

Autonomous Light-weight Integrated Direct Sampling Mass Spectrometer for TIC and CWA Detection

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Mass spectrometry (MS) is a preferred method of analysis due to fast response time, high sensitivity, selectivity in detection, and the high levels of molecular information generated. These advantages are directly applicable to ensuring public safety, such as air monitoring for toxic industrial compounds (TICs) and chemical warfare agents (CWAs). Griffin Analytical Technologies has developed a direct sampling MS which brings the power of MS to field analyses through the use of innovative sample-introduction techniques, ruggedized vacuum systems, and a miniaturized mass analyzer.

The MS system combines a cylindrical ion trap (CIT) mass analyzer with a fast sampling preconcentration inlet and direct leak capillary inlet. Gas-phase samples are drawn through one of two sorbent pre-concentration tubes where organic analytes selectively adsorb to the sorbent material. These tubes are then exposed to the MS vacuum chamber for analyte desorption under heat. Continuous coverage is achieved by simultaneously sampling and desorbing between multiple tubes. Samples not amenable to sorbent sampling, such as light inorganic gases, are admitted through a direct capillary leak. Analyte ionization is internal to the CIT via electron ionization (EI). Electrons are generated from a rugged glow discharge (GD) EI source, significantly reducing the maintenance requirements of the instrument.

Data will be presented to illustrate typical instrument response times for both the direct leak inlet (typically seconds) and individual sorbent tube channels (typically <1 minute). Instrument calibration for several TICs and CWA simulants indicate limits of detection for average sampling times using the solid sorbent inlet are in the low ppb range, below the concentrations deemed immediately dangerous to humans for those compounds. Direct leak limits of detection are usually higher, but are still adequate to provide valuable information on immediate danger levels for most analytes.

The MS data generated with this instrument illustrate the ability of the MS to collect data with unit mass resolution using air as a bath gas in the CIT rather than helium. A list of the chemicals targets is created with their respective spectra. During the analysis of an air sample, the mass spectral data are compared with this list of library spectra for the compounds of interest in order to generate an alarm if selected compounds are detected. The system has been thoroughly challenged during in-house chemical testing with individual and mixtures of TICs and interferences. Testbed deployment of the system to a variety of real-world sites, including airports, train stations, and subway stations has also been completed.