

Seawater Desalination Plant for Fujairah Fresh Water Production Company at Fujairah Port - UAE

A Case Study

Introduction

Scarcity of water and renewable water resources is a common concern in all Gulf countries. But when this scarcity is combined with a rapid expansion in the infrastructure, shortage of water becomes a serious issue. The rapid development of Fujairah, one of the emerging emirates of the UAE, necessitated an increase in the availability of fresh water. Metito was contracted to provide a 3000m³/d Seawater Reverse Osmosis Treatment Plant at Fujairah Port, consisting of 2x1500m³/d streams, with provision for upgrading the capacity to 4500m³/d through the addition of a third stream.

The contract was awarded to Metito against competitive bidding from both local and international companies, and the plant was provided to meet the stringent requirements laid down by the employer and the consultants for the project.

Scope of Work

This included the design, supply, installation, civil works, marine works, commissioning, performance test, training of Employer's personnel and maintenance through the 12 months liability period.

Plant General Information

The plant has the following main features:

- Seawater intake system including: Screen, GRP Pipeline, Screen Hydroburst System, Pump House, Intake Pumps, Priming Aid Vacuum System and Chlorine Gas Disinfection System
- Pre-treatment system including: Multimedia Automatic Filtration, Two-step Micron Filtration and Chemical Dosing Units for Coagulant and Antiscalant
- Seawater reverse osmosis units



- Post treatment chemical dosing systems
- Membranes flushing system
- Membranes stationary cleaning system
- PLC based automatic control and instrumentation, including a SCADA system for remote monitoring and control
- Medium and low voltage switch gear
- API 650 product water storage tank with transfer pumps to employer's points of use

The Plant was designed and guaranteed for 36 months from "Preliminary Acceptance" to treat the Gulf of Oman seawater of 38,500mg/l TDS down to a maximum salinity of 300mg/l.

Plant Technical Features

Seawater Intake System

Seawater is drawn from a distance of 665m in the open sea, where a Cu/Ni alloy intake screen is located at a

depth of 8.0m below mean sea level. Salty water is lifted under a 4m negative suction pressure by a set of three (2 duty / 1 standby) self priming pumps of Duplex stainless steel construction.

The intake line is made of corrosion resistant GRP, and is accompanied by a chlorine solution line, which periodically injects chlorine at the screen. This periodical shock chlorination serves to control marine growth prone to develop in the line. The intake system is geared with vacuum blowers to evict air and minimise priming time, and the screen is back-flushed periodically by means of a pneumatic Hydroburst System.

A flow proportional dosing system injects coagulant into the line prior to the multimedia filters.

Pre-Treatment System

The intake pumps boost the semi-conditioned raw seawater into a set of 2-duty/stream with one standby multi-media filter where the SDI is typically reduced from 18 to 11 units.

The multi-media filters are 3.8 m in diameter by 6.0 m high, and are made of high-grade epoxy coated carbon steel vessels with strainer plate collection system. Each filter is fitted with a nest of pneumatically actuated butterfly valves mounted on frontal uPVC pipework. The gel layer resulting from the coagulation process that takes place upstream of the filters is removed in the backwash sequence with the aid of air scouring blowers.



Filtered water from the multi-media filters is further dosed with antiscalant and a dechlorination agent before it is passed through a set of 5-micron cartridge filters followed by another bank with 1-micron particle cut-off rate. Such extensive filtration ensures that feed water to the reverse osmosis membranes has a SDI < 3.

The dosing of all chemicals is flow proportional; control of dosing pumps is hence secured through analogue signals from electromagnetic flow meters.

The quality of feedwater to the RO modules is further verified and controlled by a set of online instruments feeding back to the PLC. The oil analyser samples and analyses pretreated feedwater and detects the presence of oil to the microgram range. This is provided in view of the plant location being in the vicinity of marine traffic.

Reverse Osmosis Units

The reverse osmosis technology applied in the Fujairah plant uses thin film composite (TFC) polyamide membranes having a nominal salt rejection of 99.8% and operating at an overall recovery of 35%.

A 10-stage centrifugal high-pressure pump of Duplex stainless steel construction pressurises the pretreated water for feeding into each membrane module. The pump is driven by a 520kW, 11kV electric motor. Each High-Pressure Pump is coupled to a pelton wheel type Energy Recovery Turbine (ERT) providing a power recovery of up to 25% at rated flow. A set of isolation valves permits the system to operate without the ERT,

hence providing extra flexibility in the operation of the plant.

The pressurised water flow is controlled by a pneumatically actuated Flow Control Valve that modulates through a PID loop processed in the PLC, with feed back signals received from the permeate and reject electromagnetic flow meters.

All valves and piping on the high pressure side of the membranes are made of high molybdenum stainless steel alloy (Avesta SMO254) known for its excellent corrosion resistance to seawater chlorides.

Important operation parameters such as feed pressure, flows and differential pressure across the membranes are all measured and relayed to the PLC/SCADA system for monitoring, recording and feed back to the control.

Post-Treatment Systems

The permeate water from the RO is disinfected by the addition of chlorine from a gas chlorination system, complete with all necessary instrumentation to allow safe and accurate operation with automatic feed back to the SCADA.

Permeate water is further conditioned for drinking purposes by adjusting the pH to optimal levels through the addition of food grade lime. Raising the pH with calcium carbonate is optimal in seawater desalination applications to compensate the lack of Ca^{++} ions in the permeate. A Lime handling and dosing system is



provided for this purpose, along with all necessary instrumentation to provide a fully automated dosing system.

Flushing System

Permeate water travels to a flushing tank prior to post treatment, so as to provide a volume reserved for the purpose of membranes flushing. Flushing is automatically triggered upon shutdown of the RO plant in order to avoid stagnation of saline water in the interstitial flow channels on the high-pressure side of the membranes. In addition to extending the life span of the membranes, the process also serves as a spontaneous treatment upon a fault shutdown.

Membranes Cleaning System

The plant is also provided with a stationary cleaning system for the purpose of controlling the progressive fouling of the membranes. Such need for cleaning depends primarily on how effective is the pretreatment. The culminating parameter that decides on the need to clean is the differential pressure across the membranes, which is measured by a differential pressure monitoring switch preset for alarm. A constant permeate flow at a given feed pressure and temperature indicates that the system is stable and that no fouling is occurring.

Control & Instrumentation

The control panel is PLC based and automatically controls all aspects of plant operation. The controls are designed not only to process all feedbacks from field



instruments into respective commands, but also to protect the system against improper feed water or product quality/quantity that is out of the specified range. All such functions are displayed through a state-of-the-art SCADA system involving monitoring and control from the desktop PC. Several levels of authorities are provided to ensure that only authorised personnels have access to the appropriate range of commands through the SCADA.

The successful commissioning and operation of the Fujairah seawater desalination plant contributed to the welfare of the community, and provided a source of fresh water that serves the busy port of the Emirate. The project is a clear demonstration of Metito's dedication to providing its clients with unmatched quality of products and services whilst responding to their needs.



Desalination Plant Schematic Flow Diagram

