## E29 A Novel Vapor Delivery Device for Homemade Explosive Analysis

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**Learning Overview:** After attending this presentation, attendees will have learned about binary explosive mixtures used in Homemade Explosives (HMEs) and will understand safety concerns that limit work, be it research, vapor generation, or canine training, with such materials.

**Impact on the Forensic Science Community:** This presentation will impact the forensic science community by presenting a method of HME vapor delivery and generation using two novel odor delivery devices and how such devices can be used to overcome the challenge of working with binary explosive materials.

HMEs are commonly found in Improvised Explosive Devices (IEDs) that have become increasingly commonplace in Middle East conflicts and also pose a threat at home. HMEs are often composed of simple, binary mixtures of an oxidizer and a fuel. The individual components often have common, innocuous uses, independent when separated, but form an explosive mixture when combined. Common examples of oxidizers are Ammonium Nitrate (AN) or Potassium Chlorate ($KClO_4$), and examples of fuels include, but are not limited to, aluminum powder and fuel oil.

Mixed explosives are often difficult and expensive to safely obtain, store, and transport. Safety measures may limit use to same-day production with strict mass limits and disposal protocols. These regulations often restrict or preclude training, analytical research, and other testing using the mixtures themselves. For this reason, detection protocols often focus on the detection or sensing of the oxidizer alone. Canines, for example, are often trained on solely AN and not AN-fuel mixtures, though recent canine evaluations have shown that the canines perform better when trained to the mixed components.

A novel Mixed Odor Delivery Device (MODD) was designed to safely contain the solid or liquid components of HMEs and deliver the HME vapor signature for passive or active sampling. Within the device, vapors from the separately housed components mix as they move through the device toward the outlet. The resulting mixed vapor is representative of that which would be achieved from the actual mixed explosive material. For active sampling, air flows from an external source, through the device, carrying the mixed analyte vapor toward the instrument of choice. For passive sampling, component vapor diffuses from the bulk material through a Teflon® neck, where vapors mix before exiting the device at a bowl-shaped outlet. Both active and passive transport devices have been tested with surrogate components as well as actual explosive components. The MODD offers transportability and ruggedness for field use with minimal sample size requirement and is easily adaptable for the varied components one might encounter in the field.

Initial characterization of the active MODD was conducted using single compounds characteristic of HME components. The equilibration time for each compound in the device and the stability of the equilibrium concentration over time was measured with a focus on flow rate and temperature dependence. Run-to-run and day-to-day reproducibility in vapor generation using the MODD was illustrated by the generation of octane and 2-phenylethyl alcohol (separately) from the MODD. The equilibrium vapor concentrations for both compounds were shown to be stable for more than four hours and were reproducible over several days, respectively.

A computational model was used to predict the transport of analyte vapor by diffusion within the passive MODD. The focus of the analysis was the symmetry of the analyte vapor concentration across the MODD outlet. Assuming a symmetric concentration field at the outlet, the vapor profile would be equal whether approached from the left or from the right, and the components in the MODD would not be recognizable as separated, but instead only as a mixed vapor. The models demonstrated that the concentration field becomes symmetric due to the small central channel separating the upper and lower chambers. Laboratory evaluations were completed to ensure the model was satisfactory and that the MODD delivers a uniform mixture of vapor at a detectable level. Based on this data, it can be shown that the MODD accurately portrays the mixed vapor of these separated compounds.

**Vapor Detection, Homemade Explosives, Vapor Delivery**