Optimization of Dynamic Vapor Microextraction for Ignitable Liquid Extraction

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Dynamic vapor microextraction (DVME) is a technique that can be used to concentrate vapors from the headspace of condensed-phase samples, generating thermodynamically consistent vapor samples from single component liquids. In this work, we used DVME to collect headspace vapors from samples of complex ignitable liquids (ILs). Neat ILs were spiked onto glass beads, sealed inside nylon evidence bags, and sampled onto chilled capillaries, followed by solvent extraction for analysis with gas chromatography – mass spectrometry. DVME has many advantages over passive sampling with activated carbon strips (ACS), which is the standard method used by United States' criminalists for residual IL extraction from fire debris. ACS requires solvent extraction with carbon disulfide, a highly toxic chemical, while DVME capillaries can be eluted with acetone. DVME may be able to measure a larger range of compounds, because the simultaneous use of multiple capillaries with different adsorbent phases is possible. ACS vapor collections may be distorted by the displacement of high-volatility compounds, which can make comparisons to IL libraries challenging, but breakthrough can be easily monitored and avoided during DVME collections for more representative measurements of ILs. The first step towards the adoption of DVME for fire debris analysis is the optimization of sampling parameters (factors) for individual ILs. The factors optimized in this study are oven temperature and collection volume, which are two factors known to significantly influence vapor collection. We used 2x2 factorial design and response surface methodology to explore the relationships between the factors and the number of target compounds detected in the vapor. With these statistical techniques, optimized sampling methods for three ILs (gasoline, kerosene, and diesel fuel) were determined. Future work on the project includes using DVME to investigate simulated and real fire debris samples and comparing DVME and ACS collections from identical samples.