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Texas

Mineral recovery plant back on track

In May 2015, Houston-based Enviro Water Minerals (EWM) signed a 30-year agreement with El Paso Water to produce up to 2.4 MGD (9,084 m^3/d) of potable water from a combination of brackish RO concentrate from the utilities' Kay Bailey Hutchison (KBH) Desalination Plant and brackish well water. El Paso Water would pay EWM a \$2.00/kgal (\$0.53/m^3) processing fee for the potable water, and eliminating the need to pump the concentrate 22-miles (35km) for deep well disposal.

In return, EWM would use the RO brine as a feedstock for its innovative mineral processing facility, recovering caustic soda, hydrochloric acid, high-purity gypsum and magnesium hydroxide for re-sale to local customers. The plan would be a textbook example of the 'circular economy'.

Unfortunately, the plant—which includes NF, RO, ED, BPED and evaporator systems—never lived up to expectations. In February 2019, EWM's \$60 million project still hadn't been commissioned. EWM's investor, Nuveen Asset Management, took over the facility. It retained EWM to assist with commissioning, but did not renew their contract when it expired in September 2019.

A planned auction to sell off the equipment was cancelled, and in December 2020, Florida-based Critical Materials Corporation (CMC) bought the facility for a reported \$5 million, with plans to start-up the facility by the end of the year. The company focuses on producing battery grade lithium, as well as extracting rare earth elements from mine tailings and other industrial processes, which have been considered to be unrecoverable sources.

Steve McArthur, CMC's CEO, told *WDR*, "Following our asset acquisition, we've been conducting a thorough equipment repair assessment and doing an engineering design review of the process flows. We've determined it will be necessary to make some significant changes in order to achieve a successful commissioning.

"Our process engineering team, under [President and COO] Tom Currin's direction, is in the midst of working out a series of plant process changes. We will then undertake an extensive redesign and retrofit of the plant over the next nine months."

Although the KBH RO plant's concentrate contains very little lithium, the company is negotiating with the owners of two lithium-rich brine sources in the region. The company expects to invest an additional \$5 million in the project. It has already hired 11 people, and expects to double the local staff by the time the facility is commissioned.

McArthur also confirmed that CMC has entered into a new contract to treat KBH RO effluent and brackish well water, which El Paso Water Utilities' board approved earlier this month.

California

SWRO hearing to reconvene this week

Last week's virtual public hearing to consider the NPDES permit renewal of Poseidon's proposed Huntington Beach Seawater Desalination Plant project will continue later this week. The 12-hour long hearing, which ended after 9:00 PM local time last Friday evening, consisted largely of public comments on the proposed marine life mitigation plan revisions.

Some of the issues discussed at length, were the extent of the marine life mitigation requirements, the mitigation project costs, and how the timeliness of the work could affect the project schedule and financing.

The discussion began with former Senator Barbara Boxer, speaking on behalf of Poseidon, and in support of the 50 MGD (189,250 m^3/d) seawater desal plant, noting that the project would not be bankable until all the risks, including the extent of the mitigation efforts, were adequately defined and accounted for, to the satisfaction of the lenders.

Kevin O'Brien, a managing director for Bank of America, echoed her statement, saying that his company had already sent letters to the board, attesting to the project's financing infeasibility until "all mitigation permits and approvals have been secured." He explained that investors would view any

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provisions that hold the project liable for factors outside of its direct control as problematic.

One board member questioned "Poseidon's business model", remarking that the Water Board is not responsible for the fact that Poseidon needs the permits to secure financing. Poseidon's representative patiently explained that it is not simply a Poseidon requirement, and that the lenders conduct their own due diligence, and would not approve financing until all permits were in place, with all mitigation costs factored in the final project cost.

This, and other revisions to the tentative permit, will be further addressed, beginning Thursday morning at 9:00 AM PDT. If the NPDES permit is approved, at that meeting, it will be the final hearing before the Coastal Commission begins to formally consider the final permit: the Coastal Development Permit.

