

Simultaneous and Rapid Separation of Blood-Alcohol Compounds and Commonly Abused Inhalants by Headspace-Gas Chromatography

Author:
Timothy D. Ruppel

PerkinElmer Life and
Analytical Sciences
710 Bridgeport Avenue
Shelton, CT 06484

Introduction

The separation and identification of blood-alcohol compounds from bodily fluids is quite common in law-enforcement cases which involve driving a motor vehicle while under the influence of alcohol. This procedure typically involves the extraction of the volatiles by equilibrium headspace sampling and separation by gas chromatography. The analysis is typically performed with baseline resolution in 1.5-2 minutes per sample. This allows high sample throughput of 500 samples or more per day.

Cases which involve the use of paints and glues containing common solvents as inhalants also influence driving and require different conditions for separation and identification by gas chromatography. At isothermal temperatures, higher boiling solvents with retention times of toluene and the xylene compounds may take 10-15 minutes to elute. Using oven temperature programming elutes toluene and the xylene compounds in about 6 minutes but requires an additional 3-4 minutes

to cool the oven back down to starting temperature before the next analysis can begin. The period from injection to injection remains high at about 10 minutes per sample, drastically reducing total throughput of samples. Inhalants often comprise less than 10% of impaired driving samples, but without the elution of unsuspected inhalant compounds from the chromatographic column, their elution would be carried over into the next injection, altering or confusing the next sample with extraneous peaks. Additional analyses would have to be performed to isolate the inhalants and re-running the sample compromised by co-elution, again reducing total throughput of samples.

The proposed method separates all blood-alcohol compounds and the most commonly abused inhalants with a period from injection to injection (PII) of less than 2 minutes. In this manner, all samples can be routinely analyzed for blood-alcohol compounds and inhalants with high throughput efficiency.

Experimental

Table 1. Instrument Conditions

Gas Chromatograph:	Clarus® 500 GC
Column:	BAC1 15 m x 250 μ x 1.4 μ
Carrier Gas:	Hydrogen carrier gas, hydrogen generator preferred: 5 psi (1 min) 100 psi/min to 60 psi
Oven Temperature:	70 °C
Injector:	Capillary Split Injector – 150 °C, Programmable Pneumatics in pressure mode
Detector:	Flame Ionization Detector (FID) – 240 °C
Split Flow:	10 mL/min
Headspace Sampler:	TurboMatrix™ HS 110
Oven Time:	10 min
Pressurization Time:	1.0 min
Injection Time:	0.04 min
Oven Temperature:	70 °C
Needle Temperature:	110 °C
Transfer-Line Temperature:	120 °C

