

## Seawater Desalination Plant #497



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## 1. Executive Summary

### 1.1 Plant Capacity

- Three (3) plants available, each 7,000 M3/day (77,000 gallons per hour) of sea water

### 1.2 Plant History

- Built in 2010
- Shut down in 2013
- Completely refurbished in 2016

### 1.3 Product Quality

- Total Dissolved Solids (TDS) 35,000 mg/L to 45,000 mg/L
- Silt Density Index (SDI) < 10
- Recovery/Rejection 35 – 45 % / 98%
- pH 4 – 10
- Temperature 20 – 40 °C

### 1.4 Power Requirements

- Power Supply 11 kV, 50Hz, 3 phase
- Total Consumption 25,916 KWh/day at 16 °C

## 2. Process Description

Seawater enters the desalination plant by 4 X 33% intake seawater pumps after 5 mm screening. After two self-cleaning micron filters and optional coagulant dosing, the water enters the Ultra Filtration (UF) arrays simultaneously. UF permeate & backwash tank feed the 3 arrays of Reverse Osmosis (RO) unit. Every array consists of anti-scalant dosing (to each RO unit inlet) low pressure pump, high-pressure pump, pressure exchangers and PX energy recovery booster pump. RO LP pump delivery line split to 2 different lines: RO HP pump and PX unit. Common UF/RO brine tank is gravitationally drained to sea. SBS is injected to the combined RO feed inlet after the UF tank outlet. Optional caustic soda injection for higher boron removal is installed in the same location. Each RO array consists of 3X28 pressure vessels (total of 588 RO membranes). From RO permeate tank the water is pumped to 3 different lines:

- Service line. Fill RO/UF CIP & CEB tank (membranes cleaning procedures) by two service pumps.
- Main desalinated water stream before mixing with re-hardening stream.

- Re-hardening stream (20% from the total) which goes by two pumps to Calcite filters after hydrochloric acid injection.

The joined product stream after mixing the main desalinated water stream with the re-hardening stream (20% from the total), and caustic soda injection is supplied to the customer by 4 X 33% delivery pumps.

The CEB/CIP system includes CIP tank, two RO CIP/Flush pumps, two UF BW pumps and one UF CIP pump.

### Chemical Dosing

Dosing pumps inject the chemicals from the relevant chemical tank. For each chemical there is a double chemical dosing system, including:

1. Chemical cubes at each chemical pallet
2. Dosing pumps

### Air Supply

The air supply is made by 2X100% spiral air compressors, air storage tank, including automatic water discharge system and air dryer. The air dryer system is for the purpose of: controlled valves solenoids and UF integrity test. The air supply to the UF BW procedure is done by two air blowers.

## **3. Equipment**

<b>1 x 20' Seawater Pump Container</b>	
1 x Intake / UF Feed Pump	Horizontal Centrifugal Pump, Sulzer A44-200LM HP
1 x Motor (UF Feed Pump)	ABB, 132 kW, 690 VAC, Drive – VFD
1 x 500 micron Strainers	Self-cleaning auto-backwashable strainers
1 x Motor (500 Micron Strainer)	ABB, 0.5 kW, 415 VAC, Drive – DOL
2 x 100 micron Strainers	Self-cleaning auto-backwashable strainers
2 x Motor (100 Micron Strainers)	ABB, 0.35 kW, 415 VAC, Drive – DOL
<b>4 x 40' UF Containers</b>	
4 x UF Trains	66 UF modules per train (Total 264 UF modules), piping & Instrumentation
<b>1 x 40' SWRO Feed &amp; ERD Container</b>	
1 x SWRO LP Pump	Horizontal Centrifugal Pump, Sulzer A44-150
1 x Motor (SWRO LP Pump)	ABB, 200 kW, 690 VAC, Drive - VFD
1 x PX Booster Pump	Vertical Centrifugal Pump, Union
1 x Motor (PX Booster Pump)	ABB, 55 kW, 415 VAC, Drive - VFD
1 x Energy Recovery System	Pressure exchanger system from ERI
<b>1 x SWRO HP Pump Skid</b>	
1 x SWRO HP Pump	Horizontal Centrifugal Pump, Sulzer MBN 100-300 / 6stage
1 x Motor (SWRO HP Pump)	ABB, 710 kW, 11 kV, Drive - DOL
<b>3 x 40' SWRO Containers</b>	
3 x SWRO Trains	7 elements long x 31 pressure vessels per train (Total 651 RO membranes), Skid piping & Instrumentation

