

WATER DESALINATION REPORT

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Saudi Arabia

MARAFIQ MAKES FIRST WATER

Construction on Marafiq's Jubail independent water and power project (IWPP) is well underway, and all 27 MED systems are in place. The first units began making water on 4 June and some are now dispatching water to the distribution system. The entire 800,000 m³/d (211.4 MGD) desalination plant and 2,745 MW power plant are on track for full completion in May 2010.



Marafiq MEDs with Steam and Vapor Ducting

When the \$3.4 billion project reached financial closure in July 2007, it was the largest IWPP in the world and the largest project finance deal signed in the power sector. It is also the world's largest MED installation.

The capital cost of the MEDs was \$945 million and the water tariff has been reported at \$0.827/m³ (\$3.13/kgal). Suez Energy and ACWA Power developed the project, and Jubail Water & Power Company will own the facility.

Aruba

12 BIDDERS ATTEND SITE VISIT

Thirteen bidders have been invited to participate in an indicative tender for a new SWRO system by Water-En Energiebedrijf Aruba NV (WEB), the company responsible for the island's water and power supply. Twelve of the thirteen potential bidders who participated in the non-obligatory site visit last week were Acciona Agua, Aqua-Chem, Aquatech, Befesa, Biwater, Consolidated Water, Doosan, GE, ITT, Seven Seas, Severn Trent and Veolia. IDE Technologies did not attend.

The site visit is part of the tender's first phase, which will add 24,000 m³/d (6.3 MGD) of desalination capacity at the existing Balashi site, which currently has six 6,000 m³/d (1.6 MGD) and one 8,000 m³/d (2.1 MGD) SWRO units. WEB intends to replace four of the existing MSF units with the new SWRO system.

Since an availability and reliability analysis will be performed, WEB will consider alternative proposals that provide the required capacity and acceptable reliability and availability values when compared to the MSF option, and in consideration of any NPV evaluation differences in the proposals.

The new SWRO unit will be located adjacent to the existing unit commissioned by GE Water in March 2008. The existing open shallow lagoon intake and outfall pipeline will be employed, and the plant will produce potable water with a total dissolved solids (TDS) concentration of less than 30 mg/L at a target energy consumption of 3.75 kWh/m³ (14.2 kWh/kgal).

WEB intends to develop the project on a fast-track basis with the contract to be executed by a general contractor on a design-build/turn-key basis, in accordance with FIDIC conditions. Tendering has been split into two phases to streamline the process. The first phase will include an indicative tender from which no more than four bidders will be shortlisted, with a second-round tender subsequently submitted to the shortlisted bidders.

Indicative tenders are due on 7 September. Final tender documents will be issued in mid-October, with tenders due in late November. A January 2010 contract award is planned with final commissioning and plant hand-over to occur in March 2011.

California

BOARD VOTES "YES" FOR DESAL

In a 4 to 0 vote, Marin Municipal Water District's (MMWD) board of directors approved a 5 MGD (18,925 m³/d) desalination facility that is expandable to 15 MGD (56,775 m³/d). The vote follows the board's previous actions to invest in an aggressive water conservation program, improve its reservoir system, expand the recycled water distribution system and improve the reliability of its imported water supply.

MMWD has been studying desalination since 1990 and initiated work on an environmental impact report (EIR) in 2001. A 2005-2006 pilot study demonstrated various technical aspects of the project including seawater intake, pretreatment and SWRO arrangements, evaluated potential environmental impacts and established budgetary pricing.

Based on the pilot study and the accompanying environmental study results, it is expected that the plant will employ an offshore passive screen intake, MF/UF pretreatment and a concentrate discharge system that would blend RO concentrate with wastewater effluent from the Central Marin Sanitation Agency.

The plant is planned to be located on a seven-acre (2.7 ha) shoreline site in San Rafael and could cost \$105 million. MMWD will now initiate the permitting process, and a plant could be operational by 2014.

