

San Diego Uses EDR Technology for Desalination

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EDR technology produces low salinity irrigation water from reclaimed municipal wastewater

San Diego sells more reclaimed water for irrigation by expanding the electrodialysis reversal system (EDR) capability in its municipal wastewater reclamation plant. Advantages such as 85% water recovery rates, no need for chemical additives to feedwater, and fully pre-assembled trailer EDR systems helped city officials to opt for an Ionics solution. (Ionics was purchased by GE Water & Process Technologies in 2005.)

The city of San Diego, California, shares a problem in common with many other Western cities. That problem is meeting the ever-increasing challenge of developing adequate drinking water supplies to satisfy continuous regional development. New sources of fresh water are not readily available without spending huge sums of money.

In the late 1990s, San Diego took a major step in helping to solve this problem by equipping the brand new North City Reclamation Plant with an EDR (electrodialysis reversal) system, from Ionics. The system would desalinate tertiary treated wastewater to provide a new source of high quality irrigation water, thereby reducing demand on the fresh water supply. The wastewater supply to be treated had salinity levels up to 1300 ppm TDS during the summer and early fall.

By initially providing desalinated and blended reclaimed water having less than 1,000 ppm, with low sodium levels, San Diego used an existing 47-mile-

long pipeline system to deliver high quality reclaimed water to golf courses, plant nurseries, parks, highway green belts, and homeowner associations. The strategy was to sell this water as an attractive alternative to using hard-to-replace fresh drinking water, thereby saving that precious supply. The idea caught on quickly.

In 1998, the initial EDR plant produced 2.2 mgd (8,000 m³/day) – with blending, 3.3 mgd (13,000 m³/day) was available. With two expansions, the latest of which will be completed in early 2005, EDR will produce 5.5 mgd (21,000 m³/day) of approximately 300 ppm TDS water. With blending, up to 12 million gallons per day of irrigation water can be supplied through a lengthened 67 mile (108 km) long pipeline system. Possible future expansion will bump this blended flow up to 15 mgd (57,000 m³/day).

In 1997, city officials initially looked at using desalination with microfiltration and reverse osmosis (MF – RO) for the irrigation water project. This was an approach that had already been done at several locations in the Los Angeles area. Before committing to this approach, they looked around to see if a less expensive alternative was possible. They found that electrodialysis reversal (EDR) had been successfully used at a number of wastewater locations to desalinate reclaimed irrigation water.

EDR offered the opportunity to use a less expensive single membrane treatment process, with a higher water recovery to make better use of the available wastewater supply. MF-RO requires chemical pretreatment to control salt scale build-up on the RO membranes. EDR would operate with no chemical addition to the feedwater. Overall, MF-RO water recovery would be about 80%. EDR would



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operate at 85% recovery, which was a second advantage. One more major advantage to using EDR is that additional capacity can be added on by installing fully pre-assembled EDR systems within 53-ft-long (16-meter-long) enclosed trailers with up to 1.2 mgd (4,500 m³/day) flow per trailer.

City officials elected to use an EDR 2020 system from Ionics for the North City irrigation water project after receiving bids from general contractors. When all the bids were opened, the least expensive MF-RO option was priced at US\$4,775,975. The EDR cost was US\$3,569,000, or 25% less than MF-RO. This was for the initial 2.2 mgd (8,000 m³/day) capacity EDR system.

With MF and RO, water is forced through a membrane under pressure. MF membranes are used to pretreat RO feedwater, to remove suspended solids materials, some organics, and other fouling type materials that will affect the salt-removing RO membranes. With RO, water is pressure driven through the membrane leaving unwanted salts behind. Chemicals are added to control scale buildup from wastewater constituents, such as calcium phosphate, calcium carbonate, calcium sulphate and others that can form on the concentrate side of the RO membrane. One problem with today's high performance RO membranes is they cannot treat water that contains chlorine, an essential ingredient in helping maintain bacterial control with wastewater. Chlorine will destroy RO membranes. It must be removed prior to the RO membranes.

