By J. L. Martin-Lagardette

Desalination of Seawater

Helps Meet Fresh Water Demand

Distillation and reverse osmosis are two competing techniques in the desalination of seawater. While each method has pros and cons, both provide a vital service in making seawater drinkable. Three French water companies (Saur, Degremont and Sidem) are working to improve the quality of fresh water created by both these methods and have invested heavily in the Mediterranean and Middle East markets with these technologies.

Las Palmas, Spain

Situated in the city of Las Palmas, principal city of the Canary Islands in the Atlantic off the coast of West Africa, the Emalsa desalination company draws all its water from the sea. Each year, it is able to satisfy 76 percent (80 percent in dry periods) of the drinking water requirements of this city of 370,000 inhabitants. It is Spain's eighth largest city.

Emalsa, Las Palmas' municipal water company, is 66 percent owned by Saur in partnership with Unelco (Union Electrica de Canarias SA). The 706 million cubic feet of water distributed compensates for the very low rainfall on the islands. The reserves of fresh water (groundwater and dams) also are very sparse and are allocated to agriculture.

Water drawn from the ocean by Emalsa supplies three desalination units. The one unit uses a combined process where water is first desalinated by evaporation. The vapor then undergoes several stages of condensation and recovery. The resulting enthalpy jumps (i.e., reductions experienced in temperature and pressure) generate considerable energy. Part of this energy is used by the facility, with the rest sold to the local power grid.

The second unit is used at times of peak consumption. The third operates using the reverse osmosis process where membranes filter the saltwater. Fresh water produced by these three sites then is mixed with borehole water, remineralized and chlorinated, and then distributed through the main supply net-

Inspection of multiple-effect vapor compression distillation at Ras Al Khaima, Abu Dhabi.

work. When the project is completed, the total capacity of the site will increase to more than 3,500 cubic feet of water per day.

Palma de Majorca

A little further north in the Mediterranean, on the island of Palma de Majorca, Degremont Espagne, part of the Suez-Lyonnaise-des-Eaux group, has set up one of the largest desalination plants in Europe. The Son Tugotes de Palma de Majorque station processes 1.06 million cubic feet of water per day using reverse osmosis. After pretreatment by coagulation and filtration, the water passes through six reverse osmosis racks containing 2,058 spiral polyamide modules on two levels. Each is supplied by a high pressure pump rated at 9,900 cubic feet per hour, at a pressure of 362 psi (25 bars). Another station bordering the sea is nearing completion, and will be able to treat 1.5 million cubic feet of seawater per day.

A Possible Solution for Municipalities

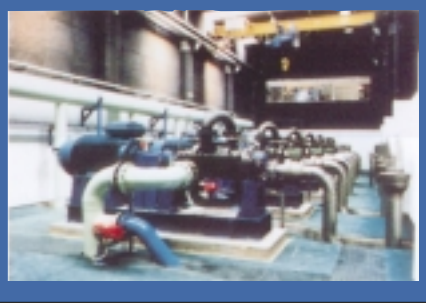
Currently there are 12,500 desalination plants in the world, supplying 706 million cubic feet per day, or 1 percent of the world's production of drinking water. The reduced cost of new desalination equipment is expected to double the world market in this field. The market could reach more than $70 billion over the next twenty years. Over the next five years, $10 billion already has been earmarked for the installation of desalination units throughout the world, which will achieve a production rate of 187 million cubic feet per day. These figures, calculated by Vivendi, take into account chronic water shortages in various countries around the world and the growing requirements in hot countries such as the Middle East, Asia and the Caribbean.

Sidem specializes in water desalination using a thermal process. The company ranks second in the world in this field, treating around 43 million cubic feet of water per day. The company has supplied 450 installations for more than twenty five years. Employing eighty people, it has a permanent office in Abu Dhabi in the United Arab Emirates and another in Tripoli, Libya, as well as a subsidiary in the Caribbean, Ucdem. The company generates sales of $54 million per year.

Sidem supplies two types of equipment: distillation plants that use the process of successive expansions known as multi-flash and units using multiple effect distillation (MED) with or without vapor compression.

In the multi-flash system, seawater is circulated through a series of cells at successively lower pressures. As it passes through each cell, the water releases the quantity of vapor necessary to reestablish equilibrium with the pressure in the cell. This technology makes it possible to build large installations, but its energy balance is not truly optimized.

In the MED process, several evaporator-condensers are installed in series. In this way, the latent heat of condensation is reused several times. The development of this technique was for a long time limited by problems with the build-up of scale. Today, the restricting of water temperature to 149° F, the size of the installa-



1.5 million cubic feet of water per day is treated by this reverse osmosis desalination plant.

tions and new anti-scaling products have overcome this problem. Sidem's MED now is reaching a unit capacity of 812,000 cubic feet per day.

There are two main competing techniques for the desalination of seawater: thermal techniques such as distillation and membrane techniques such as reverse osmosis. MED, especially coupled to a compressor, often has cheaper capital and operating costs as well as good reliability. In addition, the system does not require a high quality water supply resulting in less treatment before operation.

Reverse osmosis, a technique in which water is forced through semi-permeable membranes, requires pre-treatment to eliminate particles in suspension. On the other hand, it has less negative environmental impact than with MED. The success of this technique is due to the modular nature of its production and the fact that it is compact and easily automated, while offering good energy efficiency.

An Energy-Saving Condenser

Evaporating seawater takes a lot of energy. In order to evaporate one kilogram of water, it takes 540 kilocalories. The first evaporation and condensation systems used for desalination only used a small part of the energy consumed during treatment. Improvements to the process have tried to take advantage of this heat.

Recently, a team from the Chemical Engineering Sciences Laboratory at CNRS (National Center for Scientific Research), together with the International Water Center developed a falling-film plate evaporator-condenser that is energy efficient. Its simple design consists of two metal plates 6.6 feet high and 3.3 feet wide, spaced three-quarters of an inch apart by a polypropylene frame. The film of seawater falling onto the evaporator plate is warmed by the latent heat released by the neighboring condenser.

This new distillation process enables the production of nearly seven gallons of fresh water per hour, with an evaporation rate of 10 to 50 percent of the seawater. Modular and easy to assemble, it can be operated by unskilled workers. The Altran foundation for innovation awarded the company its 1999 European grand prix for this process.

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