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NIJ and the University of Central Florida

Fire Research: Identifying Ignitable Liquids in Debris and Providing Error Rates to Strengthen Testimony

Moving Knowledge from Research to Impact

"This technique provides an alternative objective method for classifying ignitable liquid residues, providing one of the only viable options for helping to progress fire debris analysis beyond a subjective comparison technique."

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Synopsis of Problem and Solution

Determining the presence of ignitable liquid residue among the fire debris in an arson investigation is a complicated forensic problem. Most ignitable liquids commonly encountered consist of multiple chemical constituents, and the presence of these liquids is masked by significant background interferences from combustion and pyrolysis of building materials and other objects involved in the fire.

Dr. Michael Sigman and Mary Williams from University of Central Florida developed a method for analyzing fire debris samples that are highly contaminated with pyrolysis interferences. The method averages mass spectra across an entire chromatographic run, and can effectively classify ignitable liquids according to the widely accepted ASTM International (ASTM) classification scheme.

Fire debris analysts currently provide opinions as to whether or not a sample is positive for ignitable liquid residue without stating a known error rate for the assessment. Use of this new method could help analysts estimate an objective measure of confidence based on established statistical models. As the field of forensic science turns to greater accountability and scientific basis for opinions, this new method provides analysts with more confidence that their assessment is based on scientific principles.

Benefits

- Demonstrates the use of a relatively simple algorithm to provide an objective measure of confidence when assigning the ASTM classification scheme to ignitable liquid residues
- Identifies the presence of ignitable fluid in the most challenging samples correctly 80 to 85% of the time
- Provides an approach to obtain error rates in fire debris analysis in support of a Daubert challenge
- Provides a more quantitative, scientific approach to fire debris analysis that may be more accepted in the courtroom than a subjective comparison

The Future

The National Center for Forensic Science at UCF maintains a website (https://ncfs.ucf.edu/research/physical-evidence/fire-debris/) that informs the public of ongoing and future research in the area of fire debris analysis. Highlights of this future work include

- Development of software that compares a fire debris sample to reference ignitable liquids and substrate materials
- Studies on the use of statistical data analysis methods for the classification of ignitable liquid residues, such as a combined method of TFA with a Bayesian classifier, linear discriminant analysis, quadratic discriminant analysis, soft independent modeling of class analogy (SIMCA), and self-organizing feature maps (SOFM)
- Use of hierarchical cluster analysis to investigate whether ignitable liquids group together according to the classification scheme outlined by ASTM E1618
- Investigation on the ability to determine the likelihood of an ignitable liquid residue being present in fire debris
- Enhancements to the International Database of Ignitable Liquids (http://ncfs.ucf.edu/internationaldb/?design=ILRC1)

NIJ-Funded Research

Dr. Michael Sigman, at the University of Central Florida, was awarded NIJ funding to develop a chemometric data analysis method to facilitate the identification of gas chromatography-mass spectral patterns associated with ignitable liquid classes. His research group developed a novel method based on target factor analysis (TFA) and Bayesian decision theory that classifies ignitable liquid residue in the presence of background interferences found in fire debris.

Bringing Research to Practice

- Results of this work have been published in *Forensic Science International* and the *Journal of Forensic Sciences* and presented at numerous chemistry and forensic conferences throughout the United States and internationally.
- The approaches for comparing unknowns to the ASTM ignitable liquid classification scheme are robust, relatively easy to implement and defend, and have the benefit of being supported by the most comprehensive and open-source ignitable liquid databases in existence.
- Patent US 8706426 B2 for "Classification of a Complex Mixture, or Components of a Complex Mixture, by Combining Target Factor Analysis with a Bayesian Classifier" was issued in 2014.

More Information

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