A141 The Effect of Microbial Degradation on Ignitable Liquids

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After attending this presentation, attendees will understand the concept of microbial degradation and how it affects fire debris analysis.

This presentation will impact the forensic community, the justice system by helping forensic chemists to identify degraded ignitable liquids.

The identification of ignitable liquids at the scene of a suspicious fire is a crucial part of an arson investigation. Since ignitable liquids are hydrocarbon based, they can provide a source of energy for microorganisms, particularly in samples containing organic matter such as soil, vegetation or rotting wood. As these microorganisms selectively metabolize hydrocarbons over time, the ignitable liquid can become difficult or even impossible to identify. This is problematic for the forensic chemist as fire debris evidence is often stored for days, weeks or even months at room temperature before it is analyzed, which provides ample time for the microbes to consume the ignitable liquid.

Research to date has demonstrated microbial degradation of ignitable liquids such as gasoline, camping fuel, barbecue starter fluid, and diesel fuel. For example, significant decreases in many of the aromatic compounds in gasoline, such as toluene and 1,2,4-trimethyl benzene was reported after 2 days.[1] After 4 days, n-paraffins and other aromatic compounds were significantly degraded.[1] However, degradation appeared to be specific to n-alkanes and lesser-substituted benzenes, as 1,3,5-trimethyl benzene and isoparaffins were not degraded even after 60 days.[1] Microbiological studies have shown that microorganisms such as *Pseudomonas fluorescens biovarIII* actively consumes aliphatic hydrocarbons, while *Pseudomonas putida*, actively consumes aromatic hydrocarbons.[2] GC/MS studies of microbial degradation in gasoline also showed preferential degradation of smaller n-alkanes and mono-substituted aromatics. [3] In addition, toluene was more degraded than xylenes, and the ratio between 3-ethyl toluene and 1,2,4-trimethyl benzene was reversed.[3]

Soil studies will be presented that have been conducted using commercially available potting soil to track the microbial degradation that is suspected to occur in fire debris. Samples of gasoline, kerosene, diesel, fuel oil #2 (dyed), odorless lighter fluid, odorless mineral spirits, paint thinner, charcoal starter, and camping fuel were all chosen for initial studies. Soil was placed inside a quart-sized paint can and 20mL of ignitable liquid was added. After the can was allowed to sit for a set time period (0, 2, 7, 14 days) at room temperature, a carbon strip was suspended into the headspace of the sample. The can was then heated in an 85°C oven for 4 hours. After cooling to room temperature, the carbon strip was extracted with 300mL pentane and vortexed for 1 minute. The resulting solution was then analyzed by GC/MS (DB-5 column, 1 mL/min helium, 1mL injection volume, 20:1 split ratio, 250°C injection temperature, Oven: 40°C for 3.00 min, 10°C/min to 280°C, 3.00 min final hold, 3.00 min MS solvent delay, scan from m/z 40-300).

In initial studies using samples of weathered gasoline, selective degradation of n-alkanes, specifically octane, decane, and dodecane, was identified after two days, with decane being the most degraded. After seven days on potting soil, the ignitable liquids were almost completely degraded. In samples of fresh gasoline, hexane, octane, decane and dodecane showed significant degradation after two to seven days, with decane and dodecane showing the fastest degradation. Also, the peak height ratio between 3-ethyl toluene and 1,2,4-trimethyl benzene reversed after two days, in both weathered gasoline and fresh gasoline. In samples of kerosene, an ignitable liquid for which microbial degradation has not been studied, preferential degradation occurred with the lighter n-alkanes (C_{10}-C_{12}). In a standard ASTM hydrocarbon mixture, the smaller n- alkanes (C_8-C_{12}) were degraded more quickly than the larger n-alkanes (C_{14}-C_{18}). Also, toluene was degraded more than p-xylene and the ethyl toluenes were not significantly degraded. Samples of ignitable liquid recovered from sterile substrates (e.g., laboratory wipes and autoclaved soil) did not exhibit degradation.

References:

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