

WATER DESALINATION REPORT

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Israel

ASHDOD WOES CONTINUE

Fueled by ongoing operational problems, the dispute between Mekorot, the national water agency, and IVM, the Sadyt/Minrav Holdings partnership that built and operates the Ashdod SWRO plant, seems to be growing. According to a source familiar with the situation, the disagreement focuses on the plant's rated production capacity, and has been exacerbated by a host of operating problems that each party blames on the other.

The plant passed its 28-day completion test on 26 December 2015, based on a nominal, or nameplate production capacity of 13,300 m³/h (84.3 MGD), and a maximum production of 16,000 m³/h (101.5 MGD). However, Mekorot is insistent that the plant has a nominal production capacity of 16,000 m³/h, and is therefore operating at only 80-85 percent of its required capacity due to operational deficiencies.

Another source told *WDR* that the deficiencies include a concern over water quality, excessive biofouling, the intake pumping system's inability to deliver the maximum required capacity, and the wastewater treatment system's inability to treat all the pretreatment system backwash water, which is causing regulatory challenges.

IVM is understood to agree that the plant is operating at 80-85 percent of the maximum capacity but says it is still operated at the contracted nameplate capacity. IVM believes that Mekorot is trying to get it to pay for upgrading the plant to a nominal capacity of 16,000 m³/h, as well as the repairs associated with the problems Mekorot itself caused through improper operation after banishing IVM from the site.

In late June, Mekorot hired IDE Technologies to conduct an audit of the Ashdod plant to determine the extent of the corrective actions that are required to enable the plant to operate at the required capacity. Although the audit has been completed, the final report will not be submitted until this week. However, *Globes* has reported that the cost ranges between NIS 187-349 million (\$51.5-\$96.3 million).

Mekorot has since filed an NIS 705 million (\$194.5 million) lawsuit against IVM and an arbitration process is ongoing. IVM apparently has taken some solace in the fact that until now, they have not had to make any warranty payments as a result of the claims made.

Mekorot is expected to open a tender process to sell off the plant. Because of its involvement in the audit, IDE may be unable to participate, however the partners on the other Israeli desal projects have expressed an interest in the facility. IVM Holdings has previously told *WDR* that it was also interested in buying the plant, although because of the current legal issues with Mekorot, it would not comment further at this time.

The state is said to be anxious to clear up this matter, due to a potentially severe water crisis resulting from four consecutive drought years.

Editor's note: Israel's large-scale SWRO plants are designed with hourly peak production capacities that are much higher than their nameplate, or nominal, capacities would indicate. This is due to the seasonal variations in water demand, and the hourly, seasonal and day-of-the-week variations in electricity tariffs (TAOZ). The combination of these variables allows an operator to increase production when more water is needed and/or when electricity rates are lowest.

Building a desal plant based on a load and time variable electricity tariff is more expensive than building one that operates at a flat capacity because there are many hours when the plant's production capacity is only partially utilized. Plant production can be reduced dramatically, twice a day and by up to 60 percent within a one-half hour time period. This requires changing recovery ratios, feed flow rates, pressures, fluxes, chemical dosing and more.

Company News

WORLD'S LARGEST DESIGN FIRM CROWNED

Last week, Texas-based Jacobs Engineering confirmed that it would acquire Colorado-based CH2M in a \$3.27 billion deal that will create a company with combined revenues of \$15.1 billion and a payroll that includes 74,000 employees. In addition to \$2.85 billion of equity, which will be paid 60 percent in cash and 40 percent in Jacobs' stock, the deal includes \$0.42 billion of debt.

In a presentation to investors, Jacobs CEO, said "We're not going down the path of being a construction firm. Design is key and we will be the largest design firm in the world."

WaterReuse Symposium

The 32nd Annual WaterReuse Symposium will be held on 10-12 September in Phoenix, Arizona. The Symposium will feature more than 100 presentations, panel discussions and workshops. It will also include a Sunday afternoon Reuse Bootcamp featuring an A to Z overview of all things reuse. For information, visit <https://tinyurl.com/z84gl4c>

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In its analysis of the deal, *ENR* said, “CH2M may have sealed its own fate several years ago with a shift into fixed-price contracts that exposed the company to new risks. The problem projects, together with the company’s significant debt, drained cash for several years and forced CH2M to lay off employees, cut costs and exit fixed-price EPC work and design-build transportation infrastructure.”