<b>1 x 40' Ancillary Container</b>	
1 x UF Backwash Pump	Horizontal Centrifugal Pump, Sulzer A41-200
1 x Motor (UF Backwash Pump)	ABB, 45 kW, 415 VAC, Drive - VFD
1 x UF CIP Pump	Vertical Inline Pump, Grundfos CRN64-1
1 x Motor (UF CIP Pump)	ABB, 15 kW, 415 VAC, Drive - VFD
1 x Permeate Service General Pump	Vertical Inline Pump, Grundfos CRN64-1
1 x Motor (Permeate Service General Pump)	ABB, 15 kW, 415 VAC, Drive - VFD
1 x RO CIP/Flush Pump	Horizontal Centrifugal Pump, Sulzer A33-125
1 x Motor (RO CIP/Flush Pump)	ABB, 55 kW, 415 VAC, Drive - DOL
1 x UF Air Blower	Roots twin lobe, Gardner Denver OR Equal
1 x Motor (UF Air Blower)	ABB, 37 kW, 415 VAC, Drive - VFD
1 x Air compressor	Positive Displacement Reciprocating, Atlas copco OR Equal
1 x Motor (Air compressor)	ABB, 15 kW, 415 VAC, Drive - DOL
3 x UF CEB Chemical Dosing System	Air Operated Diaphragm Pumps, Sandpiper or Equal 200 Ltrs. Dosing Tanks with Bunds
6 x Chemical Dosing Pumps	Electronic Metering Pump, 0.3 kW, 240 VAC, Grundfos OR Equal 200 Ltrs. Dosing Tanks with Bunds
<b>1 x 40' MCC container with</b>	
MV Switchgear	11 kV Switchgear
LV Switchgear	690 V & 415 V Switchgear
Control System	Allen Bradley/Siemens Control System
<b>Ancillary Items</b>	
1 x Product Water Pump	Horizontal Centrifugal Pump, Sulzer MBN100-300/2
1 x Motor (Product Water Pump)	ABB, 315 kW, 690 VAC, Drive – VFD
1 x 40' Operator Container	
1 x 11 kV to 690 V SDT	
1 x 11 kV to 415 V SDT	
1 x Calcite Filter with access platform (4m diameter tank on skid)	
1 x All interconnecting pipework and cables with overhead pipe / cable rack	



