

High Speed Multiple-Analyte Chemical Detectors for Continuous Monitoring

A large number of chemical/explosives detectors are available using a multiplicity of different detection techniques. To achieve the rapid response times and the specificity desired for chemical sensors, most utilize a detection technique that provides a multidimensional signal vector which is then compared to a library of known compounds for identification. Techniques include various forms of mass spectroscopy, gas chromatography with different types of detectors, neutron spectroscopy and flame spectrophotometry. There are currently 16 'portable' chemical detectors available that permit the detection of all classes of chemical agents; chemical weapons (CWs), explosives, narcotics and toxic industrial chemicals (TICs).

zNose 4500	Electronic Sensor Technology	gc/saw
AP4C	Proengin	flame spectrophotometer
miniPINS	Ortec	neutron spectroscopy
Griffin 450	iCX	GC/MS/MS
Hapsite ER	Inficon	GC/MS/MS
Sabre 4000	Smiths Detection	IMS
ChemProFX	EnviroNics Oy	IMS
QS-H150 Portable Explosives Detector	Implant Sciences Corporation	IMS
Inspector Ramen	Deltanu	ramen spectrscopy
Fido XT	lcx	polymer fluorescence quenching
MO-2M	Novosibirsk	IMS
Mobile Trace	Morpho Detection (formerly GE Security)	IMS
RAEGuard Toxic Gas Detector	RAE Systems	electrochemical sensor
HazMatID 360	Smiths Detection	FTIR
LCD-Nexus	Smiths Detection	IMS
Multi-mode Threat Detector	Smiths Detection	IMS

Of these fifteen, four are based on ion-mobility spectrometry (IMS) and have response times of seconds. The other eleven systems are based on analytical techniques such as IR spectroscopy and gas chromatography. For long-term continuous operation, methods such as gas chromatography and mass spectrometry are not considered suitable due to the need for well-trained technicians to keep them operating, concerns about sensor longevity, and the very small sample flows tolerated.

IMS gas detector products have been in existence for about 20 years and the technology is mature, although it is still an area where there is significant research and development going on. The IMS products in the Table above are the MobileTrace explosives and narcotics detector, manufactured by MorphoDetection, (formerly GE Security); the ChemPro FX detector manufactured by EnviroNics; the Sabre 4000 detector manufactured by Smiths Detection; and the Multi-mode Threat Detector (MMTD), also from Smiths Detection. Both Smiths products can detect all classes of chemical agents, although not simultaneously. Importantly, the Sabre does not have remote operation capability and is not suitable for



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continuous monitoring. Also, although the MMTD can detect all classes it must be switched between two modes of operation to do so, extending the analysis time.

An issue with most IMS detectors is that they are sensitive to changes in humidity and most IMS devices incorporate a dehumidifying cartridge that must be changed from time to time- typically 200 to 250 hours. Some require gas cartridges that amplify their ability to detect certain classes of gases. While not difficult to change, the both types of cartridges are a nuisance and systems incorporating them are only suitable if the performance provided is exemplary.

Examination of data sheets and conversations with manufacturers led to the selection of the MobileTrace and the ChemPro FX as two systems best meeting needs for multi-analyte continuous monitoring. The MobilTrace has extremely high sensitivity for explosives but does require good maintenance procedures. The ChemPro FX is a 'class' sensor in the sense that it cannot identify specific compounds- rather, if it detects a foreign gas it compares the signature to the signatures for various different types of gaseous chemicals, such as "Flammable" or "Nerve Gas Agent." This classification is frequently incorrect, but nonetheless the Chempro requires minimal maintenance and does not require any dehumidifying or specialty gas cartridges and is good as a generic gas alarm, in the sense that a smoke alarm alerts to the possible presence of fire.

A class of sensors not identified in the Table above, but which deserve mention, are the electrochemical detectors. These are basically batteries that provide an output current proportional to the concentration of the target gas species. These devices have wide operating temperature ranges, require no maintenance and have lifetimes of 2 to 3 years with sub part-per-million sensitivity: Sensitivity is usually comparable to or better than the IMS detectors. However, each detector is typically tuned to detect only one or two chemicals, so the threats must be known for the electrochemical cells to be of value for long-term monitoring. As an example, chlorine is a highly toxic gas that is widely used, stored at high pressure as a liquid, and is hence more accessible and dangerous than many other chemicals. Electrochemical detectors make excellent long-term chlorine sensors. In the same sense, an array of electrochemical sensors is a reasonable solution to the long-term monitoring of threat chemicals that are frequently used in commerce,



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