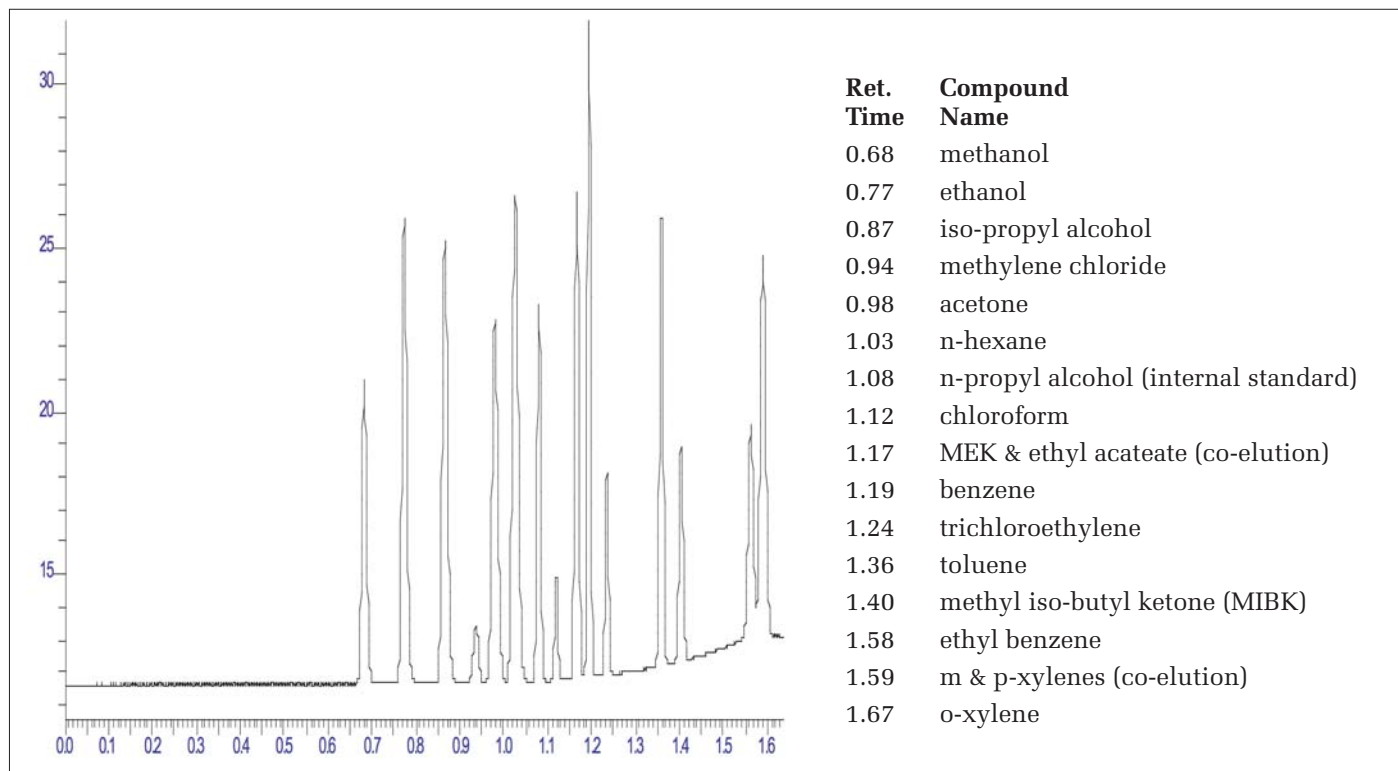


Figure 1. Example chromatogram of blood-alcohol and inhalants standard, illustrating run time of less than 2 minutes.

Results

The initial chromatographic separation takes place at a lower linear gas velocity to elute the blood-alcohol compounds. As the early alcohols elute, the column temperature is held isothermal but the carrier pressure is programmed rapidly to a higher pressure. The separation of all compounds has been completed inside the column within the first minute. The rapid carrier linear gas velocity just forces them to elute from the column quicker but without temperature programming. At the end of each chromatogram, the oven does not need time to cool and re-equilibrate. Only the carrier-gas pressure needs to go back to its starting point. That is accomplished in a matter of just a few seconds, allowing another sample injection every 2 minutes.

Conclusions

This method allows the rapid analysis of bodily fluids for blood-alcohol compounds and common inhalants. The rapid analysis is the result of the combination of several techniques:

- The shorter column (15 m vs. 30 m) will shorten the analysis time by a factor of two with only minimal reduction to resolution.
- The key to the rapid analysis is to allow the initial separation to be accomplished inside the column stationary phase followed by pressure ramping of the carrier gas to rapidly elute the remaining compounds isothermally.
- The use of hydrogen as carrier gas preserves resolution over a very wide velocity range. Hydrogen as carrier gas also allows for the analysis to be performed with only a hydrogen generator and air compressor, so no tank gases are necessary to rent or change.

In summary, a combination of optimized parameters with a programmed pressure increase yields productivity increases and increases confidence in peak identification.

PerkinElmer Life and
Analytical Sciences
710 Bridgeport Avenue
Shelton, CT 06484-4794 USA
Phone: (800) 762-4000 or
(+1) 203-925-4602
www.perkinelmer.com



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