



Environmental Program



Flow Probe™ Chemical Analyzer

Technology Need

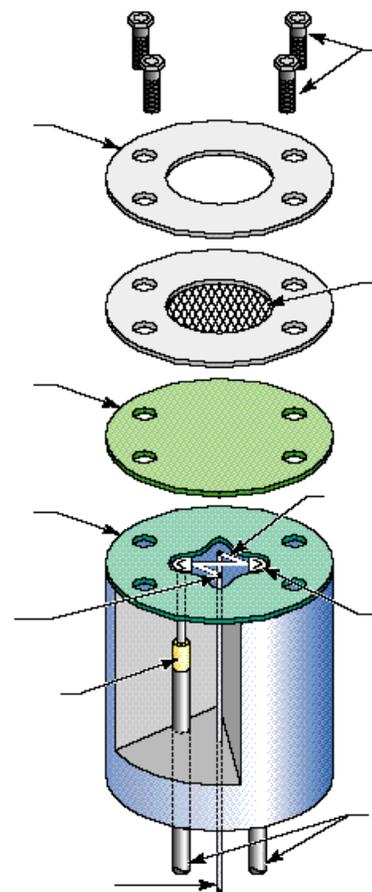
Conventional methods for characterizing hazardous waste sites have included field sampling with transportation of the samples to laboratories off-site for analysis. This type of analysis is inherently expensive and prone to errors due to the many steps involved. The high costs of laboratory analysis is often viewed as the limiting factor for site characterization. Furthermore, slow laboratory turn-around time can result in operational delays and over treatment of sites. The validity of laboratory results is often questioned due to the loss of volatile constituents during sampling and transportation. It is viewed by some environmental personnel working in the field that at least 70% of samples that are sent to off-site laboratories are useless due to these compromises. Therefore, a need exists for quick, easy, and inexpensive methods for conducting field analysis at hazardous waste sites.

Objective

The Flow Probe™ Chemical Analyzer is an in situ generic chemical speciating technology that measures chemicals in both liquid and gas states for field survey and process monitoring applications. This technology can be used wherever reagent-based chemistry exists that provides chemical concentration changes detectable by optical absorption spectroscopy. The Flow Probe™ Chemical Analyzer was designed to be an in situ generic platform for performing wet chemistry-based analyses in field survey applications and process control and monitoring applications.

Project Description

The Flow Probe Chemical™ Analyzer is a flowing reagent system in which analytes diffuse across a membrane into a reagent-containing vessel. A chemical reaction between the reagent and the analyte then produces spectrally distinct products. The absorption characteristics of the products are measured by illuminating the reaction volume with broadband white light. Using optical fibers, this light is carried from a flash lamp to the reaction volume and then to a small, solid-state spectrometer. The instrument was designed to be generic so that many different reagents and membranes could be used within a single probe body. The speciating characteristic is obtained from tailoring the reagent and membrane to analytes and the matrix. The three different contaminant environments that are being targeted include (1) metallic ions (specifically copper) in aqueous matrices; (2) volatile organic compounds (VOCs) in aqueous matrices; and (3) VOCs, specifically TCE, TCA, and chloroform in ambient air.



Exploded view of the Flow Probe™ Chemical Analyzer

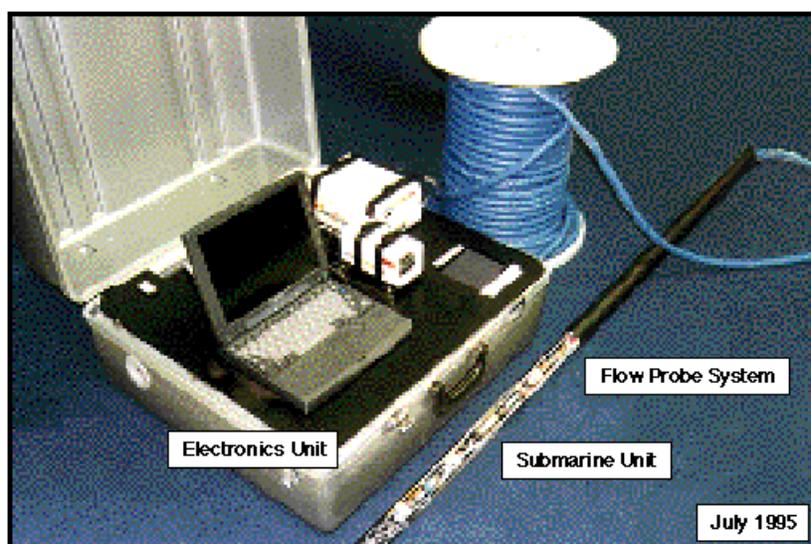
The basic Flow Probe™ Chemical Analyzer instrument is contained in a 0.5-inch-diameter cylinder. Two different configurations are being designed and built. One unit is an aboveground field- or process-monitoring instrument. The other design is a down-well unit suitable for a 2-inch diameter or larger well. Both configurations can perform up to 500 analyses before the reagent must be replenished.

The active element of the instrument is the Flow Probe™ head, which is inserted into the process being sampled. In operation, analytes diffuse from the process, across a membrane, and into the z-shaped cavity that contains the reagent fluid. A chemical reaction between the analytes of concern and the reagent produces a compound with a specific absorption spectrum. Chemometric analysis techniques determine the analyte concentration.

The Flow Probe™ Chemical Analyzer technology will be demonstrated over a two-month period at two Department of Energy production sites and four commercial industrial sites in aqueous process streams, organic contaminated dry wells, and organic contaminated water-containing wells.

Advantages

The Flow Probe™ Chemical Analyzer has the advantages of well characterized reagent chemistry and optical spectroscopy as its transduction mechanism. The sensor is compact with a small analysis volume and a relatively high detection sensitivity (a few parts per billion for many analytes). The Flow Probe™ Chemical Analyzer is very efficient allowing many analyses to be conducted before reagent replenishment and waste extraction (10 ml/500).



Down-well Instrument

Costs

The Flow Probe™ Chemical Analyzer instrumentation is currently available for approximately \$17K. The costs could be reduced to less than \$10K once instruments are in production.

Contacts

Dianna S. Blair
(505) 845-8800 phone
dsblair@sandia.gov

Patrick L. Jones
Industrial Partner
Center for Process Analytical Chemistry
University of Washington
(206) 543-3970 phone
pljones@u.washington.edu



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