
Removal and Inactivation of Water-borne Viruses Using Elemental Iron

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Photo by Danielle Quigley

Drinking water safety and the growing demand for potable water are two critical water resource issues facing Delaware. The mission of **DWRC** includes supporting research, education, and outreach programs that focus on water supply, water management, and water quality. The research of **DWRC** fellow Liping Zhang, advised by Dr. Yan Jin of the **UD** Department of Plant and Soil Sciences and Dr. Pei Chiu of the **UD** Department of Civil and Environmental Engineering, will evaluate the feasibility of using elemental iron to remove and inactivate waterborne viruses. The purpose of this research is to ultimately develop an effective and economical technology that can be used to remove pathogens from water.

Microbiological contamination of drinking water continues to be one of the greatest challenges in public health risk management in the 21st century. Among the different classes of microbial pathogens, viruses are of particular importance, as they are smaller than bacteria and protozoa, far more mobile in subsurface environments, and also more resistant to currently available water treatment technologies. The United States Environmental Protection Agency (**USEPA**) in the proposed Ground Water Rule (**GWR**) identifies viruses as critical target organisms to control because they are responsible for approximately 80% of water-borne disease outbreaks for which infectious agents were identified.

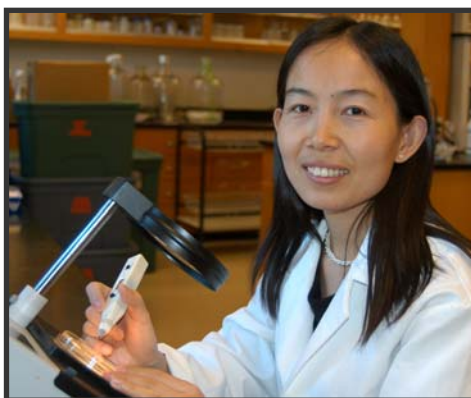
Disinfection is the most important water treatment process for preventing the spread of infectious diseases. While mostly effective for removing bacteria, classical disinfectants such

as chlorine have been shown to be less effective against viral and protozoa pathogens. High doses of chlorine also produce excessive amounts of disinfection by-products (**DBPs**) such as trihalomethanes and haloacetic acids. Many **DBPs** are known or suspected human carcinogens and are themselves subject to **EPA** regulations. Balancing the risk of infectious agents in water supply against the cost of treatment and the risk of **DBPs** is a challenging task.

This study represents the first attempt to evaluate elemental iron for removing pathogens from water. Although elemental iron has been used in permeable reactive barriers (**PRBs**) to remove chemical contaminants in groundwater for the past decade, it has never been shown to remove viruses. "My study will help to understand how viruses are adsorbed and inactivated by iron and to determine whether it is feasible to develop elemental iron-based technologies for removing waterborne viruses. Two bacteriophages, MS2 and ϕ X174, as representative viruses, will be used in a series of laboratory column experiments. "I will investigate the factors affecting virus removal and inactivation by iron, such as residence time, iron type, pH, etc. The long-term performance of iron will also be evaluated. My research will also provide information on

the interactions between virus particles and iron mineral surfaces involved in virus removal. This information will form the basis for understanding the mechanisms for virus inactivation and retention by iron and iron oxides - a process that is important in both natural systems, such as soils, and at municipal wastewater treatment facilities," Liping explains.

Liping received her M.S. in environmental science and engineering and has two and half years of experience in water quality research. She has a keen interest in her Ph.D. project, stating, "Dr. Jin and Dr. Chiu are creative persons and have extensive experience on in virus fate and transport in porous media and using elemental iron to treat environmental pollutants. Under their direction, I hope to



Liping Zhang studying water pathogen removal

provide a scientific understanding of the interactions between viruses and elemental iron and iron oxides and the factors that influence these interactions." Liping is very excited about her research, which she hopes to yield an innovative, effective, robust, and low-cost technology that can be used to remove viruses (and potentially other pathogens) in drinking water, wastewater, and groundwater, and ultimately contribute to Delaware's water quality. Other potential benefits of the iron technology may include lower disinfectant dosage and cost and reduction in disinfection by-product formation.

