

# Detection and Identification of Accelerants in Arson Studies by Fast Gas Chromatography

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## Overview

### Purpose:

Examine the applicability of fast gas chromatography in the detection and identification of accelerants in arson studies.

### Methods:

Samples are incubated in an oven. A 150  $\mu$ L static headspace fraction is collected using a gas tight syringe and injected into a 100 % dimethyl polysiloxane 20 m-0.1 mm-0.1  $\mu$ m column. The analysis is performed in split mode using a split ratio of 1:125.

Detection is performed with a flame ionization detector (FID) and ChromCard™ software. Remote data acquisition and review occur via a computer network.

### Results:

The accelerants are analyzed and detected in a fraction of the time of typical analytical technique. Optimization steps of the translation from conventional chromatography to fast chromatography are also presented.

## Introduction

Concrete scientific evidence has become of prime importance in investigation: State police force divisions specialized in scientific investigations were founded for this purpose.

In 1987, The Criminal Research Institute of the 'Gendarmerie Nationale' (IRCGN) was founded in France. The main activities of the Arson unit of the ECX department (Environment, Arson, Explosive) are field investigation and laboratory identification of flammable products, which can be found in fire debris sampled on crime scenes.

The Arson unit identifies and compares petroleum fractions using databases, and they examine ignition systems, as well as conduct investigations on burned locations in order to determine source and cause of accidents. Flammable substances used for igniting, facilitating or propagating a combustion are most often in the liquid or solid state, gelatine, or oil. Most commonly used are acetone, methylated spirits, gas oil, and high-octane petrol.

A typical sample analysis is performed in two steps: the first consists of the research of light molecules (up to C15) by head space technique; the second involves heavy hydrocarbons determination (from C13 to C36) by liquid extraction with pentane.

This application note reports the study over the light fraction which, under conventional gas chromatography, (100 % dimethyl polysiloxane column, 50 m-0.2 mm-0.5  $\mu$ m) takes up to 38 minutes.

Fast chromatography performed by the Thermo Scientific FOCUS™ GC (Figure 1), however, allows for a reduction in analysis time by a factor of 5, thus increasing laboratory productivity.



Figure 1: FOCUS GC: a compact GC using conventional column cage dimensions.

## Methods

Samples examined are commonly in the solid state. Volume used is roughly 300 mL, stored in a jar where an Internal Standard - Tetradecane (C14) is also added.

The jar is then incubated 45 minutes at 90 °C. 150  $\mu$ L of the Head Space sample are injected into a Split/Splitless injector with a split ratio of 1:125 through a 1 mm i.d. liner. The injector temperature is kept isothermal at 200 °C. Temperature program is re-optimized, setting isotherms and temperature gradient 5 times shorter than conventional methods.

## Key Words

- FOCUS GC
- Accelerants, Fire, and Arson
- Fast Chromatography
- Optimization
- Head Space

After an initial isotherm at 35 °C for 0.5 minutes, the oven temperature is programmed to reach the final value through a multi-step ramp: 5 °C/min to 45 °C, 25 °C/min to 70 °C, 45 °C/min to 170 °C, and 70 °C/min to 250 °C with isothermal hold for 0.5 minutes. Carrier gas is programmed in constant flow mode at 0.4 mL/min. Data acquisition and file review using ChromCard software are all controlled remotely via an ethernet card and a computer network.

### Experimental: Fast Chromatography Optimization

For optimum results, a shorter and narrower column must be chosen: 10 m or 20 m according to the complexity of the chromatogram. The selection of a 0.1 mm-0.1 µm as i.d. and determination of phase thickness are good starting points for the fast chromatography optimization process.

The use of shorter and narrower columns, however, strongly reduces the overall column capacity. Hence, the volume introduced must be adjusted to avoid loss of separation efficiency. Figures 2 and 3 show the influence of split ratio (Figure 2) and injected volume (Figure 3) on resolution.

