Advanced Wastewater Reuse Technology

By Lior Eshed

LIKE MANY OTHER places, California has been severely impacted by drought. As the state faces an ongoing shortage of groundwater, advanced water reuse is proving a sustainable alternative for a clean, efficient and safe water source. The reused water can be used to recharge the depleting aquifers and avoid seawater intrusion, help maintain proper water levels in lakes, supply water to the industrial sector or even for direct use in the potable conveyance system.

The key to reaching this level of high-quality water is the implementation of cutting-edge treatment technology with tight control of the treatment process.

Case Study

In an effort to demonstrate the feasibility of a treatment process of this kind, the City of Grover Beach, Arroyo Grande and the Oceano Community Services District (OCSD) in California have initiated Central Coast Blue, an indirect potable reuse project. The aim of this project is to prove the reliability of the process and the feasibility of turning wastewater into high-quality fresh water that will be recharged into the groundwater basin.

Historically, the three cities and Oceano have obtained surface water from Lopez Lake - a reservoir on Arroyo Grande Creek formed by the Lopez Dam - and groundwater from the underlying Santa Maria Groundwater Basin. Oceano and Pismo Beach also receive a portion of their water supply from the California State Water Project.

Severely affected by the recent drought, Lopez Lake has struggled to recover. As of early June, according to the County of San Luis Obispo Public Works Department, the water body was at 50 percent capacity. Meanwhile, concerns about the possibility of seawater intrusion into the Santa Maria Groundwater Basin prompted Pismo Beach and its neighbors to decrease their use of groundwater.

In order to develop a drought-proof, sustainable water supply, Pismo Beach and its Central Coast Blue partners aim to reuse the wastewater that they currently treat to secondary levels before discharging it to the Pacific Ocean. To this end, Pismo Beach operates a 1.9 MGD wastewater treatment facility that uses oxidation ditches, clarification, and disinfection. On average, the facility discharges about 1 MGD of treated effluent to the ocean.

Recently Pismo Beach began operating the new Central Coast Blue Advanced Water Purification Demonstration Facility at the site of its existing wastewater treatment plant. With a treatment capacity of 45,000 Gal/d, the demonstration facility treats effluent from the Pismo Beach Wastewater Treatment Plant and subjects the wastewater to additional advanced treatment processes designed to achieve a finished product that is of drinking water quality. Although the goal of the Central Coast Blue project is ultimately to inject the purified water into the groundwater basin for later extraction and potable reuse, there will not be any injection during the pilot phase. Instead, the purified water from the demonstration facility is returned to the Pismo Beach Wastewater Treatment Plant.

Central Coast Blue has collaborated with IDE Technologies, which is providing the technology for this facility. This includes a three-stage treatment composed of Microfiltration (MF), which removes suspended solids and pathogens such as bacteria and protozoa; followed by Reverse-Osmosis (RO) that removes dissolved solids and sub-micronic constituents such as viruses; and finally Ultraviolet/Advanced Oxidation (UV/AOP), which degrades any residual organic contaminants (Figure 1).

Figure 1: DOHS Process
process (termed FAT - Fully Advanced Treatment):

A) No Chloramine Injection

Normally Chloramine is dosed to the feed water to control the formation of biofouling on the membranes. However, when Chloramine comes into contact with organic matter in the water, several byproducts are formed, including NDMA (a suspected human carcinogen, currently limited to 10 ng/l according to discharge regulation), as well as other chlorination-byproducts such as Trihalomethanes and Haloacetic acids. In addition, Chloramine increases the risk of membrane oxidation, shortens the life expectancy of the membranes and adds complexity and cost to the process. In the ECO reuse process, no Chloramine is used. Instead, RO membranes are kept clean by the preventive maintenance approach - periodic cleaning of the membranes using a proprietary process termed DOHS (Direct Osmosis High Salinity). This process includes a short injection of the concentrated saline solution that reverses the flow direction in the RO membrane, thus backwashing the membrane surface. The injection of a short pulse of concentrated saline solution that takes place during DOHS causes:

- The backwash of membrane surface by forward osmosis
- A rapid increase in cross-flow velocity (shear force)
- Bacteria dehydration due to osmotic shock

Another method used to keep the membranes clean is the periodic flushing of the RO system. The RO recovery is 75-80%; the RO recovery is 75-80%. This means that about 25% of the water feed is rejected.

Figure 3: Specific Flux of the RO

Operational Results

- **Specific Flux**: The specific flux stabilized at about 0.12-0.13 gfd/psi in the first stage and 0.09-0.1 gfd/psi in the second stage (Figure 3). The specific flux of the 1st stage is about 25% higher than a parallel reuse facility in Orange County (which is 0.09-0.1 gfd/psi).

- **Differential Pressure**: The differential pressure is an indication of the fouling and scaling on the membranes. During the demonstration time, a moderate increase in the differential pressure is an indication of the fouling and scaling on the membranes.

- **Cost in the UV/AOP Process**
  - B) Lower CAPEX and OPEX
    - Following RO desalination, the water flows to its final treatment unit - the Ultraviolet/Advanced oxidation process (UV/AOP), in which high UV irradiation and injection of an oxidant initiate the formation of short-living free radicals that rapidly attack and degrade organic contaminants. The efficiency of this process is dependent on the transparency of the water (UVT value). Presence of Chloramine in the permeate water (most of the Chloramine passes through RO membranes) reduces the UVT value. In fact, the Chloramine acts as a “radical scavenger”, causes part of the free radicals formed to react with the Chloramine, therefore reduces the efficiency of the process. All this results in a lower CAPEX and OPEX.

- **Rejection of Organic Contaminants by RO**: Out of 30 tested Contaminants of Emerging Concern (CECs), 25 were found in the secondary effluent. Only one (Sucralose, 28 ng/l) was found in the RO permeate. Sucralose concentration showed a 3-log removal in the RO. The RO showed better than expected results, rejecting 94% of the nitrate and 99.9% of organic contaminants.

- **MF Performance**: remained stable throughout the demonstration time, with the flux of 33 gfd and specific flux of 4.5 gfd/psi. Chemical maintenance cleanings used only hypochlorite (every 48 h). Daily pressure decay tests proved that the membrane kept its integrity throughout the demonstration time.

**Conclusion**

Drought and climate change push for new water sources, and water reuse is a valuable approach in this effort. The recently-opened demonstration facility in Pismo beach CA yields good results and increases confidence in this process while proving that a more environmentally-friendly approach is feasible by minimizing the use of chemicals and ensuring effective performance of the future full-scale facility. The Demonstration Facility is open for tours and provides the community with an opportunity for a first-hand observation on how the process works.

**About the Author**

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