mks
Technology for Productivity

Application Note

CWA/TIC Detection

CUSTOMER PROBLEM

Many possible terrorist threats have been identified by the Department of Homeland Security, among which is the use of Chemical Warfare Agents (CWAs) or Toxic Industrial Chemicals (TICs) to either harm building occupants or cause business disruptions. In order to maintain a level of security for populated buildings, a continuous air monitoring system should be employed in the building air handling systems or at entrances, mail rooms, and shipping docks. Initial systems deployed for CWA or TIC detection used monitoring technologies which have been found to lack the sensitivity or selectivity to make them useful against multiple chemical threat sources in the presence of interferents such as common solvents and cleaners. These interferents have often resulted in a large number of false alarms which are costly and reduce the overall customer satisfaction with the monitoring system. An analyzer that can detect multiple agents very quickly with no, or extremely infrequent, false alarms will enhance the utility and security protection offered by these ambient air monitors for homeland security applications.

BACKGROUND

The devices typically deployed for CWA detection rely on very sensitive methods capable of measuring down to the part per billion concentration level with little difficulty. However, a major drawback with these technologies is that the discrimination is poor and chemically comparable materials are detected along with the CWA or TIC of interest, resulting in false positive alarms. Most common solvents, cleaners and waxes which contain volatile components with comparable molecular weights as some CWAs are one source for these false alarms. Other techniques have the ability to discriminate different molecules, but are very high priced and not ruggedized for HVAC environmental conditions. In addition, the "clear down" time of these detectors can be extremely long, essentially "blinding" the detector to further detections and failing to serve the intended purpose of protecting a building or other site or facility during this clear down period.

SOLUTION

To avoid the high false alarm rate and maintain the capability of monitoring multiple types of CWA and TIC, another method must be used, one which has very high specificity while maintaining high sensitivity. The method of choice is Fourier Transform Infrared spectroscopy (FTIR) which is the basis for the AIRGARD® air analyzer. Even though common chemical families (e.g., ketones, alcohols, amines) have similar regions of infrared absorption, the detailed spectra of each have subtle but important differences. By combining the sensitivity of FTIR with the specificity of individual infrared spectra, a system can monitor CWA and TIC levels well below the U.S. EPA Acute Exposure Guideline Level 2, 10 minute exposure ($AEGL\text{-}2_{10}$) limits.

During extensive testing sponsored by the Department of Defense (DoD) as well as the Department of Homeland Security (DHS), the AIRGARD has been located in a variety of environments: the Pentagon, a State Department mailroom, the Metropolitan Boston Subway System, the Anaheim Convention Center as well as Battelle Memorial Institute Laboratories and Edgewood Chemical and Biological Laboratories. As of this writing, AIRGARDs have been tested for hundreds of instrument-years with a false alarm rate of less than 2 per instrument-year. During the latest round of DHS-sponsored tests, known as ARFCAM, an AIRGARD was exposed to IDLH (Immediate Danger to Life and Health) levels of 8 TICs under 10 varied conditions of temperature, humidity and background interferents. In 97.3% of these tests the AIRGARD successfully detected and alarmed on each TIC within 15 seconds of exposure, with no false alarms recorded throughout testing. Further testing by DHS has shown the utility of AIRGARD in both controlled and "real world" environments, with the same low false alarm rate and sensitivity. AIRGARD is now accepted by DoD and DHS as one of the pre-eminent technologies for chemical vapor detection.

The reason for the sensitivity and selectivity of the AIRGARD is two-fold. First, advanced engineering has gone into the optimization of the FTIR itself. A custom gas cell, which has the highest pathlength to volume ratio of any cell on the market, maintains optimal throughput in a 10.18 m pathlength while only using 400mL of gas for extremely fast turnover (T_{80} < 5 seconds).* The mercury-cadmium-telluride solid state detector has been mated to a Stirling cryocooler for extremely low noise performance. This design allows for typical detection limits (dependent on the absorptivity of the molecule) in the part per billion range.

** T_{80} is the time it takes to fully replace 80% of the gas sample in the cell with new sample.*

SOLUTION (CONT'D)

The second improvement is the use of an advanced algorithm for determining which components are present; this algorithm allows the AIRGARD to detect the target species in sampled ambient air or other background environments. The spectral library contains over 350 compounds (more are being added as well) and includes the generally recognized threat lists of CWA and TIC gases. The library is customizable to allow for editing or the addition of new agents.

INSTALLATION

The AIRGARD air analyzer is a self-contained monitoring device, which has a sampling pump, FTIR spectrometer, controlling electronics and computer enclosed in a package measuring 18.5'' x 24'' x 7.5'' which can be easily wall mounted. All AIRGARD air analyzers are individually calibrated and tested for optimum signal-to-noise which ensures that consistent, reliable air monitoring will be provided in multiple deployments. The AIRGARD air analyzer incorporates an Ethernet TCP/IP interface for an XML-based remote monitoring and control protocol. This interface uses state-of-the-art encryption technology to ensure a secure and robust connection into virtually any command-and-control platform.

BENEFITS

- Consistent accurate and reliable monitoring of air quality 24/7
- False alarm rate estimated to be less than two events per year
- No recorded interference from common volatile materials such as toluene, 2-butoxyethanol (butyl cellosolve), diethylene glycol ethyl ether (DEGEE, Carbitol), acetone, diesel fumes, floor wax, paint fumes, floor stripper and bleach.
- Rapid detection identification, and quantification of CWAs and TICs
- Customizable spectral library for addition or editing of new agents

REFERENCE MATERIALS

MKS Publications:
AIRGARD® datasheet

AIRGARD® Self-Contained FTIR-Based Gas Analyzer

For further information, call your local MKS Sales Engineer or contact the MKS Applications Engineering Group at 800.227.8766.
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