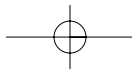
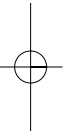
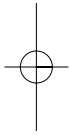


Appendices



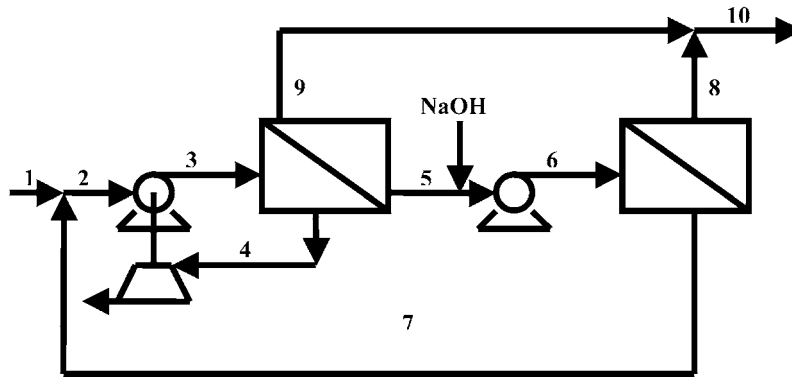
Appendix A Membrane unit configurations

Mediterranean feedwater temperature 14°C Split partial two pass: SWRO + BWRO

Feed water source: Mediterranean seawater	Feed water type: surface intake
System configuration: split partial two pass	Output capacity: 9666 m ³ /d (2.55 mgd)
Permeate recovery 1st pass: 50%	Permeate recovery 2nd pass: 90%
Total system recovery: 49.3%	Calculation for membrane age: 3 years (-20% nominal flow, +30% of nominal salt passage)
Feed flow 1st pass: 833.4 m ³ /h (3670 gpm)	Feed flow 2nd pass: 138.9 m ³ /h (612 gpm)
Feed pressure 1st pass: 69.1 bar (1002 psi)	Feed pressure 2nd pass: 14.7 bar (213 psi)
Concentrate pressure 1st pass: 67.8 bar (924 psi)	Concentrate pressure 2nd pass: 9.7 bar (141 psi)
Elements type 1st pass: SWC5	Elements type 2nd pass: ESPAB
Array 1st pass: 100 PV (8M)	Array 2nd pass: 9: 4 PV (8M)
Average flux 1st pass: 14 l/m ² /h (8.2 gfd)	Average flux 2nd pass: 32.3/m ² /h (19.0 gfd)
Feed pH 1st pass: 8.1	Feed pH 2nd pass: 10

Constituent	Feed, ppm	Permeate, ppm	Concentrate, ppm
Temperature	14°C (57°F)		
pH	8.1	8.1	8.4
Ca	483	0.3	950
Mg	1557	0.9	3061
Na	12200	34.9	23961
K	481	1.7	944
CO ₃	5	0.0	11.2
HCO ₃	162	0.7	318
SO ₄	3186	1.8	6264
Cl	22599	54	44294
F	1.4	0.0	2.7
NO ₃			
B	5	0.3	9.3
SiO ₂	1.6	0.0	3.3
TDS	40686	95	79929

Ap. A / Membrane Unit Configurations



Location	1	2	3	4	5	6	7	8	9	10
Flow, m ³ /h (gpm)	820.1 (3611)	833.4 (3670)	833.4 (3670)	416.7 (1835)	138.9 (612)	138.9 (612)	13.9 (61)	125.0 (550)	277.8 (612)	402.8 (1773)
Pressure, bar (psi)			69.1 (1002)	67.8 (983)		14.7 (213)	9.7 (141)			
TDS ppm	40668	40080	40080	79928	432	432	4249	13	131	95

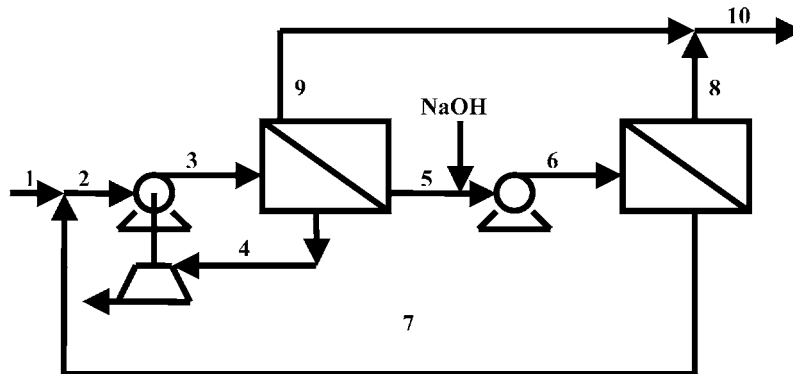
	Pass 1 and total	Pass 2
Feed pressure, bar (psi)	69.1 (1002)	14.7 (213)
Concentrate pressure, bar (psi)	67.8 (983)	9.7 (141)
Pump flow, m ³ /h (gpm)	833.4 (3550)	138.9 (612)
Turbine flow, m ³ /h (gpm)	416.7 (1835)	
Pump efficiency, %	86	84
Motor efficiency, %	94	94
Energy recovery device efficiency, %	86	
Combined pumping power, kW (hp)	2016.8 (2705)	
Recovered power, kW (hp)	661.7 (887)	
Total power requirement, kW (hp)	1355.1 (1817)	
Pumping energy, kWh/m ³ (kWh/kgal)	3.36 (12.71)	

