

Symposium Encourages Quantum Leaps in Membrane Research

This March, NWRI held the first Pacific Rim “Quantum Leap” Membrane Research Symposium, a 3-day meeting in Honolulu, Hawaii, designed to encourage international collaboration on future membrane research.

The ultimate goal of collaboration is to push membrane technology forward by producing better, cheaper membranes and by expanding the ways membranes can be used.

In the water industry, a membrane is a thin film of porous

material that allows molecules of certain sizes (water, for instance) to pass through, while preventing larger, undesirable molecules — viruses, bacteria, salts, and metals — from doing the same. Simply stated, membranes filter (or “separate”) contaminants from water.

Membranes are used in desalting seawater, treating contaminated drinking water supplies, and reusing wastewater — all of which are being looked at by the water industry as means to combat water shortages.

“We know that a majority of people in some nations don’t get potable water for drinking,” said attendee Kiran Arun Kekre of the Centre for Advanced Water Technology in Singapore. “Membranes are key to changing this.”

Kekre noted that the potential to use membranes “exists wherever they provide the ability to remove contaminants that cannot be removed by other technologies, remove contaminants at less cost, or require less land area.”

Another proponent of membrane technology,

Dr. Mark Wilf of Hydranautics in California, finds membranes remarkable for their “ability to convert impaired water sources to potable water-quality standards and to produce new potable water from highly saline brackish water or seawater.” In other words, membranes make water from water.

Because of their many advantages, membranes are now considered the treatment of choice among the water industry. However, while the use of membranes has expanded over the years, the technology has only progressed incrementally.

For instance, while membranes are accessible in developed nations, they are not necessarily easy to operate or install — or considered affordable — for those in developing nations.

The purpose of the symposium was to identify how to resolve these problems, using the expertise of delegations from the Pacific Rim nations of Australia, China, Japan, Singapore, and the U.S. Not only do these nations share an intense and rapidly growing interest in membranes, but they also have something else in common: an alarming lack of drinkable water.

Drought Down Under. The driest populated continent, Australia is currently facing severe water shortages due to changing climate and drought. “Our continued existence on this continent,” said Dr. Greg Leslie of CH2M Hill Australia Pty, Ltd., “will depend on careful stewardship of water supplies in all their forms. Membranes play an important role in this stewardship.”

What’s Australia Doing? Australia has several universities that have exhibited world-renowned expertise in membranes and is now using the technology to solve critical water problems across the country.

Population = Pollution. According to World-watch Institute, over 300 Chinese cities are facing

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The Heads of Delegations: (from left) Harry Seah of Public Utilities Board (Singapore), Dr. Masaru Kurihara of Toray Industries (Japan), Dr. Tony Fane of UNESCO Centre for Membrane Science & Technology (Australia), Honolulu Mayor Jeremy Harris, David Furukawa of Separation Consultants (U.S.), and Dr. Jun Ma of Harbin Institute of Technology (China).

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Goodbye, Jack Jorgensen

Water reclamation expert. Pioneer of desalination. Author of the “Simon Bill.” Many of us will remember Jack C. Jorgensen as an internationally renowned water resources consultant who spent a lifetime making water usable. Others will remember him as a great friend and brilliant colleague.



Jack C. Jorgensen was an 11-year member of the NWRI Research Advisory Board. He passed away in January 2004.

Jack Jorgensen passed away on January 9, 2004, from cancer at the age of 79. He left behind his wife, Dawn O’Brien Jorgensen, three children, two stepchildren, 11 grandchildren, and four great grandchildren. Services were held at Arlington National Cemetery in Virginia.

Born in Tacoma, Washington, Jack Jorgensen was a Naval veteran of World War II and a graduate from the University of Washington with a B.S. degree in Civil Engineering, emphasis in water and hydrology. “I couldn’t remember a time when I didn’t want to be an engineer,” he had once said. “My father was a building contractor, so I grew up with engineering. It became a part of me.”

Jack’s professional expertise was in water quality, water desalination, water research, and water-related legislation. His career in public service spanned 60 years, including over 30 years with the U.S. Department of Interior, where he retired in 1979 as the Assistant Director for Technology Transfer in the Office of Water Research and Technology.

