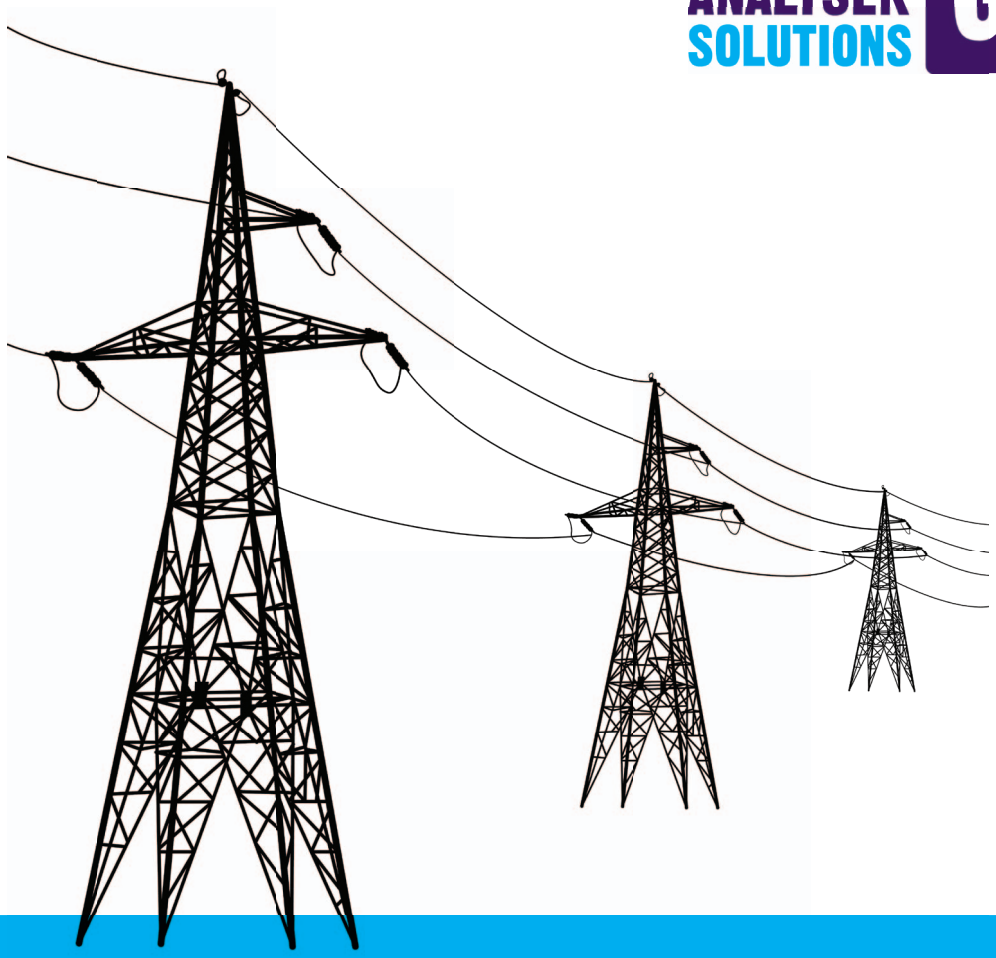
GLOBAL™ ANALYSER SOLUTIONS G·A·S



TOGA

Transformer Oil Gas Analyser

- Fully automated Transformer Oil Gas Analyser
- According to ASTM D3612c
- High uptime due to modular injector/detector technology

AN 211WA0620E

GAS offers custom configured GC analysers for many application fields since 40 years. GAS analysers are designed to meet many standardised methods from GPA, ASTM, UOP, ISO, EN and others. The efficient configurations are based on proven GC technology, resulting in robust instruments with an optimal return on investment.

Transformer oil is a highly refined mineral oil used in electrical transformers. It has excellent insulating properties, suppresses corona and arcing, and serves as a coolant. In case of electrical errors, the oil breaks down to gases, which identity and content can be related to the type and severity of the electrical fault. ASTM D3612c describes extraction and determination of gases in transformer oil based on head space sampling. GAS TOGA is available on Trace GC1300 or CompactGC4.0.