**Mediterranean feedwater temperature 28°C
Split partial two pass: SWRO + BWRO**

Feed water source: Mediterranean seawater	Feed water type: surface intake
System configuration: split partial two pass	Output capacity: 9333 m ³ /d (2.46 mgd)
Permeate recovery 1st pass: 50%	Permeate recovery 2nd pass: 90%
Total system recovery: 48.3%	Calculation for membrane age: 3 years (-20% nominal flow, +30% of nominal salt passage)
Feed flow 1st pass: 833.4 m ³ /h (3670 gpm)	Feed flow 2nd pass: 277.8 m ³ /h (1223 gpm)
Feed pressure 1st pass: 65 bar (942 psi)	Feed pressure 2nd pass: 10.6 bar (154 psi)
Concentrate pressure 1st pass: 63.7 bar (924 psi)	Concentrate pressure 2nd pass: 6.2 bar (90 psi)
Elements type 1st pass: SWC5	Elements type 2nd pass: ESPAB
Array 1st pass: 100 PV (8M)	Array 2nd pass: 18: 9 PV (8M)
Average flux 1st pass: 14 l/m ² /h (8.2 gfd)	Average flux 2nd pass: 31.1/m ² /h (18.3 gfd)
Feed pH 1st pass: 8.1	Feed pH 2nd pass: 10

Constituent	Feed, ppm	Permeate, ppm	Concentrate, ppm
Temperature	28°C (82°F)		
pH	8.1	7.9	8.4
Ca	483	0.2	934
Mg	1557	0.5	3010
Na	12200	22.9	23572
K	481	1.2	929
CO ₃	5	0.0	11.2
HCO ₃	162	0.5	312
SO ₄	3186	1.0	6159
Cl	22599	36	43664
F	1.4	0.0	2.7
NO ₃			
B	5	0.3	9.3
SiO ₂	1.6	0.0	3.3
TDS	40686	62	78615

Ap. A / Membrane Unit Configurations



Location	1	2	3	4	5	6	7	8	9	10
Flow, m ³ /h (gpm)	806.2 (3550)	833.4 (3670)	833.4 (3670)	416.7 (1835)	277.8 (1223)	277.8 (1223)	27.8 (122)	250.0 (1101)	138.9 (612)	388.9 (1712)
Pressure, bar (psi)			65.0 (947)	63.7 (924)		10.6 (154)	6.2 (90)			
TDS ppm	40668	39489	39489	78616	484	484	4647	28	124	62

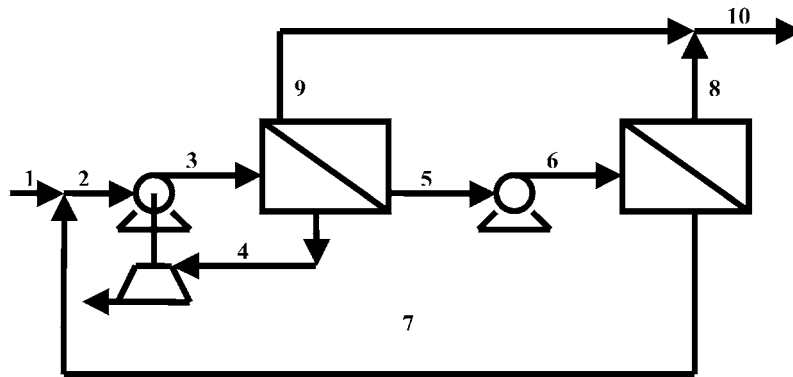
	Pass 1 and total	Pass 2
Feed pressure, bar (psi)	65.0 (947)	10.6 (154)
Concentrate pressure, bar (psi)	63.7 (924)	6.2 (90)
Pump flow, m ³ /h (gpm)	833.4 (3550)	277.8 (1223)
Turbine flow, m ³ /h (gpm)	416.7 (1835)	
Pump efficiency, %	86	84
Motor efficiency, %	94	94
Energy recovery device efficiency, %	86	
Combined pumping power, kW (hp)	1973.7 (2647)	
Recovered power, kW (hp)	621.7 (834)	
Total power requirement, kW (hp)	1352.0 (1813)	
Pumping energy, kWh/m ³ (kWh/kgal)	3.47 (13.13)	

Persian Gulf feedwater temperature 16°C
Split partial two pass: SWRO + BWRO

Feed water source: Persian Gulf seawater	Feed water type: surface intake
System configuration: split partial two pass	Output capacity: 9666 m ³ /d (2.55 mgd)
Permeate recovery 1st pass: 42%	Permeate recovery 2nd pass: 90%
Total system recovery: 41.2%	Calculation for membrane age: 3 years (-20% nominal flow, +30% of nominal salt passage)
Feed flow 1st pass: 992.2 m ³ /h (4369 gpm)	Feed flow 2nd pass: 69.5 m ³ /h (306 gpm)
Feed pressure 1st pass: 67.8 bar (983 psi)	Feed pressure 2nd pass: 12.4 bar (180 psi)
Concentrate pressure 1st pass: 66.1 bar (958 psi)	Concentrate pressure 2nd pass: 7.3 bar (106 psi)
Elements type 1st pass: SWC5	Elements type 2nd pass: ESPA2+
Array 1st pass: 110 PV (8M)	Array 2nd pass: 4: 2 PV (8M)
Average flux 1st pass: 12.7 l/m ² /h (7.5 gfd)	Average flux 2nd pass: 31.9/m ² /h (18.8 gfd)
Feed pH 1st pass: 7.0	Feed pH 2nd pass: 5.6