Electrodialysis (ED) was first commercially applied in 1954 to desalt brackish groundwater in a remote area of Saudi Arabia. ED is an electrically driven process in which charged ions making up the water salinity are pulled through flat sheet cation and anion membranes due to effect of a DC field generated between electrode plates. Water is not transported through the membranes – it continues on through the process. The ions (depending on their charge – cationic or anionic) are attracted to the anode or cathode electrode. A single ED stage will remove up to 50% - 60% TDS. For still greater salt reduction, membrane and electrode plate stacks are staged in series one after another. Typically, up to 200,000 gpd (750 m³/day) can be treated in a single line of stacks. For higher flow applications, multiple lines of ED stacks are installed in parallel.

By automatically switching the DC field in the membrane stack every 15 to 30 minutes, the EDR system cleans itself, without having to add chemicals in the feedwater. Even at 85% water recovery, with highly concentrated levels of salts in the EDR brine, EDR runs without special chemicals feed to control salt scale build-up. By choice, one chemical that is added is 0.5 ppm of chlorine to keep EDR membrane stacks free from unwanted bacterial growth. Compared to MF-RO, the only pretreatment used with EDR are 10-micron disposable cartridge filters to remove solid particulate matter prior to the membrane stacks.

Past results and today's latest developments

When the initial system started operation in 1998, it was supplied as two each, 1.1 million gallon per day units (4,000 m³/day). The systems had a single-stage membrane stack design. Approximately 55% of the salt was removed in this single stage process, then ED product water was blended up to 3.3 mgd (12,000 m³/day) at less than 1,000 ppm TDS.

The demand for EDR product flow increased as the city continued to sell more reclaimed irrigation water. In 1999, the EDR system was expanded with the addition of a third unit (a two stage, 1.1 mgd or 4,000 m³/day EDR unit), and with the retrofitting of 2nd stage membrane stacks to the original EDR equipment. With EDR product flow of 3.3mgd (12,000 m³/day) now having still better quality (less than 300ppm), more non desalted water is blended with EDR product. The plant is now rated to deliver over 7 mgd (26,000 m³/day) of < 1,000-ppm irrigation water.

To continue development of this alternate irrigation water supply city officials purchased still more EDR capacity in the fall of 2003. Two options were available. The first used the conventional approach of adding more land based EDR systems. This option required a major rework of the site, with more conventional building of sunshades, concrete pads, and extensive site installation work. The city chose the second approach that called for the installation of fully pre-assembled EDR systems within 53-ft-long (16-meter-long) over-the-road enclosed trailers. On arrival at site, a simpler retrofit using pre-assembled trailers allows for a quick

installation of two additional 1.1-mgd (4,000 m³/day) EDR systems.

Total EDR production will be 5.5 mgd (21,000 m³/day) when the latest EDR units go on line in January 2005. With blending, up to 12 mgd (45,000 m³/day) of irrigation water will be supplied to a now further expanded irrigation water pipeline infrastructure system, sending water to additional golf courses, and new home developments. This latest expansion also includes adding enough concrete pad area, and water treatment site pipeline capacity to bring in a third EDR trailer in the future. This ultimate plant will then have 6.6 mgd (25,000 m³/day) of EDR capacity, and up to 15 mgd (58,000 m³/day) + total blended flow. Results at North City have proven very positive for San Diego and for the EDR process

Future outlook

Based on this success, other municipal agencies in California are looking at EDR to treat their municipal wastewaters. In a recent tertiary treated waste water pilot test performed in California, EDR and MF-RO were run side by side for nine months. Based on a present worth analysis of capital cost, installation cost and 20 years O&M, EDR was rated as 40% less expensive than MF – RO. In another case, where EDR or MF-RO could be used, highly concentrated brines have to be trucked to a sewer line disposal site at very high costs. The ability of EDR to operate at over 90% water recovery makes treatment practical. The greater volume of MF-RO treatment does not pencil out for the project.