B35 Weathering and Microbial Degradation of Ignitable Liquids

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The goal of this presentation is to help attendees understand the purpose of the updated Ignitable Liquid Reference Collection database, pattern recognition of a reference ignitable liquid when weathered and/or degraded, and see an example that ties together weathering and microbial degradation of a simple mixture.

This presentation will impact the forensic science community by presenting the updated database in regard to weathering and degradation and by demonstrating these mechanisms quantitatively on a simple mixture.

Fire debris evidence is important in arson investigations in regard to finding the origin and cause of a fire. Most ignitable liquids are complex mixtures composed of many organic compounds that are exposed to weathering and/or microbial degradation. With both of these mechanisms either simultaneously or individually affecting the ignitable liquid, it may be difficult for an analyst to assign class and subclass based on the criteria established by the American Society for Testing and Materials (ASTM) E1618. In this research, a simple mixture was made from 14 known compounds which are commonly found in different ASTM classes and was made to undergo both weathering and microbial degradation. Each compound was degraded separately to see if any by-products that formed would coincide with compounds that may normally be present in a complex ignitable liquid. Additionally, a quantitative assessment was performed to observe and record the relative rates of degradation of the compounds found in the simple mixture. The purpose of this research was to measure the effects on a simple liquid mixture as a result of introducing soil containing bacteria. This research further quantifies the rate of compound degradation compared to the use of complex liquids which utilize pattern recognition that only indicates the presence or absence of a given compound or compound type.

Databases are designed and available, both in in-house laboratories and nationally, to aid investigators in connecting fire debris evidence to a potential source by comparing the total ion chromatograms and extracted ion profiles. The Ignitable Liquid Reference Collection (ILRC) has been extended to include examples of weathered and biologically degraded liquids from each ASTM class. The results of the weathering and biological degradation database will help investigators understand what components of the ignitable liquids are being recovered and which components are lost.

Passive-headspace adsorption/elution and gas chromatography/mass spectrometry methods were used in accordance with ASTM E1618. For weathering, 10 milliliters of an ignitable liquid were evaporated to the percentages 25%, 50%, 75%, 90%, and 95% using nitrogen gas. Twenty microliters of the weathered liquid were placed into a vial with one milliliter of carbon disulfide and analyzed. For the purpose of degradation, potting soil was spiked with an ignitable liquid in a quart-sized paint can, which was then sealed for a specified period of time (zero, two, seven, or 14 days). An activated charcoal strip was then placed in the can's headspace and heated in an oven at approximately 85ºC for approximately four hours. Once removed and cooled to room temperature, the strip was eluted using 500 microliters of carbon disulfide and analyzed.

The results of the weathered ignitable liquids were compared to the neat chromatograms in regard to what compounds were still present and if the ASTM classification was the same. Microbial degradation results revealed what compounds the bacteria prefer and comparison of the relative rates at which different compounds degrade. The results have been compiled into the ILRC to assist the analyst in visualizing the pattern of weathered and degraded samples based on evaporation percentages and time period of soil exposure. Results from the microbial degradation of a simple mixture reveal that no by-products were formed when the 14 components were tested separately for zero, seven, and 14 days. Experimental investigation of the quantitative losses of the components of a simple, but representative mixture of hydrocarbons through biological degradation is ongoing. This presentation will provide data representing the enhanced utility of the ILRC and quantitative results from the biological degradation of a simple mixture of hydrocarbons.

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