

## Application Note # CA-270372

# Analysis of Greenhouse Gases by Gas Chromatography

### 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 the infrared radiation from the earth influencing the global heat budget. Continuously measuring gives insight in the source of the different gases. We custom configured a 450-GC based system for analyzing all three gases in one run in a matrix of atmospheric air containing water vapor.

### Instrumentation

Technique: Bruker 450-GC Gas Chromatograph  
 Injection: Gas syringe (optional with sampler) into a 1041 PWOC  
 Detection: TCD, ECD and FID

Basically two channels are used of which one is equipped with two detectors. After injection on the first channel  $CO_2$  and methane are separated from air. The TCD detects the  $CO_2$  and the FID configured in series with the TCD detects the methane. On the second channel the nitrous oxide is separated from water. Water is backflushed to vent and the nitrous oxide is detected on the ECD.

### Materials and reagents

Packed columns:  
 Column A: Pre-Separation of  $CO_2$  and  $CH_4$  from water  
 Column B: Separates  $CO_2$  and  $CH_4$  from oxygen/nitrogen  
 Column C: Pre-separation of  $N_2O$  from water  
 Column D: Separation of  $N_2O$  from Oxygen

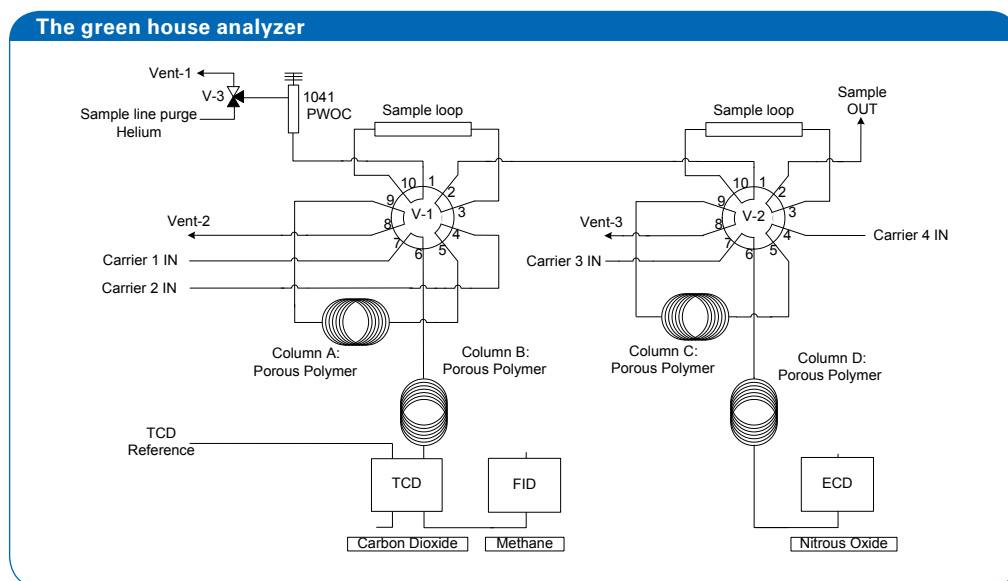


Figure 1: Analytical schematic of the green house analyzer configured on the 450-GC.

## Conditions

Carrier 1:	30.5 psi
Carrier 2:	17.0 psi, 40mL/min total flow
Carrier 3:	14.0 psi, 40mL/min total flow
Carrier 4:	29.0 psi, 50mL/min total flow
TCD:	Filament temperature 200°C Block temperature 120°C
FID:	Temperature: 300°C
ECD:	Temperature: 300°C Cell Potential: 415mV Make Up flow: 2mL/min
Carrier Gas:	TCD/FID channel: Helium ECD channel: Argon/Nitrogen
Oven:	Temperature: 50°C (isothermal)

Table 1: Valve event table.

Time	GSV-1	GSV-2	BF to Vent	V-4
Initial	Fill	Fill	Forward	OFF
0.01	Fill	Fill	Forward	ON
1.00	Inject	Inject	Forward	ON
1.20	Inject	Inject	Forward	OFF
2.05	Inject	Inject	BF	OFF
2.70	Inject	Inject	BF	OFF

## Results and discussion

When conditions are set as outlined above, three chromatograms are obtained. Figure 2 shows the TCD channel chromatogram where CO<sub>2</sub> is analyzed. Methane is analyzed on the FID channel. A chromatogram is shown in figure 3. Finally N<sub>2</sub>O is analyzed on the ECD channel. A chromatogram is shown in figure 4. To show system suitability a sample is tested multiple times. Repeatability data generated on peak area is listed in Table 1. The headspace sampler allows for the analysis of samples of different origin like air, water, soil etc. On the ECD detector N<sub>2</sub>O is analyzed. This however can easily be expanded with CFC's and SF<sub>6</sub>. Figure 5 shows the extended ECD channel for SF<sub>6</sub> analysis. Figure 6 gives a visual impression of the repeatability data with 10% variation limits. Repeatability data is very good. RSD on peak area for this kind of analysis below 2% is very good.

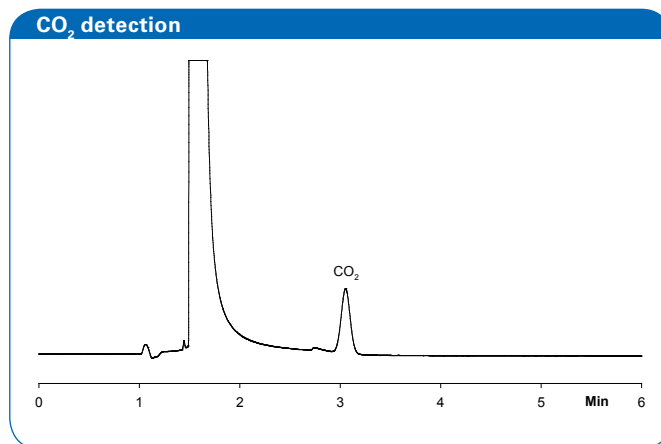


Figure 2: CO<sub>2</sub> analyzed on the TCD detector. The concentration level is 1000 PPM. The CO<sub>2</sub> is perfectly separated from the bulk O<sub>2</sub>/N<sub>2</sub> peak.

