A148 Effects of Matrix Interference, Weathering, and Thermal Degradation on the Association of Ignitable Liquid Residues to Neat Ignitable Liquids

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After attending this presentation, attendees will understand the use of objective multivariate statistical procedures for the identification of ignitable liquid residues (ILRs) in simulated fire debris. A combination of Pearson Product Moment Correlation (PPMC) coefficients, principal

components analysis (PCA), and hierarchical cluster analysis (HCA) are used to demonstrate the identification of ILRs in the debris despite the presence of matrix interferences, weathering effects, and thermal degradation.

This presentation will impact the forensic science community by providing a more objective method for the analysis of fire debris, which will help to minimize the chance of misidentifying the presence or the absence of an ignitable liquid. This method also provides a statistical means of assessing the association of the ILR to the neat liquid. Such statistical associations are consistent with the recommendations made by the recent National Academy of Sciences report.

Gas Chromatography - Mass Spectrometry (GC-MS) is a very common technique used in the analysis of fire debris. This type of analysis aims to associate an ILR extracted from the debris to a neat liquid in a reference collection by a visual examination of the resulting chromatograms. However, the association of the ILR to the neat liquid can be affected by factors such as matrix interferences and weathering of the ignitable liquid. Thus, the interpretation of chromatographic data gained from GC-MS analysis can be both challenging and subjective.

This research aims to develop an objective method for associating the ILR to the neat liquid using three multivariate statistical procedures:

(1) PPMC coefficients; (2) PCA; and, (3) HCA. PPMC coefficients are used to place a numerical value on the similarity of two chromatograms, while PCA is used to discriminate between samples by identifying the greatest source of variance among the samples, allowing for both discrimination and association. In this research, HCA is used to provide a statistical measure of the discrimination and association shown in the PCA data. The combination of several statistical procedures maximizes the potential of successful associations between ILRs and neat liquids, while enabling a statistical measure of the associations.

The first step of this research was to investigate interferences caused by common household matrices. Four matrices (e.g., nylon carpet, upholstery, denim, and glossy magazine paper) were charred using a propane blow torch for different amounts of time ranging from 10 to 120 seconds. The matrix was placed in a nylon bag and extracted using a passive headspace extraction procedure with activated carbon strips, which were then analyzed by GC-MS. The burn time for future experiments was chosen as the time that generated the maximum amount of matrix interference, based on a visual examination of the chromatograms.

Next, the effect of matrix interferences on the association of evaporated liquids to corresponding neat liquids was investigated. Three ignitable liquids (gasoline, kerosene, and diesel) were evaporated to 10% and 90% by volume. The evaporated liquids and the neat liquids were spiked onto separate burned subsamples of each matrix. Spiking the liquids onto the already burned matrix ensured that only the effects of weathering were being investigated, with no contribution from thermal degradation due to burning. A combination of the multivariate statistical procedures provided a statistical measure of the association and discrimination of the evaporated liquid with matrix interferences to the corresponding neat liquid.

In addition to the effects of matrix interferences and evaporation, the effects of thermal degradation on the ability to associate an ILR to the corresponding neat liquid were also investigated. Fire debris was simulated by spiking separate samples of each of the four matrices with each of the three neat liquids. The matrices were then burned to generate significant matrix interferences. The simulated ILR was extracted and analyzed as previously described. PCA, PPMC coefficients, and HCA showed that simulated ILRs can be associated to a neat liquid, despite thermal degradation and evaporation of the liquid, as well as the presence of matrix interferences.

Arson, Multivariate Statistics, Ignitable Liquids