Constituent	Feed, ppm	Permeate, ppm	Concentrate, ppm
Temperature	16°C (61°F)		
pH	7.0	5.1	7.2
Ca	478	0.5	818
Mg	1672	1.7	2861
Na	14099	68.6	24090
K	530	3.2	905
CO ₃	4.2	0.0	0.6
HCO ₃	154	1.3	258
SO ₄	3314	3.3	5707
Cl	24927	99	42606
F			
NO ₃			
B	5	1.0	7.8
SiO ₂			
TDS	45199	177	77256

Ap. A / Membrane Unit Configurations



Location	1	2	3	4	5	6	7	8	9	10
Flow, m ³ /h (gpm)	985.9 (3441)	992.2 (4369)	992.2 (4369)	575.5 (2534)	69.5 (306)	69.5 (306)	6.9 (30)	62.5 (275)	347.2 (1529)	409.7 (1795)
Pressure, bar (psi)			67.8 (983)	66.1 (958)		12.4 (180)	7.3 (106)			
TDS ppm	45199	44925	44925	77256	629	629	6158	15	206	177

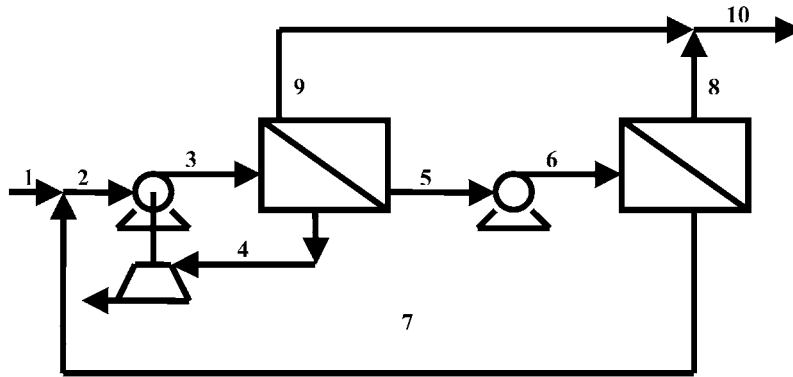
	Pass 1 and total	Pass 2
Feed pressure, bar (psi)	67.8 (983)	12.4 (180)
Concentrate pressure, bar (psi)	66.1 (958)	7.3 (106)
Pump flow, m ³ /h (gpm)	992.2 (4369)	69.5 (306)
Turbine flow, m ³ /h (gpm)	575.5 (2534)	
Pump efficiency, %	86	84
Motor efficiency, %	94	94
Energy recovery device efficiency, %	86	
Combined pumping power, kW (hp)	2304.1 (3090)	
Recovered power, kW (hp)	890.8 (1195)	
Total power requirement, kW (hp)	1413.3 (1895)	
Pumping energy, kWh/m ³ (kWh/kgal)	3.45 (13.06)	

Persian Gulf feedwater temperature 34°C
Split partial two pass: SWRO + BWRO

Feed water source: Persian Gulf seawater	Feed water type: surface intake
System configuration: split partial two pass	Output capacity: 9666 m ³ /d (2.55 mgd)
Permeate recovery 1st pass: 42%	Permeate recovery 2nd pass: 90%
Total system recovery: 41.2%	Calculation for membrane age: 3 years (-20% nominal flow, +30% of nominal salt passage)
Feed flow 1st pass: 992.2 m ³ /h (4369 gpm)	Feed flow 2nd pass: 138.9 m ³ /h (611 gpm)
Feed pressure 1st pass: 64.4 bar (934 psi)	Feed pressure 2nd pass: 10.7 bar (155 psi)
Concentrate pressure 1st pass: 62.8 bar (911 psi)	Concentrate pressure 2nd pass: 7.1 bar (103 psi)
Elements type 1st pass: SWC5	Elements type 2nd pass: ESPA2+
Array 1st pass: 110 PV (8M)	Array 2nd pass: 8: 4 PV (8M)
Average flux 1st pass: 12.7 l/m ² /h (7.5 gfd)	Average flux 2nd pass: 31.9/m ² /h (18.8 gfd)
Feed pH 1st pass: 7.0	Feed pH 2nd pass: 5.8

Constituent	Feed, ppm	Permeate, ppm	Concentrate, ppm
Temperature	34°C (93°F)		
pH	7.0	5.2	7.2
Ca	478	0.5	812
Mg	1672	1.6	2841
Na	14099	72	23919
K	530	3.5	899
CO ₃	4.2	0.0	0.9
HCO ₃	154	1.3	265
SO ₄	3314	3.3	5660
Cl	24927	106	42303
F			
NO ₃			
B	5	1.9	7.2
SiO ₂			
TDS	45199	190	76707

