Application Note

Energy and Chemicals

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Analysis of Ethylene or Propylene Stream Cracking Gas Products

Using the Agilent 990 Micro GC

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Abstract

This application note describes the use of the Agilent 990 Micro GC system for analyzing gas products from ethylene or propylene stream cracking, enabling fast and accurate detection. Two channels were used—the Agilent J&W CP-Molsieve 5Å and the Agilent J&W CP-Silica PLOT—to analyze hydrogen, nitrogen, ethane, ethylene, propane, propylene, and 1-butene.

Introduction

Ethylene or propylene cracking gas products are produced from various feedstocks, including naphtha, light naphtha, atmospheric diesel, depressurized diesel, hydrotreating tail oils, ethane, and liquefied petroleum gas, among others.

During gas cracking, yields of ethylene or propylene products should be monitored to measure the effectiveness of the process. The results of these analyses provide important process control data for optimizing cracking production and improving cracking yield—a key process parameter for cracking plants. Common cracking gas products are composed of hydrogen (H_2), nitrogen (N_2), and light hydrocarbons such as ethylene (C_2H_4), ethane (C_2H_6), propylene (C_3H_6), propane (C_3H_8), and 1-butene (C_4H_8), among others.

The Agilent 990 Micro GC enables fast and accurate detection of ethylene or propylene stream cracking gas products, a fundamental measure for determining the effectiveness of the cracking process. The system's demonstrated utility in refinery gas analysis further supports its suitability.[1]

Experimental

Channel 1

A 10 m Agilent J&W CP-Molsieve 5Å backflush channel, equipped with the retention time stability (RTS) option, was used for H_2 and N_2 analysis. The backflush and RTS option help protect the CP-Molsieve 5Å column from moisture, CO_2, and other contaminants. This is beneficial to long-term RT repeatability and column performance.

Channel 2

A 10 m Agilent J&W CP-Silica PLOT backflush channel was used for C_2H_4, C_2H_6, C_3H_6, C_3H_8, and C_4H_8 analysis.

Table 1. Analytical methods for sample analysis.

Conditions	Channel Type	
	Agilent J&W CP-Molsieve 5Å, 10 m, RTS, Backflush	Agilent J&W CP-Silica PLOT, 10 m, Backflush
Carrier Gas	Argon	Helium
Injector Temperature	80 °C	60 °C
Column Temperature	80 °C	70 °C
Column Pressure	200 kPa	150 kPa
Injection Time	40 ms	30 ms
Backflush Time	6 s	N/A

Table 2. Composition of Standard Gases A and B.

Components	Standard Gas A (mol/mol)	Standard Gas B (mol/mol)
Hydrogen (H_2)	2.6%	0.4%
Nitrogen (N_2)	0.05%	N/A
Ethylene (C_2H_4)	Balance	1.0%
Ethane (C_2H_6)	0.2%	0.1%
Propylene (C_3H_6)	9.4%	Balance
Propane (C_3H_8)	0.7%	6.4%
1-Butene (C_4H_8)	0.05%	0.5%

Results and discussion

Figures 1 and 3 show that H_2 and N_2 are well separated within 1.0 minute on the 10 m CP-Molsieve 5Å RTS backflush channel. To ensure linearity for hydrogen across a wide range of concentrations, argon was used as the carrier gas on this channel. Figures 2 and 4 show that C_2H_4, C_2H_6, C_3H_6, C_3H_8, and C_4H_8 are well separated within 2.5 minutes on the 10 m CP-Silica PLOT backflush channel.

Tables 3 and 4 present the repeatability results from 10 sample runs along with the detection limits (DLs). For all components, the RT %RSDs are less than 0.1% and the area %RSDs are less than 1.0%. The DL was calculated as the signal of three times the noise.

