A171 Multivariate Pattern Recognition Analysis of Petroleum Based Accelerants

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After attending this presentation, attendees will be introduced to the application of statistical and mathematical tools to interpret gas chromatographic patterns derived from petroleum based products commonly employed in arson.

This presentation will impact the forensic science community by demonstrating the feasibility of utilizing multivariate pattern recognition techniques to discriminate petroleum based ignitable liquids by type and brand. This study reveals that the ability of some multivariate technique to link evaporated petroleum products back to unevaporated constituents.

In fire investigations, petroleum distillate products are commonly used as liquid accelerants by the arsonist to initiate and promote the spread of fire. The use of such products is reported in many arson cases, thus discrimination and identification of these samples are of forensic interest. At present, sample classification is based on a visual comparison of a given sample to reference standards. The application of multivariate pattern recognition to discriminate and classify liquid accelerants sample has the potential of making this process rapid, less subjective and more conclusive.

Application of GC-MS for ignitable liquid analysis provides very large datasets from chromatographic and mass spectral profiles. In their original form, this information is hard to relate to; however, these data can be more easily comprehended when processed using multivariate analysis such as the Principal Component Analysis (PCA), Hierarchical Cluster Analysis (HCA) and Self Organizing Feature Map (SOFM). These computerized pattern recognition methods generally improve the visualization of large numerical datasets by presenting them in a simpler graphical form. The use of these techniques can be extended to compare, classify, and possibly link samples to potential common origins because they are able to establish underlying discriminating relationships within a complex dataset.

A set of petroleum based ignitable liquid samples from various classes designated by the ASTM classification scheme were obtained. These samples were evaporated to different evaporation degrees (from 10% weathered to 95% weathered) in order to build a database that captured the compositional changes of the samples. Samples were analysed by Gas chromatography-mass spectrometry (GC-MS) and characteristic peaks from the total ion chromatograms (TICs) were selected as variables for data processing.

Principal Component Analysis (PCA) and Hierarchical Cluster Analysis (HCA) were employed. Both of these multivariate techniques are commonly reported in studies relating to classification and discrimination of ignitable liquids. Data were also subjected to artificial neural network analysis, using Self Organizing Feature Map approach and the results were compared.

This work has shown that the the best overall discrimination within and between the samples was achieved when chromatographic data was pre-processed using the normalised fourth root power transformation. Results obtained with SOFM, when compared to PCA and HCA provided more useful and distinctive where the weathered and unweathered constituents from the same product were grouped together. Visualisation of SOFM results are also easier to digest than PCA and HCA.

Pattern Recognition, Ignitable Liquid, Arson

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