Ap. A / Membrane Unit Configurations



Location	1	2	3	4	5	6	7	8	9	10
Flow, m ³ /h (gpm)	979.0 (4308)	992.2 (4369)	992.2 (4369)	575.5 (2534)	138.9 (611)	138.9 (611)	13.9 (61)	125 (550)	277.8 (1222)	402.8 (1772)
Pressure, bar (psi)			64.4 (934)	62.8 (911)		10.7 (155)	7.1 (103)			
TDS ppm	45199	44695	44695	76707	977	977	9153	68	245	190

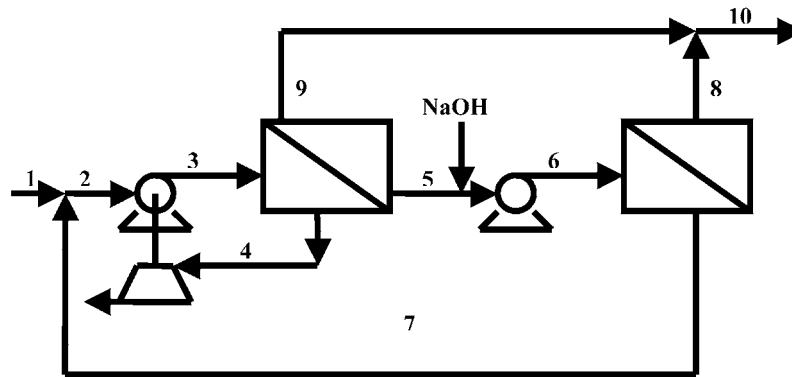
	Pass 1 and total	Pass 2
Feed pressure, bar (psi)	64.4 (934)	10.7 (155)
Concentrate pressure, bar (psi)	62.8 (911)	7.1(103)
Pump flow, m ³ /h (gpm)	992.2 (4369)	138.9 (611)
Turbine flow, m ³ /h (gpm)	575.5 (2534)	
Pump efficiency, %	86	84
Motor efficiency, %	94	94
Energy recovery device efficiency, %	86	
Combined pumping power, kW (hp)	2195.3 (2941)	
Recovered power, kW (hp)	846.4 (1135)	
Total power requirement, kW (hp)	1348.9 (1809)	
Pumping energy, kWh/m ³ (kWh/kgal)	3.35 (12.68)	

**Red Sea feedwater temperature 16°C
Split partial two pass SWRO + BWRO**

Feed water source: Red sea seawater	Feed water type: surface intake
System configuration: split partial two pass	Output capacity: 9666 m ³ /d (2.55 mgd)
Permeate recovery 1st pass: 47%	Permeate recovery 2nd pass: 90%
Total system recovery: 45.9%	Calculation for membrane age: 3 years (-20% nominal flow, +30% of nominal salt passage)
Feed flow 1st pass: 886.6 m ³ /h (3904gpm)	Feed flow 2nd pass: 185.2 m ³ /h (815 gpm)
Feed pressure 1st pass: 68.7 bar (996 psi)	Feed pressure 2nd pass: 13.6 bar (197 psi)
Concentrate pressure 1st pass: 67.2 bar (977 psi)	Concentrate pressure 2nd pass: 8.7 bar (126 psi)
Elements type 1st pass: SWC5	Elements type 2nd pass: ESPA2+
Array 1st pass: 100 PV (8M)	Array 2nd pass: 12: 6 PV (8M)
Average flux 1st pass: 14.0 l/m ² /h (8.2 gfd)	Average flux 2nd pass: 31.1/m ² /h (18.3 gfd)
Feed pH 1st pass: 8.2	Feed pH 2nd pass: 10

Constituent	Feed, ppm	Permeate, ppm	Concentrate, ppm
Temperature	16°C (61°F)		
pH	7.8	7.6	8.0
Ca	500	0.2	923
Mg	1540	0.7	2844
Na	13300	31	24546
K	490	1.4	904
CO ₃	2.3	0.0	4.4
HCO ₃	126.8	0.5	238
SO ₄	3240	1.5	5995
Cl	23180	45	42786
F			
NO ₃			
B	5.3	0.4	9.5
SiO ₂			
TDS	42389	80	78252

Ap. A / Membrane Unit Configurations



Location	1	2	3	4	5	6	7	8	9	10
Flow, m ³ /h (gpm)	868.7 (3825)	886.6 (3904)	886.6 (3904)	469.9 (2069)	185.2 (815)	185.2 (815)	18.5 (81)	166.7 (734)	231.5 (1019)	398.2 (1753)
Pressure, bar (psi)			68.7 (996)	67.2 (977)		13.6 (197)	8.7 (126)			
TDS ppm	42389	41591	41591	78252	399	399	3941	13	128	80