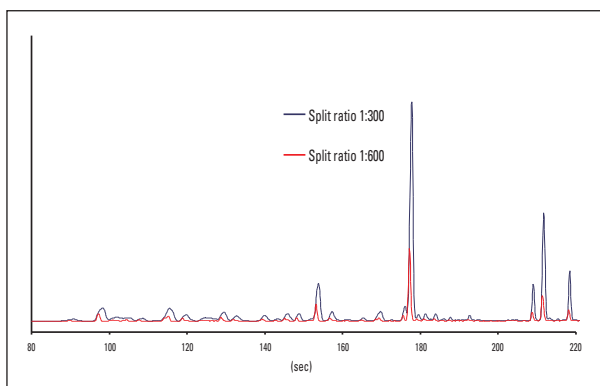


Figure 2: Influence of sample amount on resolution is demonstrated by different split ratio: 1:300 and 1:600 for 1 mL of Head Space fraction injected.

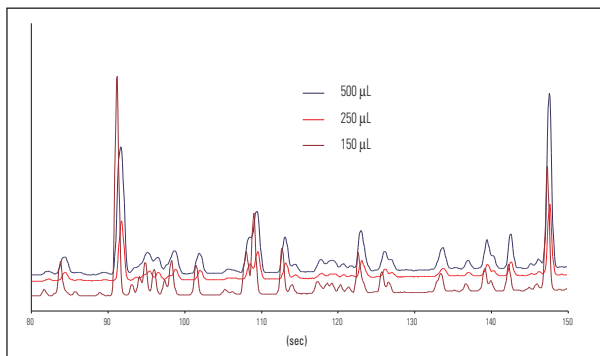


Figure 3: Influence of sample amount on resolution is demonstrated by different volumes of Head Space fraction injected: 500 µL, 200 µL and 150 µL.

Resolution of the lightest is directly dependent on liner i.d. (Figure 4).

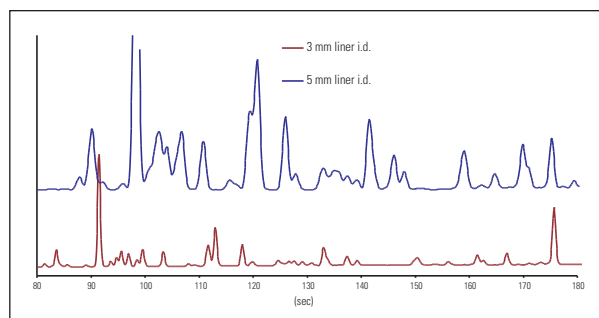


Figure 4: Influence of liner internal diameter on resolution is demonstrated: 5 mm and 3 mm used.

### Results

Figure 5 shows the high octane petrol analysis using conventional chromatography along with the same analysis optimized using fast GC.

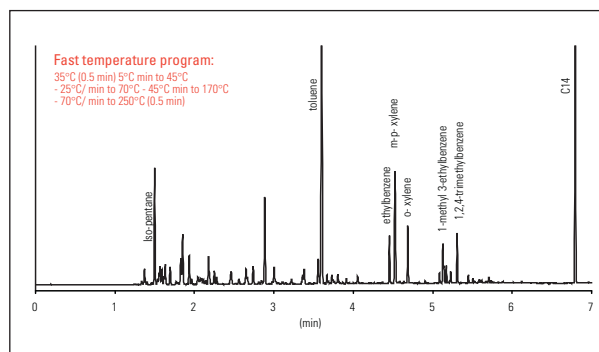
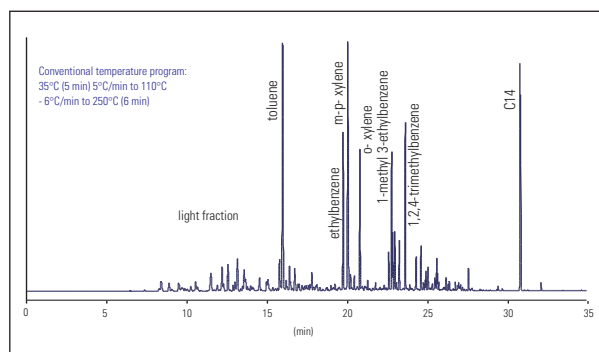


Figure 5: A direct comparison is shown of the high octane petrol standard using a conventional column and oven temperature program with the fast analysis.

