News and Comment

Desalination: Emphasis Is on Dual-Purpose Nuclear Power and Desalting Plants

Fidel Castro probably did more than anyone else has to bring saline-water conversion to public attention when he threatened off-again, on-again tactics with the water supply to the U.S. Navy base at Guantanamo Bay a year ago and the Navy countered by cutting the water line, obtaining title to a million-gallon-a-day sea-water conversion plant on the West Coast, and moving it to the Caribbean naval base.

The uprooted plant at Point Loma, near San Diego, was a multistage flash distillation plant, one of five "demonstration plants" built under the aegis of the Department of the Interior's Office of Saline Water (OSW), which is charged with sponsoring and coordinating federal research and development in converting sea water and brackish water to fresh water.

These five original plants were widely scattered—one each on the East, Gulf, and West coasts, one in South Dakota, and one in New Mexico—and each plant demonstrates a different process of saline-water conversion.

The ultimate objective of the OSW is to provide usable water at low cost, and although technology has been advancing rapidly and costs have been going down, no process has yet reached competitive parity with other current sources of water. The best performance to date seems to have been achieved by the Point Loma plant, which, before its transfer, was producing 1.4 million gallons a day at about $1 per thousand gallons, roughly three to four times the cost usually regarded as economic.

Under serious discussion for the last few years, however, has been the possibility of building very large plants which would be economically feasible. Interest has centered on dual-purpose installations—that is, desalting plants built in tandem with nuclear-powered generating plants which would produce both marketable electric power and energy for desalting operations. The Atomic Energy Commission has, quite naturally, entered the picture, and studies for several dual-purpose plants are under way.

The legislative history of the desalination program goes back to 1952, when, after previous rebuffs, a Saline Water Act introduced by the late Senator Clair Engle of California, who was then serving in the House, made it through the congressional mill and was enacted. The bill authorized $2 million for a 5-year program and set up the OSW to oversee it. Advocates of the measure seemed to think at the time that "one-shot" legislation would be adequate to achieve a breakthrough in desalination technology. But by 1955 it had become clear that the campaign would be a longer and more expensive one; the life of the program was extended and funds were increased.

Senator Clinton P. Anderson (D–N.M.), who represents a state in which new sources of water are at the vanishing point and where there are supplies of brackish water, has had a long-term interest and involvement in desalination research. One federal official called Anderson "the Moses of the program."

Anderson, for example, was instrumental in 1958 in the move to capitalize on research already done by building five demonstration plants which would utilize different desalting techniques.

In 1961, with the accession of John F. Kennedy to the Presidency, saline-water conversion shared in the general expansion of federal research and technology programs. Congress that year passed the Anderson-Aspinall Act, named for the New Mexico senator and for Representative Wayne N. Aspinall (D–Colo.)—chairmen, respectively, of the Senate and House Interior committees. The act built on existing saline-water legislation, and expenditures have averaged about $10 million a year since then.

This year the stakes are higher. Interior is asking $29 million for OSW for fiscal year 1966, and the department is preparing to propose, later in the year, expenditure of some $200 million over the next 5 years in an accelerated program of desalination R&D.

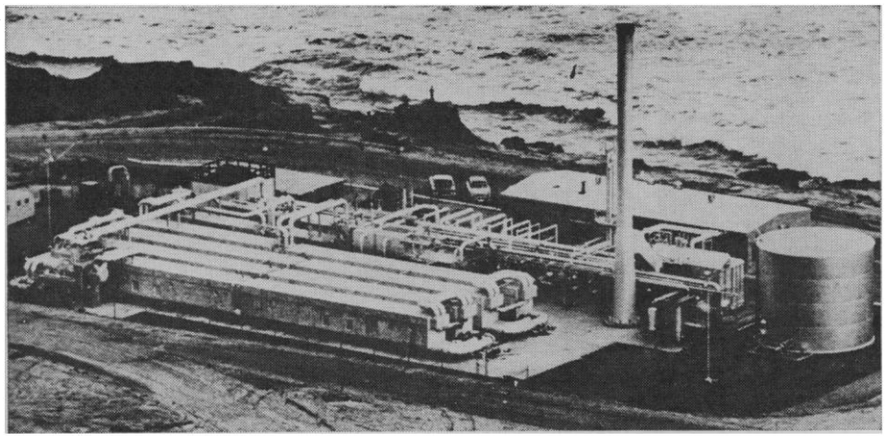
The escalation of the desalination program has been accompanied, as is usually the case when federal programs are waxing, with an obbligato of studies and reports. A National Academy of Sciences–National Research Council symposium preceded the drive for congressional approval of the demonstration plants in 1958. In 1962 an NAS–NRC report sponsored by OSW and the National Science Foundation helped both to point to and to pave the way for the Anderson-Aspinall bill. The report, "Desalination Research and the Water Problem," carried recommendations for research on desalination for the next 5 or 10 years and remains one of the most useful surveys available of the principles and problems of desalting (*Publication 941*, NAS–NRC, Washington, D.C.).

