Application Note

Refinery Gas Analysis using Micro GC Fusion® Gas Analyzer

OVERVIEW This application note describes the advantages of using Micro GC Fusion Gas Analyzer to analyse refinery gases. Simplified operation and accelerated analysis offered by the instrument significantly increase analysis throughput and operation efficiency.

INTRODUCTION Refinery gas is a product derived from crude oil distillation or catalytic cracking in a refinery. The term 'refinery gas' covers a wide range of gases, but is typically any gas that is made up of fixed gases, saturated hydrocarbons and olefins. Refinery gas analysis is found in the oil and gas, petrochemical and alternative fuel industries. Refinery gas can be used as a final product, or as raw material that will go on for further processing. For example, methane and ethane are used as refinery fuel gas or sold, and propane and butane are compressed and sold as liquefied petroleum gases (LPG). Precise and fast analysis is critical for determining quality assurance and process control, as well as for emission compliance. Gas chromatography is commonly used for refinery gas analysis, which can take up to 30 minutes to analyse these complex gases.
ASTM's Standard Test Method for Determination of hydrocarbons and non-hydrocarbons in gas mixtures (D7833-14), suggests that micro analyzers that contain up to four channels can be used for the determination of hydrocarbons and non-hydrocarbon gases in gaseous mixtures.
Micro GC Fusion configured with four GC modules can be used in analyzing refinery gas, which typically consists of fixed gases (H2, O2, N2, CO, CO2), and saturated and olefinic hydrocarbons (C1-C5, and C6+). It provides rapid temperature ramping through resistive column heating technology that can easily extend the analysis for heavier hydrocarbons.

Each GC module's temperature profile is independently programmed; extending the application range on each column and reducing downtime by providing the option to build a bakeout into the method.

EXPERIMENTAL A refinery calibration gas standard (AirGas®) was analyzed on a 4-module Micro GC Fusion:

- Module A: Rt®-Molsieve 5A temperature programmable column with a backflush injector and TCD detector
- Module B: Rt®-U-Bond temperature programmable column with a backflush injector and TCD detector
- Module C: Alumina temperature programmable column with a backflush injector and TCD detector
- Module D: Rxi-1ms® temperature programmable column with a variable volume injector and TCD detector

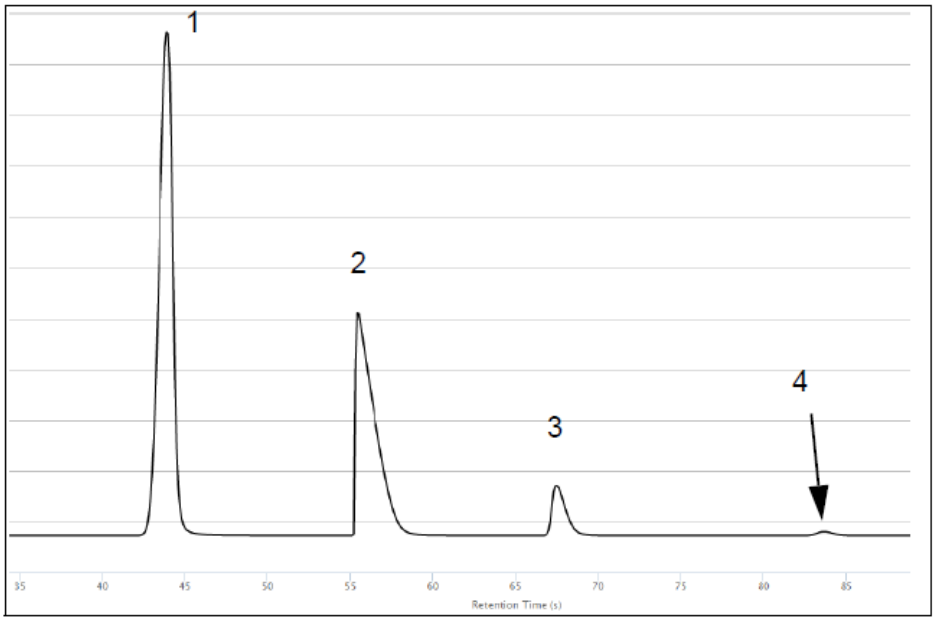
Backflush injectors are used, along with temperature programming, to ensure that unwanted components are removed from the column.

RESULTS Twenty five gas components in the refinery gas calibration standard were analyzed in three minutes.
Ten consecutive runs were conducted, which demonstrated a percent relative standard deviation (%RSD) of < 1% for peak area and < 0.1% for retention time for all compounds of interest. The concentrations of the components in the calibration gas standard and the %RSD for peak area and retention times are shown in Table 1.