Company News

ROSA ON STEROIDS

At first glance, the similarities between rocket propulsion systems and seawater reverse osmosis (SWRO) systems are not immediately apparent. But Pratt & Whitney Rocketdyne (PWR) has looked beyond the obvious and recognized that both systems share a very similar goal: the pursuit of maximum operational efficiency of a predominantly hydraulic system. The company has been using physics-based models of complex systems in both rocket and jet engines for over 50 years and is now applying those same tools to design and operate SWRO systems.

When PWR engineers began looking into SWRO system design, they noticed that most initial designs were developed using proprietary software developed by RO membrane manufacturers based on a typical set of design conditions. They also saw that energy recovery equipment suppliers independently modeled their energy recovery systems based on their own proprietary software.

Using modular modeling architecture built for analyzing thermal/hydraulic propulsion systems, PWR developed a physics-based model using a library of modules that can run numerous design points while simultaneously varying feed water characteristics, flow capacity, recovery and permeate quality requirements. The model quickly and accurately solves numerous implicit equations simultaneously.

Rather than using arithmetic or logarithmic averages across an entire RO pressure vessel, the thermodynamic state at the entrance and exit of each element is evaluated, and ionic species are tracked. The model not only has the ability to create a design point for a given configuration, it can perform a variance analysis to determine the 'maximum design condition'. It can also perform steady state and transient off-

design simulations and can be used for anomaly resolution.

Unlike a rocket engine life cycle analysis that is measured in minutes, the model would allow the SWRO evaluation to be projected over years of operation, and users could collapse 30 years of operating results into a few minutes.

Leveraging a Universal Configuration Template with a single input file, a designer can compare different plant configurations and component selections as part of the complete SWRO system, rather than in isolation. Once a preliminary design has been selected, the designer is able to optimize it with further iterations and trades.

Plants designed with this tool can also use it as a real-time advisor for plant operation with the ability to identify and flag plant performance outside normal boundary limits and recommend maintenance action based on a probabilistic failure analysis. Existing plant configurations can also be easily inputted to create this capability. The program is currently functional with sodium and chloride, with work underway to allow tracking of up to 20 ionic species and a routine to calculate chemical equilibrium.

Preliminary results indicate that this modeling tool could lead to the development of an optimal design and operating approach that may improve current SWRO system energy usage by 5 to 10 percent.

According to information provided to *WDR*, "When chemical equilibrium solutions are fully implemented, the modeling architecture will be pushed to some software limits." In other words, the number of simultaneous equations that need to be resolved to mathematically optimize a SWRO design and its operation is greater than the number required for the design and operation of a state of the art liquid rocket engine.

Who said SWRO isn't rocket science?

Technology

INNOVATION IMPROVES BWRO RECOVERY

Brackish water reverse osmosis (BWRO) systems usually operate at product:concentrate recovery rates of 70 to 80 percent. A system's actual recovery rate depends on a variety of design factors, but it is usually determined by the feedwater's scaling potential. For many inland locations, the cost of concentrate disposal is the fatal flaw that determines a project's economic viability.

Last week, researchers at Israel's Ben Gurion University in Beer Sheba announced a new development that they say could allow BWRO operation at recovery rates up to 95 percent, and result in cost savings of \$0.09/m³ (\$0.34/kgal).

As water permeates the RO membrane, the concentration of salts in the feedwater channel gradually increases, reaching

its highest level near the pressure vessel's final element. As a result of a phenomenon known as *concentration polarization*, the salt concentration at the membrane's surface may be an additional 13 to 20 percent higher than that of the bulk solution. To prevent membrane scaling at these elevated salt levels, the amount of water recovered is usually limited, and a scale-inhibiting chemical may be used.

The system, developed by Jack Gilron and Eli Korin, employs an array of sensors that evaluate feedwater conditions along the length of the RO pressure vessel. Prior to reaching the point at which the sparingly soluble salts could result in membrane scaling, the flow conditions within the pressure vessel are modified by changing the point at which feedwater is introduced.

According to Dr Gilron, the induction time for scaling constituents ranges from a few minutes to tens of hours based on water chemistry and system hydrodynamics, with the results varying between membrane surfaces and suppliers. "It is therefore necessary to determine what is happening in the boundary layer, close to the membrane surface. If we detect conditions that could result in crystal nucleation which could lead to scaling, we can initiate a flow reversal to prevent its occurrence," he told *WDR*.