Automated TOGA analysis

Figure 1. TOGA using Trace GC1300 and Versa autosampler

Transformer Oil Gas Analyser - Principle

An aliquot from the vapor phase above a transformer oil sample in a sealed vial is injected using a headspace autosampler. After H_2, O_2, N_2, CH_4 and CO have passed the first separation column (Rt-UBond), these components are isolated on the second column (Molsieve) by switching valve E1. Next CO_2, C_2H_2, C_2H_4 and C_2H_6 elute from the first column via the needle valve (NV) to the detectors. After valve E1 is switched back to the initial position, H_2-CO are detected. When C_3 and C_4 component need to be analysed as well, a valve and separation column is added to the system. CO and CO_2 are converted to CH_4 using a methaniser, enabling sensitive FID detection at ppm level. (See figure 2).

Diaphragm valves and InstantConnect detector technology result in a robust and flexible instrument.

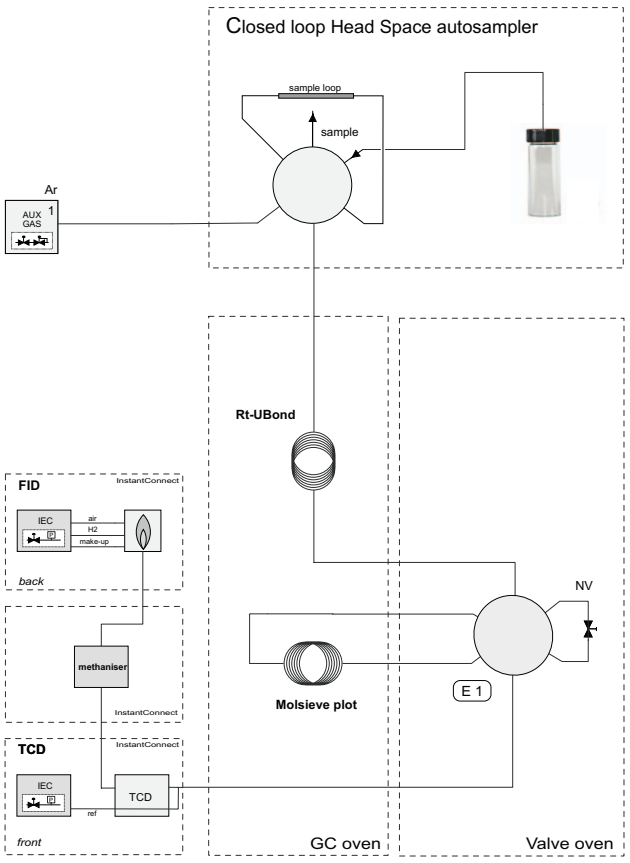


Figure 2. Schematic diagram TOGA

Headspace sampling

Up to 20 oil samples are automatically analysed using Teledyne Tekmar Versa headspace autosampler. This system uses the closed loop injection principle, so loss of components or false results from gases in air are avoided. Each sample is individual equilibrated at 70 °C. The required equilibration time is minimised by using the mixer function of the instrument. Headspace of the oil sample is transferred to the sample loop by pressurising the sample vial (see figure 3, red line). The resulting pressure forces the components to the sample loop, followed by transfer to the GC after switching the 6-port injection valve. For high sample capacity and integrated instrument control by Chromeleon data system, the Thermo Triplus 500 HS autosampler with 120 or 240 sample positions is available (figure 8).

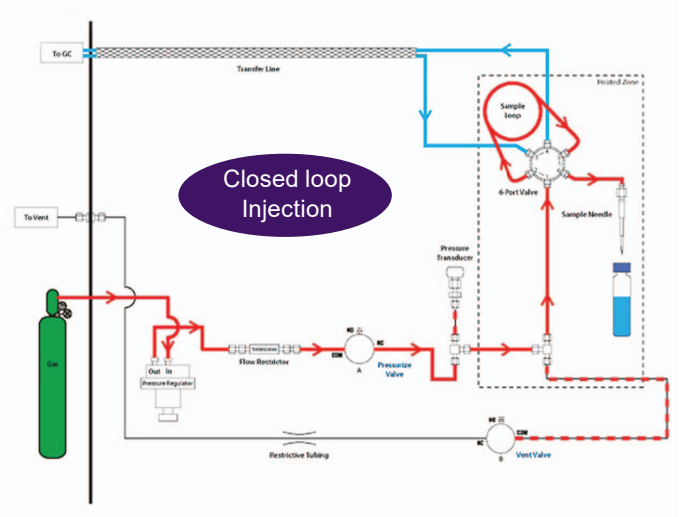


Figure 3. Versa headspace autosampler, vial pressurising phase

Results

Figure 4 and 5 show the results of 10 and 100 ppm dissolved gases in oil standards on FID and TCD. Figure 6 shows achieved Limit Of Detection per component and applied detector.

