CASE STUDY

RO | UF | MBR |

Irrigation
Almería, Spain

TORAY

Seawater Desalination Using Toray's RO Membranes to Support Almería's Thriving Agricultural Economy

BACKGROUND

Campo de Dalías is a coastal region on the Mediterranean Sea in Almería and is notable for applying accelerated farming techniques known as 'intensive agriculture.' Since introducing this method, Campo de Dalías has become heavily concentrated with greenhouses that would export around 75% of its crops to supply nearly half of the demand in Europe [1]. The arid climate, long hours of sunlight, and mulching sandy soil provide ideal conditions to produce crops, generating an estimated USD 1.5 billion per year [2]. Tourism in and around Almería also is a significant contributor to the economy of this region.

CHALLENGE

As the economy boomed, the need for freshwater required by irrigation, tourism, and the local community also grew. As a result, Campo de Dalías faced overexploitation of groundwater aquifers, such as the Campo de Dalías coastal aquifer. Furthermore, the region received less than 300 mm of rainfall per year, which could not adequately replenish the aquifers quicker than its withdrawal. These factors threatened local water supplies due to contamination by seawater intrusion and to the socio-economic livelihood of Almería.

SOLUTION

To minimize groundwater withdrawal and secure alternate freshwater sources, Spain's Ministry of Agriculture, Food and Environment implemented a national desalination plan called Programa A.G.U.A. Promoted at the state level through Aguas de las Cuencas Mediterráneas (A.C.U.A.M.E.D.), the program led to tenders for a new desalination plant in Campo de Dalías. The contract was awarded to a consortium comprised of Veolia Water Technologies as the O.E.M. and Spanish engineering firms Sando Construcciones, Inypsa, and Montajes Elétricos Crescencio Pérez to design, construct, operate, and maintain the plant for a period of fifteen (15) years.

The bidding process of the reverse osmosis membranes involved rigorous reviews of technical designs and projections. Toray successfully met the requirements and was selected as the sole membrane supplier for a two-pass system.

Construction of the plant began in early 2013 and was completed in November 2014 to produce close to 100,000 cubic meters of fresh water per day. This volume would sustain living standards for an estimated 300,000 people living in Vicar, El Ejido, and Roquetas de Mar surrounding Campo de Dalías and supply irrigation water for over 8,000 hectares of land.

Figure 1: Campo de Dalías Desalination Facility

Table 1 — Quick Facts

Feed source	Open intake seawater from the Mediterranean Sea	
Pretreatment	2-stage sand filter followed by 5-micron cartridge filter	
System capacity	98,664 m^3/d	
RO membranes*	First-pass	Second-pass
Model	TM820E-400	TM720C-430
Membrane type	Seawater	Brackish
Skid design	233 (7M)	54:18 (7M)
System recovery	47.2%	84–90%
Feed pressure [MPa (psi)]	5.52 (800)	1.03 (150)
NaCl rejection	99.75%	99.2%
Boron rejection	91% at pH 8	95% at pH 10
Flow rate [m^3/d (gpd)]	28.3 (7,500)	33.3 (8,800)
Active area [m^2 (ft^2)]	37 (400)	40 (430)
End use	Irrigation; Municipal potable	
OEM	Veolia Water Technologies (Spain)	
Commissioned	2016	

*RO membrane performance is based on manufacturer's test conditions. Actual performance depends on site's feed water conditions.

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RO SYSTEM

Seawater is collected through an open intake and carried to the desalination facility using a subsea pipeline stretching 1.6 kilometers. The RO feed is pretreated via a dual filtration stage made up of a battery of 40 dual media filters followed by 5-micron cartridge filters with 99.6% removal efficiency of particulates. As corrosion is a common problem with treating seawater, the media filters were made exclusively of glass fiber reinforced polyester (GRP) to address this.

The RO desalination process is a two-pass configuration, both consisting of six skids. The first-pass is equipped with Toray RO model TM820E-400 high-flow seawater membranes. Due to the high level of osmotic pressure, an isobaric energy recovery system by DWEER with 95% efficiency is installed, minimizing the plant's energy consumption by up to 45%. The second-pass is installed with Toray RO model TM720C-430 low-pressure brackish water membrane elements to reduce the boron content to less than 0.5 mg/L and comply with irrigation requirements. Furthermore, the concentrate from the second-pass is recirculated to the first-pass.

As part of the final step, the RO permeate is post-treated via re-mineralization followed by disinfection.

SUMMARY

The plant operates 310 days a year by a team working 24 hours a day. Also, the plant has the capacity for future expansion to a total production of 129,600 cubic meters per day.

To date, the RO membranes are operating efficiently without requiring replacement. This project further exhibits the technical capability of Toray to supply and support large-scale seawater desalination projects.

By providing an alternate water source for human and agricultural consumption, the plant has helped the aquifers naturally regenerate while supplying the region's water demands.

Figure 2: RO skids at Campo de Dalías Desalination Facility

Table 2 — RO feed water quality

Item	Influent
Temperature	14–23 °C
pH	8.2
Calcium (Ca)	436.7 mg/L
Magnesium (Mg)	1,358.7 mg/L
Sodium (Na)	12,009.4 mg/L
Potassium (K)	409.5 mg/L
Strontium (Sr)	4.9 mg/L
Carbonate (CO_3)	7.2 mg/L
Bicarbonate (HCO_3)	165.5 mg/L
Sulfate (SO_4)	2,913.6 mg/L
Chloride (Cl)	21,373.7 mg/L
Fluoride (F)	1.5 mg/L
Nitrate (NO_3)	1.0 mg/L
Silica (SiO_2)	0.3 mg/L
Boron (B)	5.3 mg/L
TDS	38,697.2 mg/L
LSI	1.5

Table 3 — RO permeate target guideline

Item	Permeate
Production	16,442 m^3/d per skid
TDS	<400 mg/L
Boron	<0.5 mg/L

REFERENCES

[1] Garcia-Caparros, Pedro; Contreras, Juana Isabel; Baeza, Rafael; Segura, Maria Luz; Lao, Maria Teresa. "Integral Management of Irrigation Water in Intensive Horticultural Systems of Almería." Sustainability, Basel, Switzerland. January 1, 2017.

[2] Pulido-Bosch, Antonio; Pulido-Leboeuf, Pablo; Molina-Sanchez, Luis; Vallejos, Angela; Martin-Rosales, Wenceslao. "Intensive Agriculture and Quarries in the Campo de Dalias (Almería, Spain)." Mine, Water & Environment. Sevilla, Spain. 1999.

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