Early in his career, he worked on major water projects in the Western U.S., including the Klamath Reclamation Project, Central Arizona Project, and various assignments in the Central Valley of California. He was transferred to the Washington

area in 1964 and served in the Office of the Secretary of the Department of the Interior on international water issues, including those between the U.S. and Mexico involving the quality of Colorado River water. This pivotal effort resulted in the construction of the Yuma Desalting Plan in Yuma, Arizona.

Even after his retirement, Jack continued to be professionally active, and was a key champion — and pioneer — of desalting technologies. He authored legislation promoting water desalination, and was the primary author of the “Simon Bill” — and, later, Water Desalination Act of 1996 — under the sponsorship of the late U.S. Senator Paul Simon. For his efforts, he was named the American Desalting Association (ADA) Man of the Year in 1994, and was subsequently elected into the ADA Hall of Fame.

He was also one of the founders of the National Water Supply Improvement Association, and founder and current President of the Board of Directors of the Beaches Water Company in Calvert County, Maryland. The Beaches Water Company began as a project to rehabilitate a condemned water-distribution system. Because of Jack’s leadership, that same distribution system now provides domestic water for more than 800 customers in the Chesapeake Bay Beach Communities of Long Beach and Calvert Beach in southern Maryland.

Jack was also an active member of the NWRI Research Advisory Board (RAB), which he joined in 1992. He rarely, if ever, missed a RAB meeting and was always willing to support NWRI activities, whether that meant offering his expertise on a project or spending a few moments to talk to grade school students interested in becoming water scientists. He will be deeply missed.

Shannon Cunniff Joins Department of Defense

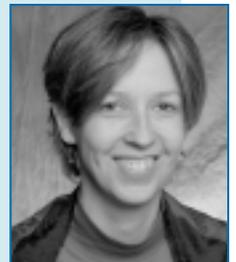
Congratulations to NWRI Research Advisory Board Member Shannon Cunniff, who joined with the U.S. Department of Defense (DoD) as Special Assistant for Emerging Chemicals under the Office of the Deputy Undersecretary of Defense (Installations and Environment) in Spring 2004.

Shannon is now the DoD’s new point person for Emerging Chemicals, a position created to draw upon her varied experiences in water resources, environmental science, and technology to facilitate the DoD’s efforts to address issues involving emerging policies of chemicals specific to DoD use.

Prior to joining DoD, Shannon served as Director of Research and Development for the U.S. Department of the Interior, Bureau of

Reclamation since 2000, where she focused on ensuring that new science and technology was developed and applied to the growing water management challenges of the Western U.S. Support for research in desalination and advanced water treatment technologies expanded during her tenure there.

Shannon’s water-resources experience includes working at the U.S. Environmental Protection Agency and U.S. Army Corps of Engineers on a broad range of federal water-resources activities, such as water supply, floodplain management, river restoration, wetlands, and watershed approaches.



Shannon Cunniff

NWRI in 2003: A Summary of Success

Riverbank filtration. Ultraviolet disinfection. Seawater desalination. These were some of the topics that NWRI tackled in 2003 — a very busy year for the Institute. Here are highlights from some of NWRI's more notable activities and accomplishments last year.

Funded Research Projects in 2003

NWRI funds research in the areas of treatment and monitoring, water-quality assessment, knowledge management, and exploratory research. The following research projects represent over \$1 million invested in water-related research for 2003:

Optimization of Filtration Flux Rate for Production of Title-22 Disinfected Tertiary Recycled Water

Kara Nelson, Ph.D.,
University of California, Berkeley, and
Bahman Sheikh, Ph.D., P.E.,
Independent Water Reuse Consultant
NWRI: \$99,805 Match: \$200,345

Feasibility Study: Applying Lawrence Livermore National Laboratory's Practical Environmental Restoration Management Process to Water Reuse and Desalination Project Management

Zafer Demir,
Lawrence Livermore National Laboratory
NWRI: \$25,000 Match: \$25,000

Dynamics of Point and Non-Point Source Fecal Pollution from an Urban Watershed in Southern California

Stanley B. Grant, Ph.D.,
University of California, Irvine
NWRI: \$50,000 Match: \$123,040



Attendees of NWRI's Second International Riverbank Filtration Conference had the opportunity to tour the 15-million gallon per day horizontal collector well at the Louisville Water Company's B.E. Payne Water Treatment Plant in Louisville, Kentucky.

