Engineers find new ways to remove pollutants 1998-11-04

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UIC engineers are experimenting with new methods to remove pollutants from the soil without excavating.

The results of their work could be a boon to the Environmental Protection Agency, which estimates it must clean up more than 200,000 sites around the country at a total cost of about $187 billion in 1996 dollars.

The sites include former dumping grounds used by the electroplating industries, underground storage tanks at gasoline stations and weapons laboratories.

"Industries and other polluters used to dump waste liquids on the ground before we had laws against those practices," said Krishna Reddy, assistant professor of civil engineering.

"Now we must remediate these sites, or the pollutants will get into the ground water and cause problems."

By fine-tuning a common technique known as electrokinetics, Reddy and fellow researchers have achieved a 90 percent removal rate for metals.

Electrokinetics works on the principle that opposite electric charges attract.

Engineers at contaminated sites, which are usually about football-field size, drill wells into the soil, place electrodes or wires inside, then connect the electrodes to a small direct-current source.

This sets up an electric field between pairs of electrodes, pulling positively charged pollutants toward the negative electrode and negatively charged pollutants toward the positive electrode.

It may take years for pollutants to migrate through the soil, but eventually they concentrate around the wells where they can be pumped out or excavated.

"Electrokinetics has advantages over other approaches," said Reddy, who was a professional engineer before coming to UIC.

"You're not excavating and disposing of the soil on a large scale, so it's safe, and you don't disturb the site operations."

In practice, however, he found limits to the technique.

"All the research was done under idealized conditions, with one type of clay soil, and one contaminant, lead," he said.

In his own research on metal contaminants such as cadmium, chromium and nickel, Reddy discovered that soil chemistry and the mix of contaminants may limit the technique's use.

For example, positive and negative ions in the pollutants migrate at different rates through the soil, causing changes in soil acidity across the site.

In turn, the changes in soil acidity may cause contaminants to condense out of the water that carries them along, like salt crystals forming along a string in a beaker of brine, so that contaminants do not reach the electrodes.

"I asked, 'What are the mechanisms that prevent us from totally removing contaminants, and how can we counter those hindering mechanisms?'" said Reddy.

To better remove metals, Reddy devised an approach using so-called purging solutions.

Engineers would apply water-soluble chemicals around the electrodes to correct acidity and draw pollutants out.

An Li, assistant professor of environmental and occupational health sciences, is working with Reddy on the problem of cleaning up soils contaminated with organic pollutants such as PCBs.

"For organics, a further problem is that they don't dissolve in water," said Li.

The trick, she said, is to add something to the water that makes the material more soluble.