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## New Technology Revolutionizing Ground Water Clean-Up; Nanoparticles are 1,000 Times Thinner Than Human Hair

3/13/02 4:03 AM  
Source: PR Newswire

BETHLEHEM, Pa., March 13 /PRNewswire/ -- At a size 1,000 times thinner than a human hair, magnetic nanoparticles are easy to overlook. But add the minute Herculean particles to contaminated groundwater, and they may just change the world.

So says a team of environmental engineers who have pioneered and tested a new technology using nanoparticles that can cleanse polluted underground aquifers that provide drinking water to an increasingly thirsty world.

Wei-xian Zhang, associate professor of civil and environmental engineering at Lehigh University, Bethlehem, Pa., has a patent pending for his remediation method and has licensed the technology to two environmental companies. He also recently received a grant from the U.S. Environmental Protection Agency to explore the potential for using nanoparticles to treat hazardous waste.

"Nanoparticles have been used in chemical processing and electrical engineering for years, but as far as I know, we are the first to use them for groundwater cleanup," says Zhang. "The potential of this technology to help improve the environment is enormous and truly has global implications."

Nanotechnology involves pumping "nanoparticles" -- minute, magnetic, iron-based particles so small that 100,000 would fit on the head of a pin, into the groundwater. With a composition that is 99.9 percent iron and less than 0.1 percent palladium, nanoparticles have a large relative surface area and a high rate of reactivity -- and they race through groundwater like bloodthirsty mosquitoes searching for prey.

When applied to water or soil contaminated with carcinogenic solvents used in dry cleaning and industrial processes, nanoparticles remove chlorine and convert the solvents to harmless hydrocarbons and chlorides commonly found in table salt. The approach is dramatically more effective than traditional cleanup methods that require water to be pumped out, treated, then disposed of.

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Nanoparticle technology offers the potential for significant savings. For example, a \$20-million clean-up project might cost \$5 million, says Zhang, and nationwide savings could be staggering when you consider that the U.S. government alone projects spending \$750 billion in the next 30 years to clean up contaminated groundwater.

The method also holds promise for reducing the impact of bioterrorist attempts to contaminate water because nanoparticles can reduce biological and chemical agents quickly, according to Zhang. For example, Lehigh researchers say the tiny particles were tested and found effective in detoxifying cyanide. The technology also might offer a safer, cheaper, and faster way to clean up nuclear waste and Superfund sites.

The effectiveness of the new technology was demonstrated at the Trane Co. recently at its Trenton N.J. manufacturing plant. Trane, a maker of air conditioning systems, has been investigating a toxic trichloroethene (TCE) plume for several years. The company put nanoparticles to work in several monitoring wells. Samples taken from the wells 12 hours after the nanoparticles had been injected showed that as much as 96 percent of the TCE was reduced to harmless ethylene and ethane.

"This is the first technology that we have found that has the potential to clean up the thousands of sites in many industries in the U.S., where currently nothing is happening," says Chang Tai, environmental and safety engineer for Trane.

Lehigh's researchers plan to test their remediation method this year at other contaminated groundwater sites, and are exploring the use of nanoparticles to neutralize explosives and treat nuclear waste sites.