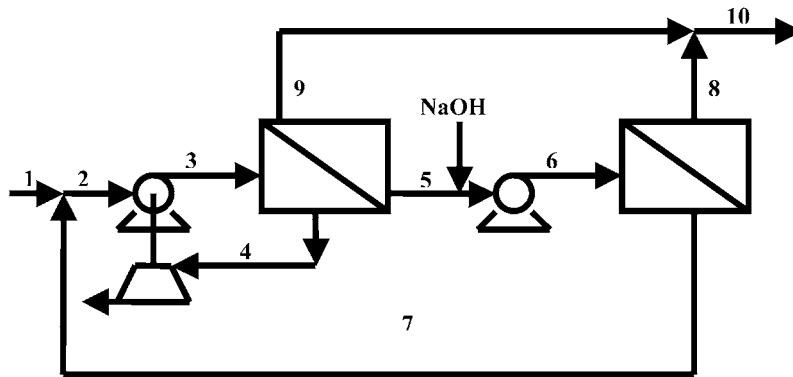
	Pass 1 and total	Pass 2
Feed pressure, bar (psi)	68.7 (996)	13.6 (197)
Concentrate pressure, bar (psi)	67.2 (977)	8.7 (126)
Pump flow, m ³ /h (gpm)	886.6 (3904)	185.2 (815)
Turbine flow, m ³ /h (gpm)	469.9 (2069)	
Pump efficiency, %	86	84
Motor efficiency, %	94	94
Energy recovery device efficiency, %	86	
Combined pumping power, kW (hp)	2147.7 (2880)	
Recovered power, kW (hp)	739.5 (992)	
Total power requirement, kW (hp)	1408.2 (1888)	
Pumping energy, kWh/m ³ (kWh/kgal)	3.53 (13.36)	

Red Sea feedwater temperature 26°C Split partial two pass SWRO + BWRO

Feed water source: Red Sea seawater	Feed water type: surface intake
System configuration: split partial two pass	Output capacity: 9666 m ³ /d (2.55 mgd)
Permeate recovery 1st pass: 47%	Permeate recovery 2nd pass: 90%
Total system recovery: 45.3%	Calculation for membrane age: 3 years (-20% nominal flow, +30% of nominal salt passage)
Feed flow 1st pass: 886.6 m ³ /h (3904gpm)	Feed flow 2nd pass: 277.8 m ³ /h (1223 gpm)
Feed pressure 1st pass: 65.6 bar (951 psi)	Feed pressure 2nd pass: 11.0 bar (159 psi)
Concentrate pressure 1st pass: 64.1 bar (929 psi)	Concentrate pressure 2nd pass: 6.4 bar (93 psi)
Elements type 1st pass: SWC5	Elements type 2nd pass: ESPA2+
Array 1st pass: 100 PV (8M)	Array 2nd pass: 18.9 PV (8M)
Average flux 1st pass: 14.0 l/m ² /h (8.2 gfd)	Average flux 2nd pass: 31.1/m ² /h (18.3 gfd)
Feed pH 1st pass: 8.2	Feed pH 2nd pass: 10

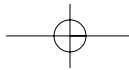
Constituent	Feed, ppm	Permeate, ppm	Concentrate, ppm
Temperature	26°C (79°F)		
pH	7.8	7.5	8.0
Ca	500	0.2	914
Mg	1540	0.5	2814
Na	13300	23	24294
K	490	1.1	894
CO ₃	2.3	0.0	5.8
HCO ₃	126.8	0.5	237
SO ₄	3240	1.0	5928
Cl	23180	35	42341
F			
NO ₃			
B	5.3	0.4	9.3
SiO ₂			
TDS	42389	61	77440

Ap. A / Membrane Unit Configurations



Location	1	2	3	4	5	6	7	8	9	10
Flow, m ³ /h (gpm)	859.5 (3785)	886.6 (3904)	886.6 (3904)	469.9 (2069)	277.8 (1223)	277.8 (1223)	27.8 (122)	250 (1100)	138.9 (611)	388.9 (1711)
Pressure, bar (psi)			65.6 (951)	64.1 (929)		11.0 (159)	6.4 (93)			
TDS ppm	42389	41591	41591	78252	399	399	3941	13	128	80

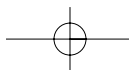
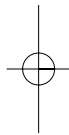
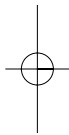
	Pass 1 and total	Pass 2
Feed pressure, bar (psi)	65.6 (951)	11.0 (159)
Concentrate pressure, bar (psi)	64.1 (929)	6.4 (93)
Pump flow, m ³ /h (gpm)	886.6 (3904)	277.8 (1223)
Turbine flow, m ³ /h (gpm)	469.9 (2069)	
Pump efficiency, %	86	84
Motor efficiency, %	94	94
Energy recovery device efficiency, %	86	
Combined pumping power, kW (hp)	2117.7 (2840)	
Recovered power, kW (hp)	705.4 (946)	
Total power requirement, kW (hp)	1412.3 (1894)	
Pumping energy, kWh/m ³ (kWh/kgal)	3.63 (13.74)	

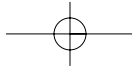


**Caribbean feedwater temperature 26°C
Single pass SWRO**

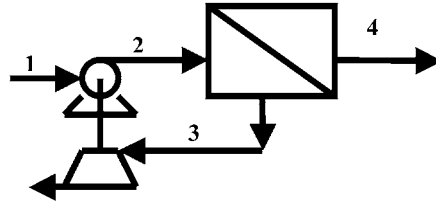
Feed water source: Caribbean seawater	Feed water type: surface intake
System configuration: single pass	Output capacity: 10000 m ³ /d (2.64 mgd)
Permeate recovery: 50%	Feed flow 1st pass: 833.4 m ³ /h (3667gpm)
Feed pressure pass: 60.5 bar (877 psi)	Concentrate pressure: 59.2 bar (858 psi)
Array: 100 PV (8M)	Elements type: SWC5
Average flux: 14.0 l/m ² /h (8.2 gfd)	Calculation for membrane age: 3 years (-20% nominal flow, +30% of nominal salt passage)
Raw water pH 1st pass: 8.2	Feed water temperature: 26°C (79°F)

