Reverse-gas stack modeling-coupled to fieldable mass spectrometry to locate chemical effluent streams for clandestine drug labs, explosives manufacturing, and chemical weapon deployment

Guido F. Verbeck, Camila Anguiano Virgen, University of North Texas

Kenneth C. Wright, Jaime L. Winfield, James D. Fox, INFICON, Inc.

Presented here is the fieldable automobile and backpack mass spectrometers. The front end of a Membrane Inlet Mass Spectrometer (MIMS) system incorporates three dual inlet ports allowing for differing MIMS materials and selectivity for specific environments. Membranes here have proved selective for a myriad of organic compounds as well as aromatic hydrocarbons, both nitrogen and peroxide-based explosives, chemical weapon simulants, and clandestine drugs. Recent results not only showcase the system's applicability to chemical warfare agent (CWA) detection, but its ability to identify the type of agent emitted. Performance against current field detectors has illustrated both the increase sensitivity and selectivity of the presented fieldable device.

The MIMS system is deployable and rugged which is especially significant considering the various environment conditions it's exposed to, and the numerous accoutrements such as foreline pumps and inert gas tanks required of a mass spectrometer. Further innovations include increasing sensitivity by development of a near-infrared (NIR) laser diode system for membrane desorption and enhanced permeability with high parts-per-trillion (ppt) limits of detection and rapid analysis performance just seconds after the initial time of exposure. All of these are incorporated with GIS, for position monitoring, mapping, and integrity of analysis. Software has been developed to incorporate the chemical mass mapping, reverse gas stack modeling (RGSM), and SAMs data to produce accurate point of source determination, even with simple drive-bys or stationary remote monitoring. By coupling the MIMS system with RGSM, the determination of upwind source locations of chemical weapon deployments, explosive manufacturing, and clandestine drug labs can be achieved by using the atmospheric dispersion parameters of their emitted chemical effluent streams. A chemical sensor downwind from a suspected emission point quantifies the emission concentration. This analytical model unifies atmospheric dispersion and other meteorological phenomenon of chemical interests with a developed mobile mass spectrometer system. As mobile mass spectrometer and other chemical sensors are developed, applying a reverse atmospheric model to datasets will provide an additional avenue to determine how sources of clandestine drug manufacturing, CWA deployment, and explosives manufacturing produce effluent stream behavior. This will lead to better Earth-Based Separation models, allowing real-time chemical separation; aiding in the minimization and prevention of chemical exposure while determining the source location of the emission itself.