The possibility of linking nuclear power plants to desalting operations evolved in the 1950's out of the work of AEC scientists and engineers and, it seems, the encouragement of Senator Anderson. At the center of this work has been R. P. Hammond, first at Los Alamos, in Anderson's home state, and then at the Oak Ridge National Laboratory (ORNL).

The proposals of Oak Ridge scientists are credited with having stimulated a 1963 study to determine the feasibility of large nuclear-powered sea-water conversion plants, made by an interagency task force convened by the Office of Science and Technology.

The report, titled "An Assessment of Large Nuclear Powered Sea Water Distillation Plants," appeared last spring. Roger Revelle, who was serving as science adviser to the Secretary of the Interior at the time the study was undertaken, chaired the task force and made this appraisal of prospects in his introduction.

"Although we are less optimistic than ORNL, we have confirmed the essential validity of the ORNL conclusion—that relatively low-cost fresh water can be obtained with very large scale, dual-purpose operations where



Multistage flash distillation demonstration plant near San Diego. New address, Guantanamo Bay.

there is a sufficiently large market for electric power, and that nuclear energy plants appear to have better economic potential in these very large sizes than fossil-fuel plants. We have made no allowances for possible major improvements in either reactor or desalting technology that cannot now be specifically foreseen.

"Our basic conclusion is that, following an orderly development program that now appears entirely feasible, water can be made available from combination plants in coastal areas in large quantities, at prices that are reasonable to pay for municipal and industrial purposes. The timing of development and the application of this technology should depend upon its comparative economics at specific locations.

"Stated more specifically, combined installations producing 1000 to 1500 megawatts of marketable electrical energy and 500 to 800 million gallons of water per day, with the water costing 20 to 25 cents per thousand gallons at the plant site (exclusive of conveyance costs) and the electric power valued at 2.3 to 2.5 mills per kilowatt hour, can be envisioned by about 1975 if an appropriate research and development program is pursued. Smaller quantities can be available at earlier dates and higher prices. Research and development are needed both to increase the scale of nuclear reactors and desalination plants and to advance their efficiency of performance."

Revelle noted that only distillation processes are sufficiently developed to permit detailed consideration in the report, but he went on to say, "It is important to point out here that promising sea water desalination techniques other than distillation are under intensive study by the Office of Saline Water, that these techniques have different characteristics in terms of energy use, and that successful development of these technologies might obviate the need for the dual-purpose operations considered here. Some of these processes would prospectively use less energy per unit of product water than the distillation process, and the energy would be largely electrical rather than thermal. This would make possible the conversion of the same amount of water with a smaller energy unit than would be possible for the distillation process."

The leading contender for use in dual-purpose plants seems to be the multistage flash distillation method employed in the Point Loma–Guantanamo plant. Heated sea water is introduced into a chamber where pressure just below the boiling point of brine is maintained. When the sea water enters the chamber the reduced pressure causes the liquid to boil immediately or "flash" into steam, which is then condensed. The operation is repeated successively in a series of chambers at progressively higher vacuum and lower temperature.

Two other variations on the distillation process are also embodied in demonstration plants. At Freeport, Texas, a so-called long tube–vertical multieffect plant is in operation, and at Roswell, New Mexico, a forced-circulation vapor-compression plant is converting brackish water. Both distillation plants are rated at a million-gallon-a-day capacity.

A fair amount of research is being done on solar distillation, but the method seems to be viewed as practical for small "solar stills" but uneconomic for large yields.

Some other desalting methods, which are less advanced than the distillation process, work by removing salt from water rather than the reverse. At the Webster, South Dakota, demonstration plant, electrodialysis is used. By the use of electric current, positively charged ions (sodium, for example) move through a negatively charged membrane, and negatively charged ions (such as chloride) pass through a positively charged membrane, leaving desalted water in a center chamber.

The demonstration plant at the OSW's East Coast test station at Wrightsville Beach, North Carolina, exploits the fact that salt crystals separate from pure water ice crystals when sea water is frozen. The freezing process is a relatively new one and presents plenty of difficulties, but it is regarded as having considerable potential.

Also regarded as a very promising process is "reverse osmosis." Under this system pressure in excess of osmotic pressure is employed to force fresh water through a selective membrane capable of rejecting dissolved salts, thus reversing the normal osmotic flow.

The OSW last week sponsored a "research membrane conference" at the Polytechnic Institute of Brooklyn, and in remarks written for delivery there OSW director Frank C. Di Luzio said, "We are convinced that membrane processes will play a major role in the desalination of not only brackish waters, but hopefully also of sea water. The simple fact that membrane processes eliminate the costly phase change required by other processes and provide an inherently inexpensive liquid to liquid desalting method is exciting testimony of their economic potential."

The immediate future, however, appears to belong to the big dual-purpose plants. The interagency task force foresaw a need for several such installations, which would "justify development costs." The report specified one or more in Southern California, several for the Gulf Coast, and one or more for the New York area, especially on Long Island.

President Johnson's interest in desalination, which goes back well into his days in the Senate, seems to have provided the spur for a new big push in desalination. Johnson asked the Interior Department to plan, in collaboration with the AEC, an aggressive and imaginative program to advance the program of large-scale desalting of sea water.

