VEOLIA

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#7

Insights from Veolia Water Technologies

TECHNOLOGY

Spidflow® Filter, advanced SRWO pre-treatment technology

INDUSTRIAL

Sadara SWRO, a desalination plant for a petrochemical complex

MUNICIPAL

Sur Extension, an addition to the first independent desalination project in Oman

Az Zour North IWPP
A series of first

WATER TECHNOLOGIES

WATER TECHNOLOGIES

SIDEM, subsidiary of Veolia Water Technologies, has over 100 years of experience in desalination dating back to the first thermal desalination units in 1890's.

Backed by a comprehensive experience in large-scale desalination plants, SIDEM recently completed major SWRO projects such as Az-Zour South, Sur extension and Sadara Marafiq.

With a total of 1,000,000 m³/day of SWRO installed capacity over the past 10 years, SIDEM combines proven expertise with unsurpassed innovation, for instance in advanced pre-treatment solutions, to offer technological excellence to its customers.

www.sidem-desalination.com

Resourcing the world

SIDEM VEOLIA

wave
Insights from Veolia Water Technologies

Desalination

An alternative solution to increase available water resources

By 2030, nearly half of the world's population will live in a situation of water stress. Population growth results in skyrocketing water needs for human consumption, agriculture and industry, thereby exacerbating usage conflicts. It is estimated that total water demand will more than double by 2050.

Up until recently, the demand for desalinated water mainly came from public authorities. Now, the industrial sector is increasingly opting for this solution to cover its water needs for production.

AN EXPERT PARTNER

Veolia Water Technologies is the world leader in water treatment technologies. Its network of business units includes renowned desalination expert, SIDEM and Entropie. Recognized as the world leader in large-scale thermal desalination, having pioneered Multiple Effect Distillation (MED), SIDEM has also gained unrivaled expertise in membrane desalination, producing more than one million m^3/day of water using reverse osmosis (RO).

INNOVATION, A STRONG DRIVER

Over the years, Veolia Water Technologies has come up with numerous innovations related to design and processes involved in desalination plants to further optimize treatment facilities and their energy efficiency while keeping costs and environmental impacts down. One of the great advantages Veolia has to ascertain its design and its technologies is its dual competence and experience as designer and builder in addition to operator.

Veolia is now bringing advanced solutions in the fields of pretreatment and post-treatment, such as its Spidflow® Filter and Combined Pressurized Filtration.

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A look at SIDEM,

Veolia's desalination expert

SIDEM is a Veolia Water Technologies business unit dedicated to large desalination projects, providing expert services in design, engineering, procurement, construction, commissioning, operation and maintenance. Headquartered in Paris, SIDEM relies on its regional offices in Abu Dhabi, Saudi Arabia and India to provide local commercial support, engineering services and resources in field activities.

Over 45 years of innovation

A true trailblazer, SIDEM is the oldest desalination company in operation in the world. The foundation of its success and longevity on this highly competitive and technologically challenging market rests on its agility and its capacity to innovate. These two qualities have allowed SIDEM to better manage the risks inherent to its activities and to build a differentiated offer.

Strength is in the people

SIDEM's structure is optimized around desalination projects and the company has developed a lean answer to market constraints. To ensure the level of responsiveness required, all employees work in project mode, under expert supervision, favoring an agile management style with short decision-making processes. Working with SIDEM means relying on responsible, committed and performing people, all qualities which have been forged through years of success in often complicated and demanding situations.

A culture of innovation

Research and development is at the heart of the organization. It too is managed in project mode, associating key people, from engineers to purchasing, whose profile or competencies bring value to the project. SIDEM will also look to experts and scientists outside its organization when necessary. MED technology was born from this methodology. The membrane desalination market is an extremely competitive one, where Veolia is bringing innovative solutions in the fields of pretreatment and post-treatment. The strong potential of the reverse osmosis (RO) market and the many large-scale projects in the Gulf, notably, based on this technology, have enticed SIDEM to invest in R&D on this technology as well.

Compact, reliable and competitive plants

Development outlook for SIDEM is essentially in the Middle East (United Arab Emirates, Saudi Arabia, Bahrain, Qatar, Kuwait and Oman), both for membrane and thermal desalination. The company is gearing to answer in the next 3 years to call for tenders on mega desalination projects (from 200,000 m^3/d to 1,200,000 m^3/d).

Present in the Middle East for over 40 years, SIDEM has proved its competitiveness as well as the performance and longevity of its installations and the quality of its after-sale service. To maintain its success, SIDEM is developing new offers to cater to clients now looking for compact and reliable plants, with less of an environmental impact and able to produce water at a more competitive price point.

To do so, SIDEM is relying on what has always been its strength: cutting-edge R&D, a lean organization, and a unique return of experience from having built and operated so many desalination plants.