Constituent	Feed, ppm	Permeate, ppm	Concentrate, ppm
pH	8.2	6.5	8.4
Ca	477	1.0	953
Mg	1160	2.5	2318
Na	11322	114.3	22530
K	386	4.9	767
CO ₃	2.3	0.0	4.5
HCO ₃	137	0.5	271
SO ₄	2600	6.0	5194
Cl	20034	184	39883
F			
NO ₃			
B	5.3	1.1	9.5
SiO ₂			
TDS	36149	316	71983



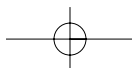
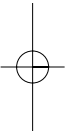
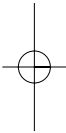


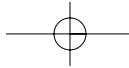
Ap. A / Membrane Unit Configurataions



Location	1	2	3	4
Flow, m ³ /h (gpm)	833.4 (3667)	833.4 (3667)	416.7 (1833)	416.7 (1833)
Pressure, bar (psi)		60.5 (877)	59.2 (858)	
TDS ppm	36149	36149	71983	316

RO train	
Feed pressure, bar (psi)	60.5 (877)
Concentrate pressure, bar (psi)	59.2 (858)
Pump flow, m ³ /h (gpm)	833.4 (3667)
Turbine flow, m ³ /h (gpm)	416.7 (1833)
Pump efficiency, %	86
Motor efficiency, %	94
Energy recovery device efficiency, %	86
Combined pumping power, kW (hp)	1738.6 (2331)
Recovered power, kW (hp)	577.7 (745)
Total power requirement, kW (hp)	1160.9 (1557)
Pumping energy, kWh/m ³ (kWh/kgal)	2.78 (10.52)

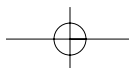
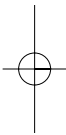
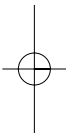




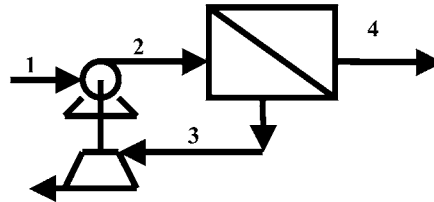
**Pacific feedwater temperature 20°C
Single pass SWRO**

Feed water source: Pacific seawater	Feed water type: surface intake
System configuration: single pass	Output capacity: 10000 m ³ /d (2.64 mgd)
Permeate recovery: 50%	Feed flow 1st pass: 833.4 m ³ /h (3667gpm)
Feed pressure pass: 57.6 bar (835 psi)	Concentrate pressure: 56.2 bar (815 psi)
Array: 100 PV (8M)	Elements type: SWC5
Average flux: 14.0 l/m ² /h (8.2 gfd)	Calculation for membrane age: 3 years (-20% nominal flow, +30% of nominal salt passage)
Raw water pH 1st pass: 8.0	Feed water temperature: 20°C (68°F)

Constituent	Feed, ppm	Permeate, ppm	Concentrate, ppm
pH	8.0	6.3	8.3
Ca	440	0.8	879
Mg	1300	2.3	2598
Na	10200	85	20315
K	380	4.0	756
CO ₃	2.0	0.0	4.0
HCO ₃	170	2.2	338
SO ₄	3000	5.6	5994
Cl	18500	137	36863
F			
NO ₃			
B	4.5	0.9	8.1
SiO ₂			
TDS	34000	238	67763

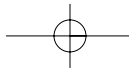


Ap. A / Membrane Unit Configurations



Location	1	2	3	4
Flow, m ³ /h (gpm)	833.4 (3667)	833.4 (3667)	416.7 (1833)	416.7 (1833)
Pressure, bar (psi)		57.6 (835)	56.2 (815)	
TDS ppm	34000	34000	67763	237

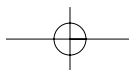
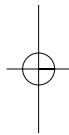
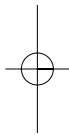
RO train	
Feed pressure, bar (psi)	57.6 (835)
Concentrate pressure, bar (psi)	56.2 (815)
Pump flow, m ³ /h (gpm)	833.4 (3667)
Turbine flow, m ³ /h (gpm)	416.7 (1833)
Pump efficiency, %	86
Motor efficiency, %	94
Energy recovery device efficiency, %	86
Combined pumping power, kW (hp)	1652.9 (2217)
Recovered power, kW (hp)	548.5 (735)
Total power requirement, kW (hp)	1104.4 (1481)
Pumping energy, kWh/m ³ (kWh/kgal)	2.65 (10.03)



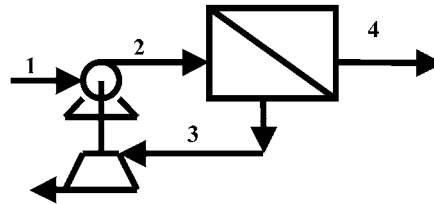
**Atlantic feedwater temperature 20°C
Single pass SWRO**