The agencies put their recommendations into two complementary reports. The AEC's recommendations center on supplementation of its reactor development program to provide economic nuclear energy sources for anticipated intermediate and large-scale needs. Expenditures of an extra $147.5 million for studies and R&D and $73 million for prototype assistance are recommended for the years through fiscal year 1975.

In summary, the Interior report recommends these actions.

"(1) That the Anderson-Aspinall Act be extended through 1972, the monetary authority increased by $200 million, and the Department's authority to build experimental facilities clarified. We will request specific Congressional authority to assist in the construction of prototype plants at the appropriate times.

"(2) That we establish a West Coast test facility where modules and full-size components of distillation plants can be tested under sea-water conditions applicable to prototype plants.

"(3) That we have construction started on at least one intermediate-size prototype plant in 1967. Prior to that time, an accelerated effort ranging from basic research to conceptual design, using the most creative minds in the country, will be conducted on the distillation processes.

"(4) That we undertake an immediate and comprehensive study of all phases of comparative water costs and needs.

"(5) That we sharply increase the basic research effort to discover entirely new desalting techniques, to develop the promising reverse-osmosis process, and to perfect the distillation processes."

It appears that the "intermediate-size prototype plant" mentioned in the recommendations would be built on the West Coast and would almost certainly be a distillation plant. A large dual-purpose plant is also under serious consideration by the Metropolitan Water District of Southern California. In August, Interior and Metropolitan entered into a contract to undertake a feasibility study of a plant which could produce between 50 and 150 million gallons of water a day and 150 to 750 megawatts. The study, financed jointly by OSW, the AEC, and Metropolitan, is being made by a private concern and is scheduled for completion in October. Such a plant might be built by 1970. The OSW has also let design contracts with six firms for plans to build a dual plant in the 50-million-gallons-a-day range by 1970.

A study for a small dual-purpose plant, providing a million gallons of water a day and 2500 kilowatts of electricity, is planned for Long Island, and activity in several other water-short areas may result in similar studies.

The United States has also signed a bilateral agreement with Israel under which an American firm is conducting technical studies for a proposed intermediate-sized dual-purpose plant to serve Israel's demands for more water for industry and municipal use and to improve the quality of present water supplies and help meet irrigation needs.

There are no U.S. security wraps on desalting technology, and the United States and the Soviet Union last year signed an agreement on exchange of information on desalting. This has resulted so far in an exchange of visits by experts from the two countries, and of some information.

The Americans who visited the Soviet Union say the Russians have a vigorous desalting program in progress. But the visitors' reaction to a showpiece pilot desalting plant seems to have been that it was "goldplated"—that is, the materials and methods employed indicated that cost was no object.

Cost is the key in the American program, but it is impossible to speculate on the future of desalting without a whirl through the wonderland of water economics. The main point to grasp is that the price of water often bears little close relation to its real cost.

In the West, it is estimated, the cost of water for irrigation in some places is six or seven times its price to users. Water for municipal and industrial use is usually subsidized—if the costs of developing water reserves, of transportation, and of distribution are taken into account.

Of course, there are plenty of reasons—good and bad—for subsidizing water, but the Interior Department's recommendation that a comprehensive study be made of comparative water costs makes eminently good sense now, as it becomes increasingly necessary to make hard decisions on alternative uses of water.

The scaling up of desalting plants to "large" (over 50 million gallons a day) and "very large" (half a billion gallons and up) involves not only serious scientific and technical problems but political difficulties as well.

Water supplies are usually municipally operated, but electric power is provided under a mixed public-private system. It is likely that, as desalting operations grow bigger and more efficient, time will bring battles reminiscent of those fought over TVA and, more recently, over the use of steam from the AEC's Hanford, Washington, reactors for power production.

The OSW, a small (still under 100 employees), research-supporting agency is, therefore, moving into a more complicated future. In January the agency got a new director, Frank C. Di Luzio, 51, who brings to the job a background as an engineer and research administrator in the Interior Department, the AEC, and industry. Most recently Di Luzio served as staff director of the Senate Aeronautical and Space Sciences Committee, of which Anderson is chairman, and Di Luzio's switch to OSW, which is "taking off" into a higher level of activity, cannot be regarded as sheer happenstance.

Di Luzio's experience on Capitol Hill should stand the agency in good stead, although the desalting program appears to have no real enemies in a Congress that is showing clear signs of understanding that the nation faces serious problems of quantity and quality with its water supply.

Prospects for the water desalination program, then, look promising from both the technical and the political viewpoints, and one by-product of the program in the years just ahead may be a serious examination of our surrealistic pricing policy on water.

—JOHN WALSH

Quackery: Senate Investigators Concerned with Billion-Dollar Business Preying on Elderly

The elderly are by no means the only Americans bilked by quack promoters, but a disproportionate share of the $1 billion this country annually spends on phony medical remedies is contributed by the people over 65, who are statistically least able to afford it. The particular vulnerability of the aged to medical and other pitchmen led the Senate Special Committee on Aging to establish a subcommittee to investigate. The subcommittee, headed by Harrison