SIDEM mobilizes in response to Hurricane Irma

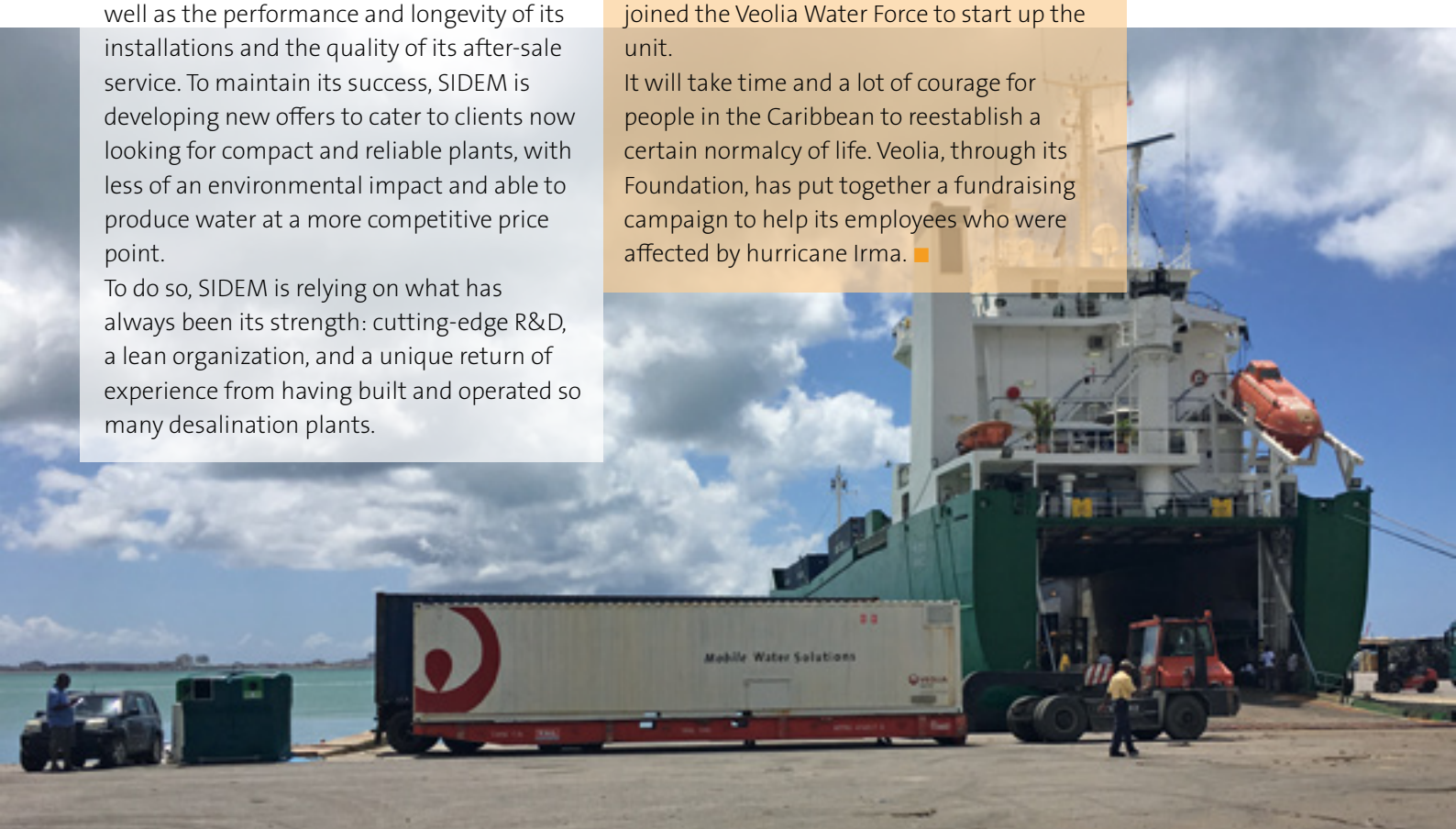
The passage of hurricane Irma is a terrible tragedy for our clients and colleagues in Saint-Martin and Saint-Barthelemy. Damages are outstanding, the hurricane having blown away houses and destroyed vehicles. People have run out of water, power and food, and the insecurity level has been very high.

Without any groundwater on the two islands, SIDEM's desalination plants represent the only means to produce drinking water. The RO part of the plant in Saint-Barthelemy was not as affected and was able to quickly start. The thermal part of the plant coupled with an incinerator is also up and running.

Unfortunately, damage to the RO plant in Saint-Martin was much more significant but the response from SIDEM's local team has been tremendous. Despite their own personal hardship, they have mobilized tirelessly to ensure that the plant can be operational as fast as possible. Electronic parts have been dried or replaced, filters have been retrieved from under crumbled walls and piping has been redone. The plant has been restarted partially.

Drinking water production is complemented by an emergency Mobile Water Services unit which Veolia Water Technologies has sent from Spain. Two SIDEM employees have joined the Veolia Water Force to start up the unit.

It will take time and a lot of courage for people in the Caribbean to reestablish a certain normalcy of life. Veolia, through its Foundation, has put together a fundraising campaign to help its employees who were affected by hurricane Irma. ■



Sadara

A desalination plant for a petrochemical complex

Located 20 km from the Gulf coast in the industrial city of Jubail, Saudi Arabia, the Sadara project is a large-scale petrochemical complex owned by a joint venture of Saudi Aramco and the Dow Chemical Company.

In order to meet the demand for high-quality industrial water of varying degrees of quality, the off-taker, Sadara Chemical Company, receives 148,800 m^3/d (nominal capacity) and up to 178,560 m^3/d (peak capacity) of desalinated water through a water supply agreement with the owner of the plant, Marafiq, the power and water utility company for the industrial cities of Jubail and Yanbu. The plant is owned and operated by Marafiq on a 20-year build-own-operate (BOO) contract, and the engineering, procurement, construction, and commissioning (EPCC) contract, with the addition of 10 years of operation, was awarded to SIDEM in June 2013. The plant was completed in December 2016.

The Sadara Marafiq desalination plant delivers three different levels of permeate quality (for cooling tower make-up, demineralized process water, and utility water) and is designed to deliver a product water capacity ranging from 20 to 100% depending on water demand.

The plant has built-in redundancies to reliably maintain maximum production, and has a reduced footprint, thanks to the removal of intermediate tanks between the ultrafiltration pretreatment, the first reverse osmosis (RO) pass, and the second RO pass. Operation is optimized through an automated and remote-controlled system, which is also interfaced with the Sadara complex's integrated fire and gas, process, and communication system.

Product water storage tank for cooling tower make-up water.

Plant specifications

As the plant is located inland, it is supplied with seawater through Marafiq's Cooling Seawater Supply network to Jubail. Seawater is drawn from the Arabian Gulf through dredged intake channels, passes through coarse trash screens and fine trash screens at the pump stations and is chlorinated before it is pumped into an open-air distribution channel and then with an intermediate

External view of the plant featuring its Veolia Spidflow® DAF pretreatment system.