Table 1 Component list of refinery gas calibration standard

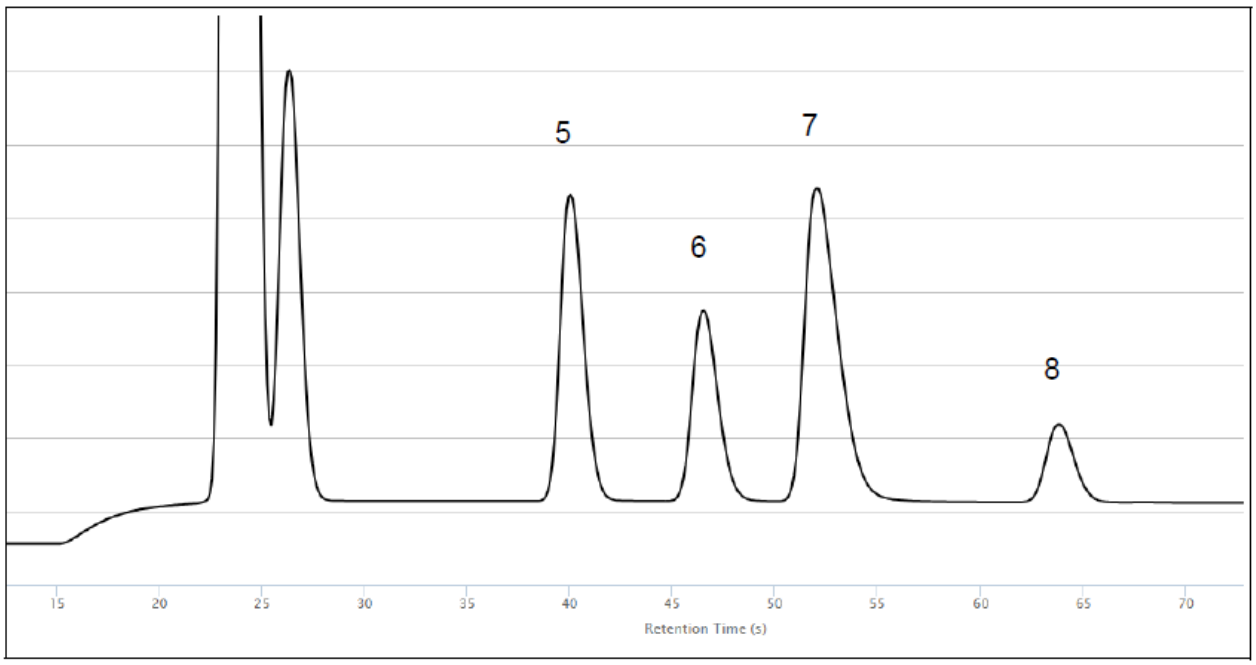
Module	Component	Mole %	Analyte Number	Retention Time (s)	RT %RSD	Area %RSD
A	hydrogen	10.00	1	43.98	0.040	0.465
A	nitrogen	Bal	2	55.48	0.036	0.418
A	methane	5.00	3	67.54	0.047	0.479
A	carbon monoxide	1.00	4	83.70	0.084	0.605
B	carbon dioxide	3.00	5	40.08	0.039	0.167
B	ethylene	2.00	6	46.58	0.041	0.105
B	ethane	4.00	7	52.12	0.061	0.117
B	acetylene	1.00	8	63.86	0.065	0.088
C	propane	2.00	9	32.40	0.030	0.265
C	propylene	1.00	10	43.86	0.014	0.259
C	i-butane	0.30	11	53.22	0.019	0.274
C	n-butane	0.15	12	56.82	0.018	0.144
C	trans-2-butene	0.15	13	83.66	0.022	0.404
C	1-butene	0.30	14	88.00	0.025	0.248
C	1-butylene	0.15	15	94.16	0.027	0.287
C	cis-2-butane	0.30	16	98.58	0.022	0.313
C	i-pentane	0.10	17	110.26	0.018	0.401
C	n-pentane	0.05	18	117.08	0.014	0.533
C	1,3-butadiene	0.30	19	130.38	0.025	0.326
C	trans-2-pentane	0.05	20	147.76	0.020	0.570
C	methyl-2-butene	0.05	21	154.12	0.024	0.531
C	1-pentene	0.10	22	158.14	0.020	0.622
C	cis-2-pentane	0.05	23	164.50	0.017	0.337
D	n-hexane	0.05	24	68.88	0.074	0.345
D	n-heptane	0.05	25	91.58	0.069	0.225