California

State considers direct reuse criteria

In December 2016, California State Water Resources Control Board released a report entitled "Investigation on the Feasibility of Developing Uniform Recycling Criteria for Direct Potable Reuse". However, before the direct potable reuse (DPR) criteria could be adopted, it was necessary to address the recommended milestones and metrics necessary for its successful implementation, as well as the non-treatment barriers for achieving reliability.

Those issues were addressed in a March 2021 report entitled "A Proposed Framework of Regulating Direct Potable Reuse in California, Addendum". Last week, that report was reviewed and discussed in a webinar hosted by WateReuse California, and which included an overview of the recommendations presented by Trussell Technologies' Shane Trussell. Some of the specific changes noted by Dr Trussell were:

- The addition of ozone and biological activated carbon (BAC) pretreatment ahead of RO
- TOC monitoring every 5 minutes, with triggers for 24-hour, 5-day, peak and shutdown levels
- New feedwater, post-AOP and finished water sampling regimes, with post-RO TOC, nitrate and nitrite monitoring
- Attenuation of elevated concentrations by a factor of ten through mixing
- Increased rigor in risk assessment, independent auditing and surveillance
- Define a procedure to establish the log removal value (LRV) credit for each process
- Design LRV values of 20-14-15 for viruses, *Giardia* and *Cryptosporidium* (respectively), with operation below 20-14-15 LRV limited to a duration of less than 24 hours, and immediate shutdown if any LRV decreased to 16-10-11

The report also clarified the definitions of key terms and provided required response times to divert flows for acute and chronic finished water quality variances. It also addressed administrative matters such as the number and qualifications of operations staff and report preparations.

In its closing comments, the report notes that DPR has great potential, "But it presents very real scientific and technical challenges that must be addressed to ensure the public's health is reliably protected at all times. Given the various possible types of DPR projects, a common framework will be needed to avoid discontinuities in the risk assessment/ risk management approach as progressively more difficult conditions are addressed."

This report is the culmination of work on DPR that started in 2010. It presents a thorough assessment of the challenges, and takes an important step towards addressing them. The draft regulations are now open for public comment, and the final regulations are due to be complete by the end of 2023.

To view last week's 2-hour Zoom presentation and discussion, visit: https://tinyurl.com/53eftb9h.

Technology

Selecting an appropriate unit of measure

In a recent GWI interview, ACWA Power's Thomas Altmann stressed the importance of defining RO feedwater quality, "However, it is often given a low priority. In an RFP, just one page out of 300 covers seawater [quality]." Altmann also observed that there is still an insufficient understanding around the metrics used to gauge water quality and that "if you ask ten people what the conversion factor is [to convert] from seawater conductivity to total dissolved solids, you will probably get eight or ten different numbers."

He is, of course, correct, and referring to the fact that in most cases, total dissolved solids (TDS) are actually derived from an electrical conductivity (EC) measurement that is then converted to TDS, rather than the more accurate gravimetric method. Whereas the gravimetric method must be done in a laboratory, and involves evaporating the water from a sample and measuring the remaining residue mass, the EC can be measured easily and inexpensively, in situ, using conductivity probes.

However, because the EC/TDS correlation is influenced by the ionic species, ionic strengths and temperature, the relationship is not linear. Typical EC/TDS correlations have been published for various waters, but the ratios are not easily defined, and the research on the subject continues to grow. A 2017 study proposed the following correlations:

EC @ 25°C	μS/cm	Ratio TDS/EC (k)
Natural water	500 – 3000	0.55 – 0.75
Distillate	1 – 10	0.5
Fresh water	300 – 800	0.55
Seawater	45,000 – 60,000	0.7
Brine	65,000 – 85,000	0.75

Correlation of EC and TDS for various waters (A.Rusydi, 2017)

Unfortunately, when working with waters that have highly variable ionic contents, such as produced waters and groundwater brines, there are no readily available correlation factor databases. It's therefore important to develop the correlations as a first step of dealing with such brines. And, since conductivity is affected by temperature (warmer water = higher conductivity), it is extrapolated to a standard temperature of 25°C, so it's necessary to ensure that conductivity meters are capable of temperature correction and are accurately calibrated.

