BEYOND MEASURE

SCION INSTRUMENTS

A True Six-Channel Solution for Impurities in Ethylene

Application Note AN0013

INTRODUCTION

Ethylene is one of the highest volume chemicals produced in the world, with over 100 million metric tons produced annually. Ethylene is primarily used in the manufacture of polyethylene, ethylene oxide and ethylene dichloride. Impurities in ethylene can damage catalysts, resulting in significant replacement costs, reduced product quality, process downtime and decreased yield.

Ethylene is manufactured through the use of steam cracking, in which gaseous or light liquid hydrocarbons are heated to 750-790°C in a pyrolysis furnace. Larger hydrocarbons are cracked into smaller hydrocarbons with the formation of unsaturated and olefinic compounds being produced. Ethylene feedstocks must be tested to ensure that only high purity ethylene is delivered for chemical processing.

In order to fully characterise ethylene impurities, a six-channel custom solution was configured. The system consists of two SCION 456-GC's each equipped with three channels. The six channels are hydrogen, oxygen/nitrogen, CO/CO_2, light hydrocarbons, oxygenates and sulphur. With this configuration, a complete characterisation of all impurities in ethylene was obtained.

EXPERIMENTAL

The channels used in this analyser were configured principally for the determination of different gases in various hydrocarbon types of gaseous matrices. The sample is loop injected by means of a gas sampling valve. The configurations of both GC systems can be found in Figures 1 and 2. Note the sample injection is from one loop into both systems.

Hydrogen, nitrogen and oxygen are detected by two TCD's using two molsieve columns. The CO/CO_2 channel is developed for simultaneous determination of carbon monoxide, methane and carbon dioxide. The first fraction of sample containing the components is sent to the FID via a methaniser.

The light hydrocarbon channel separates hydrocarbons from oxygenated components with the hydrocarbons being moved onto a MAPD column to the FID. The middle channel of the second GC system is used to analyse alcohols and acetone, again coupled to the FID. The sulphur components are analysed on the rear channel and detected using a Pulsed Flame Photometric Detector (PFPD).

A gas mixture was used to tune the analyser; the components of the mixture and their concentrations can be found in Table 1.

Table 1. Gas Mixture Components and Concentrations

Component	Conc (ppm)
1-Propanol	9.92
2-Propanol	10
Acetone	10.17
Methanol	10.02
Ethanol	493
Acetylene	4.97
Propylene	99.5
Propane	100.4
Methane	492
Carbon Monoxide	1.966
Carbon Dioxide	4.90
Carbonyl Sulphide	4.98
Dimethyl Sulphide	2.075
Hydrogen	20
Nitrogen	49.7
Ethylene	99.87

RESULTS

Figure 3 shows the chromatogram when H_2 was analysed on GC-1 with Figure 4 showing CO, CH_4 and CO_2. The analysis of O_2 and N_2 on GC-1 can be found in Figure 5. The analysis of oxygenates and light hydrocarbons on GC-2 can be found in Figures 6 and 7. Finally, the chromatogram of sulphur components can be found in Figure 8.

