



Fujairah 2 Reverse Osmosis Desalination Plant

6 YEARS OF OPERATION (2010-2016)



SUMMARY

Since the beginning of Veolia's involvement in the Fujairah 2 Reverse Osmosis Desalination Plant, the company has reached a significant number of achievements, within various fields. This project shows the capability of Veolia to propose complete solutions in terms of water management: Design, Build, and Operate & Maintain. Beyond Veolia's expertise in resource management, the Group wants to increase its impact on the socio-economic environment with each of its projects in the World and the Fujairah 2 Desalination plant is the perfect example of this strategy.

This report will highlight the main achievements of this contract through the following aspects:

- ▶ FUJAIRAH 2 AT A GLANCE ...
- ▶ FUJAIRAH 2 REVERSE OSMOSIS DESALINATION PLANT PROCESS
- ▶ PERFORMANCE & RELIABILITY
- ▶ HEALTH, SAFETY & ENVIRONMENT
- ▶ HUMAN RESOURCES
- ▶ CORPORATE SOCIAL RESPONSIBILITY
- ▶ INNOVATION
- ▶ FUJAIRAH 2 REVERSE OSMOSIS PLANT IN THE FUTURE

FUJAIRAH 2 AT A GLANCE ...

The Challenge

In the United Arab Emirates (UAE), the power demand is significantly higher during the summer due to the requirements for air conditioning and district cooling. The potable water demand remains more stable during the rest of the year, nevertheless synchronizing and optimizing the production of power and water is important to ensure sustainability. This situation is particularly true in Fujairah, one of seven Emirates, located on the east coast of the United Arab Emirates on the Gulf of Oman.

Figures

- ▶ Three years Design & build
- ▶ **12** years Operations & Maintenance started in October **2010** + eight years renewable
- ▶ Capacity of **136,500 m³** per day for the reverse osmosis desalination plant
- ▶ Capacity of **453,500 m³** per day for the multi effect distillation desalination plant

The country is experiencing high demographic growth resulting in the constant rise of electricity and drinking water demand. Despite this increasing demand, the Vision **2021** set priorities for the air quality, preservation of water resources, contribution of clean energy and implementation of green growth plans. Among these targets, the UAE wants to lower its Water Scarcity Index to **4.0**, which is an indicator that measures water overuse by monitoring fresh water usage (including surface water, renewable water and fossil water) as a percentage of overall renewable water in the UAE. The result is weighted to take into account desalination and wastewater treatment.

Seawater desalination represents an increasingly important solution to the rising water scarcity afflicting many of the world's regions. With more than **160** years of experience, numerous patented technologies and extensive knowledge in desalination, Veolia is the global leader in assisting municipalities and industries implement desalination strategies. Operating and

maintaining a sea water reverse osmosis plant at a stringent **98%** plant availability requires experience, know-how and innovative treatment solutions especially during algal blooms/red tide events.

