OPEN PATH FOURIER TRANSFORM INFRARED SPECTROMETER
APPLICATIONS FOR ENVIRONMENTAL MONITORING
OF CHEMICAL WARFARE AGENTS

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INTRODUCTION

The Chemical Biological Applications and Risk Reduction (CBARR) Business Unit is part of the U.S. Army Soldier and Biological Chemical Command (SBCCOM) located at Aberdeen Proving Ground, Maryland. CBARR provides air-monitoring (as well as soil and water sample analysis) services for a number of customers involved in a variety of efforts. One of the air monitoring technologies used by this organization is the Open Path Fourier Transform Infrared Spectrometer (OPFTIR).

The OPFTIR system employed by CBARR is currently assembled and serviced by Cerex Environmental Services, Inc. The spectrometer is a Michelson Interferometer manufactured by Bomem, Inc. The basic system includes the FTIR spectrometer, a telescope, an array of corner cube mirrors (retroreflector), and a field computer (Figures 1 and 2). The FTIR emits modulated infrared energy, through the open air, to the retroreflector. The retro then reflects this infrared signal back to the FTIR, where it is picked up by a cryogenically cooled MCT (Mercury Cadmium Telluride) detector. The practical and useful response range for this detector is 500-4500 cm\(^{-1}\) (in the mid-infrared band). Electrical responses produced by the detector are converted to a digital signal, which can then be interpreted by and archived on a computer.

Figure 1. FTIR with telescope mounted on the front of the instrument.

Figure 2. The Retroreflector.

PRINCIPLE OF OPERATION

As the infrared signal passes through a sample (in the open air), any chemical vapors present will absorb infrared energy at various wavelengths. In fact, different compounds in the vapor will produce unique fingerprints of absorbance features. These can be compared to a library of spectra on the computer, thereby providing real-time identification and quantification.

As straightforward as this concept of matching spectra to a library set sounds, it can become quite complicated when there are multiple compounds with infrared features in a sample. To minimize false alarms during monitoring, compounds of interest (as well as interferents) are specified up front. Typically, half a dozen components are monitored, though this is not a rule. With all of the spectra being archived to the computer, follow up review for additional compounds or confirmation of alarms can be easily accomplished.
This open path system is capable of operating with a one way path length of up to 400 m. However, this range is dependent upon atmospheric conditions, as well as other interferents (physical obstructions, dust, etc).

Typical detection limits at 100 m are in the single parts per billion range for many compounds. CBARR currently has over 200 different compounds in its library and is continuing to expand and improve on the current library in-house.

**DISCUSSION**

CBARR has employed the Open Path FTIR system for over five years in a variety of missions. The typical is fence line monitoring at remediation sites where chemical warfare materials are suspected to have been disposed of. Other tasks include fence line monitoring at production facilities, and as an extension to other monitoring tools at a variety of experiments. Missions have been accomplished for a number of organizations including the EPA, DOE, Corps of Engineers, and several foreign governments.

With the variety of missions, CBARR has been required to use the OPFTIR in a number of different configurations (Figures 3, 4 and 5). These include operations out of the back of a vehicle, mounting on a HMMWV, and using fiber optic cable or RF links for remote control.

**CONCLUSION**

The primary disadvantage of the Open Path FTIR system is its high detection limits. Fortunately, in many applications this is offset by its advantages. These include its portability, field hardiness, and adaptability, as well as its ability to monitor a long path. However, its greatest advantage is that it provides continuous, real-time monitoring (results in less than five minutes) for over 200 different compounds.