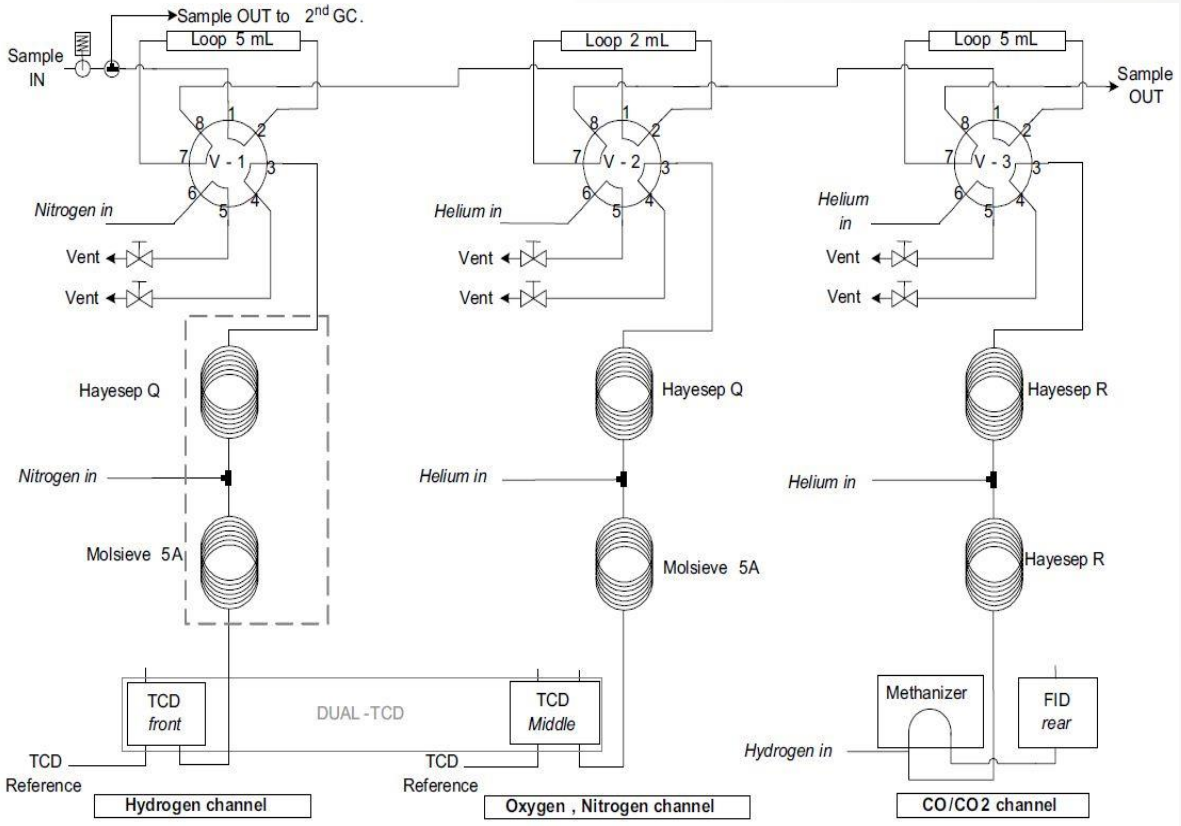

Figure 1. GC-1 Configuration

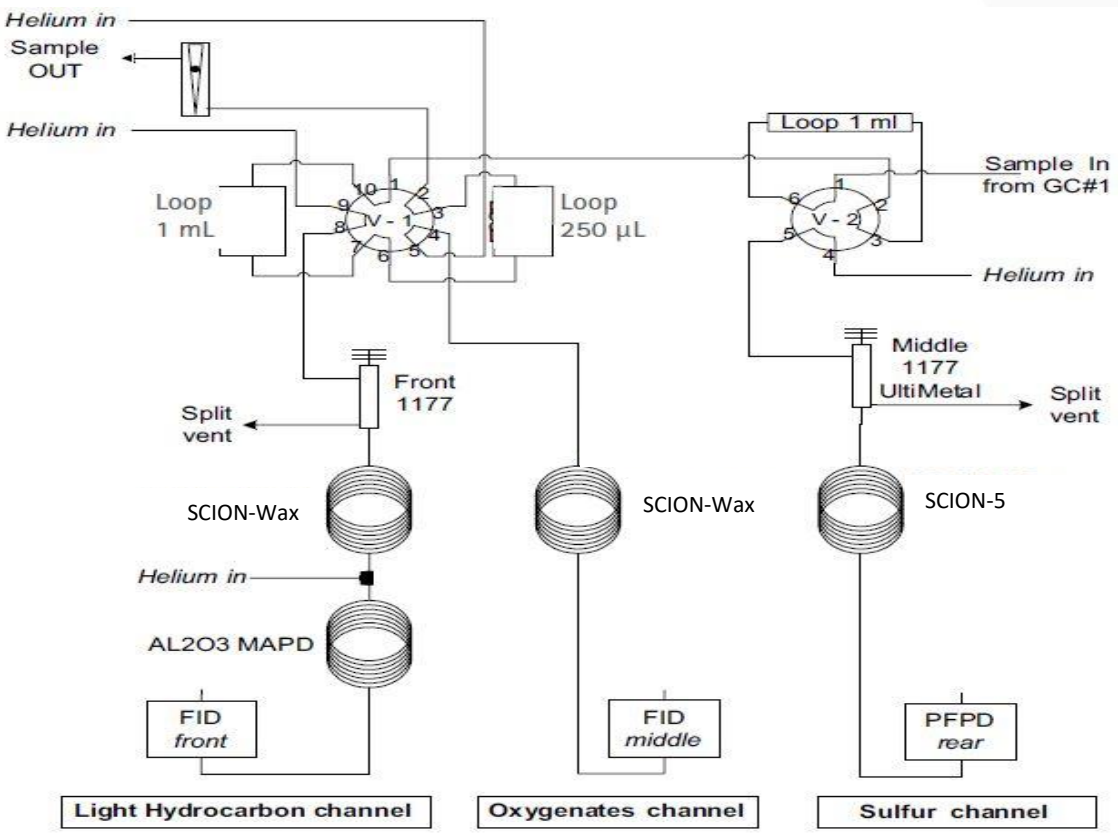

Figure 2. GC-2 Configuration

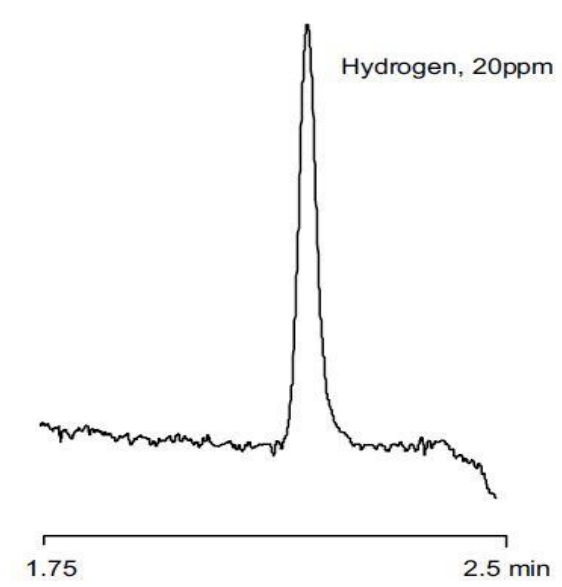

Figure 3. Hydrogen Analysis on GC-1

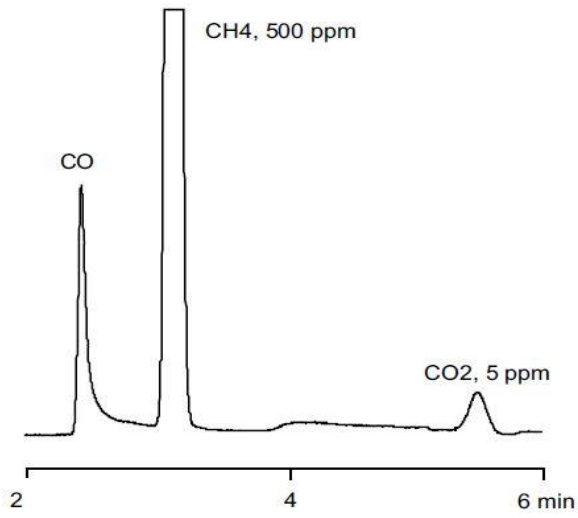

Figure 4. Analysis of CO, CH4 and CO2 on GC-1

