FUTURE WATER SUPPLIES THROUGH DESALTING

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This is the third time it has been my privilege and pleasure to address the New Mexico Water Conference. I am glad that Dr. Stucky keeps asking me back, because it means to me that he believes that desalted water is destined to play a role in providing the water New Mexico will use in the future.

When we talk about water supplies for the future, we are prone to project to the year 1980, the year 2000 or 2020. Now I know that those projections sound like some remote point in time, far removed from March 1970. But let me remind you that the year 1980 is only 10 years hence and the turn of the century is only thirty years away. In terms of water supply development, those are precious few years. To me they represent a demanding deadline.

It took from the beginning of time to about the year 1800 for the world's population to reach 1 billion, but just 130 years more to reach 2 billion and only 30 years -- until 1960 to reach 3 billion. In less than 15 years there will be 4 billion people, and every single person will be doing his full share to contribute to the pollution of our air and water. Every person will require food, fiber, minerals, and metals and to obtain each of these he will need water. He will need water to drink, to wash, for health, for irrigation, for agriculture, for industry, for recreation, etc. And each drop of water he uses and does not consumptively use -- he pollutes.

In our successful quest for more and more water, we were so determined to provide the quantity demands for water, we either ignored or overlooked the fact that each time man uses water he degrades its quality. We had to pollute Lake Erie to a point where it may never recover, we had to degrade the Mississippi River, the Father of Waters, to the point where it now is known as the Colon of America, and to increase the salinity of the Lower Colorado to a degree that it nearly is unusable before we really recognize what we were doing.

When I was in high school and I studied how the timber barons raped and pillaged, for personal profit, the vast forests of the West, I simply couldn't understand how the public could stand idly by and let our natural resources be so ravaged.

But after I see what has happened to our water resources during my lifetime, I am beginning to understand.

Call it public apathy, or perhaps a failure to understand our ecology. For whatever reason, it seems we have to make a whopper of a mistake before we recognize the error of our ways.

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Fortunately, timber is a renewable resource, and we have learned how to reforrest our land and manage our timber harvest on a sensible basis that is in harmony with nature.

Fortunately too, water also is a renewable resource, but we still have much to learn about its conservation and wise use. We are learning, and perhaps fast enough to solve the water problem, just as we learned how to manage our timber resources. There is an awakening public consciousness concerning the water problem, and this is an essential development if we are to marshall our efforts and assign the necessary priorities to solve the problem.

Earlier this year, eighty-two Representatives to the Congress of the United States joined in a call for an "Environmental Decade." Recommending that the 1970's be designated as the Environmental Decade, they suggested it would be a proper time for all Americans to make the following resolution:

> "I pledge that I shall work to identify and overcome all that degrades our earth, our skies, our water, and the living things therein, so that the end of the Environmental Decade of the 1970's may see our environment immeasurable better than at the beginning."

I would suggest, Dr. Stucky, that resolution as an appropriate theme for the New Mexico Water Conference during this decade.

Turning now to the saline water conversion program, I should like to report briefly of technological developments and how they relate to the all important aspect of our program--the cost of producing fresh water from saline waters.

In the current fiscal year the Office of Saline Water is operating with an appropriation of $25 million. Of considerable interest to the New Mexico Water Conference, I believe, is a considerable shift of program emphasis to the development of the promising reverse osmosis process.

In 1955, the OSW awarded a research contract to the University of Florida to study the possibility of reversing the osmotic flow. As you know, in nature, a less dense liquid flows through a natural membrane and becomes a more dense liquid. This, for example is how water in the soil is absorbed by the roots of a plant system and is transported up through the plant eventually to become a rather dense sap at the top of a tree or any other plant. The idea was to reverse this flow through a man-made membrane, and by reversing the flow, reduce the density of the liquid, or for our purposes, from a saline solution to fresh water.

After testing literally hundreds of synthetic membranes, the research team found a relatively simple cellulose acetate membrane through which they were able to reverse the flow by applying pressure to the saline solution. Although they measured the fresh water flow through this membrane in microliters per day, it was a significant breakthrough. Once scientists and engineers knew that the osmotic flow actually could be reversed, they began to develop theories concerning the interaction of the membrane and the dissolved salts. With these theories they cast new membranes, and gradually the flux, or the flow rate, of the membranes was increased. Other parallel developments also were necessary. Since the membrane is very thin, it required a supporting mechanism to withstand the pressures that had to be applied to overcome the natural osmotic pressure. The pressure that has to be applied is directly related to the salinity of the water to be treated. For sea water, the pressure is about 1500 pounds per square inch, but for most brackish waters the pressure requirements drop to about 600 psi. If the backing plate is too dense, it retards the flow of the water. If it is too porous, the membrane can rupture through the pores.

The flux rate of the membranes is being improved and the backing plate problem is being solved. Today, reverse osmosis membranes are available commercially with a flux rate for brackish water of 20 gallons per square foot per day and a life of about three years. But even more exciting is the fact that in the laboratory we now have experimental membranes with which we have achieved a flux rate of 97 gallons per day and a salt rejection rate of 97 percent. While the 97-97 membrane represents a giant stride forward, we do not see it as the ultimate membrane by any means. Is it any wonder then that we call the reverse osmosis process a promising new process and that we are shifting program emphasis to accelerate its development.