Feed water source: Atlantic seawater	Feed water type: surface intake
System configuration: single pass	Output capacity: 10000 m ³ /d (2.64 mgd)
Permeate recovery: 50%	Feed flow 1st pass: 833.4 m ³ /h (3667gpm)
Feed pressure pass: 60.0 bar (870 psi)	Concentrate pressure: 58.7 bar (851 psi)
Array: 100 PV (8M)	Elements type: SWC5
Average flux: 14.0 l/m ² /h (8.2 gfd)	Calculation for membrane age: 3 years (-20% nominal flow, +30% of nominal salt passage)
Raw water pH 1st pass: 8.0	Feed water temperature: 20°C (68°F)

Constituent	Feed, ppm	Permeate, ppm	Concentrate, ppm
pH	8.0	6.3	8.3
Ca	410	0.7	819
Mg	1302	2.3	2602
Na	10812	90	21534
K	389	4.0	774
CO ₃	2.0	0.0	4.0
HCO ₃	143	1.9	284
SO ₄	2713	5.1	5421
Cl	19441	145	38737
F			
NO ₃			
B	4.5	0.9	8.1
SiO ₂			
TDS	35240	250	70230



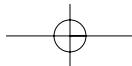
Ap. A / Membrane Unit Configurations



Location	1	2	3	4
Flow, m ³ /h (gpm)	833.4 (3667)	833.4 (3667)	416.7 (1833)	416.7 (1833)
Pressure, bar (psi)		60.0 (870)	58.7 (851)	
TDS ppm	35240	35240	70230	250

RO train

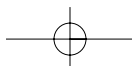
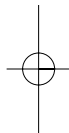
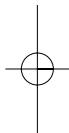
Feed pressure, bar (psi)	60.0 (870)
Concentrate pressure, bar (psi)	58.7 (851)
Pump flow, m ³ /h (gpm)	833.4 (3667)
Turbine flow, m ³ /h (gpm)	416.7 (1833)
Pump efficiency, %	86
Motor efficiency, %	94
Energy recovery device efficiency, %	86
Combined pumping power, kW (hp)	1723.2 (2311)
Recovered power, kW (hp)	572.9 (768)
Total power requirement, kW (hp)	1150.3 (1542)
Pumping energy, kWh/m ³ (kWh/kgal)	2.65 (10.03)



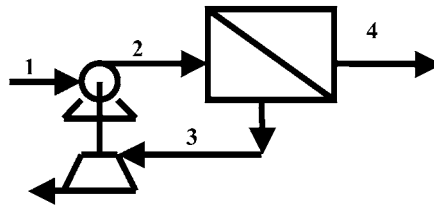
**Canary Islands feedwater temperature 22°C
Single pass SWRO**

Feed water source: Atlantic seawater	Feed water type: surface intake
System configuration: single pass	Output capacity: 10000 m ³ /d (2.64 mgd)
Permeate recovery: 50%	Feed flow: 833.4 m ³ /h (3667gpm)
Feed pressure pass: 64.8 bar (940 psi)	Concentrate pressure: 63.5 bar (921 psi)
Array: 100 PV (8M)	Elements type: SWC5
Average flux: 14.0 l/m ² /h (8.2 gfd)	Calculation for membrane age: 3 years (-20% nominal flow, +30% of nominal salt passage)
Raw water pH: 7.8	Feed water temperature: 22°C (72°F)

Constituent	Feed, ppm	Permeate, ppm	Concentrate, ppm
pH	7.8	6.1	8.1
Ca	464	0.9	927
Mg	1526	2.9	3050
Na	11700	105	23295
K	429	4.8	853
CO ₃	3.2	0.0	6.4
HCO ₃	204	2.9	405
SO ₄	3059	6.1	6111
Cl	21344	170	42519
F			
NO ₃			
B	4.5	1.0	7.96
SiO ₂			
TDS	38739	294	77184



Ap. A / Membrane Unit Configurations



Location	1	2	3	4
Flow, m ³ /h (gpm)	833.4 (3667)	833.4 (3667)	416.7 (1833)	416.7 (1833)
Pressure, bar (psi)		64.8 (940)	63.5 (921)	
TDS ppm	38739	38739	77184	294

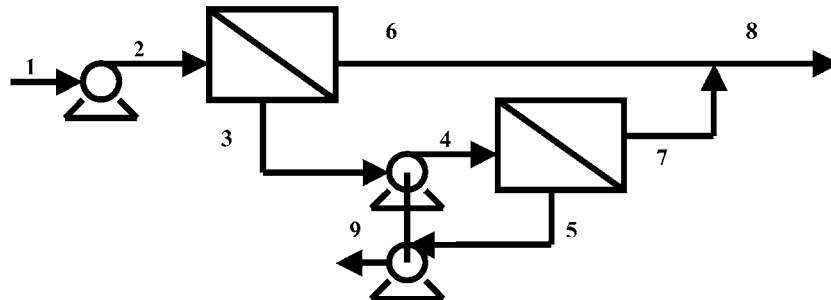
RO train	
Feed pressure, bar (psi)	64.8 (940)
Concentrate pressure, bar (psi)	63.5 (921)
Pump flow, m ³ /h (gpm)	833.4 (3667)
Turbine flow, m ³ /h (gpm)	416.7 (1833)
Pump efficiency, %	86
Motor efficiency, %	94
Energy recovery device efficiency, %	86
Combined pumping power, kW (hp)	1865.5 (2502)
Recovered power, kW (hp)	619.7 (831)
Total power requirement, kW (hp)	1245.8 (15421671)
Pumping energy, kWh/m ³ (kWh/kgal)	2.99 (11.32)