A second family of patents covers the use of the flow reversal process in conjunction with a contact crystallizer. In this arrangement, the supersaturated concentrate from the BWRO is removed and crystallized before undergoing treatment in a second stage RO system.

Pilot sites in Israel and Jordan will be set up later this year to test the technology. The NATO Science for Peace program and Middle East Desalination Research Center (MEDRC) will fund the 120 m³/d (31,700 GPD) pilot projects.

Gilron also serves as chief technology officer for Rotec, the Israeli startup that will commercialize the technology. The company initially received \$500,000 in financing from Israel's Industry and Trade Ministry and ATI Cleantech Group. In the past few weeks, the state-owned Mekorot Water Company and BDB, a private investment fund, have provided an additional \$200,000 in funding.

Rotec hopes to begin commercial sales in two to three years.

Technology

SWRO ENERGY STUDY UPDATE

In June 2008, Singapore's National Research Foundation (NRF) awarded a S\$4 million (\$2.78 million) grant to Siemens Water Technologies "to develop an innovative seawater desalination technology that is at least 50 percent more energy efficient than existing technologies." The target was defined at 1.5 kWh/m³ (5.68 kWh/kgal) with the system

producing water meeting WHO drinking water guidelines. Last week, *WDR* checked in with Siemens' Tim LeTourneau who is managing the project to check on its status.

LeTourneau said that research began on 1 October, and Siemens' proposed solution uses a combination of electro dialysis (ED) and continuous electrodeionization (CEDI) technology based on a belief that by operating together under optimum conditions, a significant power reduction could be achieved.

"Our early lab results reveal that achieving 1.5 kWh/m³ is technically possible. However, we have a considerable amount of development work to complete before a pilot unit is constructed. Additionally, our lab testing does not represent a commercially viable approach at this time," he said. Although they have not yet met the Singapore Challenge demonstration unit goals, the R&D efforts are still in the early stages, and the project is on schedule.

Editor's note: In April 2006, the Affordable Desalination Collaboration (ADC) reported operating a SWRO pilot unit with a 43 percent recovery at 1.58 kWh/m³ (6.00 kWh/kgal).

IN BRIEF

Algerian Energy Company has awarded Lahmeyer International a \$208,684 contract to review operational issues at the **Hamma Desalination Plant** in Algeria. The 200,000 m³/d (52.8 MGD) SWRO plant was commissioned by GE Water in February 2008 and, although the plant is understood to be meeting quality and quantity requirements, it is reported to have pretreatment problems related to the highly variable seawater quality in the area.

Biwater Group's **Cascal NV** is poised to take its service business into the USA and Caribbean by establishing a USA office and expanding into the desalination sector. According to a strategic vision outlined by Cascal Chairman Adrian White last week, the company will leverage its relationship with **Biwater AEW** in Monrovia, California to minimize expenses. Under the arrangement Biwater would undertake construction risk while Cascal would undertake ownership via equity investment and assumption of long term operating and maintenance contracts.

By a 6 to 0 vote, Carlsbad's Planning Commission approved an addendum to the Environmental Impact Report (EIR) in which Poseidon Resources proposed reconfiguring the plant on the Encina Power Plant site and altering the distribution pipeline route. The approval means that the environmental review process for the 50 MGD (189,250 m³/d) **Carlsbad seawater desal plant** will not have to be reopened.

Santa Cruz County Supervisor Mark Stone has been named to replace Dave Potter on the 12-member **California Coastal Commission**. Potter had been a five-term member

of the Commission, an independent, quasi-judicial state agency responsible for protecting and conserving the State's coastline. Obtaining a Coastal Development Permit from the Commission is one of the key requirements of any California seawater desalination project.

CORRECTION: Last week's graph of the **MF/UF Market Forecast for 2007–2016** was incorrectly labeled. The graph's red curve was incorrectly identified as "Drinking Water" when it should have been "Tertiary Wastewater".