While research and engineering development of the reverse osmosis process continues, our research division is working on a new type of membrane that is so different from the present membranes that it offers the potential of developing into an entirely new process. As I mentioned, in reverse osmosis, we push water through the membrane and the salts are left behind. This new membrane allows the salt to pass through the membrane and the fresh water is left behind. Now when we consider that seawater is 3½% salt and most brackish waters are in the range of .5% salt, it is rather obvious that it would be better to remove the salt than to remove the water. No one can predict at this time if our work in this direction will be successful or not, but we have moved far enough in the laboratory to refer to the process as piezodialysis or pressure-dialysis.

Another brackish water desalting process that has already found considerable commercial application is electrodialysis. The electrodialysis process utilizes a combination of anion and cation permeable membranes and an electric current to remove the dissolved solids. The first brackish water desalting plant in the United States was erected in 1959 at Coalinga, California. Utilized to desalt local well water of about 2000 ppm. the plant produced 45,000 gallons of fresh water per day at a cost of about $1.45 per 1000 gallons. Now this may be considered by most people to be high cost water, but it was a bargain for the residents of Coalinga who up to that time had been obtaining their fresh water from railway tank cars at a cost of $7.25 per 1000 gallons.

In 1962, a 650,000 gpd electrodialysis plant at Buckeye, Arizona, reduced the cost of desalting brackish water to about 65¢ per 1000 gallons, and last year a new 1.2 million gpd electrodialysis plant went on stream at

Siesta Key, Florida. This latest plant is reporting fresh water costs of 35¢ per 1000 gallons.

At Roswell, New Mexico, we are completing the construction of a brackish water test facility. The new facility has been built on a 10-acre site adjacent to the 1-million gpd demonstration plant that was dedicated in 1963 as a part of the program of the 8th New Mexico Water Conference.

A major part of our brackish water engineering development program will be conducted at Roswell. Ten types of brackish water, ranging from low to high salinity and hardness will be used for testing purposes at the new center. These test waters will be produced with chemical additions to the City of Roswell water or by blending of city water with that available from on--site wells.

The Roswell test facility has been constructed at a cost of $1.1 million, and our fiscal year 1971 expenditures at the site are programmed at just over $1 million.

In the development of distillation processes, which is the major method for desalting sea water, OSW has requested an authorization and appropriation from the Congress to construct a VTE/MSF module. The VTE is the vertical tube evaporator distillation system developed by OSW at Freeport, Texas. The MSF is the multi-stage flash distillation process on which we have conducted extensive tests at San Diego, California. A module is a slice, or a portion of a full size plant.

Our studies have indicated that a combination of these two processes would provide a more efficient system. We will ask major desalting equipment manufacturers to provide a design of a 200 million gpd desalting plant and recommend the basic unit size of the equipment required to produce that amount of water. That is, if technology dictates that we construct eight 25 million gpd units to produce 200 million gpd, we will then proceed with the detailed design of 25 million gpd units, and then construct a sufficient portion of such a plant to obtain reliable engineering and cost data. At the present time we estimate the fresh water production of the module will be about 3.5 million gpd.

The combination of the VTE and the MSF processes offers the potential of reducing capital investment by 30% and water costs by 15% or more.

The first major desalting plants constructed by the OSW produced fresh water from sea water in the range of $1-$1.25 per 1000 gallons. A 2.6 million gpd plant at Key West, Florida, is reporting desalting costs of about 85¢ per 1000 gallons, and a new 7.5 million gpd plant at Tijuana is expected to produce fresh water from sea water for about 65¢ per 1000 gallons.

Under the provisions of a cooperative agreement between the U. S. - Mexico and the International Atomic Energy Commission, the Office of Saline

Water participated in a preliminary assessment of the technical and economic practicability of a dual-purpose nuclear power plant designed to produce fresh water and electricity for the general area of the northern part of the Gulf of California.

In considering the total water needs of a vast water starved region for the first time, the study team selected desalting plants of one-billion gallons-per-day and 2,000 megawatts of electricity as the basic unit size to provide the fresh water "rivers" that would flow from the Salty Gulf of California. A series of such plants would be required to meet the projected deficit of 4.5 billion gallons per day in 1995. Capital costs for the initial plants were estimated to be in the range of $850 million to $1.2 billion depending on the site, water conveyance routing, and interest rate assumed. Product water costs, as estimated in the study report, delivered to a major distribution center ranged from 16¢ to 40¢ per 1000 gallons.

I want to re-emphasize, that this was just a preliminary assessment. There is no plan at the present time even to proceed with a detailed engineering feasibility study, much less, any plans for construction.

The study is important, however, in pointing out the direction that desalting may take in the future, and it serves to guide some of our planning as we work toward the development of multimillion gpd desalting plants. We have a long way to go before we are able to tackle a project of the magnitude of the U.S.-Mexico study.

It is clear, however, that desalting technology is developing at a pace where its potential for long-term water system planning cannot be ignored. Furthermore, within the likely time frame of need for major new water supplies, the necessary desalting technology, along with major heat supply sources, including nuclear power, can be reasonably expected to be in hand.