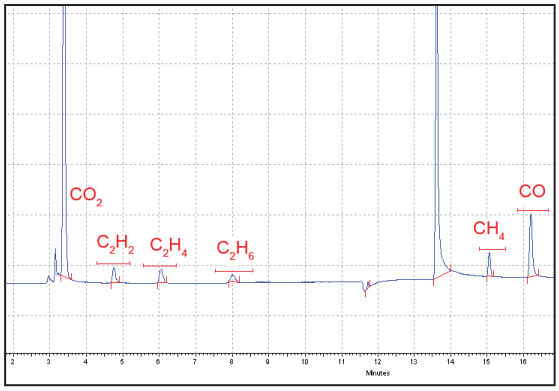


Figure 4. FID,
10 ppm Morgan Schaffer oil standard

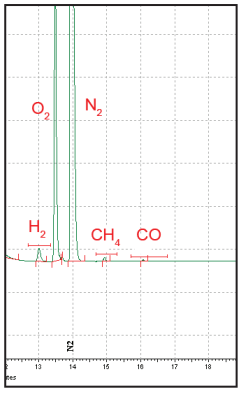


Figure 5. TCD,
100 ppm Morgan Schaffer oil standard

Component	Detection limit GAS (ppm)	Detected on
CO_2	< 1	Methaniser-FID
Acetylene	< 1	FID
Ethylene	< 1	FID
Ethane	< 1	FID
Hydrogen	< 5	TCD
Oxygen	< 100	TCD
Nitrogen	< 100	TCD
Methane	< 1	FID
CO	< 1	Methaniser-FID

Figure 6. LODs TOGA analyser

Small footprint

Figure 7: Small footprint (60 cm width) with TOGA-CompactGC

Full instrument control, 240 samples

Figure 8: Optional Thermo Triplus 500 Head-space autosampler (120/240 sample positions)

Specification

Standard methods: ASTM D3612 part c

Configuration: One channel instrument based on Thermo Trace GC1300 or CompactGC$^{4.0}$,
using microTCD, methaniser and FID.
Automated injection, closed loop principle, using:
- Teledyne Tekmar Versa (20 vials of 22ml) or
- Thermo Triplus 500 (12, 120 or 240 vials of 10, 20 or 22 ml)
Carrier gas: Argon

Application: Custom configured analyser for the analysis of dissolved gases in transformer oil.
Components: H_2, O_2, N_2, CH_4, CO, CO_2, C_2H_2, C_2H_4, C_2H_6. C_3 and C_4 components optional.

Sample requirements: The oil sample must be offered to the analyser using the appropriate 10 or 20/22 sample vials. Vials are purged with Argon before sampling (see optional sample preparation device (figure 9).

Analysis Time: 20 minutes.

Minimum Detectability:

Component	Detection limit GAS (ppm)
CO_2	< 1
Acetylene	< 1
Ethylene	< 1
Ethane	< 1
Hydrogen	< 5
Oxygen	< 100
Nitrogen	< 100
Methane	< 1
CO	< 1

Figure 9. Optional DGA Revolver Table system for TOGA sample preparation

Dynamic Range: 4 decades for TCD, 7 decades for FID.

Repeatability: Better than 5% RSD at 100ppm concentration level for all analytes specified, measured over at least 10 consecutive runs.

Optional: Additional gas sampling valve for injection of gas samples without use of the autosampler
Additonal column and switching valve for C_3/C_4 analysis
DGA Revolver Table system for TOGA sample preparation (figure 9; avoiding air interference)

Data systems: Chromeleon, OpenLab.

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