EDS Webinar, March 25. 2021 -
10:00 EST (16:00 – 18:00 CET / 15:00 – 17:00 GMT)

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Strategies for High Recovery Reverse Osmosis (brackish and municipal)
- ABSTRACTS -

Yoram Cohen

Dr. Cohen is a Distinguished Professor of Chemical & Biomolecular Engineering (CBE) at the University of California, Los Angeles (UCLA) and a Faculty member of the Institute of the Environment and Sustainability (1981-present). Dr. Cohen is a Distinguished Professor of Chemical & Biomolecular Engineering (CBE) at the University of California, Los Angeles (UCLA), a faculty member at the Institute of the Environment and Sustainability). He is a Faculty Affiliate of the California NanoSystems Institute, and Associate Faculty with the UCLA Center for Occupational and Environmental Health. Dr. Cohen is also Adjunct Professor at Ben-Gurion University (Department of Desalination & Water Treatment, Zuckerberg Institute for Water Research).

Inland Water Desalination- High Recovery RO Process Configurations, Operation and Monitoring

Inland water desalting via reverse osmosis membrane technology generally require high recovery operation to increase productivity and reduce the challenge of concentrate management. However, high recovery is often limited by increased fouling and membrane mineral scaling. Water recovery constraints due to membrane fouling and mineral scaling can be alleviated by effective feed pretreatment and various operational strategies. Also, tailoring membrane surface topography and chemistry have been promoted as approaches to reduce membrane fouling propensity and to increase the efficacy of membrane cleaning. High recovery operation can include a multiplicity of operational strategies, process configuration to overcome the constraints imposed by fouling/mineral scaling, effective membrane fouling/scale monitoring, as well as reducing equipment limitation imposed by the need for high pressure operation at high recovery desalting of high salinity feedwater. In addressing the above challenges, fundamentals and laboratory and field studies will be presented of a multi-pronged approach for high recovery RO desalting that includes the following considerations: (a) increasing recovery via the integration of primary RO (PRO) with chemically-enhanced seeded precipitation (CESP) in a fluidized bed crystallizer for RO concentrate desupersaturation and salt harvesting, followed by and secondary RO (SRO) for increased recovery, (b) flexible RO operation with steady state concentrate partial recycle and cyclic semi-batch operation to reduce RO system footprint, (c) reduction of energy utilization via process configuration and model-based control, (d) integration of UF and RO to reduce feed pressure requirements, and (e) direct monitoring of membrane fouling/scaling to ensure timely mitigation of membrane fouling and scaling at high recovery desalting.

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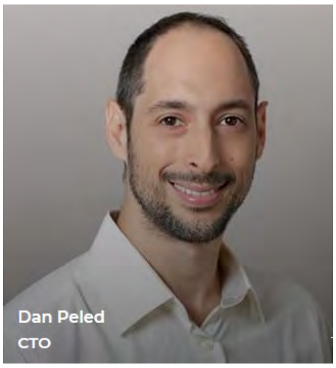
Dan Peled



Dan has been implementing ROTEC's Flow Reversal technology for high recovery desalination for the last 10 years, improving the efficiency of RO treatment in various markets (WW effluent, beverage, industry). He accompanied the technology from the first industrial pilot tests to the current large-scale implementation, and is involved in constantly updating, improving and expanding the possibility scope of the technology. Dan holds a B.Sc. from Israel's Technion University.

High Recovery RO with Flow Reversal

Conventional RO systems require frequent cleaning events when recovery is unduly increased due to scaling limitation posed by the relatively high concentrations of sparingly soluble solutes. Thus RO systems commonly operate at a lower recovery than that which is achievable osmotically in order to prevent scaling and maintenance issues. Often, RO units work at the bounds of the antiscalants' capabilities and suffer from frequent cleaning events.

Since RO recovery is becoming a critical factor in recent years, a solution to achieving high recovery economically is required. Using proprietary valving and timing techniques, ROTEC's Flow Reversal Technology exploits the finite nucleation kinetics and induction time required for scaling on RO membranes, by exchanging tail elements and lead elements before tail elements will suffer extensive scaling, thus allowing extension of the recovery envelope.

The Flow Reversal technology can be introduced either in retrofitted systems or in grassroots system design. To date, successful integration of ROTEC's Flow Reversal Technology in many new or retrofited RO plants around the world, demonstrated high efficiency in preventing scaling and significantly improved the RO process recovery. The projects highlighted in this presentation demonstrate the applicability of ROTEC's Flow Reversal Technology dealing with high supersaturation indices for Calcium Carbonate ($CaCO_3$) and/or high Silica (SiO_2) in the final concentrate.

Even in presence of antiscalant, calcium carbonate supersaturation indices (LSI) in the concentrate stream are commonly limited to 2.2-2.4 while Silica is limited to a saturation index of 2.0-2.5. Working on a variety of projects with different feed water sources and system design challenges, ROTEC achieved operation of industrial and pilot systems at LSI levels of up to 3.4 and SiO_2 SI levels of up to 4.5, without the need to add additional chemical treatment (e.g. silica removal settler, hardness softener…). At the same time recoveries were increased from 72 – 87% (silica limited system) in one case and in another case were increased to 95% ($CaCO_3$ limited system).

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Philip Davies

Philip Davies is Professor of Water Technology at University of Birmingham, UK. He began his research in desalination through the design and installation of a Seawater Greenhouse in the Canary Islands in 1993. Prior to that, he undertook research in solar energy at the Polytechnic University of Madrid. His research today combines these interests in desalination and solar energy, as he continues to develop sustainable approaches to purification of seawater, groundwater and wastewater. He is participating in several collaborative international projects, including INDIA H2O which is supported by the European Union and the Department of Biotechnology, India.

Batch Reverse Osmosis for Energy Efficiency in High Recovery Desalination

High recovery desalination is becoming increasingly important to minimise harmful brine discharges and to conserve limited water resources, but high recovery tends to result in low energy efficiency and increased operating costs. Conventional reverse osmosis (RO) based on continuous flow suffers from decreasing energy efficiency at recovery > 50%. Batch RO is an approach to improving energy efficiency whereby conditions in the system vary with time rather than spatially. The presentation will explain the rationale for batch RO and compare it to other configurations including semi-batch RO and multistage continuous RO. Batch RO can achieve theoretically ideal efficiency and take advantage of advanced membrane technologies giving high permeabilities. Nevertheless, the large size of batch RO systems makes them impractical at recovery above about 90%. To overcome this, a new approach combining batch and semi-batch operating principles is proposed. This hybrid approach enables a compact design while substantially retaining the efficiency advantage of batch RO. The presentation will also outline some of the practical advances in developing the batch RO technology to treat brackish groundwater in the context of the INDIA H_2O project.