Application Brief AB-071

IMS AND FT-IR FOR GAS DETECTION AND IDENTIFICATION

Chemical Event Timeline

Initial Response → Detection/Identification → Mitigation → Continuous Monitoring

APD 2000™

- Detects WMD/RAD in seconds
- Helps establish zones/ verifies decon

Sabre FR™

- Confirms WMD readings with orthogonal analysis
- Detects & identifies low level TICs in seconds

GasID™

- Identifies numerous gases & vapors in minutes
- Use IDs for accurate monitoring

Introduction

Air monitoring is a critical part of any hazmat event, particularly when the product of interest is a gas or vapor. According to OSHA law[1], technicians entering a potentially hazardous site must use direct reading equipment to check the atmosphere for flammability and/or toxicity hazards, oxygen deficiency or enrichment, and (possibly) ionizing radiation. A continuous air monitoring program must also be implemented once the site is fully characterized. Numerous gas and vapor detectors are available from various instrument companies for just these purposes. Unfortunately, no single instrument can detect and identify all hazardous chemicals at all concentrations. As a solution, Smiths Detection offers a suite of air contaminant measuring devices: The APD 2000, the Sabre FR and the GasID. Each instrument has a specific purpose, yet the information from all the devices can be complementary, making them a valuable collection of hazmat tools.

Ion Mobility Spectrometry (IMS)

Ion mobility spectrometry provides ppb-level detection and identification of toxic industrial chemicals (TICs) and chemical weapons of mass destruction (WMD). IMS works by selectively ionizing a sample via chemical interactions with gaseous molecules, then measuring the drift times of differently sized and shaped ions traveling within an electric field. The IMS signal of a compound is characteristic and can be used for field identification. The APD 2000 can analyze six different chemical agents and two common irritants, and it has a built in gamma-radiation detector. The Sabre FR can analyze ten WMDs, as well as nine common TICs vapors. Because these instruments operate differently and utilize different ionization chemistries (see Table 1), they produce complementary results for similar compounds, such as WMD. In addition, the Sabre FR can be user-programmed for additional compounds, providing additional flexibility.

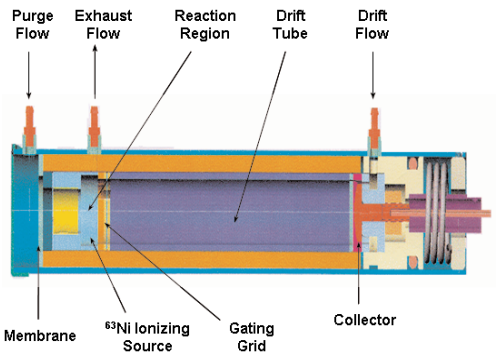

Figure 1. Schematic of IMS drift tube.

Fourier Transform Infrared (FT-IR) Spectroscopy

Fourier transform infrared spectroscopy uses light to probe chemicals, and it provides identification of a broad range of organic and inorganic compounds. A sample is collected from the air and injected into an FT-IR cell where it interacts with IR radiation. Most covalently-bonded molecules produce unique IR absorption patterns which can be used for field identification. The GasID system has a library of over 5,500 spectral patterns, and users can easily add additional patterns. FT-IR generally lacks the sensitivity of IMS, but substances can be identified at 10's of ppm levels in minutes (including sampling time). Conversely, the GasID can handle a greater concentration range (up to 10,000 ppm), making it useful in highly contaminated atmospheres that are problematic for IMS instruments.

Table 1. COMPARISION OF SMITHS DETECTION GAS AND VAPOR INSTRUMENTS			
PRODUCT	**APD 2000**	**SABRE FR**	**GasID**
Technology	IMS (ammonia / water chemistries)	IMS (nicotinamide / hexachloroethane chemistries)	FT-IR (44 cm gas cell)
Compounds Analyzed	8 (CW agents, irritants)	19 (CW agents, TICs)	5,500 (organics, inogranics)
Sensitivity	Single ppb	Single ppb	10's of ppm
Analysis time	15 sec	15 sec	15 min
Detect RAD?	Yes (gamma)	No	No
User library?	No	Yes	Yes