There was a time when having very accurate data was less crucial, and operators tended to pick a design TDS value, often based on historical information and flow rate, before turning the plant on, and letting it run. However, as plants become bigger and more complex, the stakes increase. Relatively minor temperature changes—and the resulting energy consumption and membrane performance—are more impactful when a plant is producing hundreds of thousands of cubic meters of water per day.

As plants grow more reliant on machine learning and artificial intelligence (AI), it is vital that their operational algorithms are fed accurate data.

Relatively small changes in water temperature impact membrane performance. Most desalters are familiar with the rule-of-thumb that a 1°C temperature change has a 3% impact on membrane performance. It is essential that the baseline salinity and temperature data used is accurate, and the plant is operated accordingly.

So many different units – For relatively dilute solutions such as potable, brackish or seawater, it's usually impractical to describe the concentration of salts and other dissolved solids as percentages. A more meaningful method is to report concentrations in a weight/volume relationship, and for desalination and other water treatment applications, the most convenient and widely accepted weight/volume measurement is "milligrams per liter" (mg/L).

Another common method of reporting concentrations is "parts per million" (ppm), a weight/weight ratio. Because one liter of water weighs 1,000,000 million grams at 4°C, one milligram per liter was considered to be equal to one ppm.

By definition, 'ppm' isn't 'mg/L' but really 'mg/kg', and 'ppt' isn't 'g/L' but rather, 'g/kg'. For drinking water applications, the differences are minor, so people are usually comfortable using 'ppm' and 'mg/L' interchangeably.

WDR asked GHD's Kishor Nayar which units he preferred to use, and why?

"Because I started my career working in seawater, I'm most comfortable with 'g/kg', where the reference salinity for seawater is 35 g/kg, because you don't have to worry about density changes affecting concentration when you're modeling desalination processes. Those in the water industry generally deal with room temperature water at a constant density where it's easier to use 'g/L' or 'mg/L'," explained Dr Nayar, referring to the following table:

Water Type	Temperature	Density	Δ vs Pure Water
Pure water	4°C	1,000 kg/m³	n/a
Pure water	25°C	997 kg/m³	–0.3%
Typical Seawater	25°C	35 g/kg or ~1,023 kg/m³	+2.36%
SWRO concentrate	25°C	70 g/kg or ~1,050 kg/m³	+5%
Concentrated brine	25°C	120 g/kg or ~1,088 kg/m³	+9%

Salinity-based Water Density Comparisons

"When I'm in a brine concentration or ZLD mode, I usually use 'g/kg' or 'g/L' because it's easier to visualize 200 g/kg than 200,000 mg/L. But you must be careful with high salinities, where the differences between the two increase. For example, 200 g/L of seawater is 180 g/kg, a detail that matters a lot when costs are considered.

"When working with potable water, 'mg/L' makes the most sense. For example, 350-500 mg/L looks better than 0.35-0.5 g/L, and it's easier to look at sub-parameters such as hardness or sodium, which will be even smaller quantities.

"The 'mg/L' approach also makes sense for low-salinity groundwater or surface waters tested in US laboratories, where the results are reported in 'mg/L. EPA standards are usually focused on low salinity waters, so they're almost always reported in 'mg/L', and thus, most people are used to seeing 'mg/L'."

Moles and molarity – Researchers and chemists often prefer to work with a solution's molar concentration, or molarity, which is a measure of the concentration of a specific chemical species in a solution. Molarity is usually stated in terms of moles per liter (mol/L), and a 1 mol/L solution is referred to as a 1 molar (1 *M*) solution, using an italicized *M*, to differentiate it from mega (M). The use of molarity is particularly helpful in stoichiometry calculations, in calculating dilutions and titrations. Since desal-related chemistry usually deals with sodium chloride (salt, or NaCl) solutions, it is helpful to know that NaCl has a formula atomic weight of 58.44 g/mol; therefore, a 0.5 mol/L solution of NaCl contains 29.22 g of salt in one liter (e.g. 0.5 mol/L * 58.44 g/mol = 29.22 g).