FALL CONFERENCE CALENDAR

26-27 August (Germany): Seminar on Materials and Corrosion in Seawater Desalination in Achern-Fautenbach, Germany. Visit www.DME-eV.de.

13-16 September (USA): 24th WaterReuse Annual Symposium in Seattle, Washington. Visit www.watereuse.org/conferences/symposium/24.

17-18 September (Caribbean): CaribDA will hold a two-day RO operator training program in St. Maarten. For information, contact m.pereira@aqualectra.com.

21-22 September (USA): Water Finance – Investment Opportunities in Washington, DC. Visit www.fralc.com/conference.aspx?cocode=B733.

21-25 September (Australia): 7th IWA World Congress on Water Reclamation Reuse in Brisbane, Australia. Visit www.reuse09.org/.

30 Sept–2 Oct (Italy): WaterMed 2009 will be held in Rome, Italy. Visit www.watermed.com/en/index_wtm.asp.

4-8 October (USA): 2009 International Water Conference will be held in Orlando, Florida. Visit www.eswp.com/water/index.htm.

5-8 October (Singapore): PUB and AWWA will sponsor the Global Conference on Microbial Contaminants in Drinking Water in Singapore. Visit www.waterpathogens2009.com/.

11-13 October (Saudi Arabia): Saudi Water & Power Forum in Jeddah, Saudi Arabia. Visit <http://www.thecwcgroup.com/SWPFIDA.aspx>.

11-14 October (USA): WEFTEC Technical Exhibition and Conference will be held in Orange County, California. Visit www.weftec.org/home.htm.

13-15 October (Germany): Filtech Int'l Conference for Filtration and Separation, Wiesbaden, Germany. Visit <http://cwc.msgfocus.com/q/11bfOrdv0rgQ/wv>.

15-16 October (USA): Alden Labs is sponsoring a seawater desal intake/outfall workshop in El Segundo (Los

Angeles), California. Visit www.aldenlab.com/index.cfm/AldenACRES/Desalination_2009.

25-27 October (USA): SEDA Fall Symposium on Ultrafiltration and Microfiltration in Miami, Florida. Visit <http://www.southeastdesalting.com/>.

4-6 November (USA): SCMA Annual Conference will be held in Fort Worth, Texas. Visit www.scmembrane.org/091028-scmconference.php.

7-12 November (Dubai): IDA World Congress on Desalination and Water Reuse will be held in Dubai, UAE. Visit <http://www.idadubai2009.com/>.

17-19 November (Israel): The 5th International Water Technologies & Environmental Control Exhibition and Conference in Tel Aviv, Israel. Visit www.watec-israel.com/index.php.

14 December (Israel): The Israel Desalination Society will hold its annual conference at Ben Gurion University of the Negev. The event is held in memory of Professor Sidney Loeb. Visit w3.bgu.ac.il/ziwr/documents/11thANNUALIDSCONFERENCE-Program_000.pdf.

PEOPLE

Dow senior research scientist **Bill Mickols** was selected co-recipient of the 2009 Heroes of Chemistry Award from the American Chemical Society. Dr Mickols was recognized for his scientific contributions to RO and desalination for improving membrane flux and salt rejection. He shared the award with **John Cadotte**, who was posthumously recognized for inventing the thin-film composite RO membrane.

Woongjin Chemical's filter division – the group responsible for the CSM brand of RO, NF, UF and MF membrane products – has undergone a restructuring. **Dr Im Hee Seok**, the former RO sales director, has been appointed managing director of the RO division. He will also serve as CEO of Woongjin Chemical America. He can be contacted at heeseoki@wjchemical.co.kr. **Moon Sang-Ok**, former plant superintendent for membrane and filter manufacturing facilities in Gumi, Korea, has been appointed managing director of the cartridge and MF products division. He can be contacted at msosang@wjchemical.co.kr. The company's US branch office in Irvine, California has been incorporated as Woongjin Chemical America, Inc with responsibility for the North and South American markets. **Kenneth Yoon** has been appointed its chief financial officer in addition to his duties as general manager, and can be contacted at kenyoon@wjcsm.com.