Jacobs has formed an Integration Management Office (IMO) to oversee the integration of the two companies, and has hired an independent consulting firm to support it. At the close of the transaction, which is estimated to take place by December, Jacobs’ board will be expanded to include an additional director from CH2M.

The use of the CH2M name in branding has not been decided.

Company News

TINY BUBBLES

A California startup has come a long way in a very short time. Founded in 2016, Los Angeles-based Moleaer has closed its first seed financing round earlier this year and has successfully installed its XTB Nanobubble Generator in over a dozen projects across a diverse range of applications in various water and wastewater markets.

“Our XTB nanobubble generator is ideal for enhancing or retrofitting existing biological treatment processes, including MBR systems. It is cost effective, and because it sits outside the body of water, it can usually be installed in under a few hours,” said company CEO Nick Dyer, the former vice president of sales and marketing for LG Chem-NanoH2O.

“Moleaer is Latin for ‘tiny air’, and our generator produces nanobubbles that are less than 100nm in diameter, with concentrations of over 100 million bubbles per milliliter. Small bubbles are less buoyant and remain suspended in water much longer. This increases oxygen transfer efficiencies by 10 times compared to best-in-class fine bubble diffusers or other aeration methods used in wastewater treatment systems.”

In addition to wastewater treatment systems, the company has also retrofit several DAF installations to improve flotation. Moleaer is currently retrofitting its first MBR with its XTB generator, and has additional MBR retrofits planned in food and beverage applications.

Nanobubbles are a new category within the aeration and gas transfer market. Although their efficacy in certain applications is still under development, their unique properties should present numerous opportunities for existing water and wastewater processes.

Technology

FO DRAW SOLUTION READY FOR FIELD PILOTING

In 2013, *WDR* reviewed a proprietary draw solution for forward osmosis systems following its proof-of-concept testing at Queen’s University in Kingston, Ontario. The nascent technology had just been spun off from the University to form Toronto-based Forward Water Technologies. The company was in the process of developing the chemistry platform, optimizing its performance and benchmarking the technology against other draw solutions before proceeding with its commercialization.

Last week, Howie Honeyman told *WDR* that the two-phase draw solution is now ready to move from the laboratory and engineering skids into the field. “At the time of the earlier story, the IP [intellectual property] was not yet in place, so we described the draw solution as using a ‘switchable salt’ that changed from a gaseous form to a bicarbonate for regeneration and recovery. We can now confirm that we employ a trimethylamine-carbon dioxide [TMA-CO₂].

“The TMA has a comparable volatility to ammonia, which is used in some FO systems, but it has a lower reverse permeation which improves TMA recovery and lowers energy requirements by as much as 40 percent, which leverages low-grade heat sources often available in industrial facilities,” said Honeyman, who added that the TMA-CO₂’s lower energy consumption and lower reverse permeation were confirmed in a 2015 *Journal of Membrane Science* paper by Yale’s Menachem Elimelech.

The same paper also identified one of the solution’s biggest challenges—its low odor threshold—something that the company has been able to successfully address in the system design.

Acknowledging that FO has not been found to be cost-effective when compared to RO in seawater desal applications, Honeyman told *WDR* that there are many industrial applications where minerals or saline wastewater must be concentrated up to saturation, noting, “Our approach has a lower capital cost than evaporative techniques, and can use solar thermal to further reduce costs. It is also scalable for use in individual units of over 500 m³/d [132,100 gpd]”

The company is now in the process of identifying a strategic partner interested in conducting a 15-30 m³/d (4,000-8,000 gpd) pilot test of the technology, and is also seeking investors willing to support their efforts with up to \$3 million in financing.

WDR has increased this technology’s CDR rating from its original to 6.3.

