Earth Based Separations using Reverse Gas Stack Model for Localization of Chemical Effluent Utilizing Mobile Mass Spectrometry

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Abstract

Vehicular engagement of a field-portable membrane inlet mass spectrometer enables concurrent mobile sampling and GPS location to continuous chemical mass determination. The system is capable of spatial mapping and quantitation of chemical interests, while plotting functionality through Geographic Information System (GIS) programs. Spatially relevant datasets are subject to a variety of environmental influences and meteorological influences. Models of how gases travel in the environment have been established to determine how pollutants will atmospherically travel from a source location. Since these constituents have different kinetic and thermodynamic properties in the environment, the chemicals of interest can be separated on the move. Employing mobile mass spectrometry, field detections can be utilized in a new model that utilizes atmospheric gas dispersion in reverse to determine a chemical of interest source locale with a 7 second response time. This reverse gas stack with Earth-Based Separation (EBS) model has use in locating source emissions from an environmental, hazmat, and forensic chemical effluent streams.

This new methodology is performed using a plugin hybrid vehicle with a mounted membrane inlet mass spectrometer, which continually samples while in operation. Electric only drive is used to eliminate any self-contamination, while gas only drive is used to reach a given site. Mass spectrum scans are GPS tagged as each scan is completed. Geographic Information System programs are utilized to plot obtained intensities as points over a sampled region. A developed 'reverse gas stack model' utilizes the endpoint data collected, the downwind dispersion of chemical interests, and approximates a given source emanation point. This model takes into account the mass of the chemical of interest, in addition to other chemical and physical properties, and atmospheric and meteorological conditions.

The current configuration of this mobile platform has detected benzene, toluene, ethylbenzene, and xylene (BTEX) in regional areas, especially with active petroleum production. Furthermore, this system has detected precursor chemicals arising from a mock clandestine manufacture of methamphetamine, PCP, and fentanyl.