ISRAEL

Applications of the MBR technology in the Middle East

The water supply system in Israel is currently undergoing a deep crisis. The main reason is a sequence of three consecutive dry years that resulted in depletion of the large potable reservoirs - the mountain aquifer, the sea of Galilee and the coastal aquifer. Further pumping from these reservoirs may cause an irreparable increase in salinity. In order to overcome the crisis, the government has taken a number of emergency measures. First, it was decided to immediately begin with desalinatio n of saline and sea water. The first 50 million cubic meters per year BOT contract has already been awarded at a cost of 52.7 cents per cubic meter. Additional measures taken by the government include encouraging end-users to replace potable water with recycled water where possible. Utilization of the emerging membrane technology in wastewater treatment, and the resulting high-quality effluent produced, fit well within the goals set by the Ministry of Infrastructure and The Water Commission. It is expected that over the next few years, MBR technology will be used in a number of different applications, some similar to those found in other countries, and some which are unique to specific Israeli conditions.

The total water supply potential in Israel from all sources is 1.800 million cubic meters per year. The rainy season lasts only four months per year, from November through February. The potable water supply to the main three sectors - agriculture, industry and the residential sector - is based on three main reservoirs: The mountain aquifer, the Sea of Galilee and the coastal aquifer. These reservoirs serve as seasonal and multiannual operational storage, while recharge takes place during the rainy season. The level of recharge depends mainly on the quantity of rainfall and its distribution throughout the country.

The drought experienced over the past three years has resulted in a deficit of 500 million cubic meters of water and, when added to the pre-existing deficit, now brings the deficit to some 2.000 million cubic meters, or the equivalent of a full year's water supply.

It is estimated that the country will require 2.200 million cubic meters of potable water annually by the year 2020. This estimate assumes that agriculture will remain at its present size of 200.000 acres which consume over 1.000 million cubic meters. However, it is estimated that only 50% of the water supply for agriculture will consist of potable water.

The balance of 500-600 million cubic meters will be supplied from recycled water.

Consequently, 500 million cubic meters of potable water will be diverted for residential use, and combined with 400 million cubic meters of desalinated water will supply the demand of population which is estimated to reach over eight million people by 2020.

It is however clear, that such an ambitious program for replacing of drinking water by recycled water requires excellent reclaimed water quality, including the need to desalinate effluents in order to allow irrigation over the main aquifers without causing soil and groundwater salination.

Current status of wastewater treatment

Most WWTPs were built during the last 15 years. The requirement for effluent discharge at a minimal standard of 20 mg/l BOD and 30 mg/l TSS, which become legally binding in 1992, accelerated the construction of new activated sludge plants.

Today, most of the wastewater in Israel is treated to secondary level, while extensive nitrogen and phosphorous removal take place in only a number of plants.

The largest water reclamation project is located south of Tel Aviv. Secondary effluent from the Dan Region WWTP, the largest activated sludge plant in the country (treating 130 million cubic meters per year), is recharged into a dedicated section of the coastal aquifer through spreading basins. The effluent is then re-pumped out of the aquifer and conveyed to the Negev, the country's southern region, where it is used for unlimited agricultural irrigation.

In additional local reclamation projects secondary effluents are utilized for limited irrigation, depending on the effluent quality, the type of crops grown, and the locally applied standards.

Government policy regarding recycled water

The Ministry of Infrastructure and the water commission have instituted a policy intended to encourage the use of reclaimed water where possible. Some of the measures taken are listed below:

- Municipalities which desire to construct a WWTP utilizing government subsidy are required to present a comprehensive program for effluent reuse, for both the dry summer season and the rainy winter season;
- Potable water prices have been increased for all sectors;
- A differential pricing system was set up to encourage water conservation;
- Water quotas for agriculture and for local authorities have been cut;
- A national master plan for effluent reuse was prepared, which will allow gradual replacement of potable water with reclaimed water over the next 20 years;
- A subsidy of up to 60% will be granted for investments related to water reclamation projects, which will promote replacement of potable water with reclaimed water.

Application

The main advantages of utilizing the MBR are listed below:

- high quality effluent supplied at high reliability;
- the option to decentralize erection of WWTP for sites distant from main collection systems while reclaiming the water for local use;
- MBR effluent is an ideal pretreatment method for RO because it allows utter removal of suspended solids and colloidal materials reliably and without chemicals;
- the combination of MBR and RO allows effluent desalination;
- reclaimed water for industrial usage for a variety of applications including cooling water, boiler feed water etc.

The main obsticles are:

- Reclaimed water costs should compete with other alternatives including low cost sea water desalination;
- Technology should be embraced by public authorities, municipalities, engineering companies etc.

