Development of a Membrane Inlet Mass Spectrometry-Based Strategy for Environmental Monitoring

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Across the country increased energy demand has led to an upsurge of urban exploration for energy sources, particularly natural gas and oil. Along with this increase in exploration comes an increased need to accurately monitor effluent streams in real time to develop leak mitigation strategies along with sufficient regulatory statutes. With the continual growth of urban and suburban oil and gas exploration, BTEX components have continued to be at the forefront of monitoring technologies. Our goal is to develop a mass spectrometric based monitoring process incorporating a polydimethylsiloxane membrane inlet to act as a broad-spectrum analyzer to help understand the risks of environmental contamination by BTEX components. To accomplish this, we have incorporated a custom-built membrane inlet system on a commercial mass spectrometer and made the system suitable for portable operation. The goal of this work was: 1) to determine if membrane inlet mass spectrometry is amenable to analytes of environmental importance, 2) to evaluate the response time of various membrane inlet geometries, 3) based on the most efficient membrane inlet geometry, determine the limits of detection for both a Faraday type detector and an electron multiplier, and 4) to apply that membrane inlet to some real-world samples to get an understanding of the response factors. Initial testing on acetonitrile showed that the membrane inlet was a good candidate for monitoring at environmentally important levels, and subsequent evaluation revealed limits of detection that were two orders of magnitude lower than the OSHA PEL for a Faraday cup detector and three orders of magnitude lower for the electron multiplier.