

Analysis of Greenhouse Gases by Gas Chromatography

Application Note

AN0012

INTRODUCTION

Nitrous Oxide (N₂O), Carbon Dioxide (CO₂) and Methane (CH₄) are considered to be very powerful greenhouse gases. These gases reflect in the atmosphere, stopping the incoming and outgoing radiation that warms the Earth, thus causing the greenhouse effect. Continuously measuring the greenhouse gases gives insight into the source of the emissions, helping us fight climate change. A SCION 456 GC was custom configured specifically for the analysis for all three gases in a single matrix of atmospheric air containing water vapour.

EXPERIMENTAL

A SCION 456 GC was equipped with a gas syringe, PWOC 1041 injector, TCD, ECD and FID detectors. Two channels are used with one equipped to two detectors. After injection on the first channel, CO₂ and CH₄ are separated from the air. The TCD detects the CO₂, configured in series with the TCD, detects the CH₄. The ECD, on the second channel, detects the N₂O once separated from the water. The water is backflushed to vent. Figure 1 shows a schematic drawing of the greenhouse gas analyser.

Four columns are required for the analysis; all being 1/8th inch stainless steel packed columns. Two of the columns were used for the pre-separation of the compounds from the matrix and the final two for the complete separation of compounds. Table 1 shows the role of the columns used within this application.

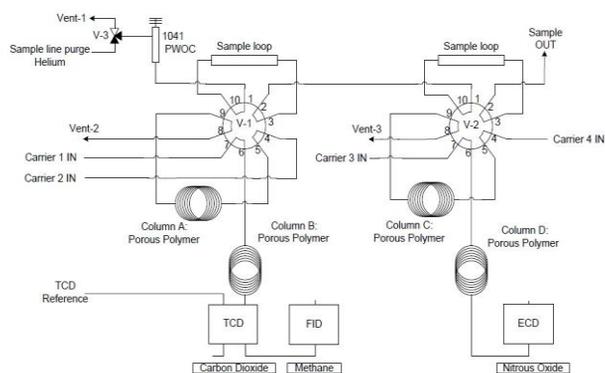


Figure 1. Schematic configuration of the greenhouse gas analyser

Table 1. Analytical requirements of the four columns

Columns	Analytical Requirements
Column A	Pre-separation of CO ₂ and CH ₄ from H ₂ O
Column B	Separates CO ₂ and CH ₄ from O ₂ /N ₂
Column C	Pre-separation of N ₂ O from H ₂ O
Column D	Separation of N ₂ O from O ₂

Table 2 shows the analytical parameters for the greenhouse gas analyser.

Table 2. Analytical parameters

Conditions	
Column A	30.5psi
Column B	17.0psi, 40mL/min
Column C	14.0psi, 40mL/min
Column D	29.0psi, 50mL/min
TCD	Filament 200°C Block 120°C
FID	300°C
ECD	Temperature 300°C Cell: 415mV Make up: 2mL/min
Carrier	TCD/FID: Helium ECD: Argon/Nitrogen
Oven	50°C (isothermal)

RESULTS

The configuration of the analyser allows three simultaneous chromatograms to be obtained. Figure 2 shows the TCD channel chromatogram where CO₂ is analysed. CH₄ is analysed on the FID channel, as shown in Figure 3. Figure 4 shows N₂O when analysed on the ECD channel.

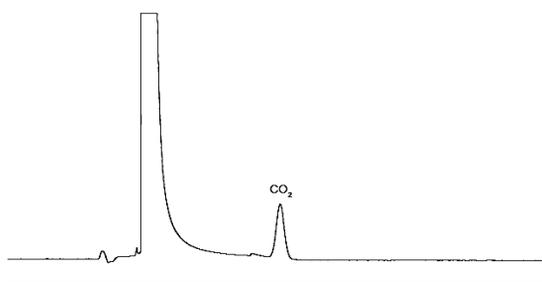


Figure 2. Separation of 1000ppm CO₂ from O₂ and N₂.

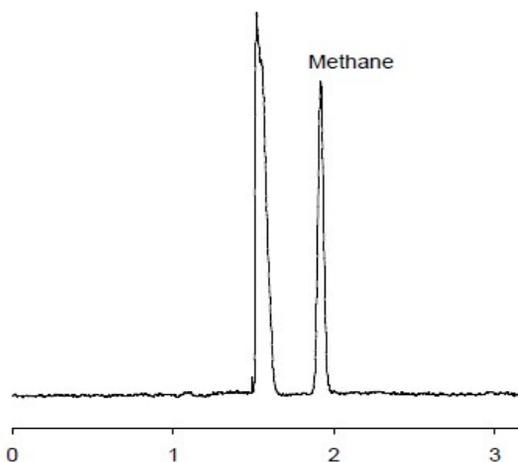


Figure 3. Separation of 5ppm CH₄ from O₂ and N₂

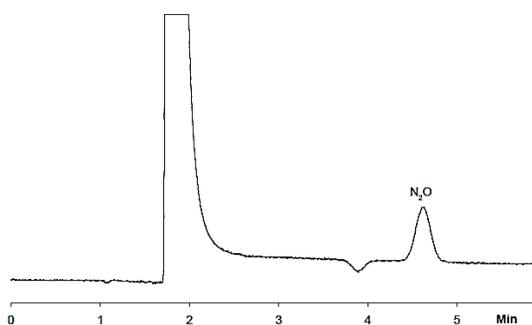


Figure 4. Separation of 1ppm N₂O from bulk O₂

The system suitability and repeatability were tested through a test sample being analysed with ten replicates. Table 3 details the repeatability data. The repeatability data was excellent with an RSD below 2% for all analytes.

Table 3. Repeatability data on peak area

Run	CO ₂	CH ₄	N ₂ O
1	13451	2947	900
2	13472	2986	913
3	13477	2928	935
4	13497	2961	929
5	13450	2933	916
6	13482	2996	922
7	13547	2974	875
8	13508	2972	901
9	13535	2967	904
10	13390	2982	904
Average	13481	2965	910
Std. Dev	45.31	22.51	17.07
RSD%	0.34	0.76	1.88

The configuration of the analyser also allows for expansion of N₂O to CFC's and SF₆. Figure 5 shows the extended ECD channel for SF₆ analysis.

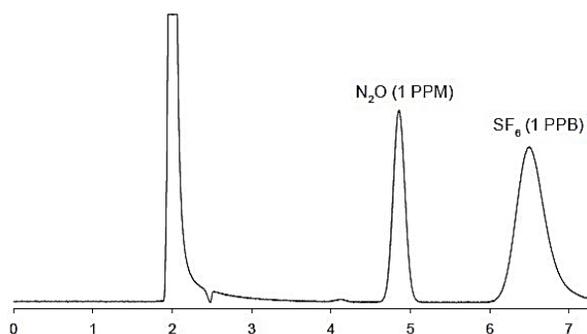


Figure 5. Separation of 1ppb SF₆ from N₂O

CONCLUSION

A SCION 456 GC was configured as a greenhouse gas analyser for the analysis of carbon dioxide, methane and nitrous oxide in a single run. Repeatability data was excellent showing that the system is perfectly suited for the analysis of greenhouse gases. This system is highly flexible with the application range easily expanded to cover CFC's and SF₆.