B132 Individualization of Gasoline by Gas Chromatography/Mass Spectrometry and Covariance Mapping

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After attending this presentation, attendees will learn results from a study on the use of a covariance mapping method to discriminate between fresh gasoline samples collected from a single geographical area.

This presentation will impact the forensic community and/or humanity by demonstrating an approach to discrimination of non-biological physical evidence samples at a known statistical certainty of Type I errors, while controlling the probability of a Type II error at less than 1%.

Ten gasoline samples from various gas stations in the Orlando Florida area were collected and analyzed in triplicate by gas chromatography/mass spectrometry. The analyses followed the ASTM E 1618-01 standard test method for the identification of ignitable liquid residues from fire debris samples. A covariance mapping technique combined with a t-test statistic was utilized to differentiate the gasoline samples from one another. A covariance matrix for each sample was calculated from the retention time-ion abundance data obtained from the gas chromatography-mass spectrometry data. Distance metrics were calculated between the covariance matrices of the same-sample replicate analyses (30 analyses) and the different-sample analyses (405 analyses). The same-sample and different-sample analyses were shown to comprise two distinct populations with significantly different average distances and standard deviations. The significance of the differences between the populations was determined based on a statistical t-test. A power analysis was performed to determine the number of analyses required to discriminate between two samples while maintaining a probability of a Type II error (ß) occurring below 1%. Based on the power analysis results, the triplicate analyses of two samples was shown to be sufficient to discriminate the samples using a t-test while keeping ß less than 0.01 at a significance level, α of 0.05. Analysis of the 45 possible pair-wise comparisons between the gasoline samples found that 100% of the samples were statistically distinguishable from one another with no Type II errors occurring. Blind tests were conducted with two of the 10 gasoline samples presented as unknowns. The two unknowns were compared against the 10 known samples of gasoline using the distance metric. One of the unknowns was found to be undistinguishable from the corresponding sample from the original set (i.e. the unknown was correctly identified). In the other case, the unknown was found to differ from the original sample constituting a type I error. The results of these tests offer a new way for forensic scientists to discriminate between unaltered gasoline samples, those which are not evaporated, degraded by microorganisms or contain interfering products from fire debris. The statistics for the test offer known error rates, which are controlled by the experimental design. The results demonstrate a statistically acceptable method oh physical evidence comparison in forensic science.

Covariance Mapping, Gasoline, Gas Chromatgraphy/Mass Spectrometry

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