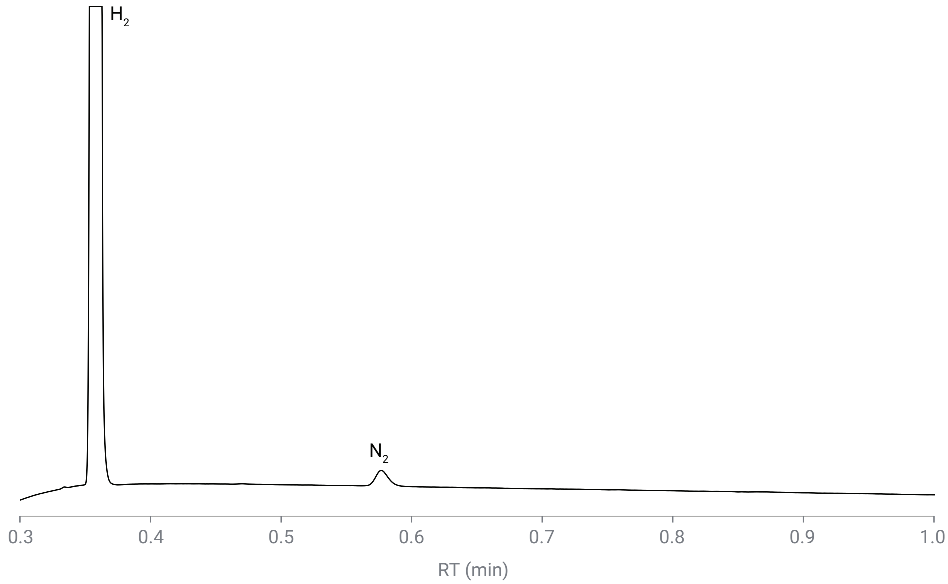

Figure 1. Chromatogram of hydrogen (H_2) and nitrogen (N_2) from Standard Gas A on the 10 m Agilent J&W CP-Molsieve 5Å channel.

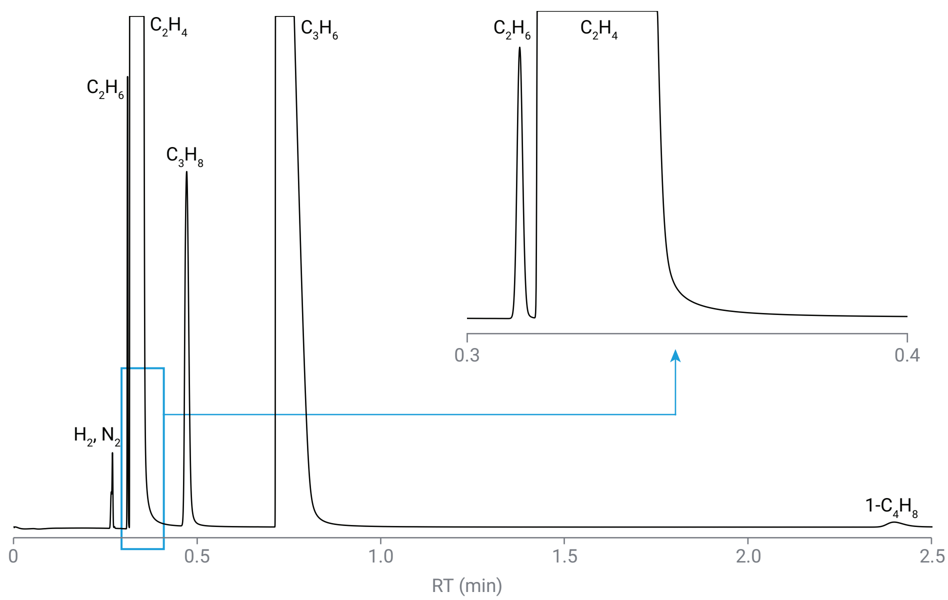

Figure 2. Chromatogram of ethylene (C_2H_4), ethane (C_2H_6), propylene (C_3H_6), propane (C_3H_8), and 1-butene (C_4H_8) from Standard Gas A on the 10 m Agilent J&W CP-Silica PLOT channel.

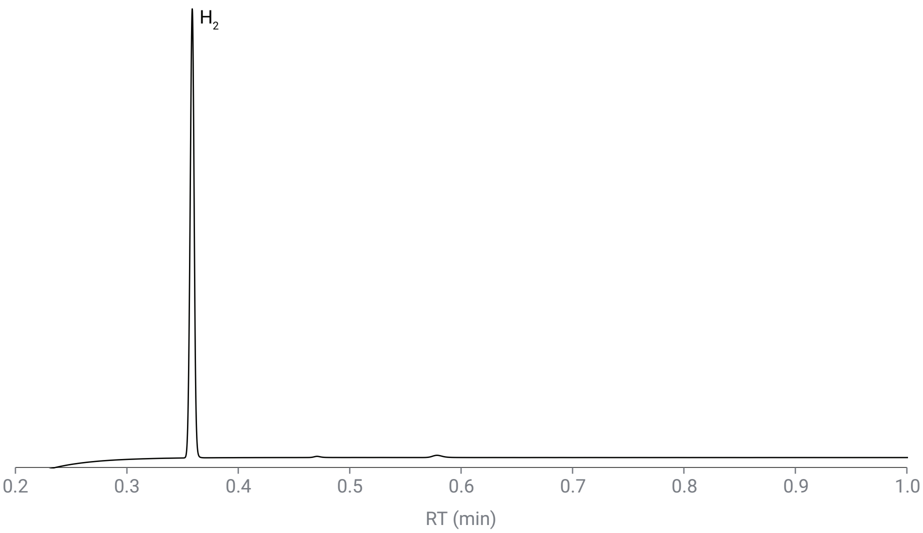

Figure 3. Chromatogram of hydrogen (H_2) and nitrogen (N_2) from Standard Gas B on the 10 m Agilent J&W CP-Molsieve 5Å channel.