Technology

DUBIOUS DESAL IDEAS

Three weeks ago, in a story titled “The Best, Least Successful Desal Ideas”, this newspaper highlighted seven ideas that, despite having technical merit, did not (yet) prove commercially successful. That list called to mind several other dubious ideas that *WDR* has covered and which had little or no merit, even though some of the ideas involved, or were endorsed by, highly successful entrepreneurs.

The Slingshot – Besides inventing helpful medical devices, Dean Kamen cemented his legacy as a clever inventor by developing the Segway personal transporter. Unfortunately, the Slingshot—a 1,000 L/d (264 gpd) vapor compression distiller introduced in 2008—was not quite as ingenious.

Kamen’s promotional acumen got him spots on several network TV shows, where he demonstrated the ability to desalt water, in one case, after the show’s host added a bag of potato chips to the feedwater. He boasted that the unit’s energy consumption was half that of a hairdryer, which *WDR* calculated to be about 24 kWh/m³ (91 kWh/kgal).

Kamen lamented that despite approaching the World Bank, the UN, the WHO, the Bill and Melinda Gates Foundation and many other governmental agencies, he could not find someone to mass-produce and distribute to them to the poorest countries. *WDR* suspects it had something to do with the fact that its energy consumption appears to be 8 times higher than a SWRO system.

He called it a 21st century solution to a 21st century problem, but the process and performance more closely resemble a slickly packaged 1970s vintage single-effect distiller. Not an unworkable idea, just an old, energy-inefficient idea.

The Rainmaker – In 2012, Manoj Bhargava, the billionaire entrepreneur-inventor of the *5-hour Energy* drink—the small, 1.93-ounce (57mL) red-bottled drink that sells for \$3—said that he was developing the Rainmaker, a machine that would desalt water at a cost that was 80 percent lower than RO. When *WDR* reached out to him for comment, he would only say that he wasn’t ready to talk.

Three years later, he made a documentary spotlighting the Rainmaker as “an attempt to deliver innovations that can directly impact humanity.”

As it turned out, the Rainmaker was a 24,000 gpd (92 m³/d) MVC evaporator. He proposed putting an estimated 500 of these energy-guzzling units on a barge, suggesting, “If you had 100 or 200 barges off California’s coast, all the [water] short fall of southern California would be covered. If you have thousands of barges throughout the world, we can address ridiculous amounts of people.”

If you’re able to become a billionaire by selling a caffeinated, vitamin-filled drink for \$200,000/kgal (\$52,600/m³), you would probably believe anything is possible.

Silicon Valley Brain Trust – In early 2014, a California newspaper writer bemoaned the regional drought, and used his platform to propose that billionaire investors Peter Thiel (PayPal), Elon Musk (Tesla Motors/SpaceX), Mark Zuckerberg (Facebook) and Don Mattrick (Microsoft/Zynga) “need to beat the drought with desalination”. He suggested that they use their “brilliant tech minds to swiftly solve our temporary water problem.”

The writer thought that nuclear power should be used to generate all the electricity needed for those new desalination plants, apparently forgetting that all but one of California’s nuclear plants had been shut down. By June 2016, an agreement was reached to close the state’s last remaining nuclear plant.

Creative thinking should never be discouraged, but pundits shouldn’t be seduced by the fact that because someone well known has achieved success in one field, it will be possible for them have the same (or any) impact in another highly technical and totally disparate field.

Q-Cell Wave Form Separation – At a 2010 water conference, California-based Quantaic’s co-founder predicted that his company would have revenues of \$223 million in five years based on the success of its new technology, which was described as “being similar to a mechanical vapor compression [evaporator]”. The concept was so secret that its inventor was only identified as “Joel M.”

The company would not provide a flow diagram or energy/heat balance, and would only tell *WDR*, “The less people know about how it works at this point, the better. When we have a stronger balance sheet, more technical disclosure might become available. Serious business inquiries under non-disclosure would consider different circumstances.”

Although its energy requirements were supposedly similar, the process was claimed to have a CapEx that was 50 percent lower than SWRO, a process their website criticized by saying, “A reverse osmosis membrane has been sold as a semi-permeable material, but it is actually a microfilter. It is an outdated technology.”