## 5. Power Consumption

ELECTRICAL POWER CONSUMPTION LIST																										
7 MLD UF + SWRO PLANT																										
Project		7 MLD Desalination Plant										Proposal Ref. No.		OPPOXXXX		PREP		CHKD		APPR						
Doc. No.		OPPOXXXX - EPCL										Rev.		0		SB		BW								
Date		16-July-2019										Page		1 of 1												
No.	Equipment Item No.	System/ Equipment Name	Design Duty Condition	Starter	Power Requirement (Note-1)	Rated Volt (V)	Rated Power (kW)	Break Horse Power (BkW)	Pump Efficiency (%)	Motor Efficiency (%)	VFD Efficiency (%)	QTY (Note-2)			Average Installed Working Load in kWh		Instantaneous Installed Working Load in kWh		Installed Load (kW)	Operating Load (kW)	Power Consumption kWh	Daily Power Consumption based on TDS at Corresponding Temperature (Membrane Age 1 Yrs)				
												CON.	INT.	SB.	Duty Condition %	Motor Rating (kW)	Duty Condition %	Motor Rating (kW)				at 16 °C	at 25 °C	at 30 °C		
																									kWh/d	kWh/d
1	OPPOXXXXFHP001	SWRO High Pressure Pump 001	292 m3/hr at 63 bar	DOL	N	11000	710.00	655	78.0%	97%	-	1			100%	710.0	100.0%	710.0	710.00	710.00	675.58	15,749	16,212	16,341		
2	OPPOXXXXRCP001	RO Recirculation Pump 001	387 m3/hr at 4 bar	VFD	N	690	55.00	53.1	81%	95%	97.0%	1			100%	55.0	100.0%	55.0	55.00	55.00	57.62	1,037	968	899		
3	OPPOXXXXSWP001	Seawater intake Pump 001	805.1 m3/hr at 4.5 bar	VFD	N	690	160.00	115.87	85.2%	93%	97.0%	1			100%	160.0	100.0%	160.0	160.00	160.00	128.45	3,083	3,083	3,083		
4	OPPOXXXXSWP002	LP Feed Pump 001	679 m3/hr at 8.0 bar	VFD	N	690	200.00	174.14	85%	93%	97.0%	1			100%	200.0	100.0%	200.0	200.00	200.00	193.04	4,633	4,633	4,633		
5	OPPOXXXXSWP003	UF Backwash Pump 001	420 m3/hr at 2.0 bar	DOL	N	690	45.00	31.38	82.5%	93%	-	1			26.67%	0.0	1.11%	0.0	45.00	45.00	9.00	216	216	216		
6	OPPOXXXXSWP003	UF CIP Pump 001	70 m3/hr at 3.8 bar	DOL	N	690	11.00	8.79	82.5%	93%	-	1			26.67%	0.0	1.11%	0.0	11.00	11.00	2.52	60	60	60		
7	OPPOXXXXCIP001	RO CIP Pump 001	350 m3/hr at 4 bar	DOL	N	690	55.00	46.41	82.2%	94%	-	1			0.56%	0.3	100.0%	55.0	55.00	55.00	0.27	7	7	7		
8	OPPOXXXXCIPH002	CIP Tank Heater	-	DOL	N	690	15.00	12.75	-	93%	-	1			0.56%	0.1	100.0%	15.0	15.00	15.00	0.08	2	2	2		
9	OPPOXXXXCIPH001	CIP Tank Mixer	-	DOL	N	690	3.70	3.145	-	93%	-	1			0.56%	0.0	100.0%	3.7	3.70	3.70	0.02	0	0	0		
10	OPPOXXXXACB001	UF Air Scour Blower 001	-	DOL	N	690	37.00	31.45	-	93%	-	1			13.33%	4.9	100.0%	37.0	37.00	37.00	4.51	108	108	108		
11	OPPOXXXXACB002	Compressor for ON/OFF Valves	-	DOL	N	690	25.00	21.25	-	93%	-	1			5.00%	1.3	100.0%	25.0	25.00	25.00	1.14	27	27	27		
12	OPPOXXXXABWS001	Auto Backwash Strainer 001	-	DOL	N	690	0.25	0.2125	-	93%	-	1			100%	0.3	100.0%	0.3	0.25	0.25	0.23	5	5	5		
13	OPPOXXXXABWS002	Auto Backwash Strainer 002	-	DOL	N	690	0.25	0.2125	-	93%	-	1			100%	0.3	100.0%	0.3	0.25	0.25	0.23	5	5	5		
14	OPPOXXXXHDP001	UF Hypochlorite Dosing Pump 001	-	DOL	N	230	3.00	2.55	-	85%	-	1			100%	3.0	100.0%	3.0	3.00	3.00	3.00	72	72	72		
15	OPPOXXXXHDP002	UF Caustic Soda Dosing Pump 001	-	DOL	N	230	3.00	2.55	-	85%	-	1			100%	0.0	0.0%	0.0	3.00	3.00	3.00	72	72	72		
16	OPPOXXXXFCP001	UF HCl Dosing Pump 001	-	DOL	N	230	3.00	2.55	-	85%	-	1			100%	3.0	100.0%	3.0	3.00	3.00	3.00	72	72	72		
17	OPPOXXXXASIP001	Antiscalant Dosing Pump - 001	-	DOL	N	230	0.75	0.6375	-	85%	-	1			100%	0.8	100.0%	0.8	0.75	0.75	0.75	18	18	18		
18	OPPOXXXXMBSFP001	SMBS Dosing Pump - 001	-	DOL	N	230	0.75	0.6375	-	85%	-	1			0%	0.0	100.0%	0.8	0.75	0.75	0.00	-	-	-		
19	OPPOXXXXLCP001	Local Control Panel	-	DOL	UPS	230	15.00	17.00	-	100%	-	1			100%	15.0	100.0%	15.0	15.00	15.00	17.00	408	408	408		
20	OPPOXXXX xxxx	Container Lighting	-	DOL	N	230	7.00	10.00	-	100%	-	1			100%	7.0	100.0%	7.0	7.00	7.00	10.00	240	240	240		
																					Total Power Consumption (kWh/d)			25,916	26,310	26,370
																					Specific Power Consumption (kWh/m3) at varying temperatures			3.70	3.76	3.77
																					Specific Power Consumption (kWh/m3) at average temperatures			3.74		

**NOTE**

- 1. Power Requirement :
  - N : Normal Power
  - ES : Essential Power from Emergency diesel generator
  - UPS : Uninterrupt Power System
  - DC : DC power

- 2. Q'ty
  - CON: Continuous Load
  - INT: Intermittent Load
  - SB: Standby Load

- 3. Electrical Load List is tentative for tender purpose only and subject to revision based on actual rated power to be confirmed during detail engineering and vendor finalization.
- 4. The Working Load and Installed load are indicative for sizing of Electrical system only.
- 5. Average Power consumption is based on the worst case scenario (minimum temperature conditions).