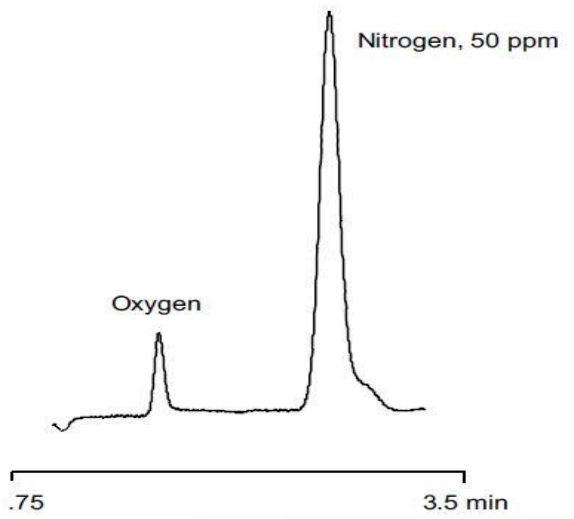

Figure 5. Analysis of O2 and N2 on GC-1

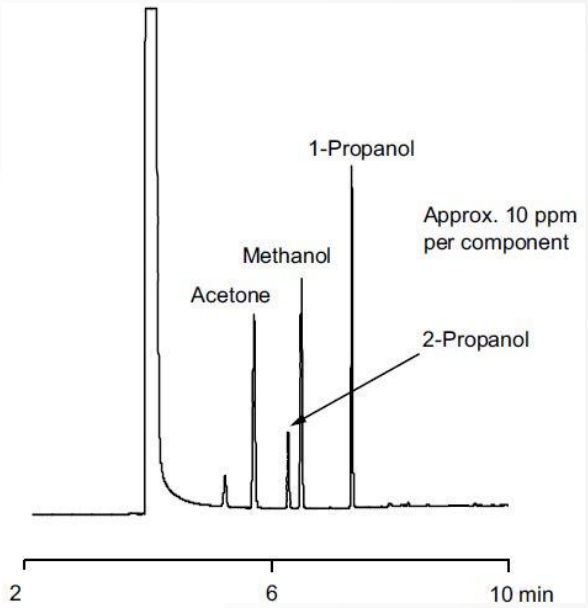

Figure 6. Analysis of Oxygenates on GC-2

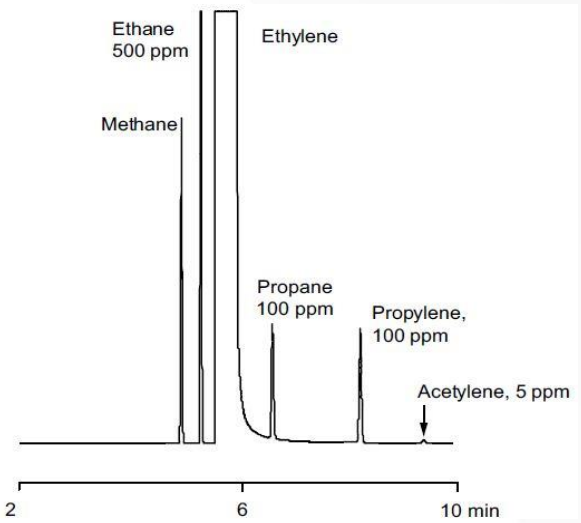

Figure 7. Analysis of Light Hydrocarbons on GC-2

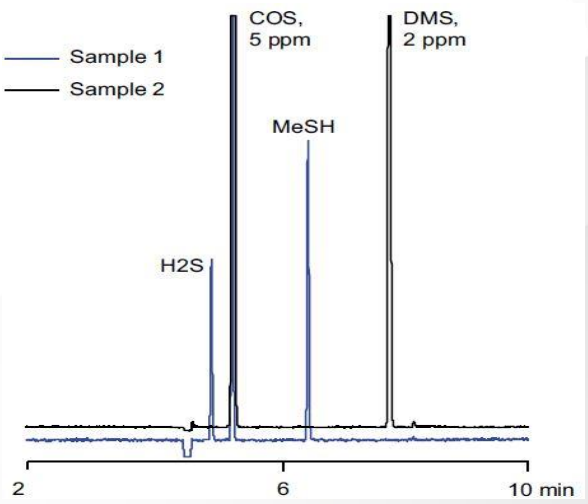

Figure 8. Analysis of Sulphur Components on GC-2

The repeatability of the system was determined for all components. 20 consecutive injections were used for repeatability testing; the data of which can be found in Figures 9-15. The red lines represent the average and 5% variation with respect to the average. All components show excellent repeatability on the two GC systems.