Novel Membrane Biofilm Reactor for Groundwater Treatment and Remediation

Samer Adham, Ph.D., *MWH*
NWRI: \$100,000
Match: \$103,011

The Rate of Bromate Decomposition in the Human Stomach

Joseph Cotruvo, Ph.D.,
Joseph Cotruvo Associates
NWRI: \$48,500 Match: \$48,500

Water Demand and Aging

William F. Gayk,
Center for Demographic Research,
California State University Fullerton
NWRI: \$5,000

Water Softener Pilot Program

Kim L. Knight and David S. Kung, Ph.D.,
Claremont Graduate University
NWRI: \$17,500 Match: \$170,000

2003 NWRI Fellowship Awards

NWRI awards fellowships to graduate students in U.S. universities conducting water-related research. Three new fellowships were awarded in 2003:

Investigation of *Bacillus Subtilis* and *Bacillus Megaterium* Spore Inactivation Behavior for Enhanced Understanding of Disinfection Processes

Sarahann Dow, Ph.D. Candidate,
University of Colorado, Boulder

A Priori Predictions of Macroscopic Behavior of Fluids in Simple Porous Media

Mikhail Gladkikh, Ph.D. Candidate,
University of Texas at Austin

The Treatment of Micropollutants in Potable Water

Deborah A. Ross, Ph.D. Candidate,
University of Michigan at Ann Arbor

Publications

NWRI supported, funded, and edited the following three publications, which were released in 2003:

- ◆ *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse*, Second Edition
- ◆ NWRI Occasional Paper: *Assessing Risk Information Concerning Coastal Runoff*
- ◆ *Riverbank Filtration: Improving Source-Water Quality* (both hardbound and paperback versions), released by Kluwer Academic Publishers



Gerald Anderson, P.E., of Washington State Department of Ecology, James Hagstrom, P.E., of Carollo Engineers, and Bruce Willey, P.E., of HDR Engineering, Inc., look at defining processes and resources to update standards and review alternative technologies in Washington State's quest to develop a water reuse program. They were attendees at a Nominal Group Technique workshop conducted by NWRI.

NWRI Works Overtime in 2003

Continued from Page 3

NWRI Peer Review Panels

NWRI is an objective third-party that provides experts for peer review panels of the projects or programs of an outside organization. The following four panels were organized in 2003:

- ◆ Secondary Treatment Standards Program Review (on behest of the Orange County Sanitation District)
- ◆ Asset Management Review Panel (on behest of the Orange County Sanitation District)
- ◆ Selenium Treatment Review Panel (on behest of the Irvine Ranch Water District)
- ◆ Washington State Water Reuse Advisory Panel (on behest of the Washington State Department of Ecology)



NWRI organized a Blue Ribbon Panel consisting of toxicologist Dr. Richard Bull of MoBull Consulting, environmental consultant Dr. Harvey Collins, risk analyst and physician Dr. Mary McDaniel of McDaniel Lambert, Inc., and environmental consultant Dr. Joseph Cotruvo of Joseph Cotruvo Associates to assess the Irvine Ranch Water District's plans to construct an underground selenium treatment project on land to be used as a school playground. Not pictured is risk assessment expert Dr. Bruce Macler of the U.S. Environmental Protection Agency.

Nominal Group Technique Workshops

NWRI held six Nominal Group Technique workshops to identify priority issues on key topics in water research. Each workshop was facilitated by NWRI, but sponsored by another organization.

- ◆ "Water Quality and Resources Management Issues" (with Lawrence Livermore National Laboratory)
- ◆ "Decision Support Systems" (with the American Water Works Association and Stratus Consulting)
- ◆ "Seawater Desalination: Opportunities and Challenges" (with the Metropolitan Water District of Southern California)
- ◆ "Water Reuse Planning for the State of Washington" (with the Washington State Department of Ecology)

- ◆ "CALFED-Bay Delta Drinking Water Quality" (with the U.S. Environmental Protection Agency Region IX and CALFED Bay-Delta Drinking Water Quality Program)
- ◆ "Value of Water" (with Stratus Consulting and the American Water Works Association)

Conferences / Workshops

NWRI held two major events in 2003 that were open to the public:

- ◆ The NWRI *Workshop for Elected and Appointed Officials* in San Diego, California, offered decision makers an opportunity to strengthen their knowledge and understanding of the challenges facing water and wastewater utilities. Workshop abstracts were published.
- ◆ The *Second International Riverbank Filtration Conference* in Cincinnati, Ohio, which showcased over 40 international speakers, focused on the experiences of waterworks worldwide and addressed the issues currently faced by users of riverbank filtration technology, including riverbed dynamics, microorganisms and chemicals, operational experience, and public policy. Conference abstracts were published.

