B45 The Surprising Effect of Temperature on the Weathering of Gasoline

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After attending this presentation, attendees will understand how the evaporation temperature affects the distribution of remaining compounds after gasoline samples have been weathered to simulate fire debris samples.

This presentation will impact the forensic science community by providing practitioners with an explanation of why gasoline samples often do not appear to be evaporated to the same extent as one might expect based on the very high temperatures of structure fires.

Arson investigations often involve the identification and characterization of ignitable liquid residues in fire debris. The most commonly used ignitable liquid is gasoline because it is so readily available and particularly effective. Gasoline often evaporates from its containers during storage as well as through exposure to high temperatures, such as during a fire. Such evaporation is often termed weathering, and it is widely accepted that ignitable liquid residues are more likely to resemble weathered liquid samples than pristine liquid samples.

Prior research has investigated the weathering characteristics of gasoline under a variety of experimental conditions, but to date this has been limited to basic pattern recognition of the resulting chromatograms. Relatively little work has been performed to understand how weathering conditions — such as temperature, pressure, or convection — affect the distribution of the various classes of volatile components. For the current study, gasoline samples were weathered at atmospheric pressure using a stream of nitrogen gas and under vacuum. At both pressures, samples were weathered to 75%, 90%, and 95% by weight and at three different temperatures of 25°C, 60°C, and 90°C. After weathering, samples were analyzed using an Agilent® Gas Chromatograph/Mass Spectrometer (GC/MS) with conventional conditions on a 30m DB5 column. The resulting chromatograms showed that the earliest eluting, most volatile compounds — like toluene and the C_2-alkyl benzenes — tend to remain at significantly ($\alpha<0.05$) higher levels at higher temperatures relative to weathering to the same level at lower temperatures.

For example, at 75% weathering, samples weathered at 90°C had toluene and C_2-alkyl benzene peaks that were three to four times more abundant than samples weathered at room temperature ($\alpha \sim 1x10^{-7}$, n=20). At 90% and 95% weathering, the same peaks were typically below threshold when weathered at 25°C and 60°C, but were typically above threshold when weathered at 90°C. The use of nitrogen had a small effect on weathering, but was insignificant relative to the temperature effect. The consequence is that samples weathered at higher temperatures appear less weathered (on a percent level) than one would expect. These results are consistent with the known relationships between vapor pressure and temperature for the different compounds. The relationship between vapor pressure and temperature was further validated by weathering of a simplified synthetic mixture of seven compounds found in gasoline, and the simulated (purely theoretical) weathering of the same compounds based on published Antoine constants.

This study may help explain why real fires often cause gasoline residues to appear far less weathered than one would expect based only on the expected weathering temperatures.

Arson, Gasoline, Weathering