#### Nanotechnology Fact Sheet

- Scientists say much of the nation's groundwater is already contaminated. Over the next 30 years, the U.S. government alone estimates it will spend \$750 billion to clean up contaminated groundwater, or about \$8,000 per American family.
- The traditional "pump and treat" clean-up method requires hydraulic pumps to bring the groundwater to the surface. The contaminated water then needs to be treated in a treatment vessel to meet federal drinking water standards. Only at this point can the water be discharged.
- Nanoparticle technology treats water "in situ," or right in the ground. The nanoparticles are injected into the ground and they race around cleansing the contaminated water.
- At the Trane Co. manufacturing site in Trenton, N.J., water samples were taken from wells 12 hours after the nanoparticles were injected, and 96 percent of the chemical pollution was reduced to harmless gases. Prior to that, the most effective method produced only a 25- percent reduction.
- Zhang and Dan Elliott, a Ph.D. candidate who left his job as a promising industrial engineer to work with Zhang on the breakthrough technology, published the results of their Trenton site tests in November 2001 in the journal *Environmental Science and Technology*. Their work was also featured in the Dec. 17, 2001, issue of *Chemical and Engineering News*.
- The Lehigh scientists are searching for funding to scale up their nanoparticle production, as they cannot produce them fast enough for the tests they want to do.
- Nanoparticle technology could work to counter terrorist attempts to contaminate drinking water supplies, as the particles can reduce biological and chemical agents quickly. For example, researchers have found that nanoparticles can detoxify cyanide.
- The tiny particles could be useful in cleaning up nuclear waste, as larger particles have

already been found effective in treating uranium. Nanoparticles also are effective in neutralizing organic solvents, which make up the contamination in half the nation's Superfund sites.

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SOURCE Lehigh University

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Message

**Meadows, Richard L LRH**

**From:** Beaujon, James S LRN  
**Sent:** Thursday, March 21, 2002 10:20 AM  
**To:** Meadows, Richard L LRH; 'spang@sprintmail.com'  
**Cc:** Ingram, Linda LRN; Humphreys, Lisa A LRH  
**Subject:** RE: GW Remedial Investigation

With our limited funds at this point in the quarter I'm not scheduled to attend the RAB next week. Mike or the other Mike will have to be prepared to field these concerns.

Mr. Bohne's concern that we might be missing the actual site are understandable first thought responses. My thoughts on how to reduce his concern follow:

- 1) I have no doubt that aerial photo overlays properly applied will indicate we are investigating the correct location(s).
- 2) In addition, given the size of the West Ponds, especially the existing "swan pond", as well as the age and locations of the trees surrounding the ponds there isn't much chance to have missed the right place.
- 3) Also since its groundwater we're talking about the exact location of a well isn't as critical as being in the right general location relative to flow direction.
- 4) Besides the suggestion that the plume (if there had been one) has moved on, there are some chemistry/bioactivity explanations for prior TNT groundwater contamination to have been reduced to acceptable levels.
- 5) In Mr. Bohne's 13 March e-mail he wonders more about the sediments in the ponds than the water. Dames & Moore sampled sediment and I think IT did some too. Our results as I recall didn't indicate levels of concern for TNT. Maybe there is contamination deeper than we sampled, but if the pond water isn't contaminated and the groundwater isn't contaminated is remediation of stable sediments necessary? We would be destroying the ecosystem the remediation would be intended to protect.

Anyway those are my thoughts. (I'm sure Doug has some too.) The Mikes are pretty good at what they do so they'll have sound responses to the RAB's questions.

Jim Beaujon

-----Original Message-----

**From:** Meadows, Richard L LRH  
**Sent:** Thursday, March 21, 2002 8:42 AM  
**To:** Beaujon, James S LRN; 'spang@sprintmail.com'  
**Cc:** Ingram, Linda LRN; Humphreys, Lisa A LRH  
**Subject:** FW: GW Remedial Investigation

Mike/Jim:

Please note Mark's comments below. The first part of his comments are in line with what I expect from our GIS implementation. I know we have old photos, etc and I am sure these were all used in scoping the investigation (hope I'm right!!!!????). Could you please be prepared to discuss this with Mark at our meeting next week. As for what Mr.. Browne had to say; he said hot loads of TNT were dumped at the twin ponds. I assumed he meant West area ponds. He did not know exactly where, he was never there at the ponds when a load was dumped. He worked on the manufacturing line.

Thanks!  
 Rick

-----Original Message-----

**From:** Mark F. Bohne [mailto:hilltop@lrbcg.com]  
**Sent:** Wednesday, March 20, 2002 9:37 AM  
**To:** Rick Meadows  
**Cc:** Lisa Humphreys; Helen Owens

3/21/02