Performance Characteristics of Detectors Operated in Harsh Environments

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A truly field portable mass spectrometer, capable of laboratory quality analyses, has long been a dream for industrial hygienists, forensic pathologists, law enforcement officers and other Homeland Security requirements. Government funding will likely provide the impetus to drive the development of this instrument and applicable methods to fruition.

Early instruments, described as field portable, were often better termed as transportable. To achieve true portability, it is necessary to further reduce the size, the weight and the power consumption of these early instrument models. New detector designs have moved the operational pressure range of microchannel plate (MCP) based detectors from micro-Torr or better into milli-Torr pressure range. Use of high gain, low noise detectors that can operate at milli-Torr pressures will allow use of simple, low cost and much lighter weight vacuum systems in the next generation of field portable mass spectrometers. The new detectors eliminate the need to maintain high vacuum and overcome one of the main obstacles in the development of small portable instruments.

MCP based detectors routinely operate at 10 – 30 milli-Torr pressure in the Inficon XPR instrument. To date, hundreds of these instruments have been sold. The XPR is a fully functional quadrupole mass spectrometer originally developed as a plasma etching, process monitor for the semi-conductor industry. A researcher is currently using this instrument to analyze gasses present in seawater that have diffused across a membrane.

The ideal mass spectrometer detector of the future must be able to operate at milli-Torr pressures or higher. It must produce high gain and maintain low noise at elevated pressures. The ideal detector must be economical to use. It must exhibit long life time when operated at elevated pressures, must tolerate poor vacuum conditions throughout the duty cycle, must be robust enough to withstand system failures, and must withstand periodic venting to atmosphere and tolerate storage in atmosphere.

Comparative data for different types of detectors operated at elevated pressures will be presented. Included detector types will be MCPs, Channeltron® single channel electron multipliers (CEM), Spiraltron™ electron multipliers and discrete dynode multipliers. Performance data will be presented for detectors repeatedly cycled through intervals of routine operation at elevated pressure followed by venting to atmosphere or nitrogen for overnight intervals. CEMs, manufactured using Spiraltron™ technology, have demonstrated a greater tolerance to operation at elevated pressures than other types of CEMs. Performance data at elevated pressure will be presented for a MAGNUM Electron Multiplier®. MAGNUM® detectors are fabricated using Spiraltron™ technology.

The objective of this paper is to summarize progress made to date in the development of miniaturized high operating pressure detectors, to provide examples of existing detectors capable of operating at elevated pressure, and hopefully, to provide a glimpse into future detector developments.