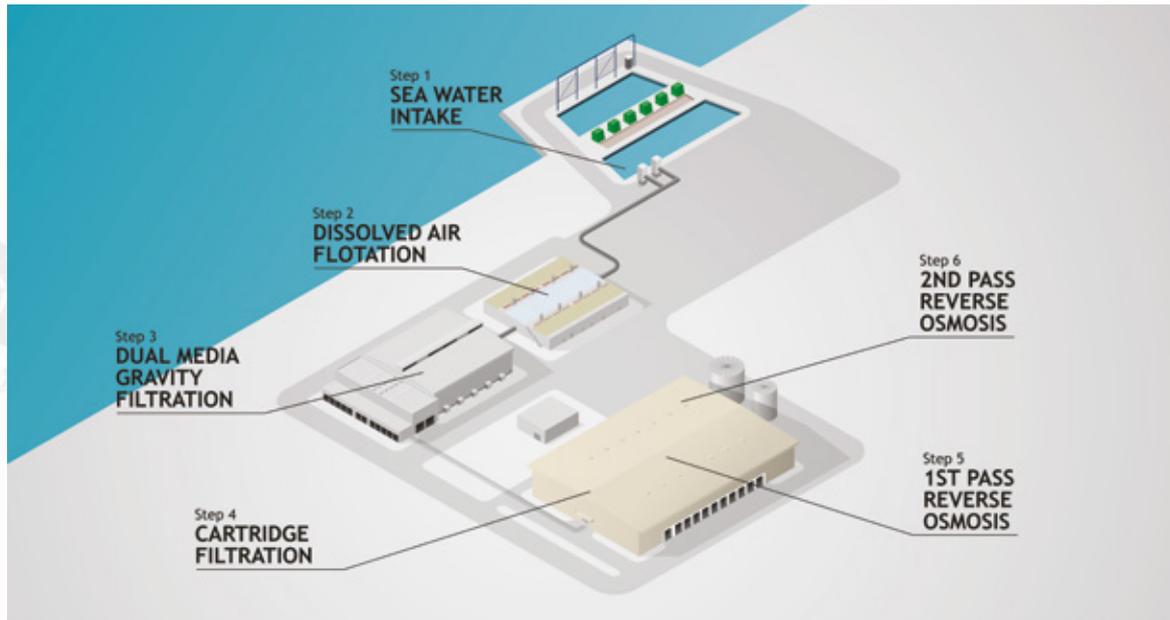
Veolia's solution

Veolia developed a unique hybrid concept by merging thermal desalination and reverse osmosis (RO) for the sustainable and most optimum use of available power and production of potable water. Veolia, through its technological subsidiary SIDEM, was awarded the design and build contract for the **590,000 m³/d** Multi Effect Distillation (MED) and reverse osmosis desalination plants which is linked to a **2,000 MW/d** power plant. The Fujairah 2 Independent Water and Power Plant can therefore be considered as one of the most efficient power and desalination plants in the world.

The Fujairah 2 RO plant comprises the innovative Veolia Spidflow® Dissolved Air Flotation (DAF) process which was included to effectively mitigate algae blooms/red tide events and to ensure the uninterrupted operation of the reverse osmosis plant for continuous water production.

Process Description

- ▶ **16** modular Spidflow® DAF units with coagulation and flocculation
- ▶ **12** high rate dual media gravity filters
- ▶ **16** cartridge filters
- ▶ **10** first pass reverse osmosis racks
- ▶ **10** high pressure pumps with energy recovery turbines
- ▶ Two second pass reverse osmosis racks for boron removal



THE FUJAIRAH 2 REVERSE OSMOSIS DESALINATION PLANT PROCESS

Step 1: Open sea water intake

Sea water from the Gulf of Oman is collected with three parallel pipelines (four meter in diameter) from a distance of **500 m** off-shore to a deep intake well. Before entering the intake well, the sea water is screened using static and traveling band screens to prevent any marine life or debris entering the plant. The intake well is equipped with four vertical shaft turbine pumps (three on duty, one on standby) to supply the required amount of seawater to the RO plant at all times and depending on the production demand. The sea water is chlorinated on an intermittent basis to discourage marine growth in the plant structures.

Step 2: Dissolved Air Flotation (DAF)

Seawater pretreatment aims at removing solids before the water enters the reverse osmosis process. The first pretreatment step comprises coagulation and flocculation (chemical addition and mixing to form small flocs) followed by dissolved air flotation. The microscopic air bubbles produced attach to the small flocs and suspended solids, which float to the water surface where the accumulation takes place as a brown scum layer. This layer is periodically removed as waste and is treated in the sludge treatment plant.

The **16** DAF process units have been added with the specific purpose of maximizing the removal of algae blooms and "red tides". The unique DAF process acts as barrier and ensures RO plant production capacity at all times irrespective of the sea water quality. The unique process has become the norm in RO pretreatment in the Gulf Region but was first incorporated in the Fujairah 2 RO Plant.

Step 3:

Dual Media Gravity Filtration (DMGF)

A double layer of pumice (special volcanic material) and quartzite sand acts as the filtration media inside the **12** filters. After filtration times of **40** to **60** hours, filters are backwashed one by one in order to remove all accumulated flocs and suspended material. Dirty backwash water is transferred and treated in the sludge treatment plant. Filtered sea water is pumped through the cartridge filters with the use of 10 booster pumps.

