UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Washington, D.C. 20460

ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM
VERIFICATION STATEMENT

TECHNOLOGY TYPE:	**FIELD-PORTABLE GAS CHROMATOGRAPH/ MASS SPECTROMETER**
APPLICATION:	**MEASUREMENT OF CHLORINATED VOLATILE ORGANIC COMPOUNDS IN WATER**
TECHNOLOGY NAME:	**HAPSITE with Headspace Sampling Accessory**
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PROGRAM DESCRIPTION

The U.S. Environmental Protection Agency (EPA) created the Environmental Technology Verification Program (ETV) to facilitate the deployment of innovative environmental technologies through performance verification and information dissemination. The goal of the ETV Program is to further environmental protection by substantially accelerating the acceptance and use of improved and cost-effective technologies. The ETV Program is intended to assist and inform those involved in the design, distribution, permitting, and purchase of environmental technologies.

Under this program, in partnership with recognized testing organizations, and with the full participation of the technology developer, the EPA evaluates the performance of innovative technologies by developing demonstration plans, conducting field tests, collecting and analyzing the demonstration results, and preparing reports. The testing is conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible. The EPA National Exposure Research Laboratory, in cooperation with Sandia National Laboratories, the testing organization, evaluated field-portable systems for monitoring chlorinated volatile organic compounds (VOCs) in water. This verification statement provides a summary of the demonstration and results for the Inficon HAPSITE field-portable gas chromatograph/mass spectrometer (GC/MS) system.

DEMONSTRATION DESCRIPTION

The field demonstration of the HAPSITE portable GC/MS was held in September 1997. The demonstration was designed to assess the instrument's ability to detect and measure chlorinated volatile organic compounds in groundwater at two contaminated sites: the Department of Energy's Savannah River Site, near Aiken, South Carolina, and the McClellan Air Force Base, near Sacramento, California. Groundwater samples from each site were supplemented with performance evaluation (PE) samples of known composition. Both sample types were used to assess instrument accuracy, precision, sample throughput, and comparability to reference laboratory results. The primary target compounds at the Savannah River Site were trichloroethene and tetrachloroethene. At McClellan Air

Force Base, the target compounds were trichloroethene, tetrachloroethene, 1,2-dichloroethane, 1,1,2-trichloroethane, 1,2-dichloropropane, and *trans*-1,3-dichloropropene. These sites were chosen because they contain varied concentrations of chlorinated VOCs and exhibit different climatic and geologic conditions. The conditions at these sites are typical, but not inclusive, of those under which this technology would be expected to operate. A complete description of the demonstration, including a data summary and discussion of results, may be found in the report entitled *Environmental Technology Verification Report, Field-Portable Gas Chromatograph/Mass Spectrometer, Inficon, Inc., HAPSITE.* (EPA/600/R-98/142).

TECHNOLOGY DESCRIPTION

GC/MS is a proven laboratory analytical technology that has been used for environmental characterization and monitoring for many years. The combination of gas chromatography and mass spectrometry allows the rapid separation and identification of compounds in complex mixtures. The gas chromatograph separates the sample into individual components. These components are introduced into the electron impact source module of the spectrometer, where the molecules are fragmented into ions by an electron beam. The ion fragments are further separated by mass and detected by an electron multiplier. The resulting mass spectrum is characteristic of a particular compound and can be used to identify each component in the sample extract through comparison with a reference spectral library. Quantitation is achieved by comparing the abundance of ions which are characteristic of a specific compound with the detector response from the analysis of a standard mixture. Field-portable GC/MS is a versatile technique that can be used to provide rapid screening data or laboratory-quality analyses. As with many field analytical studies, it may be necessary to send a portion of the samples to an independent laboratory for confirmatory analyses.

The Inficon HAPSITE with a headspace sampling accessory is a commercially available GC/MS system that provides laboratory-grade performance in a field-transportable package. The instrument, including the on-board computer, is designed for field use and is encapsulated in a weather-resistant case. The GC/MS unit weighs about 35 pounds and the headspace sampling accessory weighs about 15 pounds. Both units can be easily transported and operated in the rear compartment of a minivan or station wagon. The instrument utilizes an equilibrium headspace technique for the analysis of VOCs in water. Instrument detection limits for most chlorinated VOCs in water are in the range of 5 to 10 µg/L. At the time of the demonstration, the cost of the HAPSITE with headspace accessory was in the range of $75,000 to $95,000, depending upon instrument options. Operational costs, which include consumable supplies but not labor costs, are on the order of $150 per 8-hour day.