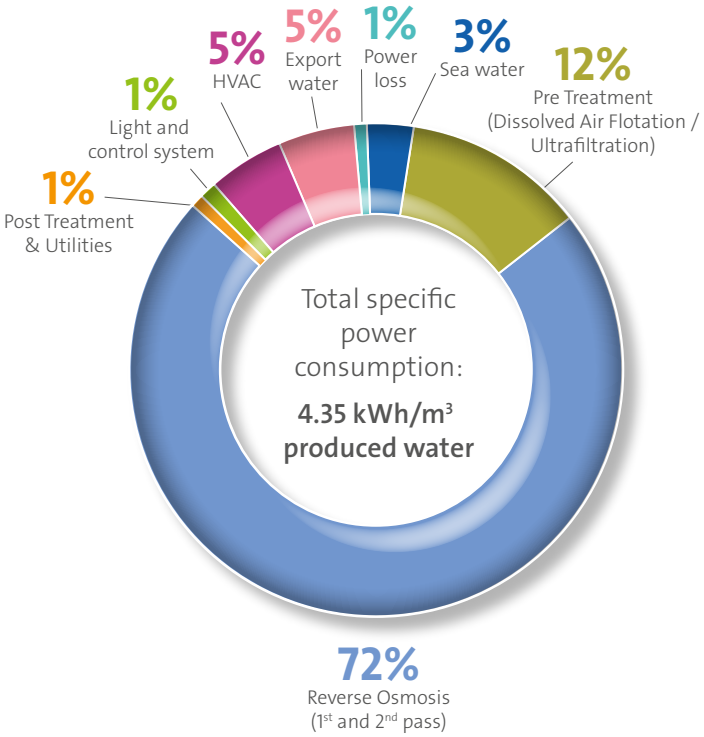
Total capacity	148,800 m³/d (Design capacity 178,560 m³/d)
Date awarded	2013
Date commissioned	2016
Feedwater TDS	<45,000 mg/L
Product recovery	45% 1st Pass, 90% 2nd Pass, ~37% total
Product quality	<40 mg/L (before remineralization)
Feedwater Temperature	15-38 °C
RO Process description	Two-pass
RO Operating pressure	<71 bar
Intake	Marafiq cooling seawater network
Concentrate disposal	Marafiq cooling seawater return network
Number of trains	30 UF, 11 1st pass, 5 2nd pass
Energy consumption	4.35 kWh/m³
ERD	ERI; Isobaric PX
Membrane supplier	Dow
Pretreatment	Spidflow® DAF, strainers, UF
Post-treatment	Multiflow™ lime saturator, CO_2, Cl_2 gas
Storage	149,000 m³ of cooling tower make-up
Equipment supplier	SIDEM (Veolia)
Procurement model	BOO (20 years) between Sadara and Marafiq; EPC+10 years O&M contract between Marafiq and Sidem
Offtaker	Sadara Chemical Company (Dow/Aramco)

boosting station located several kilometers away feeding the plant with underground pipes.

The seawater supply and brine discharge piping infrastructure are pressurized and the plant has been designed with an intermediate seawater open air break tank with a dedicated pumping station for the pre-treatment lines, and with brine break tanks to enable a gravity flow up to the reject some 20 km away.

Brine is discharged through Marafiq's return cooling seawater network which consists of another set of inverted siphons, on-shore discharge channels, the outfall, and a dredged discharge channel. Prior to the RO process, pretreatment consists of Veolia's patented Spidflow® dissolved air flotation, self-cleaning strainers, and ultrafiltration. In order to achieve different quality levels and adhere to stringent quality limits year round, the plant consists of two passes of reverse osmosis, equipped with high-efficiency isobaric pressure exchanger energy recovery devices and fully automated flushing and cleaning-in-place systems to reduce energy consumption to around 4.35 kWh/m³, with the 1st and 2nd pass RO accounting for approximately 3.1 kWh/m³. Post-treatment consists of a clarified saturated lime water plant equipped with Veolia Multiflo® saturators, CO_2 dosing, and disinfection by injection of chlorine gas, before storage in tanks dedicated to each product water quality. ■

Power consumption breakdown at specific load (125,000 m³/d)



SPIDFLOW® Filter

The two-in-one solution for high-rate flotation and media filtration

Improved SWRO membrane protection

Sea Water Reverse Osmosis membranes are highly sensitive and can become fouled if algae, suspended solids, soluble organic molecules and hydrocarbons in feed water are not removed adequately. An effective raw water pre-treatment system upstream of a SWRO system is therefore essential to prevent the risk of membrane clogging and to ensure durability.

In order to deal with the most challenging seawater quality (red tide, high levels of nutrients, suspended solids peaks, etc.) and feed SWRO membranes with consistently good quality of seawater, Veolia Water Technologies has developed and patented Spidflow® Filter.

This unique and compact solution combines into one structure the advantages of two proven pre-treatment processes: high-rate Dissolved Air Flotation (Spidflow®) and high-rate Multimedia Granular Filtration (Filtraflo™ TGV).

Spidflow® Filter, combining the advantages of Spidflow® and Filtraflo™ TGV

Spidflow Filter benefits from all of the best features of these two technologies and presents a lot of advantages compared to other pre-treatment solutions (i.e. DAF+DMF or DAF+UF) such as lower footprint, higher availability, better performance of SWRO membranes and lower capital and operational costs.

Lower footprint

Spidflow Filter's compact design translates to a very limited footprint. The high concentration of floated sludge does not require thickening stage and thus allows CAPEX and OPEX savings. Its modular design makes it an ideal solution for plants of all sizes and an obvious choice for extending existing capacity.

Higher availability

Spidflow Filter boasts a fast reacting solution to variations in raw water quality, enhanced by optimized hydraulics and Veolia's exclusive white water injection nozzles. The frequency of backwashes is reduced thanks to an optimized filtration operation management. The plant's full production capacity is ensured at all times.

Better performance of SWRO membranes

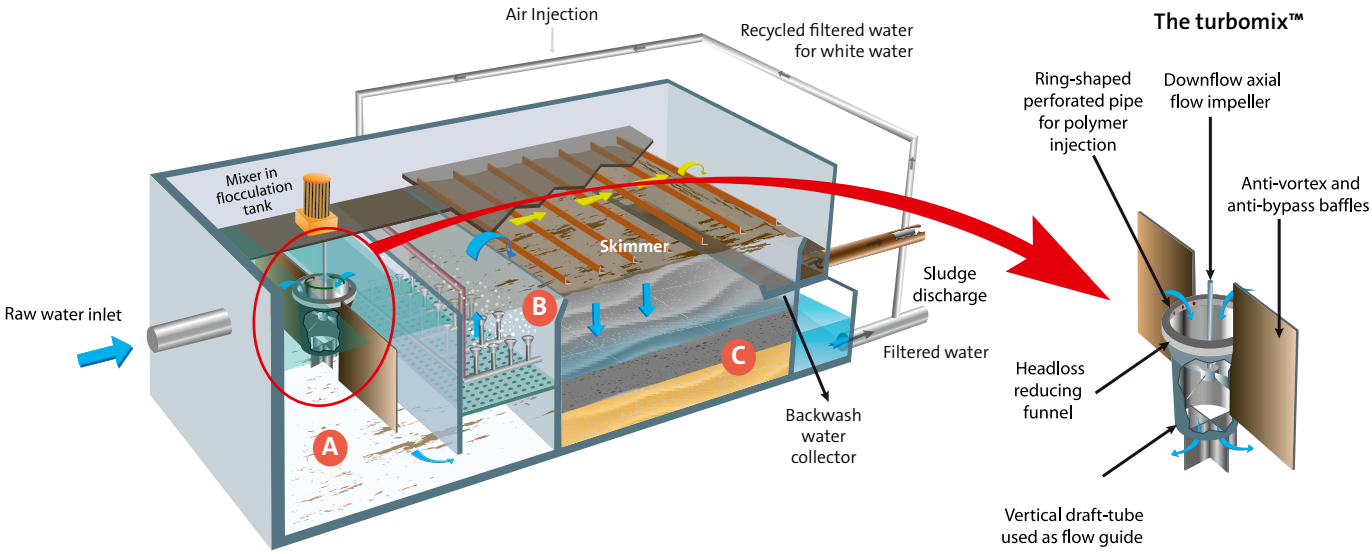
Spidflow® Filter is the ideal pretreatment solution to eliminate fouling and biofoulings agents, removing low density suspended solids, algae, oils and hydrocarbons as well as soluble organic compounds which are detrimental to SWRO membranes.