Water News You Can Use

Free "Smartyards" in the Appoquinimink Watershed: Middletown, Odessa, and Townsend area residents may apply by July 16, 2004 for one of 20 **DNREC**-funded "Smartyards" landscaping packages from the Delaware Nature Society (**DNS**) and Appoquinimink Tributary Action Team. "Smartyards" provide habitat for diverse wildlife, reduce or eliminate the need for fertilizer and pesticide applications, and conserve water resources more than traditional turf grass landscapes. The free packages include native plants from Gateway Garden Center; a bird feeder, nesting box, and bird bath provided by Wild Birds Unlimited; Backyard Habitat certification; one-on-one technical assistance from **DNS**-trained Habitat Stewards; planning and installation guidelines to ensure proper placement and maintenance of the plant materials; and a rain barrel to help conserve water resources. Reach **DNS** at (302) 239-2334 or smartyards@dnsashland.org

Boy Scout Soil and Water Conservation Merit Badge Training was provided to 32 scouts by **DWRC** and **UD** Institute of Soil and Environmental Quality staff at **UD** Ag Day April 24. Visit ag.udel.edu/dwrc/publications.html, click "Public Programs" link for highlights.

Upcoming Local Water Conferences:

- **Sept. 26-30, 2004:** "Managing Nutrient Inputs and Exports in the Rural Landscape". **USEPA** 12th National Nonpoint Source (NPS) Monitoring Workshop, Ocean City, MD. Visit <http://www.ctic.purdue.edu/NPSWorkshop/NPWorkshop.html> or call 765-494-1814.
- **Oct. 13, 2004:** 4th annual Delaware Water Resources Statewide Forum, **UD** Clayton Hall. Details TBA: <http://ag.udel.edu/dwrc/>.
- **April 2005:** White Clay Creek Symposium.

Details TBA in Fall 2004's WATER NEWS and White Clay Creek Watershed Management Committee's site http://mercury.ccil.org/~wcc_ws/ Mr. Rick Darke (see www.rickdarke.com), nationally recognized author/ photographer of White Clay subjects, will deliver the keynote speech "The Liveable Landscape."

- **Jul. 19-22, 2005:** "Managing Watersheds for Human and Natural Impacts: Engineering, Ecological, and Economic Challenges": 9th American Society of Civil Engineers (**ASCE**) Watershed Management Conference, Williamsburg, VA. Local point of contact: Dr. William Ritter (william.ritter@udel.edu). Visit <http://ag.udel.edu/www.asce.org/conferences/watershedmanagement2005/>

New Reports from U.S. / DE Geological Surveys:

Results of a recent 3-year study of nutrients' and pesticides' impact on local wells, streams, and groundwater are now available in **USGS** Circular 1228, "Water Quality in the Delmarva Peninsula, Delaware, Maryland, and Virginia, 1999-2001" by phone at 1-888-ASK-USGS or http://water.usgs.gov/nawqa/nawqa_sumr.html Findings of regional and national interest are highlighted in a separate **USGS** report "Water Quality in the Nation's Streams and Aquifers-- Overview of Selected Findings, 1991-2001." Visit <http://water.usgs.gov/nawqa/> for these and other publications, national data sets, and maps. **From Delaware Geological Survey:** "Ground-Water Recharge Potential Mapping in Kent and Sussex Counties, Delaware", Report of Investigations No. 66, 2004, 20 pages, by A. Scott Andres asandres@udel.edu. Also new from **DGS**: Hydrographs and brief discussions of daily ground-water levels from two shallow wells at Newark and Trap Pond, with daily groundwater temperature data for the Newark site, is now available for viewing on the **DGS** site at <http://www.udel.edu/dgs/hydro.html>.

Thank you Dr. Kent S. Price, Jr.

Dr. Kent Price has stepped down from the **DWRC** state Advisory Panel after many years of service. He retired from the **UD College of Marine Studies** in Feb. 2000 after a 33-year faculty career, during which he conducted research on fisheries and the ecology of the Delaware Inland Bays, and now continues to head the Scientific and Technical Advisory Committee on the board of the **Center for the Inland Bays**. We thank Dr. Price for his energy and service in forwarding the **DWRC's** water resources research mission in Delaware.