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Testimony on "H.R. 2664 – To reauthorize the Water Desalination Act of 1996, and for other purposes." Reauthorization of Water Desalination Act of 2011

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The American Membrane Technology Association (AMTA) is a nonprofit technical association dedicated to the support and promotion of membrane technology for the treatment of impaired waters, desalination, wastewater treatment, reclamation and reuse. Our mission statement is:

Improving America's Waters through Membrane Filtration and Desalination

Historically, the Federal Government has supported desalination research and development since Public Law 82-448 was passed in July 1952. That commitment has led directly to the current leadership in reverse osmosis (RO) membrane technology that our country enjoys today.

The search for a low cost energy efficient RO membrane began in the early 60's at the University of Florida, Gainesville, where Professors Reed and Breton, working with grants from the Federal Government successfully cast a reverse osmosis membrane from a cellulose acetate solution.

Later, Professor Loeb and Dr. Surirajan at UCLA were able to improve upon the casting process to form a tight "skin" on the surface of the cellulose acetate. This development increased the productivity of the membrane material, and increased the salt rejection, making RO a commercially viable process.

This UCLA membrane was developed into the forerunner of today's spiral-wound reverse osmosis membrane by General Atomic in San Diego, and reverse osmosis treatment was introduced to the industry, primarily the micro-electronics business.

At the same time the DuPont Company was developing their B-9 hollow fine fiber (HFF) membrane device. The membrane material was derivative of Nylon 66, and the inert nature of this material exhibited important characteristics, such as chemical resistance, and longevity.

Working experience with the DuPont HFF led to the development of the thin film composite RO membrane, made from non-cellulosic materials. The early development work was funded by the Office of Saline Water, Department of the Interior. An early US supplied seawater plant in Jeddah, Saudi Arabia, demonstrated the validity of the research effort with greatly improved productivity and salt rejection. DuPont had developed the B-10 seawater membrane, and at one time it was estimated that the B-10 had 65% of the world's reverse osmosis membrane market. This combined with other US manufacturers was over 90%.

Perhaps the most significant breakthrough came with the development of what was to become known as the FT-30 membrane at the North Start Research Institute. Developed with funding from the Office of Saline Water, this membrane was commercialized by a start-up company, FilmTec, and revolutionized the reverse osmosis membrane market. It provided greater operational stability, maintaining high productivity and salt rejection at significantly reduced pressure, for a long period of time. Some membranes of this type have lasted in service for 10-15 years, compared to 4-5 years for cellulose acetate membranes.

The Federal Government, which owned the FT-30 patent rights, licensed several other manufacturers. The FT-30 formula is now the standard in the industry, worldwide.

In my opinion, we have reached the “conventional” reverse osmosis membrane’s limit in terms of salt rejection. The rejection of sodium chloride by seawater membranes is in excess of 99.8% while that of brackish water membranes is generally in excess of 99.5%. However, further research into improving the water passage capabilities of the membranes is justified, since it leads directly to energy savings, and AMTA fully supports such research efforts.

In addition, new membrane technologies, including nano membranes and forward osmosis offer significant promise in further reducing the energy requirements of the membrane separation process.

The incorporation of nanotechnology into the membrane environment has its first commercial endeavor. Nano H_2O is a company in Southern California which has recently been successful in the seawater marketplace. Using technology developed in part at UCLA, Nano H_2O manufactures reverse osmosis membranes with nanotubes embedded in the rejection layer. While this does not impact salt rejection, it has a significant impact on the productivity of the membrane, and thus the energy required to drive the process.

While this technology is in its commercial infancy, it is our opinion that additional research is needed, and should be supported by the Federal Government, to examine the fouling mechanisms at work in the nano environment. Because of the newness of this technology very little information is available about the impact of high flux operation on energy consumption, particularly in the seawater environment. AMTA fully supports such additional research.

Professor Loeb at UCLA wrote about Forward Osmosis (FO) while developing the early cellulose acetate RO membrane. He recognized the inherent potential in utilizing the energy stored in saline waters in the form of osmotic pressure potential.

Hydration Technologies has been quietly building FO plants for a variety of applications for a number of years. More recently, Oasys Systems has developed an FO system, and membrane, which by all accounts is on the verge of commercialization.

FO works on the principle that if salt water is on one side of a membrane, and a “draw” solution with higher osmotic pressure is on the other side of the membrane, water will pass from the saltwater side through the membrane into the draw solution, without the use of pumping energy. The water must then be removed from the draw solution, which is then recycled. This requires energy to accomplish. Research is needed to identify additional NSF certifiable draw solutions, and to identify ways to separate the water from the draw solution with minimal energy input. Research is also needed to develop more efficient and long lasting membranes, and to study the effects of fouling. AMTA fully supports such research.