Lower capital & operational costs

- Compact design leading to lower equipment and construction cost.
- Energy-efficient design.
- Optimisation of chemicals consumption.
- Increases membrane life duration compared to UF pre-treatment.

SWRO: *Sea Water Reverse Osmosis* - ***DAF + DMF:*** *Dissolved Air Flotation + Dual Media Filter* - ***DAF + UF:*** *Dissolved Air Flotation + Ultra Filtration*
CAPEX: *CAPital EXpenditure* - ***OPEX:*** *OPerational EXpenditure.* -

Spidflow® Filter Process



Spidflow® Filter: the best choice for SWRO desalination pretreatment

A Flocculation phase: increases collision probability between particles to increase floc size

- *Turbomix® technology to reduce the footprint of the flocculation tank if required*

B Dissolved Air Flotation: flocs are carried to the surface by very fine and calibrated air bubbles, resulting from extensive R&D work. Flocs are then removed by skimming:

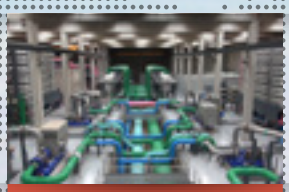
- *Deals successfully with raw seawater quality upsets (turbidity peaks, algal blooms or hydrocarbon contamination)*
- *Guarantees consistent seawater quality to feed the subsequent filtration step*
- *Very efficient Veolia Water Technologies' skimming process: minimizes pre-treatment water losses & lowers disposal volume with highly concentrated sludge production*

C High rate Multimedia Gravity Filtration:

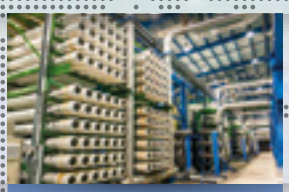
- *Removes smallest particles*
- *Allows biomass development in the media depth which degrades biofouling molecules – Significant advantage compared to MF/UF process (only mechanical filtration barrier) which does not remove dissolved nutrients*
- *Provides long filtration cycles through constant feed water quality, even in the most challenging conditions*
- *Fast maturation enabling to feed quickly & safely SWRO units*

Veolia Water Technologies' expertise on Spidflow® and Filtraflo™ TGV has been proven over many years, with more than 15 Spidflow units & 30 Filtraflo TGV units installed and operating successfully worldwide. Spidflow® Filter is the unique re-engineered combination of these two best-seller processes.

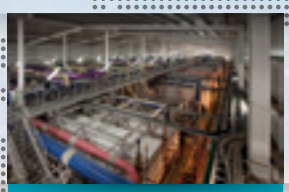
Long term performance has been assessed during extensive operation in challenging raw water conditions in different locations of the Gulf region. As a technology partner for Masdar (Abu Dhabi Future Energy Company), Veolia developed an advanced, low energy desalination plant in the UAE, incorporating Spidflow Filter, with a performance consistently beyond expectations.



Campo de Dalias
(Spain)
97,200 m³/day (RO)

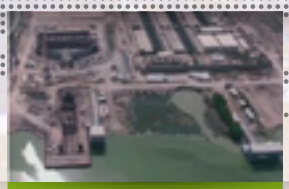


Az Zour South
(Kuwait)
136,000 m³/day (RO)



Sur
(Oman)
130,000 m³/day (RO)

Az Zour North
(Kuwait)
490,970 m³/day (MED)



Basrah
(Iraq)
199,000 m³/day (RO)

Marafiq
(Saudi Arabia)
809,109 m³/day (MED)

Major desalination references

Membrane desalination

Project name / Site	Country	Client
Basrah Desalination Plant	Iraq	Ministry of Municipality and Public Works
Oman Sur -Extension	Oman	Sharqiyah Desalination Company
Masdar Revewable Energy Desalination Program (advanced technology pilot)	UAE	Masdar
Sadara SWRO Plant	Saudi Arabia	Marafiq (end user: Sadara)
Az Zour South	Kuwait	Ministry of Electricity and Water
Gold Coast Desalination Plant	Australia	SureSmartWater (Queensland state and Gold Coast City Council JV)
Fujairah 2	UAE	Fujairah Asia Power Company (end user: ADWEA)
Sydney Desalination Plant	Australia	Sydney Water & Government of New South Wales
Oman Sur	Oman	Sharqiyah Desalination Company
Campo de Dalias	Spain	ACUAMED

Thermal desalination

Project name / Site	Country	Client
Shougang Unit 5	China	Beijing Shougang International Eng. Tech. Co.
Az-Zour North 1 IWPP	Kuwait	Shamal Az Zour Al Oula K.S.C
Yanbu 2 (jointly with Entropie)	Saudi Arabia	Hanwha Engineering and Construction
Aktau	Kazakhstan	MAEK Kazatomprom
Ras Laffan C IWPP	Qatar	Mitsui Bahrain
Marafiq IWPP	Saudi Arabia	Marafiq
Fujairah 2 IWPP	UAE	Fujairah Asia Power Company (end user: ADWEA)
Al Hidd IWPP	Bahrain	HPC - Hidd Power Company

