U.S. water crisis provokes new look at science of desalination

by Marcia Merry

"Desalination is an emerging technology presently analogous to the 'Stanley Steamer in automotive development,' " University of California civil engineers Prof. John A. Dracup and Prof. Julius (Bud) Glater told the U.S. Congress about the state of seawater purification methods. Their testimony came in hearings on desalination research convened by the House Committee on Science, Space, and Technology's Subcommittee on Science July 17. They called for basic research in methods of desalting water in order to solve the problem posed by the fact that projected U.S. water demands exceed current projected supply.

The "Water Desalination Act of 1991" has been recently introduced into the House (H. 5215) by Rep. James Bilbray (D-Nev.), and a similar measure into the Senate by Sen. Paul Simon (D-Ill.). In 1982, federal assistance for desalination research all but stopped.

The bills call for a Phase I period of basic research into optimum ways to produce usable water from saline water; Phase II would provide for demonstration projects; and Phase III would be a desalination implementation period, intended for three years hence. The bills mandate cost-sharing, which the administration has criticized. The level of funding under discussion by the Bureau of Reclamation for fiscal year 1992 is $1 million for research, a paltry sum compared with the $12-15 million spent annually in the late 1970s and early 1980s.

However, there is renewed interest because of the acute water crises hitting regions across the country. California is in the most severe crisis, but the situation is bad in Florida, in much of the Upper Missouri, in sections along the Eastern seaboard, and elsewhere. This is the inevitable result of the policy decisions to stop infrastructure development over the past 25 years.

Bilbray reported in the June 27 *Congressional Record* that the bill "will revitalize an important research and development program to convert fresh water from seawater. The program was initiated in 1953. President Kennedy was a fervent supporter of desalination research. He believed that economic desalination would serve the long-range interests of humanity and dwarf other scientific accomplishments.

"The program flourished for 30 years until 1982 when the Reagan administration discontinued federal funding. Technological advances in desalination could not have been possible without federally sponsored research and development. It is needed now more than ever. Severe drought conditions, growing populations, contaminated groundwater, [and] competing municipal, industrial, and agricultural uses all require water.

"Without new research there will be increasing conflict over the existing, limited water supply."

The hearing was chaired by subcommittee chairman Rep. Rick Boucher (D-Va.) and co-chaired by Rep. Ron Packard (R-Calif.). The districts of both these men are experiencing water supply problems.

The subcommittee heard testimony from seven individuals with engineering or science expertise in water development. Dr. Joyce Starr, a specialist in geopolitical water control schemes favored by the Bush administration, also testified.

The hearing was characterized by an uncommon amount of give and take, reflecting the heat from constituents demanding solutions. The water crisis has provoked a new concern with scientific questions, prompted by the desire to see the most energy-inexpensive means used to build new water treatment plants. In the discussion, the congressmen revealed how "green" they, and the general public, are when it comes to science. For example, Dr. Leon Awerbach, head of the International Desalination Association, was asked about the benefits of using solar power for desalination. Awerbach pointed out that the capital costs of solar power capture units are "very high" relative to other available means of desalination.

Desalination methods in use today

There are basically three forms of desalination in use today: 1) distillation, through various modern methods—multi-stage flash distillation, vapor-compression distillation, and multi-effect distillation; 2) reverse osmosis membrane desalination; and 3) electrolysis. About 95% of the world's desalination plants use distillation.

In the early 1950s, there were about 27 million gallons per day (mgd) produced by 225 land-based desalination plants worldwide. Today there are about 3,000 mgd produced from 3,500 plants around the globe. About 60% of the world's desalination capacity is in the Middle East, concentrated in Saudi Arabia, Kuwait, and the United Arab Emirates.

Most of the present capacity in the United States is connected to water for industrial processes. There are about 750 installations, with a combined production capacity of 212 mgd.

In the U.S., the commonly used method is reverse osmosis. However, worldwide, 82% of the large desalination plants (those producing more than 1 mgd) use multi-stage flash distillation.

The question now confronting localities around the United States is: Which way to go from here?

Nuclear is the way to go

The efficiency (performance ratio) of desalination plants is measured in pounds of fresh water produced per 1,000 BTU of heat input. The performance ratio of present Mideast plants is eight, which is low and is acceptable only because of the low cost of local energy, for example flare gas, which would otherwise be wasted.