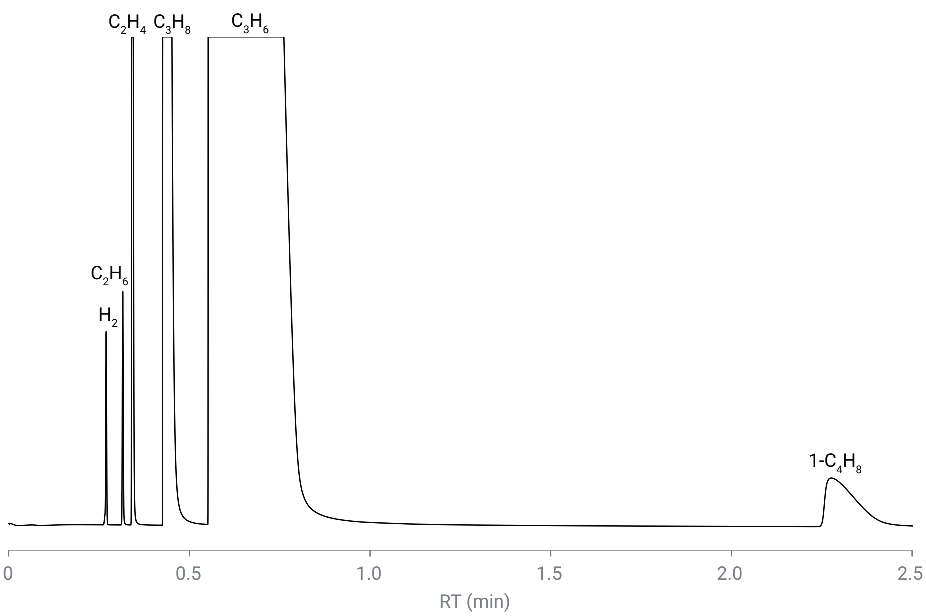

Figure 4. Chromatogram of ethylene (C_2H_4), ethane (C_2H_6), propylene (C_3H_6), propane (C_3H_8), and 1-butene (C_4H_8) from Standard Gas B on the 10 m Agilent J&W CP-Silica PLOT channel.

Table 3. Retention times (RTs), areas, and detection limits (DLs) for 10 runs of Standard Gas A. RT and area repeatability are expressed as percent relative standard deviation (%RSD).

Compounds	RT (min)	RT %RSD	Area (mV×s)	Area %RSD	DL (ppm)
Hydrogen	0.360	0.002	68.398	0.049	1.03
Nitrogen	0.577	0.028	0.108	0.970	36.5
Ethane	0.311	0.020	2.299	0.199	0.27
Ethylene	0.318	0.018	934.691	0.418	2.34
Propylene	0.716	0.008	135.681	0.097	4.20
Propane	0.472	0.015	10.861	0.498	1.17
1-Butene	2.399	0.009	0.691	0.611	5.96

Table 4. Retention times (RTs), areas, and detection limits (DLs) for 10 runs of Standard Gas B. RT and area repeatability are expressed as percent relative standard deviation (%RSD).

Compounds	RT (min)	RT %RSD	Area (mV×s)	Area %RSD	DL (ppm)
Hydrogen	0.359	0.004	11.490	0.033	0.67
Ethane	0.316	0.032	1.589	0.262	0.46
Ethylene	0.342	0.035	14.844	0.294	0.63
Propylene	0.554	0.073	1,667.784	0.261	11.8
Propane	0.428	0.056	124.016	0.283	1.89
1-Butene	2.273	0.082	11.316	0.472	10.5

Conclusion

This study demonstrates the applicability of the Agilent 990 Micro GC for analyzing ethylene or propylene stream cracking gas products, providing essential process control data for optimizing cracking production and yield. Quantitation precision was evaluated through 10 consecutive analyses of calibration standard gases, showing retention time (RT) repeatability (%RSD) less than 0.1% and area repeatability (%RSD) less than 1.0% for all compounds. These results confirm the instrument's excellent performance in reliably qualifying and quantifying these stream cracking gas products.

Reference

1. Zhang, J. Refinery Gas Analysis Using the Agilent 990 Micro GC, *Agilent Technologies application note*, publication number 5994-1043EN, **2019**.

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