Figure 1 Chromatogram Module A



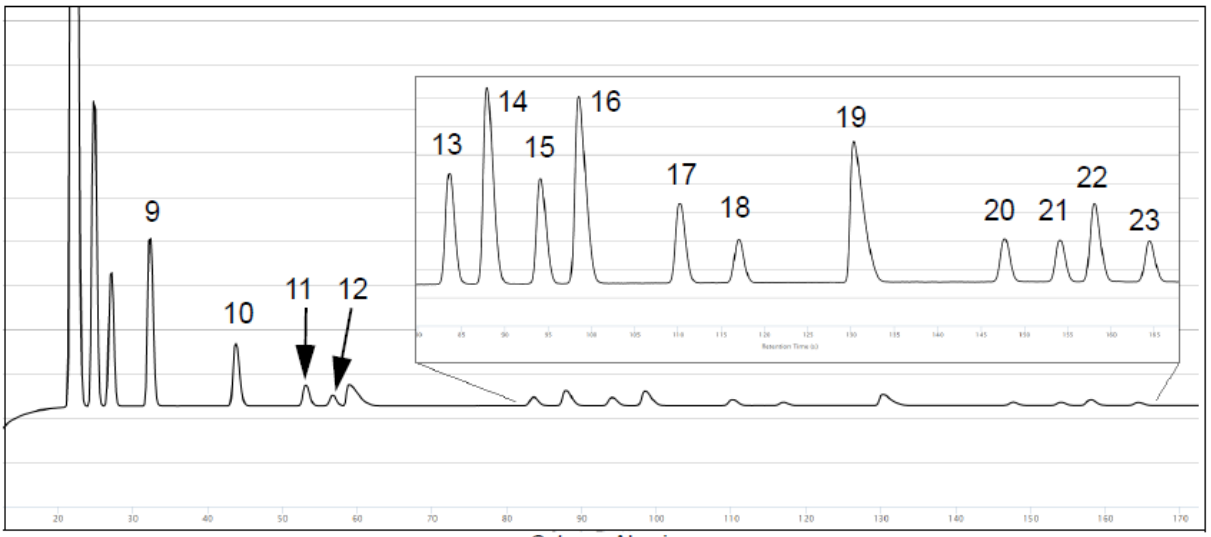
Column: Rt-Molsieve 5A
Column Temperature: 110°C (hold 100 s) » 200°C (hold 20 s); *Ramp Rate*: 1.5°C/s
Column Head Pressure: 33 psi; *Carrier Gas*: Argon

Figure 2 Chromatogram Module B



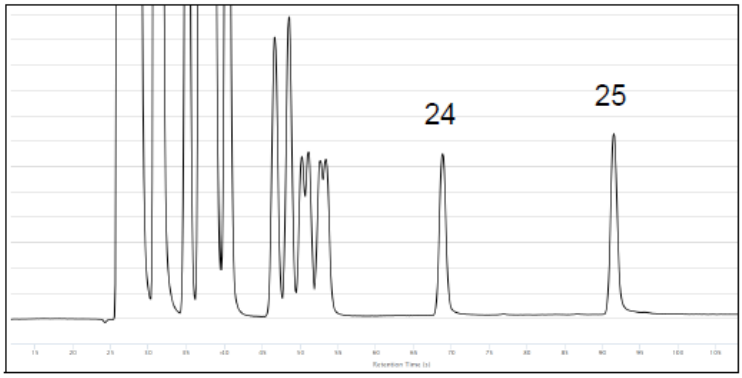
Column: Rt-U-Bond
Column Temperature: 60°C (hold 30s) »170°C (hold 40 s); *Ramp Rate*: 1.0°C/s
Column Head Pressure: 16 psi; *Carrier Gas*: Helium

Figure 3 Chromatogram Module C



Column: Alumina
Column Temperature: 115°C (hold 20s) »120°C (hold 0 s) »170°C (hold 30s); *Ramp Rate*: 0.1°C/s, 0.5°C/s
Column Head Pressure: 24 psi; *Carrier Gas*: Helium

Figure 4 Chromatogram Module D



Column: Rxi-1ms
Column Temperature: 70°C (hold 30s) »180°C (hold 10 s); *Ramp Rate*: 1.0°C/s
Column Head Pressure: 23 psi; *Carrier Gas*: Helium

CONCLUSION Micro GC Fusion offers tremendous precision and a simple, cost effective means to meet the demanding needs of refinery gas analysis. Analytical results in less than three minutes ensure the most up-to-date information is available for quality assurance. Micro GC Fusion simplifies and accelerates refinery gas analysis, turning data into profit.

REFERENCES

1 McMahon, Mary. Last Modified 18 February 2017, "What Is Refinery Gas?" http://www.wisegeek.com/what-is-refinery-gas.htm.
2 2017, ASTM D7833-14: Standard Test Method for Determination of Hydrocarbons and Non-Hydrocarbon Gases in Gaseous Mixtures by Gas Chromatography