According to *21st Century Science & Technology* magazine board member Jonathan Tennenbaum, the high cost of current desalination technologies could be lowered if more scientifically advanced methods were developed. The promising route is in advances in optical biophysics and laser chemistry. A better understanding of how water behaves in the setting of living organisms, in which there are inherent harmonic properties, will be helpful. For example, the amount of sodium in living cells differs from that in the surrounding medium. It would be fruitful to examine the electromagnetic structure of water and the role of nuclear magnetic resonance.

While research proceeds, it is clear that nuclear power is the best choice at present. A presentation on this was given to the American Power Conference in Chicago April 29-May 1 by General Atomics officers R.W. Schleicher and C.J. Hamilton. They said that the modular high-temperature gas-cooled reactor (MHTGR) is the "ideal candidate for water and power production at sites near coastal population centers."

Their proposal: "A dual-purpose MHTGR desalination plant consisting of four 350-megawatt (MW) modules with a multi-effect distillation system supplied with backpressure steam from the MHTGR can produce 106 mgd of fresh water in addition to 466 MW net electric output."

The view of the experts

The experts would probably concur on the desirability of fundamental research into the nuclear makeup of water, and into using advanced nuclear power systems. But in deference to the de facto gag rule against talking of nuclear technologies, they did not bring this up directly.

The panelists, all engineers, were, in addition to Leon Awerbach: Gary J. Hazel, Metropolitan Water District, Los Angeles; Tom Leahy, III, Virginia Beach, Virginia; John Dracup, University of California at Los Angeles; Peter Skelland, Georgia Institute of Technology, Atlanta; James Taylor, University of Central Florida, Orlando. The first expert witness of the day was Dr. Wayne N. Marchant, chief of the Research and Laboratory Services Division, U.S. Bureau of Reclamation.

Marchant reported on the bureau's work at its Yuma, Arizona project—the world's largest reverse osmosis desalting plant. Also, the bureau will cosponsor a desalting research workshop entitled "Water—the Challenge of the 1990s" at a conference of the International Desalination Association in Washington, D.C. Aug. 25-31.

Professors Skelland and Taylor testified on the prospects for improved membranes for detoxifying wastewater. The use of reverse osmosis membranes began in the 1950s, and since then there have been advances in ways to resist bacterial degradation and other characteristics. Skelland called in particular for work on developing liquid membranes, in suitable non-Newtonian forms.

The engineers from Virginia and California reported on the need for implementing desalination systems because the limits to regional water supplies have been reached. Southeast Virginia has been declared a "Critical Groundwater Management Area" since 1973. In southern California, the situation is even more dramatic. Gary J. Hazel, assistant chief engineer for the Metropolitan Water District, reported, "We import about half of our water by way of a 242-mile aqueduct from the Colorado River, and we purchase the remaining amount from the State of California, conveyed to our service area through a 450-mile aqueduct from northern California. We have sold as much as 2.6 million acre-feet in the year 1990 to our 27 member agencies who represent nearly 15 million people—about half the state population, in our 5200-square-mile service area." After describing special water supply measures taken—conservation, reclamation, enhanced groundwater recovery, etc., he said, "Nonetheless, in this fifth year of drought, shortages on our system have caused local agencies to reduce their demand for Metropolitan water by 20% for municipal uses and 50% for agricultural uses this year."

However, Dr. Joyce Starr, chairman of the Global Policy Group and promoter of the "Global Water Summit Initiative," took an opposing view. Starr gave lip service to advanced technologies, but pushed her pet projects: new institutions to control scarce water resources. She beat the drum for a "Middle East Water Summit" planned for Istanbul, Turkey Nov. 3-9 and financed by the Kuwait Fund, the U.N. Development and Environment Programs, and the World Bank. Instead of a perspective for increasing water for general economic development, Starr advocated water geopolitics in the tradition of British foreign policy, i.e., developing resources for political leverage. For the Middle East, surplus water runoff is available only from Turkey and the upper Nile headwaters in Sudan. During the Persian Gulf war buildup, London and Washington pressured President Turgut Özal to harm Iraq by holding back water from the Euphrates River at the Ataturk Dam.

Starr called for $10-12 million in funding, targeted to help U.S. industries, such as Bechtel, "develop an overseas role."