Special NWRI Events

NWRI was honored to present George Tchobanoglous, Ph.D., P.E., Professor Emeritus of the University of California, Davis, with a gold medallion and \$50,000 award at the Tenth Annual Athalie Richardson Irvine Clarke Prize Award Ceremony and Lecture.

Invited Presentations

Ronald B. Linsky, Executive Director of NWRI, was invited to speak on the value of water at the following events:

- ◆ Keynote speaker, *Texas Governors Water Summit*, Austin, Texas
- ◆ Speaker, *Salinity and Desalination Summit*, Las Vegas, Nevada
- ◆ Speaker, *Coalition for Environmental Restoration and Development*, Long Beach, California
- ◆ Speaker, *Hong Kong Productivity Council*, Hong Kong, People's Republic of China
- ◆ Speaker, *Asian Pacific Water Council*, Hong Kong, People's Republic of China
- ◆ Speaker, *Japanese Desalination Association Seminar*, Kyoto, Japan
- ◆ Speaker, *International Desalination Association Congress*, Singapore

Report on MTBE Remediation Options Now Available

The California MTBE Research Partnership is pleased to announce the publication of *Evaluation of MTBE Remediation Options*, the seventh in a series of reports aimed at investigating technologies that can clean-up methyl tertiary butyl ether (MTBE), a gasoline additive that has contaminated various surface and groundwater supplies throughout the nation.

Evaluation of MTBE Remediation Options provides an in-depth assessment of strategies and technologies capable of removing MTBE and its byproducts from the environment. Its purpose is to provide a general understanding of the fate, transport, and remediation of this highly soluble oxygenate.

The 130-page report was prepared by Malcolm Pirnie, Inc. and Alpine Environmental Consultants for the California MTBE Partnership. NWRI published the report in April 2004. It is divided into the following chapters:

Chapter 1 “**Introduction**” reviews the history of MTBE’s use in gasoline and summarizes the problems that have followed.

Chapter 2 “**MTBE Fate and Transport**” examines the fate and transport of MTBE following a subsurface release of MTBE-blended gasoline, as well as reviews plume studies.

Chapter 3 “**Remedial Strategies**” discusses the process for developing remedial strategies at MTBE-impacted sites, including site investigations, site conceptual model development, and stakeholder agreement on remedial objectives.

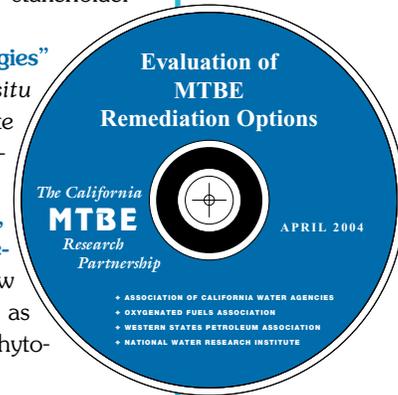
Chapter 4 “**Remediation Technologies**” examines a number of *in situ* and *ex situ* technologies that can effectively remediate MTBE-impacted sites, such as pump-and-treat and soil vapor extraction.

Chapter 5 “**Emerging Technologies, Techniques, and Process Enhancements**” examines technologies that show promise for MTBE remediation, such as advanced oxidation processes and phytoremediation.

Chapter 6 “**Remediation Case Studies**” summarizes the findings from five case studies involving subsurface MTBE remediation, emphasizing the primary lessons learned.

Chapter 7 “**Remediation Cost Estimates**” evaluates the costs associated with different remediation strategies at MTBE-impacted sites.