EPC: Engineering Procurement Construction & Commissioning - EP: Engineering Procurement - MED: Multi-Effect Distillation - IWPP: Independent Water and Po

Sadara
(Saudi Arabia)
178,800 m³/day (RO)

Al Hidd
(Bahrain)
272,760 m³/day (MED)

Fujairah 2 (UAE)
136,000 m³/day (RO)
454,600 m³/day (MED)

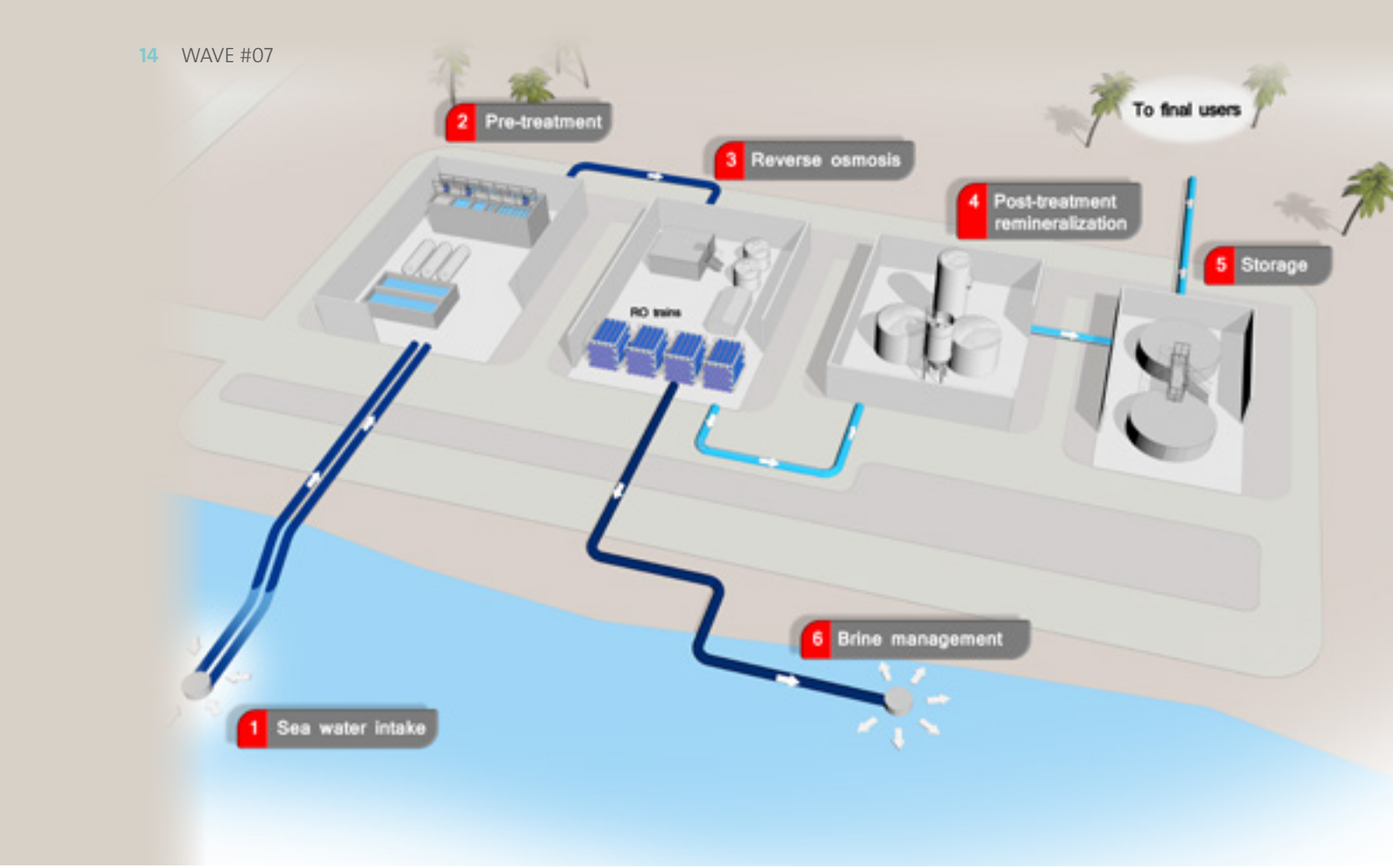
Sydney
(Australia)
250,000 m³/day (RO)

Gold Coast
(Australia)
133,000 m³/day (RO)

Total output (m³/d)	Feed water	Pretreatment	Award date	Commissioning date	Contract type
199,000	Brackish Water	Primary Settler, UF	2014	Expected 2018	EPC
48,000	Sea Water	DAF (Spidflow®), DMPF	2014	2016	EPC
300	Sea Water	DAF (Spidflow®) and DMGF(Filtraflo™) combined (Spidflow® Filter)	2014	2016	EPC
178,800	Sea Water	DAF (Spidflow®), UF	2013	2016	EPC
136,000	Brackish Water	DMGF (Filtraflo™) High Velocity	2011	2013	EPC
133,000	Sea Water	DMGF (Filtraflo™)	2007	2010	EPC
136,000	Sea Water	DAF (Spidflow®), DMGF (Filtraflo™)	2007	2010	EPC
250,000	Sea Water	DMGF (Filtraflo™)	2007	2010	EPC
80,000	Brackish Water	DMPF (Filtraflo™)	2007	2009	EPC
97,200	Sea Water	DMPF (Filtraflo™)	2012*	2015	EPC

No. of units	Technology	Total output (m3/day)	Award date	Commissioning date	Contract type
1	MED	35,000	2016	2018	EP
10	MED	490,970	2014	2016	EPC
2	MED	63,348	2011	2013	EP
2	MED	24,000	2010	2013	EP
10	MED	295,490	2008	2010	EPC
27	MED	809,109	2007	2009	EPC
12	MED	454,600	2007	2009	EPC
10	MED	272,760	2006	2007	EPC

wer Plant



Technology corner Reverse

Among the various processes, membrane desalination via reverse osmosis (RO) has become the most widely used solution.

With more than 1,950 RO plants and compact systems operating across the world, Veolia is a key market player

40 years of expertise in membrane desalination

With numerous membrane desalination references – ranging from modular equipment to large turnkey projects producing up to 392,000 m^3 of drinking water per day – Veolia Water Technologies is the world's undisputed industry leader. Ever since the first seawater reverse osmosis (SWRO) desalination plant in the late 1970s, Veolia has played a major role in the development of technologies and their improved cost-effectiveness through the experience gained on the projects and its research & innovation teams.

