A Comparison of Porous Layer Open Tubular (PLOT) Columns for the Separation of Refinery Gases

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Overview

This poster demonstrates the use of various Thermo Scientific TracePLOT Porous Layer Open Tubular columns for the analysis of low molecular weight hydrocarbons.

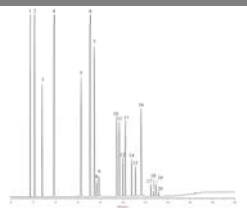
Introduction

Porous Layer Open Tubular (PLOT) columns are well suited for the analysis of light hydrocarbons such as those found in refinery gases. These highly selective columns are capable of separating low molecular weight hydrocarbons at above ambient temperatures and the columns can then be programmed to higher temperatures to elute higher boiling compounds. An increasingly wide variety of PLOT column coatings are available, including alumina deactivated with Na_2SO_4 and with KCl, as well as a range of porous polymers with varying degrees of polarity.

The differences in selectivity of numerous types of Thermo Scientific TracePLOT columns are demonstrated by the differences in the separation of light hydrocarbons in a refinery gas sample.

Results

FIGURE 1. TracePLOT™ TG-BOND Alumina Na_2SO_4- Refinery Gas



1. Methane
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3. Ethylene
4. Propane
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6. Isobutane
7. n-Butane
8. Propadiene
9. Acetylene
10. trans-2-Butene
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12. Isobutylene
13. cis-2-Butene
14. Isopentane
15. n-Pentane
16. 1,3-Butadiene
17. trans-2-Pentene
18. 2-Methyl-2-butene
19. 1-Pentene
20. cis-2-Pentene

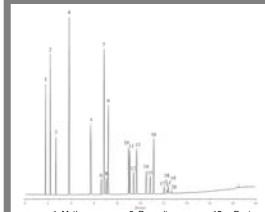
Instrument – Thermo Scientific TRACE GC Ultra

Column: TracePLOT TG-BOND Alumina Na_2SO_4, 30m x 0.53mm ID x 20um
Sample – Refinery Gas #5
Injection – 10µl (manual-syringe)
Split injection
Split flow - 52mL/min (Split ratio 13:1)
Liner – 3mm FocusLiner, straight, no glass wool
Injector Temperature - 200°C
Carrier Gas – Helium, Constant Flow at 4.0mL/minute
Oven Program - 50°C (2 min) - 200°C (3min) at 10°C/min
Detection – FID 250°C.

TracePLOT Alumina Columns

Alumina is often used for the analysis of volatile hydrocarbons due to its selectivity which provides baseline resolution of most isomers at above ambient temperatures. The highly retentive nature of alumina requires that the surface be deactivated with inorganic salts such as sodium sulfate or potassium chloride to control retention.
Note the difference in selectivity between the alumina deactivated with Na_2SO_4 (Figure 1) versus the alumina KCl (Figure 2) deactivation. For example alumina Na_2SO_4 elutes propadiene and acetylene after butane while alumina KCl elutes acetylene before propadiene and butanes. Not shown in these chromatograms, alumina Na_2SO_4 elutes methyl acetylene (a.k.a. propyne) after 1,3-butadiene, while alumina KCl elutes methyl acetylene before 1,3-butadiene.

FIGURE 2. TracePLOT TG-BOND Alumina KCl - Refinery Gas



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Instrument – TRACE™ GC Ultra

Column: TracePLOT TG-BOND Alumina KCl, 30m x 0.53mm ID x 20um
Sample – Refinery Gas #5
Injection – 10µl (manual-syringe)
Split injection
Split flow - 52mL/min (Split ratio 13:1)
Liner – 3mm FocusLiner, straight, no glass wool
Injector Temperature - 200°C
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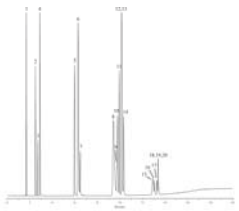
TracePLOT Porous Polymer Columns

Three porous polymer PLOT columns were used for the analysis of a refinery gas sample. TracePLOT TG-BOND Q+ (Figure 3) is a porous divinyl benzene homopolymer of intermediate polarity incorporating a lower amount 4-vinyl pyridine into the polymer. TracePLOT TG-BOND S (Figure 4) is a midpolarity divinylbenzene incorporating higher amount of 4-vinyl pyridine. TracePLOT TG-BOND Q (Figure 5) is a non-polar 100% divinylbenzene polymer. These three different types of porous polymers show significant changes in elution order as compared to the two alumina PLOT columns. This would be useful for purity analysis of a specific hydrocarbon in situations where an impurity elutes after the main peak of interest on an alumina column, which can cause in the impurity to be overrun by the main peak, resulting in co-elution. The differences in selectivity between these columns does not result in elution order changes between these three porous polymer PLOT columns, but there are differences in separation factor for many of the components.

FIGURE 3. TraceGOLD TG-BOND Q+ - Refinery Gas



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18. n-Pentane
19. cis-2-Pentene
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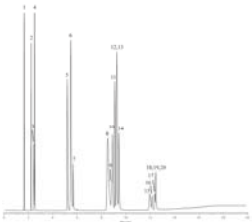
Instrument – TRACE GC Ultra

Column: TracePLOT TG-BOND Q+, 30m x 0.53mm ID x 20um
Sample – Refinery Gas #5
Injection – 10µl (manual-syringe)
Split injection
Split flow - 52mL/min (Split ratio 13:1)
Liner – 3mm FocusLiner, straight, no glass wool
Injector Temperature - 200°C
Carrier Gas – Helium, Constant Flow at 4.0mL/minute
Oven Program - 50°C (2 min) - 200°C (3min) at 10°C/min
Detection – FID 250°C

FIGURE 4. TraceGOLD TG-BOND S - Refinery Gas



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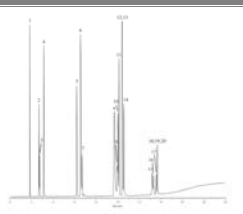
18. n-Pentane
19. cis-2-Pentene
20. 2-Methyl-2-butene

Instrument – TRACE GC Ultra

Column: TracePLOT TG-BOND S, 30m x 0.53mm ID x 20um
Sample – Refinery Gas #5
Injection – 10µl (manual-syringe)
Split injection
Split flow - 52mL/min (Split ratio 13:1)
Liner – 3mm FocusLiner, straight, no glass wool
Injector Temperature - 200°C
Carrier Gas – Helium, Constant Flow at 4.0mL/minute
Oven Program - 50°C (2 min) - 200°C (3min) at 10°C/min
Detection – FID 250°C.

FIGURE 5. TraceGOLD TG-BOND Q - Refinery Gas



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Instrument – TRACE GC Ultra

Column: TracePLOT TG-BOND Q, 30m x 0.53mm ID x 20um
Sample – Refinery Gas #5
Injection – 10µl (manual-syringe)
Split injection
Split flow - 52mL/min (Split ratio 13:1)
Liner – 3mm FocusLiner, straight, no glass wool
Injector Temperature - 200°C
Carrier Gas – Helium, Constant Flow at 4.0mL/minute
Oven Program - 50°C (2 min) - 200°C (3min) at 10°C/min
Detection – FID 250°C

Conclusions

- Separation of saturated, unsaturated and branched chain light hydrocarbons such as those found in refinery gases is best accomplished on deactivated alumina PLOT columns.
- Porous polymers PLOT columns offer a different selectivity and elution order for refinery gas components versus alumina which may be useful for purity analysis of individual hydrocarbons.

For additional information, please visit our Chromatography Resource Centre which can be found at: www.thermoscientific.com/chromatography

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