B125 The Effects of Adsorption-Based Extraction Methods on the Recovery of Aliphatic and Aromatic Compounds in Medium Petroleum Distillates

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Following this presentation, the attendee will have a greater understanding of the following: (1) the importance of relative aliphatic:aromatic concentrations in classifying medium-range petroleum products; (2) how adsorption-based extraction methods can affect these ratios with respect to the recovery of a medium petroleum distillate from simulated fire debris; and (3) the effects of ignitable liquid concentration on the aliphatic:aromatic ratios.

This presentation will assist examiners in understanding the phenomena associated with the extraction process and how it may skew data. This knowledge may ultimately assist in minimizing the likliehood of false inclusions or exclusions when comparing data.

Classification of ignitable liquids in accordance with voluntary consensus-based standards published by the American Society of Testing and Materials has become increasingly specific, relying upon both the chemical composition and the boiling point range of submitted ignitable liquids. Specifically, the classification of petroleum distillates and dearomatized petroleum distillates has been distinguished, such that each represents a distinct class.

In the first part of this study presented in 2003, the compositions of a variety of medium-range ignitable liquids were examined with regard to their relative proportions of aromatic and aliphatic content, as represented through the use of extracted ion profiles (EIPs). A variety of commercially available products in the medium range exhibit a broad range of compositions with respect to the proportion of aromatic compounds relative to the major aliphatic compounds present. It was shown that there are not separate and distinct ranges of aromatic content for dearomatized products, distillates, and blends; rather, there is a continuum.

This portion of the study examines how the extraction process affects the relative proportion of aliphatic and aromatic compounds recovered. Samples of simple and complex substrates were spiked with varying volumes of a medium petroleum distillate. These samples were then extracted in accordance with ASTM 1412-00 Standard Practice for Separation of Ignitable Liquid Residues from Fire Debris Samples by Passive Headspace Concentration With Activated Charcoal. Data was then examined to determine if the process of extracting the liquid from debris affected the relative proportion of aromatic and aliphatic compounds. Using data from the neat liquid for comparison, data from extracted samples were compared to note the effects of substrate type and volume of liquid. Examination of the data revealed that the primary factor affecting the recovery of aromatic and aliphatic compounds relative to one another was the concentration of ignitable liquid in the sample. A greater volume of medium petroleum distillate on the sample resulted in a greater recovery of aromatic compounds relative to aliphatic compounds. Also affecting the recovery and subsequent ratios was the nature of the debris. The more complex charred debris samples showed a greater relative recovery of aliphatic compounds compared with their recovery from a simple, non-charred substrate. These results are consistent with the hypothesis that competitive adsorption can alter aliphatic:aromatic ratios due to the fact that charred debris can provide sites for adsorption. This also further demonstrates that overloading adsorption sites can lead to skewing of data not only relative to boiling point as previously reported,[1] but also with regard to relative aliphatic:aromatic ratios. These factors studied which were found to affect recovery—amount of ignitable liquid present, and nature of sample substrate—are beyond the control of the laboratory analyst in actual casework. It is therefore incumbent upon the analyst to be aware of the significant effects of the extraction process when utilizing aliphatic:aromatic ratios in the classification process or when comparing data from extracted samples with one another or to data from a liquid source.

[1] Newman, RT, Dietz, WR and Lothridge, K. "The Use of Activated Charcoal Strips for Fire Debris Extractions by Passive Diffusion. Part I: The Effects of Time, Temperature, Strips Size, and Sample Concentration," (1996) *Journal of Forensic Science*, Vol. 41, No. 3, 361370.

Fire Debris Analysis, Extraction, Aromatic Content

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