Cases

Four typical cases of MBR applications in Israel are described bellow. The first one is a 'conventional' MBR operating as a WWTP with water recycling. The other three are variations of the MBR technology used for specific applications, which are relevant to the specific Israeli conditions:

- Municipal wastewater treatment

The first MBR-based WWTP was designed to treat the wastewater from a newly constructed neighborhood to the south east of Jerusalem, treating 4.000 cubic meters a day. The plant, which is located 250 meters below the Jerusalem watershed line, will produce excellent quality effluent, which will be pumped back to the watershed, and will then be reused by the municipality to irrigate public gardens inside the city. Primary and secondary sludge, mixed together, will be pumped directly into the main collection system, to be treated at the municipal WWTP. The construction of the plant is currently being delayed, due to reasons related to the unstable situation in the region.

- MBR for reservoir effluent polishing

Hundreds of reservoirs ranging from 100.000 - 4.000.000 cubic meters were built for seasonal storage of treated effluent. In most cases the water quality is similar to secondary effluent though algae growth and high ammonia concentrations (10-50 ppm) restrict the usage for intensive agricultural applications. In order to polish reservoir effluent to achieve water quality of BOD less than 5 ppm, TSS less than 5 ppm, ammonia less than 1 ppm, it is necessary to employ the MBR technology, which in this case could be named 'Biologically Enhanced Ultra Filtration Process'.

In most cases when chloride level exceeds 250 mg/liter, RO addition is inevitable. Two plants of this type with capacities of 7.500 - 15.000 cubic meter per day have been designed and will be implemented in the near future;

- MBR for high quality effluent generation

Due to the absence of dual distribution system, it is essential to produce high quality effluent in the vicinity of the reclaimed water end user. The conceptual design is to locate the MBR WWTP adjacent to wastewater collection systems, which are in proximity to large public gardens. During the dry season (approximately seven months a year) wastewater will be 'harvested' from the main pipe, and after undergoing biological treatment, the effluent will be supplied directly to the drip irrigation system. The sludge produced will be pumped back into the collection system. Three plants at a capacity of three or four million cubic meters per year are currently being designed;

- The Sharon effluent reclamation project

The reclamation project, centered in the Sharon region (the central coastal plain), is planned to collect and upgrade secondary effluent in the densely populated central region of the country. The effluent from five activated sludge plants will be collected in an operational reservoir. From the reservoir the effluent will be upgraded using MBR/RO technology. The reclaimed effluent will meet most potable water quality criteria, and will have a chloride concentration of about 30 mg/l. The resulting brine will be pumped to the sea.

Water reclamation

The project 'Water reclamation' is planned to recycle 20 million cubic meters annually by 2003, and 30 million cubic meter per year by 2020. The reclaimed effluent will be utilized in a number of ways:

- groundwater recharge through coastal wells in order to create a 'hydrological barrier' (see below)
- and direct supply for unlimited agricultural irrigation for seven months of the year. During the five winter months, as agricultural demand drops off, the reclaimed effluent will be recharged into a dedicated sector of the coastal aquifer isolated from sectors where potable water is produced. During the seven summer months water will be repumped from this sector for irrigation, in order to prevent spreading of the recharged effluent beyond the designated zone.

Additional options for future expansion of the project include the following:

- reuse of the reclaimed water for municipal supply, utilizing dual distribution supply system, which will be implemented in new housing projects. The reclaimed water will be supplied for all uses except drinking, cooking and washing
  and indirect potable water supply.

  Reclaimed water will be recharged to the aquifer through non-point recharge areas (unlike recharge through wells as described above). This recharge will allow reclaimed water to be diluted in native water, and following a two year underground residence time, the water will be usable for all potable water application.

The hydrological barrier

The concept of a hydrological barrier involves the injection of water into wells parallel to the coast and inland from the area where seawater has already penetrated the aquifer. By raising the aquifer water level in a relatively narrow band, positive head is created preventing further intrusion of seawater toward the aquifer.

Design concept

Desalination of effluents is the key to reuse of the effluents for irrigation above a sandy aquifer, in order to retain potable water quality in a sandy aquifer and prevent transportation of micropollutants and salts into it. Protection of aquifer water quality, in turn, allows the aquifer to be used for multiannual water storage and equalization. The coastal aquifer in Israel represents about 10% of the county's water potential but almost 100% of its multiannual storage potential; hence the great importance of this aquifer for the Israeli water supply system.

Conclusions

The goal to replace 500 million cubic meter per year of potable water with reclaimed water for unlimited agricultural use can be achieved through the utilization of the best available technologies of which the MBR seems to be very promising. ¶

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