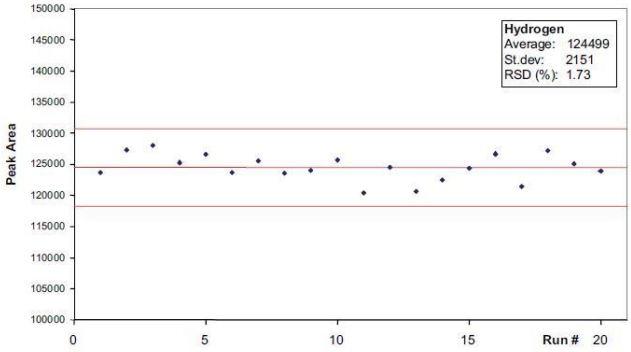

Figure 9. Repeatability data of H2 with 5% Variation Limits

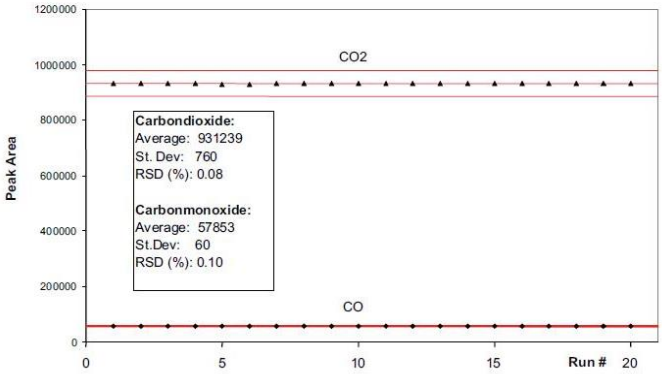

Figure 10. Repeatability data of CO and CO2 with 5% Variation Limits

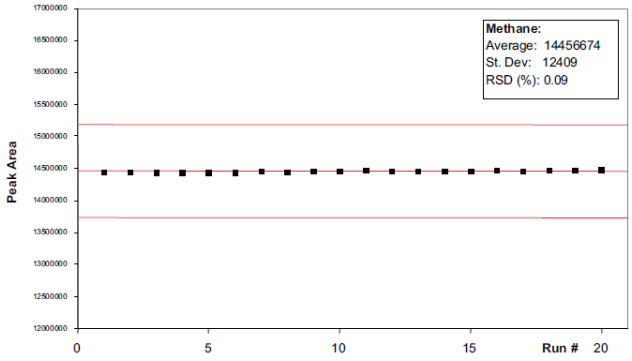

Figure 11. Repeatability data of CH4 with 5% Variation Limits

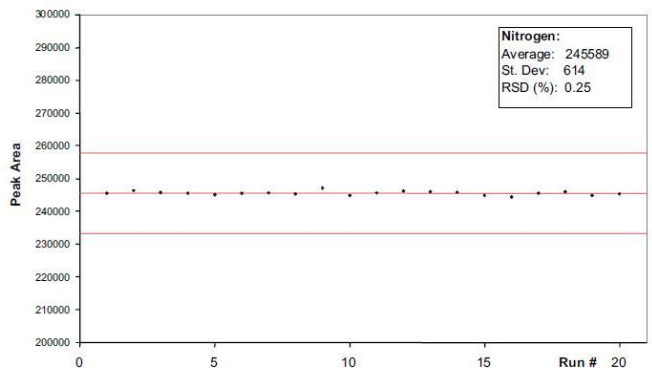

Figure 12. Repeatability data of N2 with 5% Variation Limits

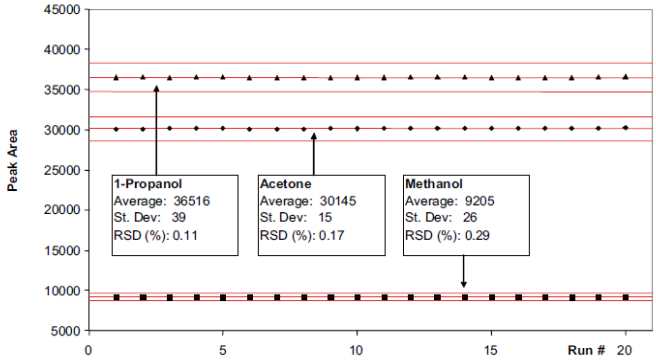

Figure 13. Repeatability data of Oxygenates with 5% Variation Limits

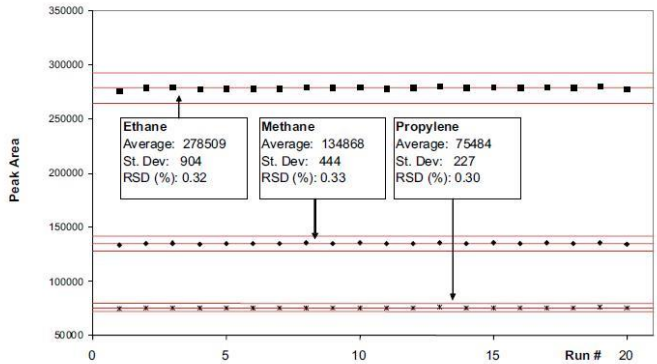

Figure 14. Repeatability data of Light Hydrocarbons with 5% Variation Limits

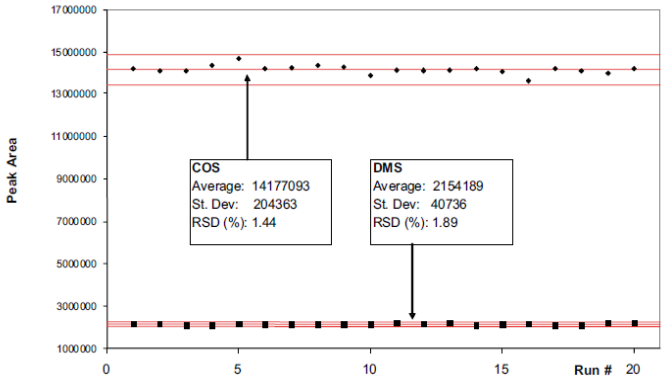

Figure 15. Repeatability data of Sulphur Components with 5% Variation Limits

CONCLUSION

The SCION two GC, 6 channel system, was able to comprehensively analyse ethylene for impurities. GC-1 was configured with a H_2, CO, CO_2 and permanent gas channel whilst GC-2 was configured with light hydrocarbons, oxygenates and sulphur channels. All channels performed exceptionally, showing relative standard deviation figures (based on peak area) well below 2% and in most cases below 0.5%. These results demonstrate that the 6-channel custom solution is perfectly suited for the total characterisation of ethylene and its impurities.

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