Technological developments have made it possible to reduce the plants' energy consumption by a factor of 4, lower operating costs and environmental impacts, optimize the pre-treatment of raw water (indispensable to avoid damaging the membranes), improve production costs and the efficiency of the membranes.

Membrane desalination is based on the principle of reverse osmosis. It consists in pushing water under high pressure through semi-permeable membranes, in order to beat osmotic equilibrium. The salts and other impurities are retained on the side of the saltwater supply. RO is efficient for low or high concentrations of salts and can thus be used to treat brackish water as well as seawater. The saline solution to be treated is separated into two phases: the permeate (freshwater free of salts and impurities) and the concentrate stream (brine enriched with the dissolved salts retained).

Comprehensive know-how and technological solutions for each stage of RO desalination

1 Seawater intake

Veolia adapts the type of intake to local natural constraints and has experience with beachwells, offshore intakes and colocated intakes. As the quality of the raw water varies, depending on whether it was pumped directly from the sea or from beachwells, the subsequent treatments and equipment used will vary accordingly.

2 Pre-treatment

RO membranes are highly sensitive to variations in water quality, temperatures, algae, etc. Selecting the appropriate raw water pretreatment system is a key factor in the design of a sustainable RO desalination plant..

- **Actiflo®**: compact high-speed lamellar clarification process, particularly efficient on turbidity, organic compounds, color and algae
- **Spidflow®**: Rapid and compact DAF system to treat wate with low-density particles, algae or humic matter
- **Filtraflo™ TGV**: high-speed gravity filtration through a granular medium, particularly efficient in eliminating turbidity
- **Spidflow™ Filter**: a compact bundle involving both rapid DAF and high-speed gravitaty filtration through a granular media.

3 Reverse osmosis

For a selection of RO membranes suited to the applications requested by customers, Veolia Water Technologies relies on a dedicated center of expertise within Veolia Research & Innovation (VERI). Independently from manufacturers, this entity assesses the equipment available on the market, defines ideal operating conditions according to situations, and tests the equipment over the long term to optimize the processes.

4 Post-treatment - remineralization

The freshwater extracted via the RO process must be treated in accordance with the type of end-use and legal requirements.

- Injection of CO_2 to remineralize the water
- Calcite filter to neutralize the pH of the water produced and minimize its corrosiveness
- Multiflo™ clarification for the production of limewater

Osmosis

Proven adaptability with a wide variety of contract models

Beyond the technological aspect, Veolia also provides engineering to its customers, adapting its level of response and intervention to their financial constraints, governance choice, economic/social/environmental situations, the number of project partners, etc. This widely recognized adaptability is an additional asset for clients. High-growth countries, such as the Arabian Gulf countries, have launched into major programs to expand their water and/or power production capacities. These projects are divided into two categories – Independent Water Projects (IWP) and Independent Water and Power Projects (IWPP) to attract investors and benefit from top private-sector expertise. Taking part in this type of complex projects which involve numerous players is a challenge which requires total coordination and comprehension among all parties involved, skills that Veolia has developed over the years. Recognized for its contract management expertise, our company stands out as a subcontracting partner, supplier of EPC equipment, or provider of wider expertise in a growing number of these unconventional installations. ■

The **Fujairah 2 hybrid desalination** project in the United Arab Emirates was the world's second biggest IWPP when its construction was completed in 2010. It was entrusted to a consortium made up of the Abu Dhabi Water and Electricity Authority (60%), International Power (20%) and Marubeni (20%), who chose Veolia Water Technologies for its engineering and construction and for the supply of equipment for all MED and RO desalination aspects. The operation and maintenance of the RO facility was entrusted to Veolia under another specific contract.

Az Zour North IWPP Desalination Plant

Supplying fresh water to Kuwait with pride

A series of firsts

As Az-Zour North's Phase 1 project water plant supplier, SIDEM is proud to have been involved in several firsts.

First IWPP in Kuwait: In cooperation with Hyundai Heavy Industries (HHI), SIDEM has built the Az Zour North Phase 1 Independent Water and Power Plant (IWPP) in Kuwait for the benefit of Shamal Az-Zour Al-Oula, the Project Company primarily owned and managed by Engie and Sumitomo Corporation. SIDEM is recognized as the best EPC contractor for large size IWPP, after delivering successful projects such as Ras Laffan C, Marafiq Jubail, Fujairah 2 and Al Hidd.

First MED-TVC technology based desalination plant units in Kuwait: Kuwait was previously relying on old MSF technology for its desalination plants but decision makers made an historical yet logical move given that MED-TVC is currently the most reliable, efficient and economical technology available.

First MED units in the world with capacity exceeding 10 MIGD: With an individual design capacity of 10.84 Million Imperial Gallon per Day and a successful test capacity of 11.5 MIGD, the Az Zour North Phase 1 MED units are now recognized as being the largest capacity units in operation worldwide. This achievement sets a new industry benchmark and demonstrates SIDEM's unrivalled position as global leader in MED technology.

State of the Art MED-TVC Technology

Benefiting from SIDEM's experience in the design and supply of MED units for over 40 years, the latest Az-Zour North MED plant features the world's largest and most efficient MED-TVC units.

The MED system currently under commercial operation provides a very high efficiency with a design GOR of 11.2 and an actual performance tested GOR of 12.1. Similarly, the system was performance tested at an actual daily production of approximately 11.5 MIGD, compared to the design daily production of 10.84 MIGD. Remarkably, this performance was achieved using a very low steam pressure of 2.7 bar(a) and the MED operation is guaranteed within a wide seawater temperature range (10 to 38°C).

EPC: *Engineering Procurement Construction & Commissioning*
MED-TVC: *Multi-Effect Distillation - Thermal Vapor Compression*
GOR: *Gain Output Ratio*
MIGD: *Million Imperial Gallon per Day.*

Smart technical solutions for the benefit of the plant owner

Many innovative technical solutions were implemented for Az-Zour North Phase 1 project to minimize investment and operating costs and to increase ease of operation.