Chromatographic profiles obtained by fast chromatography (Figure 6) are specific for each accelerant. Relative molecule proportions and retention time are used for positive identification.

These profiles also allow semi-quantitative evaluation of the amount of accelerants present in the material sampled on the crime scene.

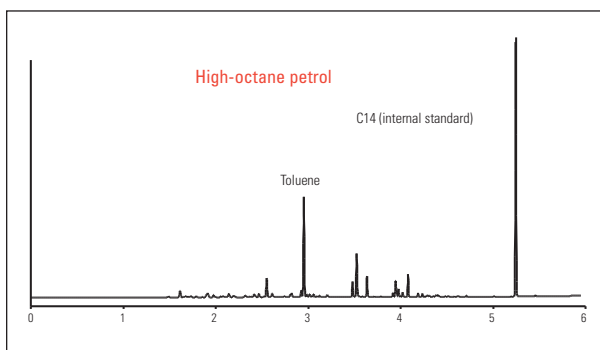
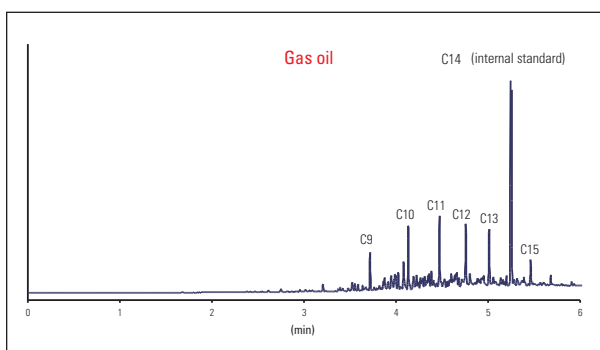
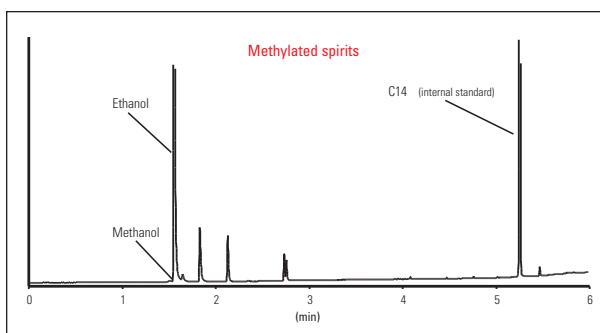
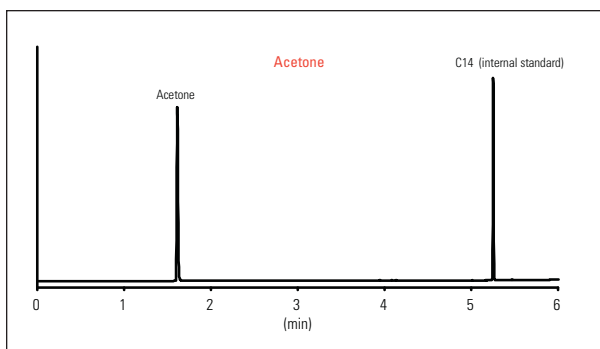


Figure 6: Chromatograms under fast GC of the 4 principal accelerants: acetone, methylated spirit, gas oil, and high octane petrol.

## Conclusions

Analysis, detection, and identification of accelerants in arson studies are indeed applicable in fast chromatography. Results are acquired in a fraction of the time of typical analytical techniques under conventional chromatography. Moreover, the applicability of a remote control via an ethernet card and a computer network open future prospects in the practice and automation of fast GC analyses.

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