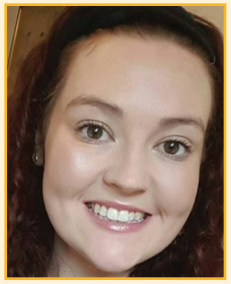

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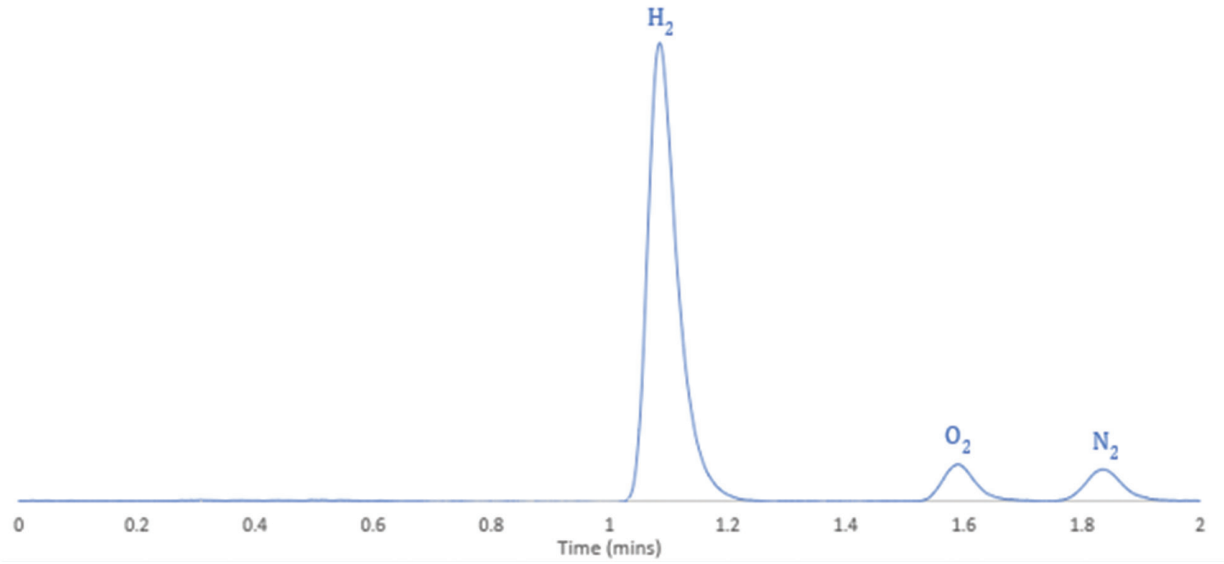

Fig 2. Oil sample; TCD channel

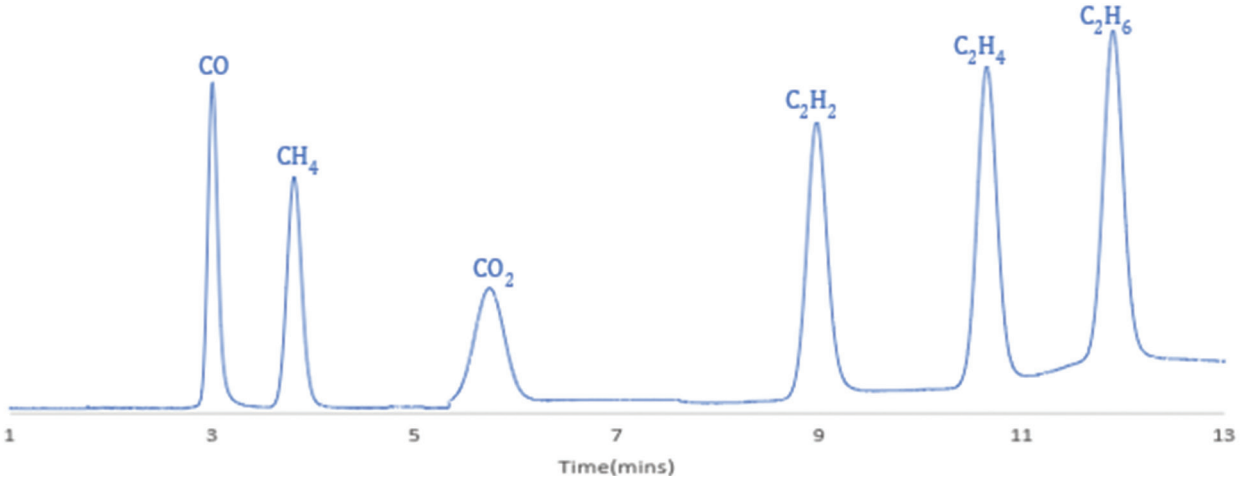

Fig 3. Oil sample; FID channel

Table 2. Comparison of stripper column and headspace TOGA analyser repeatability values (RSD%, n=3)

Instrument	H_2	O_2	N_2	CO	CH_4	CO_2	C2H2	C_2H_4	C_2H_6
Stripper Column	0.37	0.84	0.23	2.02	2.01	0.18	1.52	0.18	0.11
Headspace	0.19	0.99	1.21	0.32	0.26	0.19	0.14	0.31	0.25