Speaking of units of measure…

Although the most frequently used and universally understood unit used to measure water volume is the cubic meter (m^3), Australasian countries often use megaliter (ML), which equals one million liters, or one thousand cubic meters. Americans (still) usually measure water volume using the *US gallon*, with plant capacities described in terms of *million gallons per day* (MGD).

However, many Western US states use *acre-foot* (ac-ft, or AF) to report large water volumes. The unit has its origins in agricultural applications, where it represents the volume of water that would cover a one-acre (0.4 hectare) area to a depth of one foot. Some Middle Eastern countries and many Caribbean islands quantify desal plant output in *million Imperial gallons per day* (MiGD), where one Imperial gallon equals 1.2 US gallons.

One's understanding of the most common volumetric units can become muddled when they are expressed on an annual, rather than a daily or hourly basis, e.g. *million cubic meters per year* (MCM/yr), *acre-feet/year* (AFY) or *gigaliters/year* (GY).

New readers may wonder about the seemingly inconsistent use of units of measure in stories. Nothing illustrates the local complexion of the desal markets more than the units of measurement used to measure a facility's production capacity or the currency used to report its cost. Therefore, the primary units and currencies used in *WDR* articles are those either used by the facility itself, or those commonly used in the region in which a facility is located.

In most articles, a secondary unit is included parenthetically, as a reference for those readers who may be unfamiliar with the primary unit. And, when water prices are reported, they are almost always stated in both $/$m^3$ and $/kgal.

In brief

The European Desalination Society (EDS) will hold a webinar entitled ***Brines: From Waste to Value*** on Thursday, 29 April at 15:00 to 17:00 GMT. The webinar is part of the EDS Desalination And Water Reuse Webinar Series 2021. The program will include a discussion moderated by University of Bremen Professor Heike Glade, and a call for SWRO brine samples by Miriam Balaban. For more information, and to register, visit https://tinyurl.com/yuzwuzdw.

Acciona, and Besex, its EPC partner, have completed the construction of the 182,000 m^3/d (48 MD) **Jebel Ali SWRO Plant** for Dubai Electricity & Water Authority (DEWA). The AED871 million ($237 million) plant, below, is operating at 100% of capacity, and has begun to supply water to the city's network. ILF was the project engineer. The plant construction reportedly surpassed 6.5 million man-hours without a lost-time injury.

zNano WaterTech, a California based start-up, has rebranded and reincorporated itself as **zNano Membranes** to focus on selling its bioinspired nanoceramic specialty membrane element for difficult-to-treat wastewaters. Its flagship product, the zUF50 ultrafiltration membrane—which operates over a pH range of 1-12, and at operating temperatures of up to 80°C (176°F)—is currently being used in the oil and gas market and is available commercially.

People

Ali Kalantar has been appointed as Nanostone Water's vice president of desalination. Formerly the CEO of Doosan Heavy Industries' Water Group, he has 35 years of desal experience, and is based in Dubai, UAE. He may be contacted at Ali.Kalantar@nanostone.com.

Nanostone Water has also announced the appointment of **Kelly Lange-Haider** as the company's applications director. Formerly with DuPont (Dow) Water, and CH2M Hill, she has over 35 years in the water industry, which include 15 years of membrane experience. She is based in Minneapolis-St Paul, Minnesota, and may be contacted at kelly.lange-haider@nanostone.com.

Tom Mollenkopf has been named president of the International Water Association (IWA). He has been active in the water sector for 25 years, is the former CEO of the Australian Water Association and has worked extensively for WaterAid Australia. He is based near Melbourne, Australia.