Quantaic’s co-founder has since joined a company that sells software to schools, and Joel M. could not be located.

Electromagnetic Frequency Technology – In late 2011, California’s Itonis Holdings acquired Paramount Discoveries’ electromagnetic frequency technology (EMFT), which it claimed had the ability to stimulate magnetism in sodium chloride so that it could be easily removed from water. The

publicly listed company blanketed the industry with press releases, which said it was well-positioned to be a player in the \$95 billion desal market.

Using permanent magnets and a wave form generator, the company maintained that it could apply a “rare frequency”—which it said it discovered despite overwhelming scientific odds—to each element or mineral to sustain its “magnetic moment”, so that it could control its removal to desalt water.

Nothing has been heard of the technology in the last six years, and according to the Itonis website, the company is now highly focused on bringing homeopathic pharmaceutical products to the market.

Technology

A FOUNTAIN OF FRESHWATER FROM THE SEA

A California water start-up has developed a new approach to a previously attempted idea: desalting water deep beneath the sea. This past April, on its second attempt, San Francisco-based Naiad Physics Corp was able to produce seven gallons (26.5L) of potable quality water during a test conducted nine miles (14.4km) off the California coast at a depth of 2,200 feet (670m). The system was outfitted with off-the-shelf, 4-inch diameter elements and used no electricity.

Employing a basic rig to demonstrate the physics of their approach, founders Esteban Guerrero and Chris Hood successfully harnessed the hydrostatic pressure deep below the surface to drive RO membrane separation. According to CEO Chris Hood, their WaterHarvest™, system differs from other submarine RO approaches because of a patent-pending method of dealing with concentration polarization, and the fact that it is a purely mechanical system that does not require electricity.

“Desalination at depth liberates the process from common onshore constraints,” said Hood. “First, with naturally high ambient pressure, we are able to eliminate a lot of hardware. This reduces the cost of additional membrane area, so that it is possible to operate at a low-flux design that eliminates marine life impingement and entrainment and simplifies concentrate disposal.

“The biggest economic challenge we face is the cost to convey product water to shore; a problem we address by using renewable energy. We have identified nearly 100 locations

around the world where there is sufficiently deep water that is close enough to shore that a system could provide a 20-50 percent lower total cost of water than a comparably sized onshore system,” said Hood

He said that a commercial system is envisioned as being made up of multiple 20,000 gpd (57 m³/d) modules, and the company is currently seeking a \$2.5 million investment to build and operate a full-scale demonstration module.

Editor’s note: As Hood correctly mentions, there have been many attempts to use the natural pressure deep beneath the ocean to drive the RO process, some of which are almost as old as the RO membrane itself. In most cases, the deal-killer for depth-driven systems has almost always been the cost to convey product water to shore, something that Naiad Physics believes that it has adequately addressed. WDR’s CDR rating for this technology is 3.7.

IN BRIEF

Saudi Arabia’s **Water & Electricity LLC (WEC)** has issued a request for expressions of interest (EOI) from project developers for a 600,000 m³/d (158.5 MGD) SWRO project at Rabigh to serve the cities Jeddah and Mecca. The project will be structured as an independent water project under a 25-year BOO contract. EOIs are due on 21 August, and WEC expects to issue RFQs to shortlisted contractors by the year’s end. The project should be online by 2020.

PEOPLE

Hydranautics has announced the appointment of product managers for its Process Separation and UF/MF products:

- **Boon Ikekubo** will manage the HYDRASub (MBR solutions) product line. He is based in Shiga, Japan, and may be contacted at boon.ikekubo@nitto.com.
- **Umang Yagnik** will be responsible for the HYDRACapMax UF products and will continue as the regional account executive for Canada. Based in Vancouver, Canada, he may be contacted at umang.yagnik@nitto.com.
- **Jayesh Shah**, the firm’s global marketing manager and RO/NF product manager, will now also manage the Process Separation product line. He is based in Oceanside, California, and may be contacted at jayesh.shah@nitto.com.