The report is only available on CD-ROM, and is both PC and Mac compatible. To purchase a copy of *Evaluation of MTBE Remediation Options* for \$10.00, please visit the NWRI Store at www.nwri-usa.org.



visit: www.wkap.nl

Riverbank Filtration: *Improving Source-Water Quality*

Edited by:

Chittaranjan Ray, Department of Civil and Environmental Engineering and Water Resources Research Center, University of Hawaii at Manoa, Honolulu, Hawaii, USA

Gina Melin and Ronald B. Linsky, National Water Research Institute, Fountain Valley, California, USA

For more than 100 years, riverbank filtration (RBF) has been used to produce drinking water. Written by over 30 experts from the United States and Europe, this book explores three themes — the mechanics behind RBF, its ability to remove contaminants from surface water, and critical research needs. Individual chapter topics range from the occurrence and fate of pesticides, pharmaceuticals, and personal care products at RBF sites to using RBF as a pre-treatment for nanofiltration membranes. This book describes the current and state-of-the-art applications of RBF technology as currently practiced on two continents. No other resource like it exists. Its purpose is to show that RBF is a low-cost and efficient alternative water treatment process for drinking-water applications.

Please visit: www.wkap.nl/prod/b/1-4020-1838-X

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NWRI Supports Henry Rodriguez Scholarship for Native Americans

Henry Rodriguez believed in education. The future of his people, he knew, was interlinked with learning to get along with others, becoming educated, and being open to new ideas.

“Mr. Rodriguez was a leader, mentor, and guide for his tribe, all Indian people, and particularly Indian youth,” said Christopher Kenney, Director of the Native Affairs Program of the Office of Native American Affairs, Bureau of Reclamation. “His message highlighted the importance of education and his goals focused on those activities that benefit the future of Indian Tribes.”

A member and tribal leader of the La Jolla band of Mission Indians (known as Luiseños) in San Diego, California, Rodriguez was a lifelong advocate for better education, water rights, and the preservation of Native American culture.

He had been active in California Indian politics since the 1940s and was a national authority on Indian water rights. Along with other tribal leaders, he fought for and won the water rights of the San

Luis Rey River, considered “the lifeblood and namesake of the Luiseño people.”

The Henry Rodriguez Reclamation College Scholarship and Internship was established in memory of Rodriguez’s “dedication and contributions to his tribe, Indian people, and the United States,” said Kenney. Rodriguez died in a traffic accident in 2002 at age 82.

The scholarship is a joint effort between NWRI and the Office of Native American Affairs of the U.S. Department of the Interior, Bureau of Reclamation to support college students of Native American descent who are seeking a bachelor’s degree in water sciences and environmentally related fields.

For NWRI, education is the key to creating and maintaining future water supplies. This scholarship represents an opportunity to spread the word about the importance of water to society as a whole, and not just for physical or environmental reasons.

“NWRI has a strong interest in Native American culture and its perception of water,” said NWRI Executive Director Ronald B. Linsky. “For many tribes, water is the lifeblood that protects and sustains their cultures. It is valued both spiritually and culturally. NWRI is a firm advocate of the value of water, so it is important to us to support young people who share these same values.”

For the Bureau of Reclamation, which is committed to increasing opportunities for Native

Americans to maintain their water resources, the scholarship is a means to promote self-determination among Native American tribes.

The scholarship is meant to educate students “in natural resources, water rights, water law, engineering, and other related fields,” said Kenney. “Indian students will then be better able to assist tribes in the protection of their resources.”

The ultimate goal is for these students to “assume leadership roles and become future decision makers in their communities.”

As part of the scholarship, students are awarded \$5,000 per year for up to 4 years and are given the opportunity to serve an 8- to 10-week paid internship with the Bureau of Reclamation prior to graduation. According to Kenney, the internship is meant to “provide an experience for Indians to learn the challenges of water, particularly in the West, and have Reclamation learn about Indians.”

The scholarship is managed by the American Indian Science and Engineering Society (AISES), a national nonprofit organization dedicated to building community by bridging science and technology with traditional Native American values.

“A part of our mission is to increase the number of Native American professionals and experts in the sciences, including water resources,” said Shirley LaCourse, Higher Education Program Manager for AISES. “It is vital for Native Americans to be educated and aware of the many issues surrounding water resources, including tribal water rights and sustaining resources for their home communities.”

The 2004 scholarship awardees included:

Edward Hawley, of Gros Ventre & Assiniboine descent, is a second-year college student from the Fort Belknap Reservation in Hays, Montana.

Jason Hrdlicka, part Oglala Sioux, is in his third year at the University of North Dakota, majoring in Chemical Engineering. *See story on Page 7.*

Amanda John, a Navajo from Twin Lakes, New Mexico, is a freshman at the University of Colorado at Boulder, majoring in Architectural Engineering.