While conventional RO membrane improvements, which in my opinion will be minimal, will tend to reduce the energy requirement for reverse osmosis, the new technologies of nano membranes and Forward Osmosis show great promise.

However, energy is a requirement all these processes to a greater or lesser extent. It therefore behooves us to examine alternative energy sources to drive these processes.

Experiments have been made with both solar and wind power supplying the energy to drive reverse osmosis and other processes.

Two major plants in Australia, Perth 1 and Sydney, are powered indirectly by wind farms, a requirement for their construction. These wind farms do not power the plants directly, but rather feed into the grid. The plants then draw their required power from the grid, insulating them against those times when the wind doesn't blow, or wind turbine maintenance is required.

Reverse osmosis plants are modular, so they are not ON or OFF. Most of the time, they are partially on, drawing only part of their full capacity energy requirement from the electric grid. This makes the excess energy available at times to all users of the grid, resulting in some reduction of the overall carbon footprint of the grid.

A desalination plant really doesn’t care where its power originates. What is needed however, is research into the best methods of incorporating renewable energy sources into the plant infrastructure, to enable the facility to fulfill its mission, even when power is not available

Small brackish water plants in inland areas such as Arizona and New Mexico may not be able to follow the Australian model, best suited to larger plants. So what can wind and/or solar powered desalters do to provide water when renewable energy is not available?

Is battery storage the answer? If so, how much should be provided? Should the plant be oversized, using storage to bridge the cloudy or windless days? How can the water be pumped to the customers when there is no electricity?

Research in the area of renewable energy for desalination should be focused on the best fit technologies, how to bridge the gap, how to minimize costs. AMTA fully supports research of this type, which will ultimately benefit the entire desalting community

In spite of the great advances in reverse osmosis membrane technology over the past few years, this one missing achievement is the successful development of a chlorine resistant membrane.

All modern membranes are intolerant to chlorine. If chlorine is used in the pretreatment process, as is typical with surface seawater and brackish water, any residual chlorine must be destroyed.

A chlorine resistant membrane would allow the system to operate with a small continuous chlorine feed, where appropriate. This would control bio-fouling, which if present and uncontrolled requires additional pressure to maintain production. Development of such a membrane with Federal funding would place the resulting technology in the public domain, to the benefit of all.

Perhaps the greatest obstacle impeding the development of water desalination, particularly in the arid southwest where the need is possibly the greatest for small communities, is the ability to dispose of the concentrate produced in a cost-effective but environmentally safe manner.

Concentrate from reverse osmosis and other membrane based treatment facilities is merely a more concentrate solution of the salts that entered as feed water.

This concentrate water, because of the pretreatment required by membrane systems, is physically cleaner than the feed water. An additive used for scale control may be present, but the NSF approved products that are used are non-toxic and biodegradable.

Many approaches to concentrate disposal have been investigated. These include:

Surface discharge

Deep well injection

Evaporation

Zero liquid discharge

In Florida, which has been the national leader in the use of membrane technology for brackish water, and has the largest seawater reverse osmosis plant in the US, disposal was traditionally by surface discharge to a brackish or salt water environment. More recently, deep well disposal has been used even for coastal plants, with mixed success. In many cases because of the classification of the injection well, the cost of construction and the required maintenance can be as costly as the treatment plant itself.

What is needed, and what should be funded by Federal research investment, is a comprehensive study of the impacts of surface discharges, removal of the classification of concentrate as an industrial waste, and creation of a new category such as "discharge from membrane-based water treatment plant." These steps would reduce the cost of concentrate disposal, without jeopardizing environmental protection. This is a critical item in the continuing development of desalination, particularly for inland desalting plants.

The development and global application of the reverse osmosis membrane is an American success story. We achieved this dominance through the expeditious use of federal research support, beginning in 1951. Today, offshore companies are challenging

America's leadership in the field, with membranes now available from Japan and Korea. It is only a matter of time before we see Chinese RO membranes entering the marketplace, challenging our domestic producers. AMTA urges this subcommittee to look favorably upon the pending legislation, and to provide assistance to the engineers and scientists working in the field to push the technology envelope with the goal of reducing the cost and environmental impact of desalination to the benefit of all Americans. The US has always been the leader in membrane technology, and will remain so with the support of the federal government.

Thank you.