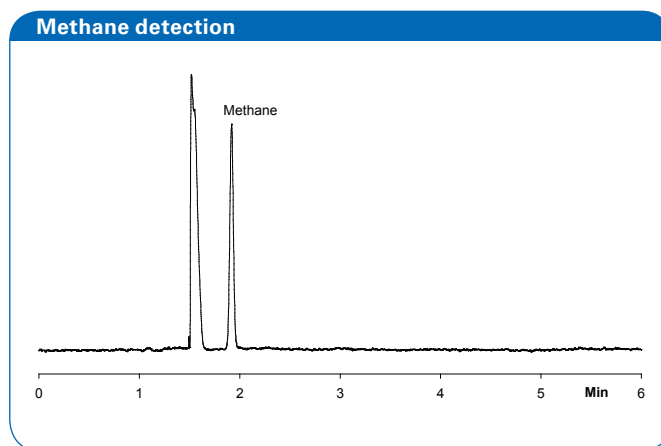


Figure 3: Methane analyzed on the FID detector. The methane concentration is 5 PPM.

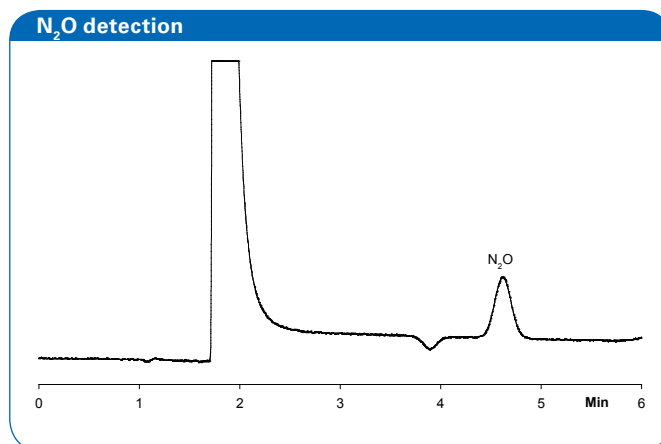


Figure 4: Nitrous oxide analyzed the ECD detector. The N<sub>2</sub>O is perfectly separated from the bulk oxygen. Water is back flushed from the pre-column and consequently not detected by the ECD detector. The N<sub>2</sub>O amount is 1 PPM.

Table 2: Repeatability data on peak area.

Run	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> 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 Deviation	45.31	22.51	17.07
RSD %	0.34	0.76	1.88

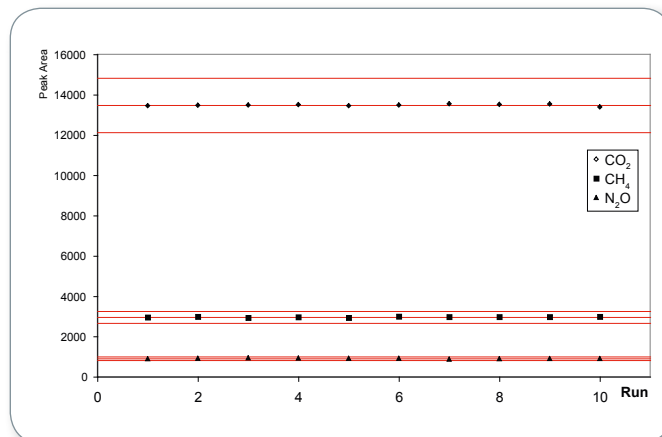


Figure 6: Repeatability data with 10% variation limits.

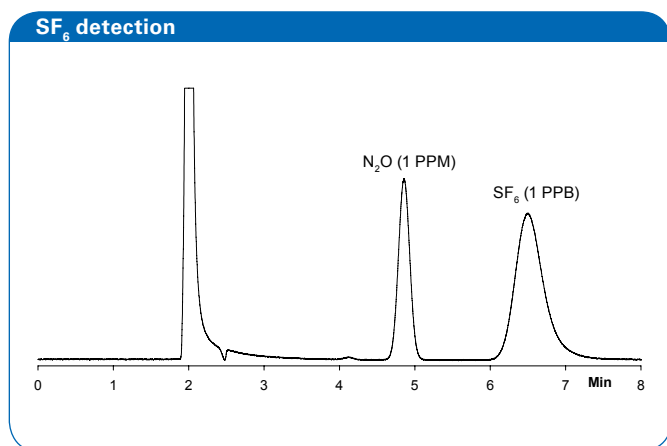


Figure 5: The N<sub>2</sub>O channel is extendable to measure SF<sub>6</sub>. The component elutes perfectly separated from N<sub>2</sub>O peak.

## Conclusion

The green house analyzer is based on the 450-GC gas chromatograph for the analysis of the greenhouse gases carbon dioxide, methane and nitrous oxide in one run. The headspace sampler allows for the analysis of samples of different origin. Air, soil and water samples can be handled in this way. Repeatability data shows that the system is perfectly suited for the greenhouse gas analysis. This system is highly flexible and the application range can easily be expanded with CFC's and SF<sub>6</sub>.

### Keywords

Green house gases  
Carbon dioxide  
Methane  
Nitrous oxide

### Instrumentation & Software

Green house gas analyzer  
450-GC gas chromatograph  
Galaxie CDS software

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