B163 The Effects of Burning and Mold Growth on the Analysis of Fire Logs

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After attending this presentation, attendees will better understand the different fuel types in fire logs and the effects burning and mold growth will have on extraction, analysis, and comparison.

This presentation will impact the forensic science community by raising awareness of the change in fuel type of many fire logs from petroleum-based waxes to vegetable oils. This change in fire log composition means that different methods must be used to analyze fire log evidence, specifically the extraction method and instrument parameters. Fire debris analysts who receive fire log samples will also need to take into consideration the effect fire and mold growth have on the composition of the logs.

Artificial fire logs have become a popular substitute for wood to burn in fireplaces due to the fact that they are readily available, easier to light, and will burn unattended for longer periods of time. These fire logs are typically manufactured by combining a cellulosic material, such as sawdust or wood particles, with a combustible binder. The binder or fuel typically has been a petroleum (paraffin) wax; however, in recent years, many manufacturers have switched to using vegetable oils instead of petroleum waxes. While research has been published regarding vegetable oils and spontaneous ignition as well as the analysis of fire logs containing petroleum-based waxes, none has yet been published concerning the analysis of vegetable oils in fire logs.

Vegetable oils are primarily composed of triglycerides, which consist of three fatty acids attached to a glycerol backbone. The fatty acids in vegetable oils are typically unsaturated straight chains consisting of an even number of carbon atoms. Fatty acids are not well-resolved on a typical fire debris non-polar column but can be derivatized into methyl esters and analyzed on a polar column for best separation.

The Bureau of Alcohol, Tobacco, Firearms and Explosives laboratory received evidence from a case in which it was suspected that a fire log was used to initiate a fire. Numerous samples contained vegetable oil-based fuels and exhibited mold growth. Microbial degradation of petroleum products in soil and building materials has been reported. This degradation makes the classification of the petroleum products nearly impossible. Although the vegetable oil-based fuel in the case samples could be identified, apparent microbial degradation made the comparison of questioned and known samples more difficult.

This study was designed to determine the effects that both burning and mold growth have on the composition of the fire log. A total of 34 fire logs, varying in brand and type, were cut into approximate thirds. One third were analyzed intact and served as the clean, unburned sample. One third were burned until charred, extinguished by smothering the flame, and subsequently analyzed. The final third were burned until charred, extinguished with water, and stored in metal cans outdoors for a month in order to allow mold growth before analysis.

The fire logs were extracted in pentane and the extracts were analyzed by High Temperature Gas Chromatography-Mass Spectrometry (HTGC/MS) to identify any petroleum-based waxes present. The same pentane extract was then derivatized using a base-catalyzed reaction to form Fatty Acid Methyl Esters (FAMEs) and run on a GC/MS with a column specific for FAMEs in order to determine whether the fuel contained vegetable oils. GC/MS data of the intact fire logs indicated that a majority contained petroleum-based waxes and vegetable oils, thus requiring the use of both instruments. Chromatographic differences in the petroleum and FAME compositions of the intact, burned, and burned/molded samples were documented through visual comparisons and peak area ratios. While petroleum waxes appeared unaffected by fire and mold, vegetable oils showed significant changes in composition.

Fire Logs, GC/MS, Vegetable Oils