VERIFICATION OF PERFORMANCE

The following performance characteristics of the HAPSITE were observed:

Sample Throughput: Throughput was approximately two to three water samples per hour. This rate includes the periodic analysis of blanks and calibration check samples.

Completeness: The HAPSITE reported results for all but one of the 166 PE and groundwater samples provided for analysis at the two demonstration sites. One sample was dropped during preparation.

Analytical Versatility: The HAPSITE detected all of the compounds in the PE samples for which it was calibrated. Its calibration included 84% (27 of 32) of all chlorinated and nonchlorinated volatile hydrocarbon compounds included in the PE samples at the demonstration. Additional compounds could have been detected with a longer GC/MS run time and a reduced sample throughput. The HAPSITE detected all (59 of 59) of the groundwater contaminants in excess of 5 µg/L reported by the reference laboratory at both sites. A total of 68 contaminants, at concentration levels of 1 µg/L or higher, were detected by the reference laboratory in all groundwater samples.

Precision: Precision was determined by analyzing sets of four replicate samples from a variety of PE mixtures containing known concentrations of chlorinated VOCs. The results are reported as relative standard deviations (RSD). The RSDs compiled for all reported PE compounds from both sites had a median value of 12% and a 95th percentile value of 29%. By comparison, the compiled RSDs from the reference laboratory had a median value of

7% and a 95th percentile value of 25%. The ranges of HAPSITE RSD values for specific target compounds were as follows: trichloroethene 7 to 18%, tetrachloroethene, 6 to 22%; 1,2-dichloroethane, 2 to 12%; 1,1,2-trichloroethane, 8 to 28%; 1,2-dichloropropane, 7 to 21%; and *trans*-1,3-dichloropropene, 7 to 17%.

Accuracy: Instrument accuracy was evaluated by comparing HAPSITE results with the known concentrations of chlorinated organic compounds in PE mixtures. Absolute percent difference (APD) values from both sites were calculated for all analytes in the PE mixtures. The APDs for all reported compounds from both sites had a median value of 8% and a 95th percentile value of 27%. By comparison, the compiled APDs from the reference laboratory had a median value of 7% and a 95th percentile value of 24%. The ranges of HAPSITE APD values for target compounds were as follows: trichloroethene, 1 to 20%; tetrachloroethene, 6 to 33%; 1,2-dichloroethane, 2 to 20%; 1,1,2-trichloroethane 1 to 21%; 1,2-dichloropropane, 3 to 21%; and *trans*-1,3-dichloropropene, 1 to 15%.

Comparability**:** A comparison of HAPSITE and reference laboratory data was based on 33 groundwater samples analyzed at each site. The correlation coefficients (r) for all compounds detected by both the HAPSITE and laboratory at or below 100 µg/L concentration levels were 0.983 at Savannah River and 0.978 at McClellan. The r values for compounds detected at concentration levels in excess of 100 µg/L were 0.996 for Savannah River and 1.000 for McClellan. These correlation coefficients reveal a highly linear relationship between HAPSITE and laboratory data. The median absolute percent difference between groundwater compounds mutually detected by the HAPSITE and reference laboratory was 13%, with a 95th percentile value of 60%.

Deployment: The system was ready to analyze samples within 30 minutes of arrival at the site. At both sites, the instrument was transported in a minivan and was operated in its rear luggage compartment. The instrument was powered by self-contained batteries or from line ac power. The recommended training interval for routine sample processing is about 3 days for a chemist with limited GC/MS experience. Method development and analysis of very complex samples requires a higher level of operator training and experience in GC/MS data interpretation.

The results of this demonstration show that the HAPSITE can provide useful, cost-effective data for environmental site screening and routine monitoring. This instrument could be employed in a variety of applications, ranging from producing rapid analytical results in screening investigations, to producing accurate and precise data that are directly comparable with that obtained from an off-site laboratory. These data could be used to develop risk assessment information, support a remediation process, or fulfill monitoring requirements. In the selection of a technology for deployment at a site, the user must determine what is appropriate through consideration of instrument performance and the project's data quality objectives.

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