D43 Analysis of Ignitable Liquids in Fire Debris With Comprehensive Two-Dimensional Gas Chromatography-Mass Spectrometry (GCxGC/MS)

Glenn S. Frysinger, PhD, and Richard B. Gaines, PhD, Department of Science, U.S. Coast Guard Academy, 27 Mehegan Avenue, New London, CT*

The goals of this presentation are to discuss a new analytical technique, comprehensive two-dimensional gas chromatography-mass spectrometry (GCxGC/MS), for the forensic analysis of fire debris samples.

Comprehensive two-dimensional gas chromatography (GCxGC) is a new analytical technique with a demonstrated capability to separate and identify ignitable liquid compounds in complex fire debris samples. The increased separation capability of GCxGC represents a significant analytical advantage over traditional gas chromatography (GC) and gas chromatography-mass spectrometry (GC/MS) methods for fire debris samples containing abundant pyrolysates. In traditional GC analysis, chromatograms of the fire debris extract are used as a fingerprint to determine if a particular ignitable liquid is present. However, the determination is often impossible if an abundant pyrolysate background obscures the chromatogram. GC/MS methods improve detection because extracted ion chromatograms may be used to isolate specific ignitable liquid compounds like alkylbenzenes. The enhanced chromatographic separation achieved with the new analytical technique of comprehensive two-dimensional gas chromatography and the unambiguous identification provided by mass spectrometric detection permit the rapid detection and identification of the full range on chemical compounds present in ignitable liquids.

GCxGC uses two different chromatography columns coupled serially by a modulator to produce a volatility-by-polarity separation and distribute compound peaks across a two-dimensional retention time plane. The two-dimensional separation produces hundreds- to thousands of resolved peaks, a significant improvement over traditional GC separations. The two-dimensional separation yields a two-dimensional image that is well suited for fingerprinting. In addition, the grouping or ordering of the peaks in the GCxGC chromatogram facilitates the iden- tification of specific compounds unique to ignitable liquids against a complex chemical background of fire debris pyrolysates. When coupled with a mass spectrometer detector, the GCxGC/MS method produces a single-component, interference-free mass spectrum for each resolved peak that leads to accurate matching with mass spectral libraries.

GCxGC/MS methods were used to produce a library of chromatograms for different petroleum-based ignitable liquids as well as chromatograms of pyrolysates for common fire debris materials. GCxGC/MS chromatogram images were used to rapidly detect and classify ignitable liquids in fire debris samples.

Arson Analysis, Fire Debris, Analytical Chemistry

 ** Presenting Author*