NAVFAC

TechData Sheet

Naval Facilities Engineering Service Center
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Rapid Sediment Characterization of PCBs With ELISA

An Immunoassay Technique
A Rapid Sediment Characterizaton (RSC) Tool

INTRODUCTION

This TechData Sheet focuses on the applicability of the polychlorinated biphenyl (PCB) immunoassay test kits for the screening of PCBs in *sediment* samples. Traditional sampling and analysis methods of marine ecosystems, namely sediment, do not always provide the information needed in a timely and cost-effective manner. The Navy has been testing simple immunoassay field screening methods for soil in the marine environment to determine its suitability to provide near-real time data that can support accelerated site characterization and reduce cost. The PCB immunoassay test is one of a group of Environmental Protection Agency (EPA) verified techniques that identify and quantify a wide range of organic and inorganic compounds. In addition to PCBs, immunoassay tests can be used to detect polycyclic aromatic hydrocarbons, pesticides, and mercury.

TECHNICAL DESCRIPTION

The enzyme-linked immunosorbent assay (ELISA) is used for environmental field analysis because it can be optimized for speed, sensitivity, and selectivity, has a long shelf life and is relatively simple to use. Immunoassay tests use antibodies to bind with a target compound or class of compounds; in this case PCBs. Concentrations of the PCB and the target analyte are identified through a colorimetric reaction. The determination of the PCBs' presence is made by comparing the color developed by a sample of unknown concentration with the color formed by the standard containing the analyte at a known concentration. The concentration of the PCB is determined by the intensity of color in the sample and is measured with a spectrophotometer. Figure 1 depicts how the contaminant part of an enzyme conjugate binds with antibody sites. Immunoassay kits are relatively quick and simple to use with a short training session. Detection limits can vary depending on the dilution series used. The detection limit for PCBs test kits in soil ranges from 50 to 500 parts per billion (ppb).

METHODOLOGY

Commercial immunoassay test kits are readily available from several vendors. The test kits typically

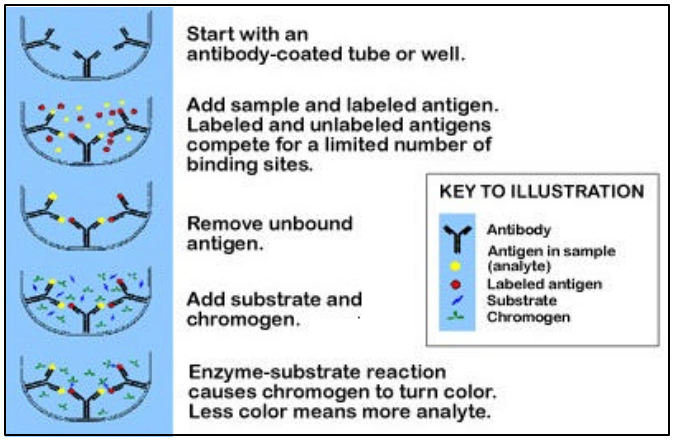

Figure 1. Schematic of contaminant-enzyme binding (Source: U.S. EPA, 1996).

include test tubes, the enzyme conjugate, the chromogen, other necessary solutions, and calibration standards. Typical test kits are designed to analyze 10 to 20 samples at a time. Calibration standards, and sometimes control samples, are analyzed with each batch. Once the process begins, all samples are carried through timed steps in equal fashion. Typically, 50 sediment samples per day can be achieved. The cost of analysis usually ranges from $20 to 40 per sample, plus the cost of labor.

APPLICATION

The immunoassay technique is very useful for preliminary assessments of contaminant distribution as in environmental field screening applications. It can also be used during various phases of the Ecological Risk Assessment process, depending on the specific questions being addressed. A subset of 10 to 25% of the screening samples should be sent for confirmatory analyses by a certified laboratory. Combining screening data with a select number of laboratory analyses will result in more efficient sampling and analysis to characterizing the nature and extent of contamination at a site.

Immunoassay tests are ***not*** applicable to sites with unknown site conditions and contaminants. Sites with a single contaminant, or only one type of chemical class of contamination, are the sites most suited for the immunoassay method. Immunoassay tests may not be applicable to sites contaminated with complex mixtures of chemicals because interference may arise.

The immunoassay screening data for PCBs in sediments have been successfully validated against standard laboratory methods.

Figure 2 shows a comparison of immunoassay and certified laboratory results on split samples. A close correlation was observed between the methods (Coefficient of Correlation $R^2 = 0.92$).

ADVANTAGES

- Commercially available test kits.
- High throughput, about 50 samples analyzed per day.
- Near real-time results; results can guide further sampling.
- Low cost analysis ($20 to 40 per sample, plus labor).
- Data are appropriate for delineating trends.
- Detection limit for Aroclor 1254™ ranges from 50 to 500 ppb.

