



K37 Applications of Fire Debris Analysis to Problems in Toxicology

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After attending this presentation, attendees will understand how methods and procedures used in one of the disciplines of trace evidence, fire debris analysis, applies to problem solving in toxicology. Attendees will learn of methods and solvents to use with a case example showing the usefulness of the application.

This presentation will impact the forensic community by describing how methods and procedures in fire debris analysis could be useful to the toxicologist in certain cases. Cooperation between laboratory sections brings results unattainable by staying with existent expertise in a section. The static adsorption-elution approach should be considered by toxicologists when faced with volatile or ignitable liquid substances.

Toxicologists often use liquid-liquid or solid phase extraction to solve the majority of their case work. When faced with a poisoning case where the agent is gasoline, charcoal starter fluid, or other ignitable liquids, these typical methods fail. Ignitable liquids consist of various mixtures of alkanes, isoparaffins, aromatics, and cycloparaffins. These hydrocarbons would extract with tissue matrix consisting of fats, proteins, and cellular decomposition products soluble in organic solvents. These co-extracting matrix compounds could mask or interfere with interpreting the ignitable liquid chromatograms.

Fire debris analysts have similar problems separating the ignitable liquids from condensed pyrolysates and post-burn residues which extract similarly. By using the static adsorption-elution (SAE) method borrowed from industrial hygienists and used in fire debris analysis, a majority of the matrix materials can be separated from the compound(s) of interest. To capture the volatiles, the method uses activated charcoal strips and warming the sample to approximately 65 °C.

To elute the captured liquid, an appropriate solvent such as carbon disulfide (CS₂) or n-decane can be used depending on the anticipated analyte(s). Most ignitable liquids will elute after CS₂ allowing the analyst to categorize the captured liquid without the solvent interfering. Using a GC-FID or GC/MS with a DB-1 column (or equivalent) with a length of 15 meters, 0.25mm diameter and 0.25µm film thickness, the GC method ranges from 40° C to 300° C for typical samples, with a 2 minute hold at the lower and upper limits. A rapid 25° per minute ramp rate allows for a short 14.4 minute analysis. Inject 1 µL of the eluted liquid. The MS is turned on at injection, turned off just before the CS₂ solvent elutes, and then turned on immediately after CS₂ elutes until the end of the run. Comparison of the resulting total ion chromatogram and extracted ion chromatograms against n-alkane series and previously categorized laboratory standards of consumer ignitable liquids analyzed on the same instrument will permit classification of the ignitable liquid according to ASTM E-1618.

If the potential liquid consists primarily of low boiling compounds, a later eluting solvent such as n-decane would be suggested. Use an isothermal temperature program at low temperatures (e.g., 35° C) with the MS active from the time of injection until just before the n-decane (or other chosen solvent) elutes. Using different analytical strategies can improve detection of the volatile analytes of interest. The method can be used to determine the presence of toluene and similar compounds in huffing cases.

In one case of petroleum consumption suicide, the SAE method with CS₂ was used. The male decedent a one-gallon and a one-quart paint thinner cans in his vehicle nearby. No trauma or significant levels of drugs were found. The SAE method was used to extract the lung, liver, brain, stomach contents, blood, and vitreous fluid then analyzed by GC-FID and GC/MS. The blood and vitreous did not have recognizable chromatograms. The chromatograms of the lung, liver, stomach contents, and brain eluted from the octane (C₈) to the dodecane (C₁₂) n- alkanes with at least two significant n-alkane peaks, and unresolved compounds creating a Gaussian like peak over the C₈ to C₁₂ range which was categorized in the medium petroleum distillate category. Many paint thinners are included in this category. The lung, liver, and brain each showed slight variations in their chromatograms from each other and the stomach contents. Close inspection of the stomach contents chromatograms with the liquid from each paint thinner can from the car revealed the decedent likely drank from the one-gallon container. A comparison against corresponding tissues from non-petroleum consumption deaths showed no similar compounds naturally occurring. The death was ruled a suicide by consumption of the paint thinner.

Using the SAE method can help extract volatile liquids cleanly from most toxicological matrix materials. Accomplishing identification or categorization of the captured liquid can be performed easier with a chromatogram containing fewer matrix peaks.

Ignitable Liquid, Toxicology, Analysis