Applications of in-water mass spectrometry for detection of volatile organic compounds and dissolved gases

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In-situ chemical analysis of aqueous systems is advantageous for a number of reasons. Inadvertent contamination and degradation of samples, that can occur when samples are transported to laboratory for analysis, can be avoided. Monitoring of water quality can be obtained in real-time and, in principle, adaptive sampling strategies can be employed to track chemicals to their sources. We have developed and deployed two underwater membrane introduction mass spectrometry (MIMS) systems that can operate autonomously or under user control via a wireless rf link.

The initial underwater MIMS systems uses a linear quadrupole mass filter, provides detection limits for most volatile organic compounds (VOCs) in the 1-5 ppb range and has a power requirement of 95 Watts. In addition, the quadrupole MIMS system can be used for in-situ dissolved gas analysis. The second version uses an ion trap mass spectrometer, provides detection limits below 1 ppb for most VOCs and consumes on the order of 150 Watts. Both systems can be deployed either as moored sensors or on unmanned underwater vehicles.

We have collected data from each of the two systems under a variety of deployment scenarios. For example, the quadrupole system has been used to monitor waste-water influent over a period of several days. The system was submersed in an influent tank during the analysis period. The data show clear time dependences of toluene and chloroform concentrations during the monitoring period. We have also recently used the system for *in-situ* studies of hydrothermal vents in the Gulf of Mexico

The ion trap system has been used to monitor marina motor boat traffic over a weekend period by detection of VOC component of gasoline exhaust. The system was moored in the St. Petersburg Marina for several days and was able to detect increases in toluene concentrations during peak motor-boat traffic activity. We have also deployed the system on an autonomous guided underwater vehicle to investigate the integrated system utility for detection of chemical spills or plumes of other chemicals in the water column. Preliminary data indicate that real-time observation of the ion trap mass-spectral data can be combined with vehicle navigation to achieve this goal.