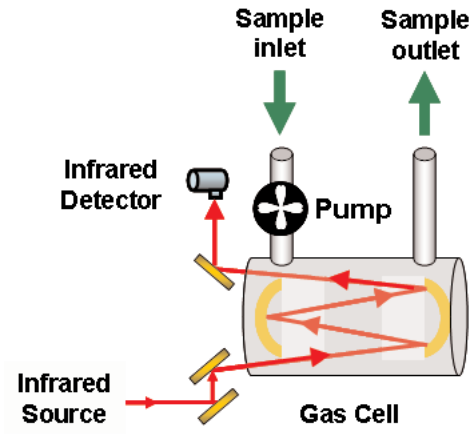

Figure 2. Schematic of FT-IR gas cell.

A Complement of Tools

Deployed independently, the APD 2000, the Sabre FR and the GasID each provide valuable pieces of information in a chemical event. However, using all of these tools together as part of an overall response plan provides greater confidence when dealing with unknown scenarios. For initial air monitoring and zone establishment, the APD 2000 can detect the presence of chemical WMD vapors well below their IDLH levels. It will also alert to the presence of gamma-radiation, which can be critical since there is no available PPE for such exposure.

This information obtained at the beginning of a response (along with four gas, PID and other readings) helps confidently define "safe" and "unsafe" areas, especially when chemical and/or radiological agents are suspected. Further into the hot zone, the APD 2000 and the Sabre FR can both be used to locate and confirm the presence of chemical agent vapors. The Sabre FR will provide additional capabilities for several TICs that are problematic for other detectors (such as corrosives). If a gas or vapor is detected at relatively high concentrations (10's of ppm), the GasID can identify the culprit with its expansive chemical library. Having this information not only helps in mitigating the situation, but it also allows other meter readings (such as PIDs) to be adjusted for accurate monitoring throughout the event. Following an event the APD 2000 can be used to verify decontamination of victims exposed to chemical agents.

Scenario: Suspect Chemical WMDs

If law enforcement officials uncover a suspected militant group thought to be dealing with chemical weapons, a hazmat team may be called upon to address the various chemicals being hoarded. The Smiths Detection suite of gas analysis tools can be used throughout this event scenario. The APD 2000 can readily detect the presence of G- and V-series nerve agent and mustard vapors upon reaching the scene. It can also determine if gamma-radiation is present, should the suspects be involved in "dirty bomb" activities. If no agent vapors are initially detected, the APD 2000 can provide continuous agent monitoring and inspection of suspicious containers. Precursors and other types of chemicals agents (either within containers or in the air) can also be detected with the Sabre FR (such as hydrogen cyanide and phosgene). If a vapor is detected (for example, such as isopropanol or thiodiglycol in a poorly sealed container) but not initially identified by IMS or other instruments, a sample can be collected into a thermal desorption tube and analyzed with the GasID. Since many different types of chemicals may be encountered in this scenario, having a variety of tools readily available provides the greatest chance of success.

Scenario: Clandestine Labs

Hazmat teams are often called in to clandestine drug lab raids when unmarked chemical containers or potentially hazardous substances are discovered. As with any other event, air monitoring must be conducted, and Smiths Detection instrumentation can be invaluable. The APD 2000 can be deployed to check for chemical agent or irritant vapors to help determine the hot zone boundary. Inside the lab, the Sabre FR can monitor for precursor TICs, especially if the lithium-ammonia reduction of ephedrine was used to synthesize methamphetamine. Should gases and vapors be present at levels that are too high for IMS (such as unmarked gas cylinders), or common precursors are present that the IMS instruments are not programmed for (such as ether or acetone), the GasID can provide identities in minutes.

Summary

Even if chemical identities in a hazmat event are not "unknown," chemical hazards can be unexpected. When dealing with real-world scenarios, hazmat teams need tools that detect over a range of sensitivities and identify a broad array of compounds. The APD 2000, the Sabre FR and the GasID fulfill this need. From radiation to WMDs, and from TICs to VOCs, the Smiths Detection suite of hazmat gas instrumentation covers a greater range of hazards than any one tool can do alone.

References

[1] 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response (HAZWOPER), www.osha.gov

21 Commerce Drive Danbury, CT 06810-8153 Phone: (203) 207-9700 Fax: (203) 207-9780 www.smithsdetection.com

smiths