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Desalination Trends

Prefiltration options & new applications

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Prefiltration for Desalination

By Jim Lauria

Enhancing desalination ROI and ROE with prefiltration technologies

Desalination must deliver a positive return on investment (ROI)—a profit based on the cost per gallon of water treated—but it must also generate a positive return on environment (ROE), which is the balance between creating clean water while reducing the environmental footprint of the desalination process. In a well designed multistage approach to prefiltration, each element makes the others more efficient and effective, enhancing both ROI and ROE.

Reducing the environmental footprint of a desalination facility can take many forms, addressing resources ranging from water and chemicals to energy and space.

Due to increasing regulation and growing public scrutiny, disposing of reject water—brines and backflush water—is a rising challenge in many desalination operations, so minimizing backflush water is paramount. Desalination plant operators can see a preview of the future of wastewater management in California's Title 22 regulations, which strictly govern the release of wastewater into the environment.

Disposal of solid wastes such as filter cartridges is also costly in terms of direct costs (e.g., replacement materials and disposal fees) and indirect costs (e.g., labor and handling). Increasing the interval between chemical cleanings of membranes has a significant impact on both ROI and ROE, as does improving the life and recovery rate of the membranes. Energy costs also can be impacted significantly by the pressure needed to pump water through membranes and other filtration technologies.

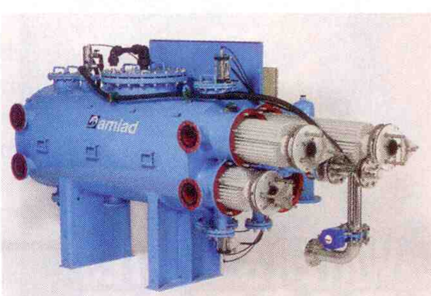
The numbers add up quickly on the bottom line. According to a 2006-2007 study by the Pacific Institute of the costs of desalination, consumables accounted for 3% of a typical reverse osmosis (RO) desalination plant budget; membrane replacement was 5%, and labor was an additional 4%. Energy accounted for a whopping 44%. Reducing each of these line items quickly adds up in an environment in which budgets tend to have a lot of zeroes. Prefiltration can impact each of those inputs.

Mysterious Foulants

Developing a prefiltration system requires a prescriptive approach, much like a visit to a physician. The first step is diagnosing the problem. In water terms, that requires a careful look at the condition of the raw water.

Grit can be a significant challenge, both in intake water from seafloor or well sources as well as downstream of sand media filtration systems, which can be prone to media carryover, especially after backflushing. Fibrous materials can be a particular problem with membrane bioreactors. Scale and precipitates can be a significant challenge in many water sources, as can oxidants such as chlorine or gases such as hydrogen sulfide.

Biologicals are coming under increasing scrutiny, largely because they are surprisingly mysterious. Well understood



An automatic microfiber system is an effective technology for removing TEP: It is capable of filtration down to 2 microns.

biological contaminants such as algae and mollusk larvae—which can mature in intakes, pipes and membrane housings—are a recognized threat. But academic papers have indicated that transparent exopolymers (TEPs) may be a bigger threat than previously understood.

TEPs appear to play a major role in biofouling, both directly and as a breeding ground for bacteria that can form destructive colonies. TEP macrogels are deformable, gelatinous colloids from 0.4 to 200 microns in size. They often go unnoticed because they are transparent. They are comprised of bacterial mucous, protective gels that surround algae and diatoms, secretions from aquatic organisms or nonbiological material. TEP is ubiquitous in both freshwater and seawater. Near-surface seawater has been shown to contain 3,000 to 40,000 TEP/mL.

TEP colloids become hot spots of microbial and chemical activity because they often travel with resident bacteria and create a nutritious substrate for bacteria, microorganisms, plankton and fish. They also aggregate with debris, creating "marine snow."

Adding to the challenge, TEP is very difficult to manage in most prefiltration systems. For instance, a study published in the journal *Desalination and Water Treatment* in 2009 observed that a sand media filtration system in an Israeli desalination plant reduced chlorophyll and silt density index by 90%, but removed less than one-third of the TEP. The scientists' recommendation: Begin looking for TEP using a new stain method and consider how to remove it effectively.

Prefiltration Technology

One effective technology for removing TEP is an automatic microfiber (AMF) system. At the heart of the automatic self-cleaning system is a set of cassettes, each with a plastic core tightly wound with polyester microfiber capable of filtration down to 2 microns. The fibers trap suspended particles, including deformable ones such as TEP or the organic polymers used to maximize turbidity removal in a current AMF trial at the Affordable Desalination Collaboration facility at California's Port Hueneme.

When a target pressure differential between the clean side and dirty side of the system is reached, a jet of water is directed through the fibers. The high-pressure stream is deflected by the specially designed core, traveling back through the fibers to dislodge and remove the trapped material.

The self-cleaning action of the AMF prevents the system from building up films of TEP and other colloids as sand media systems do, or becoming blinded by gel as cartridges can.

Upstream of AMF filters—or fine cartridge systems—automatic self-cleaning screen filters also play an important role in prefiltration. Producing 75% less backflush water than sand media systems, demanding minimal energy, requiring no chemicals or consumables and occupying a compact physical footprint, the self-cleaning screen filters can significantly reduce the sediment load on fine filters downstream while reducing the environmental footprint of the whole system.

Case Study: Goodyear, Ariz.

Amiad automatic self-cleaning screen filters played a significant role in streamlining a brackish water RO system in Goodyear, Ariz. When a drinking water shortage required the city to treat brackish well water prior to blending it with a fresh well water source, the original 5-micron and 1-micron wound cartridge filters required replacement every 10 days due to a high silt load.

The city added four 10-micron EBS filters in front of the cartridge filters to reduce the sediment load, wisely allowing the cartridges to focus on fine filtration rather than squandering the costly consumables on larger sediment. The city also began injecting sulfuric acid upstream of the RO membranes and sodium hydroxide downstream of them.

The new system increased recovery in the RO system from 70% to 85%, and it boosted permeate production from 300 gal per minute (gpm) per train to 350 gpm. Adding the automatic self-cleaning filters before the cartridges tripled cartridge life, saving the material and labor cost of 18 to 24 cartridge replacements per year.

Further Efficiencies

Minimizing backflush water is an important element of reducing the environmental footprint of a water treatment system. In Goodyear, backflush water and concentrate must be injected into a dry well, as the high salt content would damage biological remediation organisms in the city's wastewater treatment plant and also make treated sewage water unsuitable for irrigation. Minimizing the amount of wastewater that needs to be injected impacts the operating cost of the daily operation as well as the life of the receiving well.

Sediment, turbidity and biological contaminants are just a few of the challenges facing desalination plant operators and their equipment. Using an array of prefiltration technologies, however, to manage contaminants can help deliver both a positive ROI and ROE. MT

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