FTIR addressing the Gas Identification Gap for Hazmat/CBRNe

When responding to a Hazmat incident, knowing what you're dealing with is key to keeping people safe and effectively dealing with the situation. Once you identify a material, the hazards and properties of that material are readily at your fingertips. For solids and liquids there are many tools available for identification of unknowns.

Introduction

Led by the "white powder" scares of the early 2000's, FTIR and Raman instruments have been developed which can quickly and easily identify thousands of unknown solids and liquids. Many Hazmat teams worldwide have successfully used this equipment, providing identification of unknowns and improving the safety of their community.

In contrast to solids and liquids, though, there has been a real gap in the ability of instruments to identify unknown gases for Hazmat response. By their very nature, gases exist at lower concentrations, making identification more difficult. Unfortunately, gases pose the greatest danger in emergency response. They can be toxic at low concentrations, and they are uncontained. To describe the danger in common terms, "They can come out and get you".

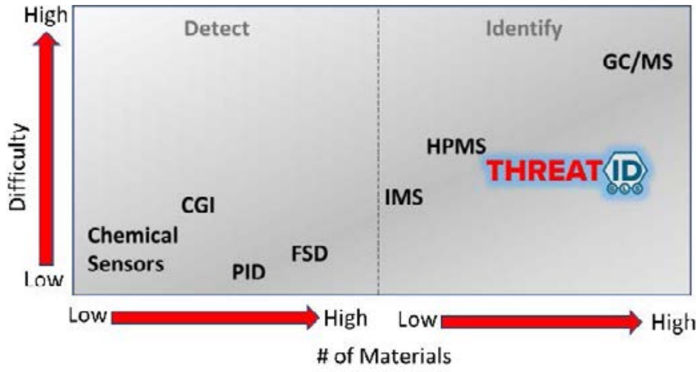
The new ThreatID-GLS from Redwave Technologies addresses this gap by providing identification of solids, liquids and gases using FTIR spectroscopy. Adding sensitive gas measurement to the well-known FTIR technology now allows responders to identify gases which pose the greatest danger to both the responders and the community with an already familiar technique.

Challenge: Detection vs. Identification

First responders have many tools to detect and quantify gases. Combustion gas indications (CGI), photo ionization detectors (PIDs) and chemical specific sensors (such as a 4 or 6 gas meter), all indicate if certain gases are present and predict a concentration, but none of them actually identify the material. The PID is a great example. It is highly sensitive, and it can detect a wide variety of gases. With the proper calibration it can also accurately quantify many gases. Teams love using the PID because it can see so many different materials. This universal nature is both its advantage and its downfall. If there is a gas present, most likely the PID will respond, telling you something is there. Unfortunately, you still don't know what is there. What are the dangers? How much of it is a problem? How do you remediate it? The PID lets you find it but doesn't tell you what it is. Pairing the PID with the ThreatID-GLS gives the ability to quickly detect and locate the gas of interest (using the PID), as well as accurately identify the material (using the ThreatID-GLS). Additionally, once the identification is made with the ThreatID-GLS, the correct calibration factor can be entered into the PID, allowing for accurate quantitative measurement.

Chemical specific electrochemical sensors and flame ionization spectrometers are more specific that CGI or PID detectors, but their identification abilities are still limited. Electrochemical sensors are targeted at specific compounds, such as hydrogen sulfide or carbon monoxide; however, they have cross reactivity to other compounds as well. A positive reading is indicative of the gas present, but not a real identification. Flame spectroscopy detectors (FSD) are more specific than PID's. Commonly used handheld models respond to compounds containing arsenic, nitrogen, sulfur and phosphorous. Similar to the electrochemical sensors, this allows classification but not identification.

Other instruments provide identification for specific threats; however, the ThreatID provides the largest coverage of commonly found gases at relevant concentrations. Ion mobility spectroscopy (IMS) and high-pressure mass spectrometry (HPMS) both provide sensitive detection of specific,



targeted threats. Both are important tools for the detection and identification of CWA's and dangerous narcotics. For general use, though, they present some issues. First, the number of materials identifiable by these systems is quite low. IMS are very sensitive, but they're targeted at CWA and a few select toxic industrial chemicals (TIC's); they provide identification or classification of approximately 50 compounds. HPMS is more versatile, covering CWA, TICs and many narcotics. Each of these can be detected with great sensitivity, but the number of compounds identified is on the order of several hundreds. By comparison, the ThreatID-GLS has 5600 compounds in the library covering a wide range of TICs and volatile organic compounds (VOCs). This allows simple identification of many substances found on typical hazardous materials calls.

Sensitivity vs. Usability

An instrument with high sensitivity can accurately identify even a small amount of material. Obviously, high sensitivity is advantageous when dealing with hazardous materials. Making an identification at a low concentration helps to keep both responders and the public safe.
Sensitivity can have a downside as well, because the system can be easily contaminated with too much sample. The ThreatID-GLS can identify most compounds at concentrations in the part per million (ppm) range. Additionally, with partial filling of the gas cell, it can identify compounds over 3 orders of magnitude. As an example, ammonia can be accurately identified at concentrations ranging from 25 ppm to over 0.5%. This gives the ability to identify and address both small and large problems. The pre-view screen alerts the user when sufficient

sample is in the cell for an identification. If excess sample is added to the cell, it can typically be pumped clean in a matter of minutes; there is no need to conduct an extensive cleaning, or “bake-out”, procedure.

Small Molecules

Absorbances measured by infrared spectroscopy is based on covalent chemical bonds present in the sample and consequently is unaffected by the molecular weight of a sample. There is no limit, either high or low, to the sample molecular mass which can be measured by infrared. Mass spectrometers, on the other hand, have a molecular weight range for which they are effective. In particular, the minimum molecular weight measurable by most portable mass spectrometers is approximately 50 atomic mass units.

Many hazardous gases which have low molecular weights are identifiable by the ThreatID-GLS, but not by commercially available mass spectrometers. Examples include ammonia (17 amu), diborane (27 amu), formaldehyde (30 amu), hydrogen cyanide (27 amu), carbon monoxide (28 amu) and phosphine (36 amu). All of these gases are listed by the Occupational Safety and Health Administration (OSHA), as hazardous industrial gases and are identifiable by the ThreatID-GLS.

Simple Use, Important Results

The ThreatID-GLS allows for easy identification of many chemicals, whether they are solids, liquids or gases. By extending well accepted infrared spectroscopy identification to gases, the ThreatID-GLS allows responders to increase safety and improve response to chemical gases and vapors which represent one of the larger dangers which they deal with. Overall, the system can identify over 5,600 gases, and over 23,000 solids and liquids, providing the broadest range of chemical identification available.

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