LIMITATIONS

- Semi-quantitative, non-specific data (cannot speciate between different Aroclor™ mixtures or individual congeners).
- Must know site condition and contaminants.
- Field screening data are not always accepted for regulatory compliance, but can be used to develop sampling strategies.
- Cross-reactivity for some classes of contaminants.
- Tests require stringent attention to kit's procedure.

CASE STUDY

A sediment screening study was conducted in April 2000 at Hunters Point Shipyard to support a baseline risk assessment sample design. Surface sediment samples were collected in a grid pattern from 94 locations in the 5 offshore areas of concern. The surface sediment samples were screened for PCBs using the field immunoassay technique at the Space and Naval Warfare Systems (SPAWAR) Center San Diego Laboratory. The screening sample results were used to refine the sampling design for a more detailed study of sediment chemistry, toxicity, and bioaccumulation. In particular, the screening results were used to ensure that the baseline assessment study sampling stations span the entire range of contaminant concentrations and therefore represent the full range of potential exposure. Ten percent of the sediment screening samples were submitted to an independent and certified analytical laboratory for quantitative analysis of all contaminants of concern, to verify the screening results, and provide additional surface sediment data to support the assessment study.

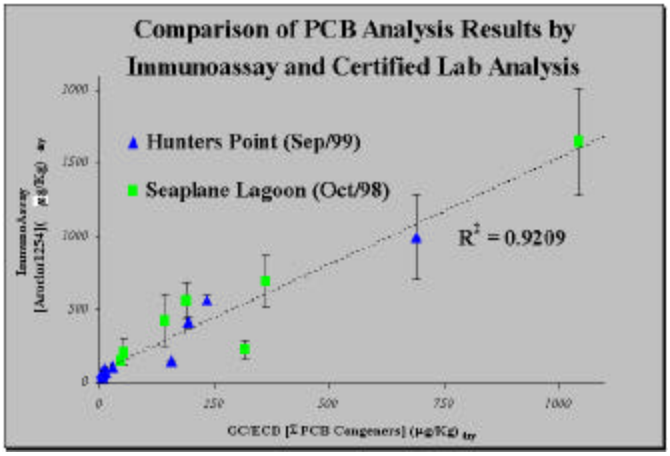

Figure 2. Close correlation is observed between immunoassay and certified laboratory results for total PCBs.

In order to fully evaluate the extent of contaminant distribution, the immunoassay screening results for PCBs are shown from one of the five offshore areas of concern (Figure 3). These results indicate two potential source areas for elevated PCBs in these offshore sediments, one on the northeast side and one on the west side of the embayment. Although the northeast area may be related to Navy operations, the source area to the west is at a creek mouth with potential non-Navy contributions from upstream locations contributing contamination to Navy property. The screening results can be used to delineate strata boundaries to ensure each potential source is sampled and laboratory data will be available to estimate relative source contributions to Navy sediments. As is often the case in sediment assessments, multiple potential sources are typically present. These sources need to be considered in designing the sampling plan for the baseline assessment because they may require some method of source allocation. RSC screening results may also aid in pollution prevention programs by identifying potential source areas in need of control before any extensive remedial options are considered in affected offshore sediment areas.

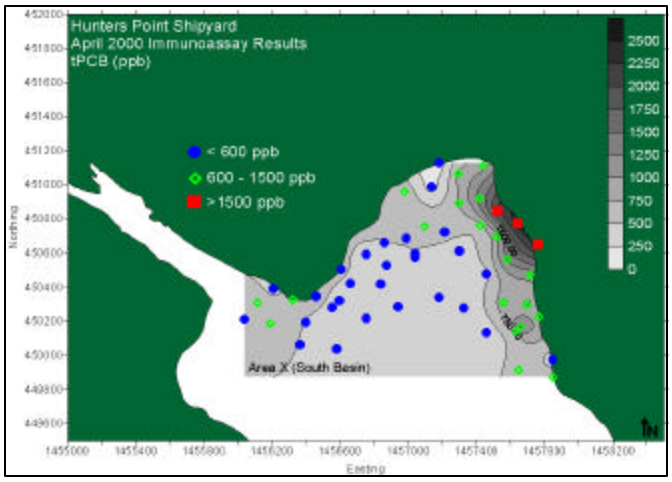

Figure 3. Immunoassay results of PCBs concentration at Hunters Point Shipyard.

COST COMPARISON

Immunoassay	Laboratory
~ $20 to 40 per sample	$400 per sample
(30 to 50 samples per day)	(30 to 90 day turn around)

For further information on Rapid Sediment Characterization of PCBs with ELISA contact:

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