Joseph Knight, of Cherokee and Choctow descent, is a freshman at Dartmouth College, majoring in Architectural Engineering.

Amanda Pablita Naranjo is a senior at the University of Findlay, Ohio, studying Environmental Management. She is Jicarilla Apache and Pueblo of Santa Clara.

Leona Sam, a Navajo, is a senior at the University of New Mexico, majoring in Civil Engineering.

Kevin Lee Whirlwind Horse, Jr., an Oglala Sioux, is a freshman majoring in mathematics at the South Dakota School of Mines and Technology.



Scholarship recipients were honored in Albuquerque, New Mexico. From left: student Amanda John; mechanical engineer Floyd Standing Warrior of Lakota Engineered Systems, LLC; Christopher Kenney of the Office of Native American Affairs, Bureau of Reclamation; and student Kevin Lee Whirlwind Horse, Jr.

Student Seeks Heritage in Bureau of Reclamation Internship

Jason Hrdlicka wants to learn more about his Native American heritage — and the U.S. Department of Interior, Bureau of Reclamation is going to help him.

This summer, 21-year old Jason — a third-year Chemical Engineering student at the University of North Dakota — will work full-time as a paid intern for the Bureau of Reclamation's Office of Native American Affairs through the Henry Rodriguez Reclamation Scholarship and Fellowship for Native Americans, which promotes the development, management, and protection of water resources.

"I didn't have a lot of exposure to my Native American roots growing up," said Jason. "So I'm looking forward to working with the rural Indian communities this summer, and helping out in addressing their water and environmental concerns."

Jason is part Oglala Sioux, from his mother's side. The Oglala Sioux belong to the Great Sioux Nation, a collection of tribes who once spread across the Great Plains and are most famous for defeating General George Custer and the Seventh Cavalry at the Battle of the Little Big Horn in 1876. Their reservations are concentrated in the Dakotas, of which Pine Ridge — the site of the 1890 massacre at Wounded Knee — is the most well-known.

As part of the Bureau of Reclamation internship, Jason will work for water treatment facilities around his hometown of Pierre, South Dakota, including water systems at Pine Ridge. He will also work with the Mni Wiconi treatment plant and core system — one of Reclamation's projects in the Great Plains region.

Upon its completion in 2008, Mni Wiconi will be the largest rural water system in the United States. It is a project between Lyman Jones/West River, the Rosebud Sioux Tribe, Oglala Sioux Tribe, and Lower Brule Sioux Tribe to provide water by pipeline to reservations in rural South Dakota (about 50,000 people), as well as to local ranchers and farmers. Mni Wiconi means "water is life" in the Lakota (Western Sioux) dialect.

For about 8 to 10 weeks, Jason — whose interests include general and organic chemistry — will conduct research on levels of arsenic in the area's aquifers and will learn how to treat chlorinated water.

"I'm really excited about this internship," he said. "I went into chemistry with the intention of doing environmental work. I like being outdoors, and I know how important it is to mitigate pollution."

And Jason has had plenty of experience with removing pollutants from the natural environment. For the past 2 years, he has worked part-time at the university's Chemical Engineering Department on several major projects, including constructing and researching a combustion furnace that will analyze the removal of trace elements (such as mercury) from coal before and after it is burned and monitor the pollutants that are released into the atmosphere. "It's just easier to remove these elements when the coal is solid," he said, "rather than after the coal combusts and you have to try separating them from a gas phase."

Jason learned about the scholarship and internship through the university's student chapter of the American Indian Science and Engineering Society (AISES), which he has been actively involved in since his freshman year. In fact, Jason helped organize the April 2004 AISES regional conference, held at his university, to promote possible careers and educational goals to Native American high school and college students in the area.

AISES manages the Henry Rodriguez Reclamation Scholarship and Internship, which is sponsored by the Bureau of Reclamation and NWRI. The scholarship provides Jason with \$2,500 per semester and fully funds the mandatory internship.

"The internship offered with the scholarship is a great opportunity," said Jason. "It's giving me the chance to meld my heritage and my interests — energy and the environment — with the need to provide safe, clean water. I'm looking forward to the experience!"



Jason Hrdlicka

"The internship offered with the scholarship is a great opportunity. It's giving me the chance to meld my heritage and my interests — energy and the environment — with the need to provide safe, clean water. I'm looking forward to the experience!"

