Case Example

Texas Instruments Incorporated: Improving Efficiency at Water Production Plants in Texas

Texas Instruments (TI) was able to achieve a significant reduction in city water use and dollar savings through a recent project involving three of the company's ultra-pure water (UPW) plants located in Dallas and Sherman, Texas. UPW plants are responsible for processing city water into the high quality water needed in the company's semiconductor manufacturing process. Initial processing at the plants is performed by reverse osmosis (RO) systems. Once the city water impurities are removed through RO, they are discharged from the plant in a stream called "reject brine." By improving the efficiency of the RO systems incrementally at each plant over a period of three years, TI was able to reduce city water consumption by more than 400 gallons per minute (GPM), which led to an annual savings of more than $550,000 (USD).

Project development. In 1999, a team of TI water quality experts identified that water consumption could potentially be greatly reduced through ultra pure water production at TI's Dallas and Sherman sites by improving the efficiency of the plant's RO systems. A brine concentration method was first tried as a means of improving efficiency at SC "PRECIP," a smaller UPW plant, and then implemented at the much larger TIME UPW plant. At each plant, the available equipment and/or the incoming city water quality required minor differences in the concept's application.

Implementation phasing and challenges. The PRECIP plant was first modified to validate the concept that water savings could be achieved through improved RO system efficiency. This was done by reconfiguring a redundant RO system (common in large UPW plants such as those needed for semiconductor manufacturing) to serve as a reject brine recovery unit. This change made it possible for additional quantities of water to be recovered from the reject stream rather than having the entire reject brine go down the drain.

Since this smaller UPW plant had deaeration in place, prior to the production RO system, significant carbonate loading could be eliminated.

Moreover, although the calcium fluoride concentrations were projected to exceed the published solubility limits by modest margins, practical experience indicated that no actual problems would occur.

The brine recovery system was equipped with used reverse osmosis modules and was able to turn 66 percent of UPW production brine into a product water that was superior to city water. This reprocessed water was then piped to the city water pretreatment tank for reuse. As a result, about 40 to 50 GPM of brine was recovered.

The SC PRECIP UPW plant brine recovery trial run demonstrated that existing reverse osmosis processing systems could be utilized to improve RO water efficiency from about 75 percent to near 90 percent — and that it could be accomplished at a low cost. If the concept worked at the PRECIP plant, it was determined that it could be adopted at the TIME plant with only a few necessary changes due to the higher brine concentrations.

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In 2000, TI's in-plant facilities team designed the brine recovery unit system, controls, and the installation at the TIME plant. The design included a necessary new decarbonator for carbon dioxide removal to prevent membrane scaling. In September, a contractor was awarded a turnkey contract to purchase and install the system. The main TIME process step modifications were:

- Collection of the brine streams from the production RO arrays
- Acidification of that common stream by sulfuric acid injection
- Decarbonation of the common stream in an induced-draft packed stripping column
- Re-pressurization and treatment in an existing RO array set aside for brine recovery and routing the "product" water to the city water tanks

In June 2001, the main TIME Building UPW plant was commissioned and in January 2002, the Sherman plant modification was brought on line.

The original goal at the TIME plant was to recover an average 240 GPM and as a precaution, the reconfigured brine recovery system included in its design the ability for a quick conversion into a regular production RO array in the event of an emergency. The recovery method implemented at TI uses existing, normally redundant RO equipment. This has the decisive advantage of decreasing the project cost, installation difficulties, increasing the payback rate and allows the concept to be economically feasible even where water rates are low.

Other considerations. Besides the perceived increased risk whenever a material is reused in a production area, there are two main difficulties with these types of projects. The first is justifying the cost of new equipment in cities with low utility costs. In this instance, new RO system equipment may cost as much as $1,000 per GPM of capacity. The second difficulty is that when the waste RO brine is "squeezed" for more recovery, the chance of RO membrane scaling is increased. Normally this is due to the formation of calcium carbonate and it is dependent on inlet water quality and pretreatment prior to the RO. At the PRECIP plant, the inlet water pH was reduced to the production RO's, which allowed the recovery unit to work at a lower pH. At the TIME plant, due to its size, only the brine to be treated has its pH lowered and carbon dioxide removed in a new decarbonator. At Sherman, no pretreatment to prevent scaling was needed.

Realized benefits. Besides the more than half-million dollars a year savings, the project reduced TI's impact on local water infrastructures. This is especially important to TI and the community at large, as the TI Sherman and Dallas manufacturing plants are the largest water consumers in their local areas.

Almost equally important, during the period that the project was conceived, the Dallas Water Utility expressed concern about commercial and residential water use as reservoir levels dropped during a drought. Although the reservoirs were eventually replenished, population growth in North Texas continues to grow, making water resources scarcer in the coming years.