- *A compact plant arrangement was engineered to minimize footprint, resulting in an area of less than 80,000 m^2 in total.*
- *High thermal efficiency MED units were provided based upon SIDEM's in-house knowhow and world best TVC technology.*
- *An optimized remineralization plant design was engineered and provided, including high efficiency degassifiers installed downstream of limestone filters to significantly reduce caustic soda consumption.*
- *Special care was taken for integration of the CO_2 plant in the remineralization process.*
- *A limestone filter automatic filling system using hydro carriage was engineered to improve operational conditions.*
- *The limestone filter wash water recovery system results in a daily savings of approximately 5,000 m^3 of potable water.*

Excellence in project delivery

Innovation and "firsts" are not possible if not supported by extremely efficient project management that ultimately allows smooth project execution and on time delivery of a performing plant. SIDEM's lean organization at every stage from engineering to procurement, logistics, construction and commissioning was the key to SIDEM's successful involvement in this project. Notable achievements include the early delivery to site of 10 fully assembled and tested MED-TVC giant evaporators (2,600 tons each and 54 m long, 33 m wide, 14 m high) and the fast track commissioning with 10 units started-up in less than 5 months. SIDEM was also able to complete the reliability test flawlessly at the first attempt.

Az Zour North Phase 1 IWPP main figures

- *107 MIGD Water Plant output, equivalent to 20% of Kuwait fresh water production*
- *10 MED units, each with individual 10.84 MIGD capacity*
- *Project executed on time in 35.5 months*
- *30,000 km, or 6 times the distance between Paris and Kuwait City, is the total length of MED heat exchanger tubes.*

Seawater sulfate removal goes deep

Among the major challenges in the increasingly complex environment of offshore oil systems are the space and weight limitations on what the industry calls "topsides:" oil platforms and Floating Production, Storage and Offloading (FPSO) units. With the need to find room for items such as oil and gas processing facilities, power generation utilities, crew living quarters, safety and drilling equipment, the trend in the industry is to look to subsea production systems in which the equipment can be installed under water, on the seabed.

One such process that has been shown to be suitable to make the underwater dive is the technology for removing sulfates from seawater, prior to injection into the oil reservoir. The seawater is injected to maintain the pressure in the reservoir, a process known as "waterflooding," to increase the oil-production rate and, ultimately, the oil recovery.

Sulfate removal is crucial as a scale-control measure in reservoirs containing high levels of barium or calcium to prevent any precipitation or mineral deposition as well as to prevent well souring caused by sulfate-reducing bacteria. Seawater sulfate removal units using specialized nanofiltration (NF) membrane systems are widely deployed today on topsides.

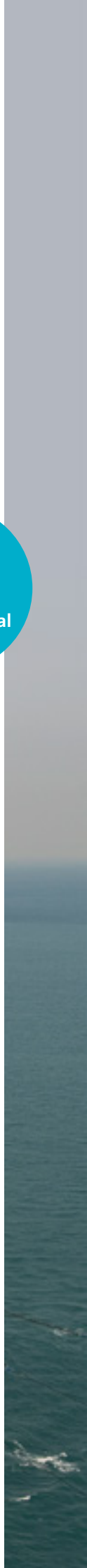
SPRINGS® (Subsea Process and Injection Gear for Seawater) is the underwater membrane solution for sulfate removal, the first time the treatment has been applied in subsea processing. The technology, developed through a joint research program between Total, Saipem and Veolia, has completed a successful subsea deep-water test program and is being readied for full-scale deployment.

In addition to reducing topsides space and weight demands, major advantages offered by SPRINGS® include simplification of the pre-treatment and greater flexibility in the water injection pattern for improved sweeping of the reservoir. Pretreatment is simplified as the higher-quality water from the ocean depths reduces the filtration requirement upstream of the membranes. Placing a dedicated SPRINGS® module local to each injection well allows the injection water quality and capacity to be matched to the needs of the reservoir for optimal sweeping.

The standard SPRINGS® module has a capacity to treat up to 60,000 barrels of seawater per day. Initial applications are expected to occur either on existing production facilities where a subsea solution may be the only technically or financially viable option for water injection, or on new developments that require long tie-backs to small, remote oil fields for which a subsea solution may be the best economic option. ■

Underwater membrane solution for sulfate removal

SPRINGS®



Sur Extension

An addition to the first independent desalination project in Oman

Since September 2016, the city of Sur, located in the South-East of the Sultanate of Oman, has increased its production capacity and is now able to supply drinking water to almost 600,000 inhabitants. The Sur Desalination Plant, in service since 2009 has been expanded to reach a total production of 29 MIGD (131,800 m^3/day).
The expansion project, awarded in 2014 to SIDEM, is an Independent Water Project (IWP) developed on a Build-Own-Operate (BOO) basis by Sharqiyah Desalination Company (SDC) and is located next to the existing reverse osmosis plant. The additional water capacity produced by the expansion project will help in meeting the projected demand for potable water in the Sharqiyah region.

Pretreatment innovation

Contrary to the first Sur Desalination Plant, which pumps seawater from beachwells, the expansion plant draws seawater through a 700 meter pipe equipped with passive screens, cleaned daily with an air blast system. Pretreatment consists of Veolia's patented Dissolved Air Floatation system, Spidflow®, followed by an innovative combination of dual media pressure filter and cartridge filters. This feature helped in reducing the footprint of the pretreatment. The Spidflow® units protect the plant from the natural algal blooms event, also known as red-tides, therefore guaranteeing maximum plant availability throughout the year. Outside of these exceptional events, they also bring substantial relief to the operation of the pressured filters by removing a significant part of suspended solids as concentrated sludge, ready to be dewatered.

Reverse osmosis system

The prepared seawater is treated in a one-pass reverse osmosis stage. The brine's energy is recovered using high-efficiency isobaric pressure exchangers before being blended with the first plant's brine and diffused to the sea. Thanks to a dedicated team of engineers, the performance-oriented design of the plant succeeded to reduce the energy consumption of the expansion plant down to only 3.2 kWh/m^3.
The permeate produced is then sent to the existing post-treatment for mixing, remineralization and final disinfection.

MIGD: *Million Imperial Gallon per Day* - ***M&C:*** *Media and Cartridge Filters* - ***SWRO:*** *Sea Water Reverse Osmosis*
RO: *reverse osmosis* - ***CF:*** *Cartridge Filters* - ***DMPF:*** *Dual Media Pressure Filter*

M&C filtration: a compact pretreatment solution for RO Reducing SWRO pretreatment footprint

SWRO membranes are highly sensitive to variations in water quality and require pretreated water with high water quality and low solids content. A raw water pretreatment system upstream of a RO unit is indispensable as it prevents the risk of membrane clogging and ensures its durability.