Step 4:

Cartridge filtration

This sea water polishing step comprises **16** cartridge filter vessels, each containing **224** cartridge filters. During this step all suspended material above **10** micron in size is removed. Spent cartridge filters are replaced and disposed of periodically under strict disposal regulations.

Step 5:

Reverse osmosis

Reverse osmosis is the core process of the desalination plant, and produces fresh water from seawater with the use of spiral wound polyamide RO membranes. High pressure pumps provide the necessary pressure (**60** bar) required by the reverse osmosis process.

The Fujairah 2 RO plant has the following unique features: permeate split first pass configuration with a partial second pass. **10** first pass skids with **12,960** membranes, two second pass racks with **1,600** membranes, **10** high pressure feed pumps with turbine as energy recovery device.

Chemicals such as antiscalant (continuously) and bisulphite (when required) are added to protect the reverse osmosis membranes. Performance of the RO process as a whole is maintained over the years thanks to a carefully managed membrane replacement and chemical cleaning programme.

Step 6:

Post Treatment

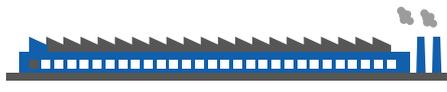
The permeate produced by the RO plant is blended with distillate from the adjacent Multi Effect Distillation (MED) process after which the water is remineralized (addition of essential minerals) to render the final water potable as prescribed by the Drinking Water Regulations. Remineralization typically comprises water stabilization, pH adjustment and disinfection prior to final storage in four **100,000** cubic meters storage tanks adjacent to the Fujairah 2 water and power plant.



“We strive to be international benchmark in RO plant operation & maintenance.”

PERFORMANCE & RELIABILITY

In the context of water scarcity in the region of the Middle East, Veolia’s mission is to enhance the overall performance of the Fujairah 2 plant for sea water desalination. With the increasing population in the UAE and an increasing demand in access to water, the performance and reliability of the plant has to be at its highest.

 More than **99%** of plant availability

 **90%** Very high reliability: plant load factor above 90% of the nominal capacity on the last year of operation

 A specific power consumption of less than **3.5 kWh/m³** after six years of operation

 **220,000,000 m³** total production volume since the plant commissioning = approximately **40 Olympic swimming pools** per day

HEALTH, SAFETY & ENVIRONMENT

Occupational health and safety is one of Veolia's core values. Our most valuable resource, and therefore our prime asset are the women and men of Veolia. Our goal is to perform our activities with zero accident. For this purpose, we have based our policy on the guidelines of the International Labor Organization and Veolia's standards. In matters of HSE, we are targeting excellence and this requires full commitment from the management and from the team working in the Fujairah 2 RO plant. Several initiatives were put in place in order to respect this commitment.

1 Achievements

- ▶ For the sixth consecutive year, no record of any LTA (Lost Time Accident). It represents more than **500'000** working hours reached without LTA
- ▶ Set up of specific HSE Tool Box Talk before every work, aiming at raising employees and subcontractors awareness on all the hazards present on site
- ▶ Use of a state-of-the-art Permit To Work (PTW) system, ensuring maximum safety while maintenance works are carried out
- ▶ HSE report card system allowing any employee to immediately report any hazards, incident, near-miss or plant improvement
- ▶ Issuance of a monthly safety bulletins
- ▶ Monthly safety "walk" performed by the plant management
- ▶ Continuous improvement of the plant facilities, including construction of permanent platforms to access high locations, and thus ensure a safer working environment
- ▶ Organization of high pressure risks safety audit, mutualizing other Veolia desalination plants and independent consultants expertise

"We are extremely proud of the O LTA record after more than six years of operation. It is the result of continuous and always reinforced efforts of each and every member of the team."





HUMAN RESOURCES

Led by the founding values of Veolia Group that create power and cohesion, Human Resources is a fundamental element in this project. We are committed to maintaining our efforts in qualification training courses and learning and work-study courses. They are part of our DNA and corporate responsibility towards the communities where we operate our activities.

