Enhanced Detection of Toxic Agents

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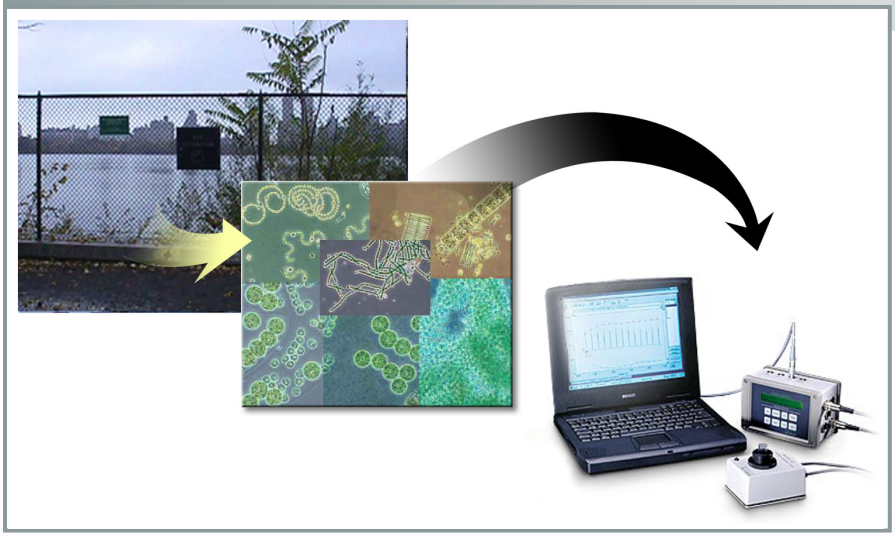

Technology Summary

Researchers at ORNL and the University of Tennessee have taken the next step in the development of their AquaSentinel water quality monitoring system by improving the sensitivity of the process using a new electrokinetic enrichment technique.

Most of the primary source drinking water in the United States is vulnerable to the introduction of toxic substances, either through human error or deliberate human actions such as bioterrorism. ORNL's AquaSentinel technology uses changes in the chlorophyll fluorescence induction properties of naturally occurring microalgae to detect the presence of toxic substances. An original algorithm developed by the researchers correlates the florescence induction curves of "poisoned" algae with those of healthy algae to identify the specific pollutant/chemical agent that caused the change in fluorescence. Unlike conventional water quality sensors, it is self-contained, can be operated 24/7, and uses naturally occurring biosensors (the microalgae) that are continuously refreshed. However, use in the field demonstrated that microalgae in many cases are present in such low concentrations that reliable detection cannot be guaranteed in real time. Reliable detection at lower concentrations means earlier detection, truly making the algae like microscopic canaries in a coal mine.

To solve the problem and create a more sensitive early warning system, ORNL researchers used the recently developed technique of biased AC electroosmosis to generate microfluidic flows that accelerate algae movement to the AquaSentinel fluorescence sensors, thus increasing algal concentrations and lowering detection limits . The biased AC electroosmosis cell has been integrated with AquaSentinel in a lab-on-a-chip configuration that receives the fluid to be analyzed and concentrates the microalgae, then a photodetector measures photosynthetic activity in the concentration region and an electronics package analyzes the measured photosynthetic activity to indicate the presence (or absence) of chemical, biological, or radiological agents in the fluid. Integration of biased AC electroosmosis with the AquaSentinel technology provides earlier detection than previously possible, greatly improving AquaSentinel under real-world conditions.

Advantages

- No sample preparation necessary
- Little or no training necessary
- Noninvasive
- Highly sensitive, real-time detection
- Simplicity; low power requirements and no moving parts
- Less need for manually testing water (and associated costs)
- Reagentless
- Mobile, field-deployable, submersible
- Automatic, continuous testing, 24/7
- Self-operating and self-cleaning
- Cost-effective

Potential Applications

- Early detection of primary source drinking water contamination
- Early detection of food contamination
- Field-sampling of water by military personnel
- Air quality monitoring
- Climate change monitoring
- Tool for companies/utilities to demonstrate environmental compliance

Patents

Elias Greenbaum, Miguel Rodriguez Jr., Jie Jayne Wu, and Hairong Qi. *Method and Apparatus for Enhanced Detection of Toxic Agents*, U.S. Patent Application 20080032326, published on February 7, 2008.

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