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Agency

Environmental Sciences Division
P.O. Box 93478
Las Vegas, NV 89193-3478

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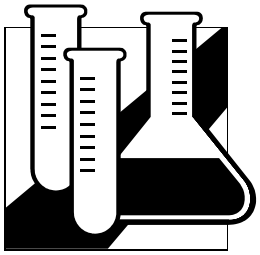
OFFICE OF RESEARCH AND DEVELOPMENT

TECHNOLOGY SUPPORT PROJECT

Immunochemisty for Environmental Monitoring



Introduction

The Environmental Sciences Division (ESD) in Las Vegas is pioneering an investigation into the usefulness of several immunochemical techniques for monitoring the extent of contamination in various environmental and biological matrices. Immunochemistry includes all methods of sample preparation and analysis that incorporate antibodies that have been developed for specific analytes or groups of analytes. Enzyme-based immunochemical techniques have been in use since the '70s and more recent efforts have focused on their applicability to the complex matrices that face environmental scientists. The ESD has developed and demonstrated several immunochemical techniques and believes that these methods hold great promise for the quantitative analysis of target analytes for use in ground-water surveillance, *in situ* hazardous waste site monitoring, and assessment of human exposure. Current work involves the analysis of chemicals, like PCBs, nitroaromatics, and certain pesticides, that are difficult to analyze by other analytical methods.

Background

Immunochemistry includes techniques such as immunoaffinity and immunoassay. Immunoaffinity is a sample preparation procedure that takes advantage of the attraction between an antibody and a specific analyte. Immunoaffinity preparations have great potential for cleanup of complex samples like dioxins. By rinsing a sample over an antibody-treated surface, scientists can isolate particular compounds in the sample that adhere to the antibody. The isolated compound is then eluted from the immobilized antibody and is ready for analysis by chromatography or immunoassay. One common immunoassay is the enzyme-linked immunosorbent assay (ELISA). The specificity of the antibody for the analyte and the resultant immune complex is the basis for the specificity of immunoassays. Most field immunoassays are colorimetric analytical methods that quantify compounds of interest. A sample is spiked with a known amount of a labeled analyte. The label is typically an enzyme. A chromogenic substrate is added to serve as an indicator of compound concentration in the sample. Laboratory-based immunoassays include fluorescent and radioactive methods that have greater sensitivity but are less portable.

Field Use

Immunoassays are portable, rugged, and inexpensive. Their use at hazardous waste sites has been investigated by the ESD. The results of Superfund Innovative Technology Evaluation (SITE) studies indicate a strong correlation between field immunoassays, laboratory immunoassays, and gas chromatography/mass spectrometry. The only equipment needed is a spectrophotometer, various microtiter plates or test tubes, precision pipets, and immunologic reagents. The 96-well microtiter plate is approximately 3" x 6" and has 96 depressions, each capable of holding about 250 µL liquid. Smaller microtiter strips are available that can be assembled to form modular sections for individual analytes. These plates and test tubes are available precoated with the antibody base.

Another field use of immunochemistry is being explored at the ESD. This use may revolutionize safety and exposure precautions used by workers who deal with hazardous chemicals. Dosimeter badges with an immunochemical twist are available for pentachlorophenol and nitroaromatics. These personal exposure monitors (PEMs) are lightweight, inexpensive, can be analyzed quickly, and provide real time indication of exposure. These badges employ a microdialysis tubing containing an immobilized antibody phase. Immediate identification of high exposure levels is critical to the conduct of safe site characterization.

Advantages and Limitations

The use of immunochemical techniques is gaining acceptance in the area of environmental science. One need that is being addressed is that of specificity. Frequently, immunoassays are available for a class, like PCBs. Specific quantitation for each component would be difficult.

Advantages and Limitations *Continued*

PEMs are available for pentachlorophenol and are being developed for parathion and chlorpyrifos. The development of PEMs must address the question of diffusion of chemicals through the dialysis tubing, the optimum concentration of the antibody, detection limits and quantitation of the badge, the efficiency of the antibody in capturing the analyte, and the capacity of the device.

Advantages	Limitations
• Field portable	• Separate immunoassay needed for each analyte
• User friendly	• More complex analysis required for quantitation of specific analytes
• Quick and inexpensive	• Long development time for new antibodies and methods
• Potential for wide range of analytes	
• Useful for many matrices	
• Low detection limits	

Future

The ESD is active in the development of all immunochemical methods that have potential for Agency use. One new avenue of investigation is the use of antibody-coated fiber optic immunosensors. Another application is the integration of robotics capability for high sample throughput and a tiered analytical approach, i.e., biological and environmental samples, biomarkers, target analytes, and degradation products. This system of analytical procedures will enable scientists to measure contamination at the source, follow the fate and transport of residual amounts, and assess human exposure.

Multi-analyte immunoassays that can identify several analytes simultaneously are expected to expand the desirability of immunoassay technology for environmental use. Work in this area is already underway at the ESD.

Reference

Immunochemical Methods for Environmental Analysis, J. M. Van Emon and Mumma, R. O., eds., ACS Symposium Series 442, ACS, Washington, DC, 229pp. 1990.

For Further Information

For further information about immunochemistry for environmental monitoring, contact:

Dr. Jeanette Van Emon
Immunochemistry Program
U.S. Environmental Protection Agency
National Exposure Research Laboratory
Environmental Sciences Division
P.O. Box 93478
Las Vegas, NV 89193-3478

Tel: (702) 798-2154
Fax: (702) 798-2243

For information about the Technology Support Center at the ESD, contact:

Mr. J. Gareth Pearson, Director
U.S. Environmental Protection Agency
National Exposure Research Laboratory
Environmental Sciences Division
P.O. Box 93478
Las Vegas, NV 89193-3478

Tel.: (702) 798-2270

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The Technology Support Center fact sheet series is developed and written by Clare L. Gerlach, Lockheed Martin, Las Vegas.