2 Achievements

- ▶ Internal promotion culture with nine employees that have either been internally promoted from another Veolia contract in the region or gained a new position in another Veolia project
- ▶ Veolia Group's integration has allowed a RO expert to be urgently detached from a Veolia contract in Australia, seconded to the Fujairah 2 RO plant team and thus cover the needs of the project
- ▶ Workforce diversity with a range of different cultures & different levels of experience hired in the team
- ▶ Support & involvement of Veolia Middle East employees during Fujairah 2 RO Plant outages
- ▶ Veolia Fujairah 2 RO Plant is used as an incubator to train young promising engineers (VIE) graduated from all over Europe. They then are ready to take operational responsibilities in other Veolia contracts in the Middle East or other regions.



Hyder Khaleeq

Hyder comes from Pakistan. He joined Veolia in 2010. Thanks to the Veolia F2 RO team support, was able to pursue higher education. He obtained in October 2015 an Engineer Degree from the University of Sharjah.

CORPORATE SOCIAL RESPONSIBILITY

The United Arab Emirates is expanding and its needs of new resources in terms of natural, economic and human resources is also increasing accordingly. Veolia's mission "Resourcing the World" takes what is discarded by some and turns it into a resource for others. The Fujairah 2 RO plant team applied this mission on site by putting in place environmental initiatives and circular economy related actions. Moreover, CSR (Corporate Social Responsibility) also includes a social aspect which is highlighted at all times in this project.

3 Achievements

Focus on social initiatives

- ▶ Team building activities organized on a regular basis for better team integration
- ▶ Sport activities (basketball and cricket teams)
- ▶ Involvement of the local subcontractors on trainings (internal and external)
- ▶ Contribution to HSBC Water Research Centre of Fujairah
- ▶ Support given to Sharjah University
- ▶ Financial support with a **0%** interest loan granted to employees

Focus on environmental initiatives

- ▶ Reuse of A/C condensate water for vegetables growing in the plant (granted to employees/subcontractors)
- ▶ Construction of a scrap yard, in order to ease waste handling and segregation
- ▶ Used oil sold to broker for reuse/recycling
- ▶ Promote the use of electrical powered vehicles or bicycles rather than any other diesel powered engine
- ▶ Systematic storage of chemicals on spill pallets/retention tanks
- ▶ Participation to local wadi clean-ups: environmental and educational excursion and cleaning activities in the Wadi Wurayah National Park





INNOVATION

Innovation at Fujairah 2 RO plant goes through several elements such as increasing plant reliability, implementing technical modifications on the plant, storing “turnkey” equipment replacement, ensuring continuous improvement of performances through new equipment/material test.

The Veolia network goes beyond borders. It allowed the Fujairah 2 RO team to use, for instance, Veolia's “state-of-the-art” Research & Innovation platforms on site and in France, as well as putting in place a continuous improvement process, source new materials and use Veolia Laboratory in China for in-depth material structure testing.

On site, the team also performed RO membranes performance analysis and replacement optimization through the use of a unique RO pilot unit. A close cooperation with the plant design team allowed a real return of experience and performance assessment of all innovations implemented.

4 Achievements

- ▶ Maintain very high plant availability (more than **99%**) despite very high plant load factor and aging equipment
- ▶ Continuous improvement policy in place, including process reviews, condition based preventive maintenance, costs reductions and expenses optimization.

FUJAIRAH 2 REVERSE OSMOSIS PLANT IN THE FUTURE

→ What are the latest achievements of the project?

One of the achievements we are particularly proud of is the trust spirit built over the years with our client. Close cooperation and full transparency ensure an optimal partnership relation.

→ What are the next milestones of the project?

One of our key targets is to use this plant as a live laboratory for future RO plant optimization, and thus allow Veolia Group to propose even more competitive and innovative offers all over the world.

→ How can Veolia contribute to the operational efficiency of the project?

As well as being a technical live laboratory, the Fujairah 2 RO site will also contribute to developing the engineers of tomorrow by allowing the most talented graduates to come, work on site and learn from the experience gained by the team.



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