BEYOND MEASURE

SCION INSTRUMENTS

# Analysis of Greenhouse Gases by Gas Chromatography

## Application Note

AN0012

## INTRODUCTION

Nitrous Oxide ($N_2O$), Carbon Dioxide ($CO_2$) and Methane ($CH_4$) 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, $CO_2$ and $CH_4$ are separated from the air. The TCD detects the $CO_2$, configured in series with the TCD, detects the $CH_4$. The ECD, on the second channel, detects the $N_2O$ 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 1/8$^{th}$ 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.

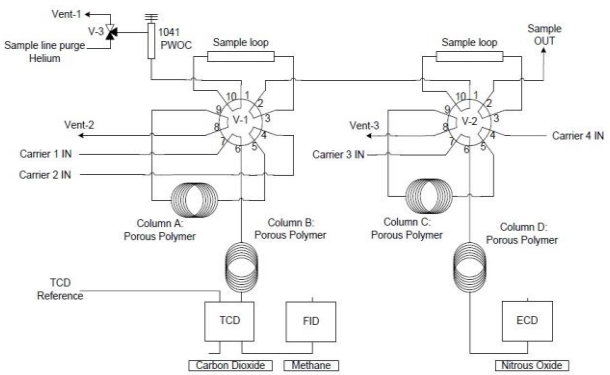


**Figure 1**. Schematic configuration of the greenhouse gas analyser

**Table 1.** Analytical requirements of the four columns

| Columns | Analytical Requirements |
|---|---|
| Column A | Pre-separation of $CO_2$ and $CH_4$ from $H_2O$ |
| Column B | Separates $CO_2$ and $CH_4$ from $O_2/N_2$ |
| Column C | Pre-separation of $N_2O$ from $H_2O$ |
| Column D | Separation of $N_2O$ 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<br>Block 120°C |
| FID | 300°C |
| ECD | Temperature 300°C<br>Cell: 415mV<br>Make up: 2mL/min |
| Carrier | TCD/FID: Helium<br>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 $CO_2$ is analysed. $CH_4$ is analysed on the FID channel, as shown in Figure 3. Figure 4 shows $N_2O$ when analysed on the ECD channel.

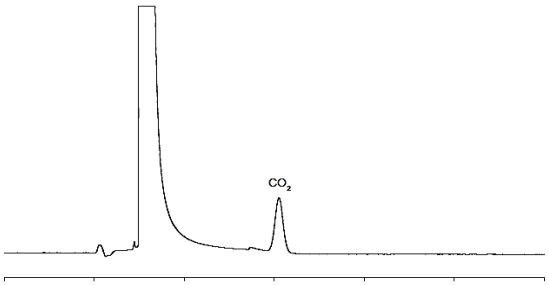


**Figure 2**. Separation of 1000ppm CO2 from O2 and N2.

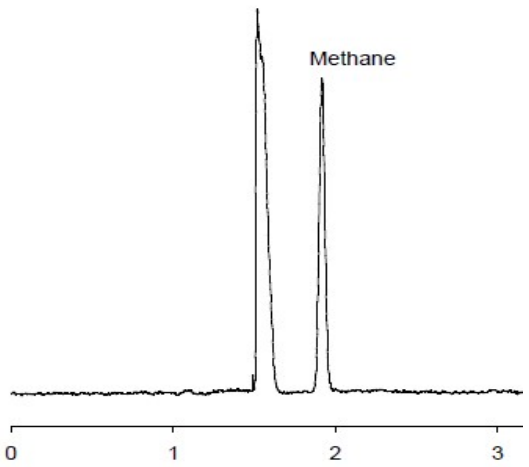


**Figure 3**. Separation of 5ppm CH4 from O2 and N2

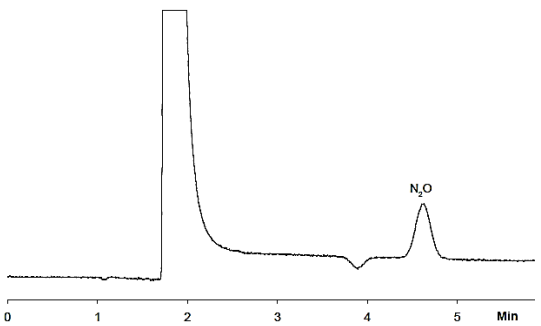


**Figure 4**. Separation of 1ppm N2O from bulk O2

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 | $CO_2$ | $CH_4$ | $N_2O$ |
|---|---|---|---|
| **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 $N_2O$ to CFC's and $SF_6$. Figure 5 shows the extended ECD channel for $SF_6$ analysis.

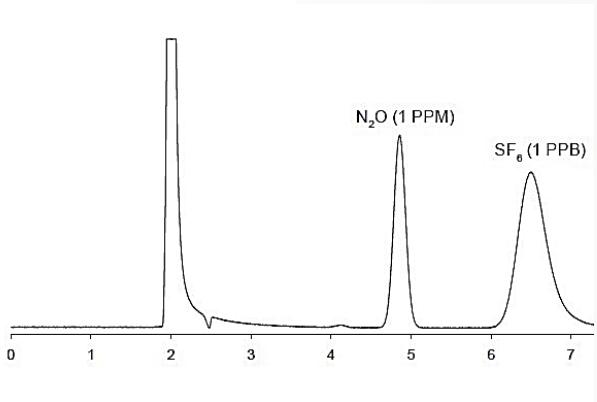


**Figure 5**. Separation of 1ppb SF6 from N20

## 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 suites for the analysis of greenhouse gases. This system is highly flexible with the application range easily expanded to cover CFC's and $SF_6$.

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