Application Brief

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Biomass Pyrolysis Gas Products Analysis Using the Agilent 990 Micro GC

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Abstract

This application note describes the use of the Agilent 990 Micro GC for fast and accurate biomass pyrolysis gas products analysis. Two channels were used—the Agilent J&W CP-Molsieve 5Å and the Agilent J&W PoraPLOT U—to analyze hydrogen, carbon monoxide, carbon dioxide, methane, ethane, ethylene, and acetylene as biomass pyrolysis gas products.

Introduction

With increasing fossil fuel consumption and greenhouse gas emissions, more actions are focused on renewable energy for sustainable growth of the public to diminish global environmental problems. Biomass is a promising clean and renewable energy, which has attracted extensive attention all over the world. Pyrolysis is the thermal degradation of organic material by cracking the chemical bonds in inert atmosphere, and it is highlighted as an important promising sustainable technology. In the past decades, pyrolysis methods of various biomass have been proposed and intensively researched to realize clean and efficient utilization of biomass.

During the pyrolysis process of various biomass, the concentration of the pyrolysis gas products should be monitored. Common pyrolysis gas products are the percentage concentration of hydrogen, carbon monoxide, carbon dioxide, and light hydrocarbons (methane, ethane, ethylene, acetylene, and so on). The Agilent 990 Micro GC provides fast and accurate detection of biomass pyrolysis gas products, which improves efficiency of biomass pyrolysis research.

Experimental

Channel 1: A 10 m Agilent J&W CP-Molsieve 5Å backflush channel with retention time stability (RTS) option is used for H_2, N_2, CH_4, and CO analysis. The backflush option and RTS are used to protect the J&W CP-Molsieve 5Å column from moisture, CO_2, and other contaminants. This setup is beneficial to the long-term retention time (RT) repeatability and column performance of the CP-Molsieve 5Å column.

Channel 2: A 10 m Agilent J&W PoraPLOT U backflush channel is used for CO_2, C_2H_4, C_2H_6, and C_2H_2 analysis.

Table 1. Analytical methods for biomass pyrolysis sample analysis.

Conditions	Channel Type	
	Agilent J&W CP-Molsieve 5Å, 10 m, RTS, Backflush	Agilent J&W PoraPLOT U, 10 m, Backflush
Carrier Gas	Argon	Helium
Injector Temperature	80 °C	60 °C
Column Temperature	80 °C	60 °C
Column Pressure	175 kPa	150 kPa
Injection Time	40 ms	40 ms
Backflush Time	8 s	10 s

Table 2. Composition of standards gas.

Components	Concentration (mol/mol)
Hydrogen	5.05%
Nitrogen	Balance
Methane	5.10%
Carbon Monoxide	10.0%
Carbon Dioxide	10.1%
Ethylene	2.50%
Ethane	1.50%
Acetylene	0.100%

Results and discussion

Figure 1 shows that H_2, N_2, CH_4, and CO are well separated within 2.0 minutes on the 10 m CP-Molsieve 5Å RTS backflush channel. To obtain a wide linear range, argon is used as carrier gas because H_2 is in the calibration standard, and real sample needs to be analyzed. Figure 2 shows that CO_2, C_2H_4, C_2H_6, and C_2H_2 are well separated within 1.0 minute on the 10 m PoraPLOT U backflush channel.

Table 3 shows the repeatability results of 10 sample runs. For all components, the RT relative standard deviation (RSD) is less than 0.1% and the area RSD is less than 0.5%

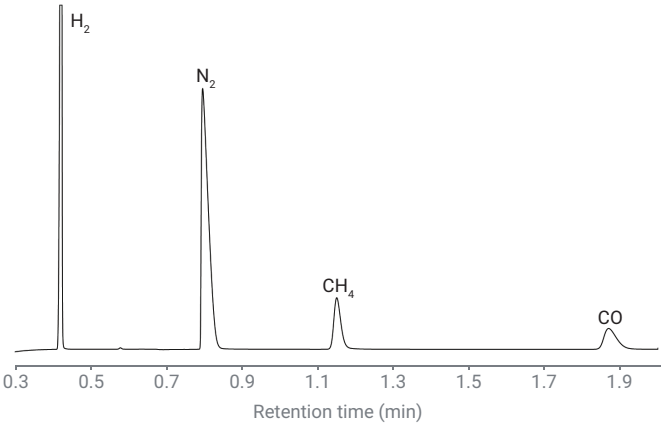

Figure 1. Chromatogram of H_2, N_2, CH_4, and CO on the 10 m Agilent J&W CP-Molsieve 5Å channel.

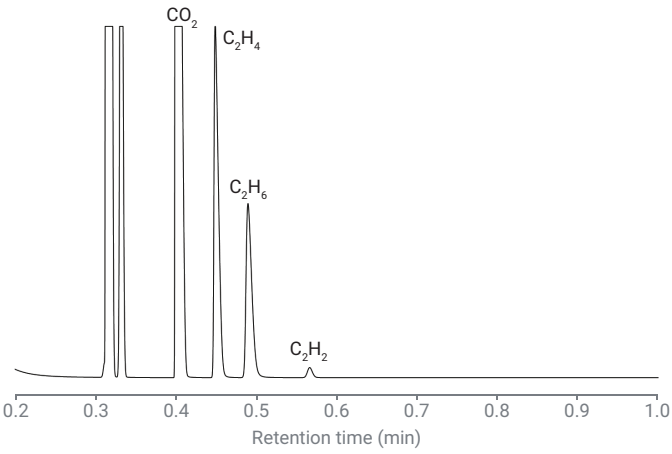

Figure 2. Chromatogram of CO_2, C_2H_4, C_2H_6, and C_2H_2 on the 10 m Agilent J&W PoraPLOT U channel.

Table 3. RT and area repeatability of 10 runs of standards gas.

Compounds	RT (min)	RT RSD (%)	Area (mV × s)	Area RSD (%)
Hydrogen	0.423	0.009	78.90	0.073
Nitrogen	0.795	0.017	92.43	0.087
Methane	1.149	0.015	18.76	0.300
Carbon Monoxide	1.870	0.034	13.64	0.162
Carbon Dioxide	0.400	0.005	71.84	0.081
Ethylene	0.449	0.006	18.24	0.032
Ethane	0.489	0.008	11.78	0.017
Acetylene	0.566	0.008	0.61	0.045

Conclusion

This study demonstrates the applicability of the Agilent 990 Micro GC for biomass pyrolysis gas products analysis, which can be used for performance evaluation of the catalyst or process control in the biomass pyrolysis. The quantitation precision was evaluated by 10 consecutive analyses of calibration standard gas with RT repeatability (RSD) less than 0.1% and area repeatability (RSD) less than 0.5%, demonstrating excellent instrument performance for reliable qualification and quantitation of biomass pyrolysis gas products.

Reference

1. Zhang, J. Biogas Analyzer Based on the Agilent 990 Micro GC. *Agilent Technologies application note*, publication number 5994-1376EN, **2019**.

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