Inferential Monitoring of Chlorinated Solvents Through Raman Spectroscopic Observation of the Vibrational Modes of Water

A highly sensitive and cost-effective Raman spectroscopy method enables detection of chlorinated solvent contamination in water systems for delineation and monitoring.

Due to widespread use in the production of household products, degreasing operations, and petroleum refining, chlorinated solvents have become common pollutants. According to the EPA Toxic Chemical Release Inventory, 1.7 million kg of trichloroethylene (TCE) and three other highly used solvents were released into the environment between 1987 and 1993. Reports estimate that 34 percent of the drinking water supply in the U.S. likely contains TCE contamination. There are many different methods to assess contaminated site chlorinated solvent levels, both in lab and in situ, but most require costly and/or sophisticated equipment and instruments, can only assess a short-list of compounds, provide information over a limited spatial extent, or are too costly for long-term monitoring. Remote sensing techniques are especially subject to poor resolution and sensitivity and have virtually no insight into subsurface conditions.

Researchers at Purdue University have developed a new method to detect the presence of chlorinated solvents in water using Raman spectroscopy. Raman analysis of chlorinated solvents traditionally involves direct monitoring of any of a number of solvent specific vibrational modes, e.g., the 381 cm-1 TCE line. This approach is limited in sensitivity by the inherently weak Raman return of chlorinated solvents. In this new approach, the presence of the solvent can be inferred indirectly by monitoring the OH stretching line of water (3393 cm-1). In experiments performed at Purdue with a 20 uJ laser, the traditional method can only detect TCE at aqueous concentrations as low as 70 ppm. The indirect method, though, is 10x more sensitive and can detect concentrations as low as ~8 ppm at the same laser power, noting that ultimate detection limits are closely tied to employed laser power in the test system. This makes the new method very useful for

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contaminant plume delineation, warning of contaminant release, or the design of tailored monitoring approaches when water systems have been exposed to chlorinated solvent contamination. This method may have value for analysis of aqueous systems containing other group seven elements such as fluorine, bromine, or iodine.

Advantages:

-Highly sensitive and can detect subsurface contamination

-Inexpensive equipment and low application costs

-Can be used in lab or field operations

Potential Applications:

-Waterway analysis

-Drinking water tests

-Pollutant detection

TRL: 4

Intellectual Property:

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