A178 A Comprehensive Study of Weathering and Microbial Degradation of Ignitable Liquids

Dee A. Turner, BS, IUPUI, Dept of Chemistry and Chemical Biology, 402 North Blackford St, LD 326, Indianapolis, IN 46237; John V. Goodpaster, PhD, IUPUI, FIS Program, 402 N Blackford St, LD 326, Indianapolis, IN 46202; and Mary R. Williams, BS, and Michael E. Sigman, PhD, Univ of Central Florida, NCFS, PO Box 162367, Orlando, FL 32816-2367*

After attending this presentation, attendees will understand the concepts of weathering and microbial degradation of ignitable liquids from all ASTM classes.

This presentation will impact the forensic science community by highlighting the major trends in bacterial degradation of various examples of ignitable liquids from each ASTM class.

An organic-rich substrate such as soil is an excellent source of carbon for bacteria. Since ignitable liquids are comprised of various hydrocarbons, soil bacteria can also utilize these fuels as a carbon source. Previous work completed in our laboratory on the biodegradation of ignitable liquids has shown a significant loss of normal alkanes in the range of C_9 to C_{16} as well as lower substituted aromatic compounds. Branched alkanes appear to be more resistant to degradation than normal alkanes. In addition, the degree of degradation was positively correlated to the length of the alkyl chain on the mono-substituted alkylbenzenes. Also, the position of the alkyl branches plays a significant role in the ability of the bacteria to metabolize the alkylbenzenes. This can be problematic for fire debris analysis as samples may sit for many weeks before they are analyzed due to case backlog. As a result, selective loss of key components due to bacterial metabolism can make identifying and classifying ignitable liquid residues by their chemical composition and boiling point range very difficult. Of particular interest in this study is the monitoring weathering and degradation of various ignitable liquids in all ASTM classes in order to expand an existing database that can be used by fire debris analysts as a tool in the identification of ignitable liquids.

Weathering is the evaporation of the more volatile compounds of an ignitable liquid resulting in a greater concentration of the less volatile compounds. Weathering of the ignitable liquid is typical in fire debris due to the heat of the fire. The effect of ignitable liquid weathering on the chromatographic profile is the loss or reduction in intensity of the peaks at earlier retention times and an increase in intensity of the peaks at later retention times. The altered chromatographic profile of the weathered ignitable liquid residue makes comparisons to un-weathered reference ignitable liquids more complicated.

For degradation experiments, 20µL of the ignitable liquid was spiked onto 100g of potting soil and allowed to age for zero, seven, fourteen, and twenty-one days. The samples were then analyzed using passive headspace adsorption followed by solvent desorption, and then analyzed by GC/MS. Weathering of the ignitable liquids was performed by volume reduction of 10mL of ignitable liquid to 7.5, 5.0, 2.5, 1.0, and 0.5 ml corresponding to 25%, 50%, 75%, 90%, and 95% weathered, respectively. The ignitable liquids were heated in a dry bath under a gentle flow of nitrogen. At each evaporation point, a 20µL aliquot of the ignitable liquid was diluted into 1mL of carbon disulfide for GC/MS analysis.

This study will show that gasoline and petroleum distillates, which predominantly contain aromatic and n-alkane hydrocarbons respectively, suffer significantly from microbial degradation in just a few days while naphthenic-paraffinic liquids, which contain branched and cyclic alkanes, generally suffer the least microbial degradation. Oxygenated liquids also are significantly degraded; however, recovery of the oxygen-containing compounds in these liquids may present a challenge. Isoparaffinic liquids also suffer from microbial degradation. When comparing branched alkanes, long chained alkanes with one alkyl substituent are less resistant to microbial degradation than alkanes with multiple alkyl substituents. The changes in the chromatographic profile of various ignitable liquids described herein are a result of the selectivity of the bacteria to metabolize the hydrocarbons found in these liquids, which is solely based on the chemical structure of the compound. Weathering is a process that is based on the boiling point of the compound. In weathering, compounds with a lower boiling point will be lost preferentially; whereas, in microbial degradation, longer chain and less branched compounds are lost preferentially.

This work was supported in part by the National Institute of Justice, Office of Justice Programs, award 2011-DN-BX-K539. The content of this publication does not necessarily reflect the position or the policy of the Government, and no official endorsement should be inferred.

Fire Debris, Ignitable Liquid, Degradation

 ** Presenting Author*