To successfully deal with the worse seawater quality and feed the RO membranes with consistently good water quality, removing high turbidity and suspended solids particles, Veolia Water Technologies has combined Media filtration and Cartridge filtration technologies on the same pressure vessel. This unique and compact solution bundles into one metallic work structure the advantages of two proven processes: high rate pressurized filtration and cartridge filters for fine removal. ■

M&C filtration is installed in Oman Sur SWRO Plant Extension.

Advantages of Combined Pressurized Filtration + CF

The combination of these two processes means benefiting from the beast features of each, thereby offering:

- *Robustness to deal with any water quality and low sensitivity to variations in parameters;*
- *High removal efficiency of suspended solids, turbidity and SDI15;*
- *Combination of the best filtration barriers to dissolved organic with biomass developing on the media bed, making it an excellent protection system by reducing risk of membrane biofouling;*
- *A reduced footprint, allowing CF to be installed directly in the DMPF vessel for treatment plants of medium sizes;*
- *A CAPEX saving for medium SWRO plant by reducing piping between filters/CF, pipe rack for CF support isolation valve numbers, civil and installation costs;*
- *Low OPEX: high water recovery with media filtration with minimum water losses, low chemical requirements, low CF replacement rate and an overall low energy consumption;*
- *Full planning control: concerted design and procurement on metallic manufacturing based on SIDEM's strong expertise;*
- *An easy access for maintenance & replacement of cartridge filters, direct access by the top platform to unscrew the CF top plate and allow guidance of CF basket inside the vessel*

Sydney, Australia

Guaranteeing drought-proof water supply

The plant provides a drought-proof water supply for 1.5 million Sydney residents

The city of Sydney is solely reliant on surrounding dams and rain for its drinking water. With Sydney's growing population and uncertain rainfall predictions due to climate change, the New South Wales Government recognized the need for a new, non-rainfall dependent source of water to secure the city's water supplies for the future.

The Government announced the decision to proceed with the desalination plant in February 2007 when dam levels were at 34.1% and dropping approximately 0.4% week. If dam levels had continued to decline at this rate, drinking water storage would have been 10% by July 2009, creating a risk of Sydney running out of water.

Guaranteeing water security for Sydney

Veolia Water Technologies worked with John Holland in a joint venture (Blue Water) to design and build Sydney's Desalination Plant on behalf of Sydney Water. Veolia is now operating and maintaining the plant and intake/outlet structures under a 20 year contract.

Seawater is treated using reverse osmosis which pushes seawater through membranes where salt and any other impurities are removed, producing freshwater.

The plant has a capacity of 250,000 m^3/day and provides a drought-proof water supply for 1.5 million Sydney residents. It is currently in water security mode. Care and maintenance operations will continue until dam levels fall below 70%, when the restart process will begin. The plant will then continue to produce drinking water until dam levels rise above 80%.

Meeting the highest environmental requirements

The energy consumption of the plant was optimized by installing a high performance energy recovery system (DWEER) on the reverse osmosis line.

The plant was built to high environmental and public health standards. Multiple safeguards protect drinking water quality and minimize the environmental impact of salty water outflows to ocean. Veolia technologies are critical to the plant's performance—for example, by providing efficient chemical pretreatment and filtration of seawater, reverse osmosis, and water post-treatment and disinfection.

The concentrated seawater is discharged via two outlet risers each with four nozzles located approximately 300 meters out to sea in water 25 meters deep. The concentrated seawater is dispersed at about one part per thousand of background salinity within 50 to 75 meters. This minimizes the impact of brine on local ecosystems. ■

Campo de Dalías

Preserving water resources through desalination

With a treatment capacity of 97,200 m^3/day, the Campo de Dalías seawater desalination plant in the province of Almería, at the southeast of Spain, is one of the largest desalination plants in Europe.

The project was promoted by Spanish Ministry for Agriculture and Fisheries, Food and Environment, through Water Spanish Society ACUAMED, and required a total investment of 130 million euros, co-financed by European Funds. The Campo de Dalías desalination plant will enable the production of water to supply 300,000 inhabitants and 8,000 hectares of irrigation land in Almería. In planning for future enlargements, the infrastructures have been set up for a capacity of 129,300 m^3/day. Among other benefits, the operation of this plant will avoid overexploitation of the aquifers for irrigation purposes, allowing natural regeneration to take place. Construction of the plant, which was completed in November 2014, was led by the Spanish subsidiary of Veolia Water Technologies, as part of the Campo Dalías Joint Venture.

The Campo de Dalías treatment line is comprised of an open water intake from Mediterranean Sea via submarine pipe, double-stage multimedia pressure filtration and a double-pass reverse osmosis process. This first pass consists of six reverse osmosis skids equipped with an Energy Recovery System (ERS) in the form of isobaric chambers. This allows for recovery of up to 95% of the brine pressure which is then transferred to the feed in order to reduce pumping requirements. The second pass reverse osmosis, also comprised of six skids, is dedicated toward reducing the boron concentration in the permeate water in order to comply with irrigation requirements. The desalinated water is then post-treated through remineralization and an added final disinfection step ensures the product water reaches the delivery points in suitable conditions for both human consumption and irrigation.

The product water distribution network is also part of the work scope which includes the execution of a product water pumping station, a 4.5 km pressure pipeline, an elevated storage tank and a 40 km gravity distribution network which delivers the product water to end users.

Environmental protection was a key issue in the design of the plant. Brine is discharged backed to the see via a 2 km pipe equipped with diffusers that have been carefully designed to prevent any disturbance to marine fauna and flora. The whole design of the plant has been made with special emphasis on its integration into the environment and reducing its visual impact thanks to an internal urbanization and careful finish of the main buildings. ■

Reduces water collection from aquifers to comply with Spain's sustainability commitment

Resourcing the world

Publication Director: Elise Le Vaillant
Chief Editor: Clément Leveaux
Coordination: Manon Painchaud
Contributors to this issue: Mathieu Balian, Dr. Mourad Ben Boudinar, Céline Delabie, Carol Easton, Mette Friis-Andersen, Maria Jesus Fernandez, Séverine Le Bideau, Sylvaine Leriquier, Anthony Millis, Manon Painchaud, Nelly Pitt, Carla Robinson.
Design: Veolia Water Technologies Graphic Design Team.
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10/2017

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