Desalination Plant To Use Nuclear Power

by Ramtanu Maitra

The world's largest desalination plant is coming online soon in Kalpakkam, India's nuclear power complex in the southern state of Tamil Nadu. The plant, designed to produce 63 million liters of potable water daily, will use the residual heat from a nuclear power plant to produce 45 million liters. The rest will be produced using the reverse osmosis (RO) process. The project, the Nuclear Desalination Demonstration Project (NDDP), involves connecting the desalination plant to pressurized heavy water reactor (PHWR) units of 170 megawatt-electric each. The civil and electrical works have been almost completed, and the project is expected to be completed by December 2002.

The NDDP is being built by the Desalination Division of the Bhabha Atomic Research Center (BARC), in Trombay, and will involve use of the thermal process known as multi-stage flash (MSF) technology, and the more common RO technology. In Tamil Nadu, 12 desalination plants are in operation in eastern coastal areas using RO technology.

Along with India, China is also seriously looking at the possible use of nuclear power to remove salt from seawater. Today, 11 seawater desalination plants using nuclear energy are in operation around the world. In China, under the leadership of the scientists at the China Society of Nuclear Science and the Beijing Institute of Nuclear Engineers, three large models are getting a look-over. Reports in scientific journals indicate that Israel is also seriously considering using nuclear power-generated steam to desalinate seawater in the near future. Although desalination plants which intake seawater are the most reliable supplier of potable water, the world has not paid adequate attention to utilizing desalination as an important part of water management. In the Middle East, where freshwater exists in very small quantity, a number of desalination plants have been installed.

The Multi-Stage Flash Process

Another important point is that the desalinated water is as pure as it comes. "Desalinated seawater is as pure as purified water sold on the market," one scientist has pointed out. "A small amount of seawater would be added to meet the mineral needs of the human body. After high-temperature treatment, the water is purified, its salt content even lower than that in the piped water we drink now."

In the MSF process, evaporated seawater at above atmospheric pressure is led to a lower-pressure unit, resulting in the release of vapor, which then condenses into potable water. Since the MSF process needs heat to produce steam, it is economical to utilize the waste heat of a power-generating plant. At NDDP, the MSF system will use low-pressure steam that drives the turbines of the PHWR. The seawater used for secondary cooling of the heavy water, which is the primary coolant in a PHWR, produces this steam.

The RO process, on the other hand, is a membrane process, in which seawater is forced through a semi-permeable membrane at pressure in excess of osmotic pressure. Potable water permeates through the membrane and is collected. The semi-permeable membrane is made of polyamide, which rejects salt and allows potable water to permeate through. Most of world's desalination plants, 60% of which are in the Middle East, can be installed almost anywhere in coastal areas.

At the RO section of the NDDP, seawater will be held in three large pressurized tanks. These pressurized tanks will have three layers of pebbles of varying sizes and graded sand. There are three other activated carbon filter tanks that also have three layers of pebbles and carbon. Seawater will first go into a clarification system where, with the addition of chemicals, collided and suspended particles will be removed. Then, this clarified water will be fed into the large pressurized tanks where filters will remove larger suspended particles. In activated carbon filters, the organics will be removed. This water will then be fed into cartridges for filtering and will be chemically treated and fed into the polyamide membrane by high-pressure pumps.

BARC's Role

Since 1975, the BARC has set up a number of desalination plants across the country, including one on the BARC premises in Trombay. The BARC has also erected desalination plants in the states of Andhra Pradesh, Gujarat, Rajasthan, Tamil Nadu, and the Andaman and Nicobar Islands, and Lakshwadeep. The basic characteristic of these areas, except that of Rajasthan, is that they are coastal areas with shortages of potable water. In Rajasthan, which is located inland, brackish water is turned into potable water through the RO process.

According to Dr. B.M. Misra, head of BARC's Desalination Division, the NDDP aims to demonstrate safe and economical production of good quality water by nuclear desalination of seawater; establish indigenous capability in the design, manufacture, installation, and operation of such plants; generate necessary design inputs for large-scale nuclear desalination plants; and serve as a demonstration project for the International Atomic Energy Agency, welcoming participation from interested member-states. He also pointed out that desalination would become inevitable by 2025, because the demand for quality potable water is expected to exceed availability.