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For further information on the Henry Rodriguez Scholarship, please contact the American Indian Science and Engineering Society at www.aises.org.

Symposium Identifies Future Research Needs

Continued from Page 1

water shortages, with population growth and pollution as the biggest culprits. "Research on membrane materials and modules must be strengthened to help solve these problems," said Dr. Liqiu Zhang of the Harbin Institute of Technology in China.

What's China Doing? China is a burgeoning market for membrane equipment and is pioneering new areas of membrane research, including the development of membrane materials.

Water, Water Everywhere, and Not a Drop to Drink. Though located in a monsoon zone, Japan suffers from a lack of suitable groundwater and surface water supplies — its

major cities have small reserves, creating water shortage problems, and its rivers, with small basins, flow erratically and provide little usable water.

What's Japan Doing? Japan is a leading nation in the development of membrane technology, including reverse osmosis, microfiltration and ultrafiltration, and membrane bioreactors. "Researchers should open their eyes to the results of recent new technologies, such as nanofiltration and biological membranes," said Dr. Akihiko Tanioka of Tokyo Institute of Technology in Japan. "They must not give up efforts for developing new membranes."

Water Wars. The city-state of Singapore receives half its water from Malaysia — but the need for more water has led to tensions between the two neighbors.

What's Singapore Doing? Membrane technology is extensively applied in the nation's water treatment, seawater desalination, and water reclamation plants. "We know that good quality water of drinking standards is now achievable and at low-cost with the use of membrane technology," said Harry Seah of the Public Utilities Board in Singapore. "In the years to come, membrane technology will be part of our daily lives, from medical treatment, and industrial application, to water supply."

Home on the Range. Droughts and wildfires continue to ravage the arid Western U.S., home to more than 58 million people.

What's the U.S. Doing? Membranes were first developed in the U.S., giving it 30 year's worth of history and experience in membrane research and development. "The U.S. is a major consumer of membranes, and the consumption of membrane-treated water will continue to grow in the future," said Dr. Douglas Lloyd of the University of Texas at Austin. "But we need to be a more active participant

in the development of better membranes and membrane processes."

To help further the advancement of membrane technology, the delegations worked together to identify the following areas of need:

- ◆ Using membranes to remove salt from water rather than saline solutions.
- ◆ Developing isoporous membranes.
- ◆ Developing biological membranes.
- ◆ Examining possible advantages of fouling.
- ◆ Applying nanofiltration technology for membrane bioreactors.
- ◆ Encouraging collaboration with medical professionals and others who can help develop and encourage the use of membranes.
- ◆ Making membrane technology easier to implement, more sustainable, and more affordable.

For instance, Dr. Zhang advocated developing low-cost, long-lived membranes with high membrane flux and fouling resistance. This development is critical to the use of membrane bioreactors (MBRs), which combine membrane separation processes with biodegradation as a new means to treat wastewater. MBRs are attracting much interest because they remove high amounts of pollutants, requires less space, and produces less sludge.

Even more important than advancing a single technology, however, was the need to ensure that membranes, overall, were accessible worldwide.

"The key words were brought up many times," said David Furukawa of Separations Consultants, Inc. in California. "One is *simple* — people in developing countries must be able to keep it working. Two, it has to be *cheap*, because many countries don't have the money to pay for expensive equipment. And, three, it has to be *sustainable*, and not just sustainable in terms of just keeping the equipment running. You must create a mechanism within that community to help provide the funds to replace membranes or whatever it may be."

Altogether, the delegates agreed that the exchange of information was not only useful, but absolutely necessary to coordinate and stimulate membrane research in these countries.

"The symposium required us to open our minds to what the future problems will be and how new membrane technologies or applications might be used to meet these needs," said Dr. Stephen Gray of CSIRO Manufacturing and Infrastructure Technology in Australia. "Hopefully, some of the issues raised will provide new research questions for participants to consider when they return home."

As a result of the symposium, the five Heads of Delegations have agreed to meet in September 2004 in Honolulu to determine their first collaborative membrane research project.



Symposium attendees take a look at the Enviroquip 0.04-micron, flat-panel membrane bioreactor while touring the Honolulu Membrane Bioreactor Pilot Study Site, located at the Honouliuli Wastewater Treatment Plant and sponsored by the Honolulu Board of Water Supply.

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