**High salinity brackish RO
Two stages with interstage booster pump at 28°C**

Feed water source: brackish	Feed water type: well water
System configuration: two stages with interstage booster	Output capacity: 10000 m ³ /d (2.64 mgd)
Permeate recovery: 80%	Feed flow: 520.9 m ³ /h (2292gpm)
Feed pressure 1st stage: 17.1 bar (248 psi)	Concentrate pressure: 20.8 bar (280 psi)
Interstage booster pressure: 9 bar (131 psi)	Interstage flow m ³ /h (gpm)
Array: 32: 16 PV (8M)	Elements type: ESPA4+
Average flux: 26.5 l/m ² /h (15.6 gfd)	Calculation for membrane age: 3 years (-20% nominal flow, +30% of nominal salt passage)
Raw water pH 1st pass: 7.0	Feed water temperature: 28°C (82°F)

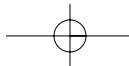
Constituent	Feed, ppm	Permeate, ppm	Concentrate, ppm
pH	7.0	6.0	7.9
Ca	105	1.0	521
Mg	130	1.3	645
Na	1837	84	8854
K	85	4.8	406
CO ₃	0.3	0.0	1.5
HCO ₃	250	18.4	1176
SO ₄	479	5.1	2374
Cl	2970	123	14356
F	1.4	0.1	6.5
NO ₃	5.0	1.4	19.5
B			
SiO ₂	17.0	0.5	83
TDS	5881	240	28444

Ap. A / Membrane Unit Configurations



Location	1	2	3	4	5	6	7	8	9
Flow, m ³ /h (gpm)	521.3 (2294)	521.3 (2294)	184.9 (814)	184.9 (814)	104.2 (458)	336.0 (1478)	80.7 (355)	416.7 (1833)	104.2 (458)
Pressure, bar (psi)		17.1 (248)	14.2 (206)	23.2 (336)	20.8 (302)				0.5 (7)
TDS ppm	5881	5881	16313	16313	28444	139	657	240	28444

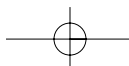
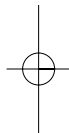
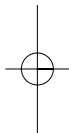
	Main pump	Booster
Feed pressure, bar (psi)	17.1 (248)	9.0
Concentrate pressure, bar (psi)	14.2 (206)	20.8 (302)
Turbine discharge pressure		0.5 (7)
Pump flow, m ³ /h (gpm)	521.3 (2294)	184.9 (814)
Turbine flow, m ³ /h (gpm)		104.2 (458)
Pump efficiency, %	82	82
Motor efficiency, %	94	94
Energy recovery device efficiency, %		80
Combined pumping power, kW (hp)	374.4 (502)	
Recovered power, kW (hp)	46.1 (62)	
Total power requirement, kW (hp)	319.4 (428)	
Pumping energy, kWh/m ³ (kWh/kgal)	0.79 (3.0)	

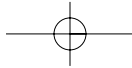


**Low salinity brackish RO
Two stages with permeate blending at 25°C**

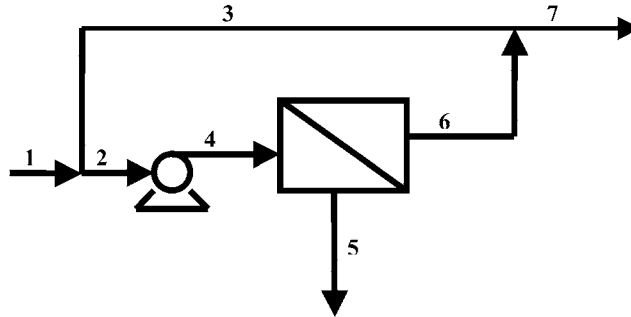
Feed water source: brackish	Feed water type: well water
System configuration: two stages with	RO permeate: 10000 m ³ /d (2.64 mgd)
Blending ratio: 28.6%	Blended output flow: 14000 m ³ /d (3.70 mgd)
Permeate recovery: 85%	Feed flow: 490.2 m ³ /h (2157gpm)
Feed pressure pass: 8.0 bar (116 psi)	Concentrate pressure: 3.3 bar (48 psi)
Array: 32: 16 PV (8M)	Elements type: ESPA4+
Average flux: 29.2 l/m ² /h (17.2 gfd)	Calculation for membrane age: 3 years (-20% nominal flow, +30% of nominal salt passage)
Raw water pH 1st pass: 7.0	Feed water temperature: 25°C (77°F)

Constituent	Feed, ppm	Blended permeate, ppm	Concentrate, ppm
pH	7.0	6.6	7.7
Ca	96	29	628
Mg	11.7	3.5	77
Na	90	32.1	549
K	6.5	2.4	39
CO ₃	0.0	0.0	0.0
HCO ₃	72.6	30.4	408
SO ₄	158.4	47.2	1041
Cl	190.7	61	1221
F	0.2	0.1	1.2
NO ₃			
B			
SiO ₂	24.3	9.3	143.3
TDS	647.3	215	4107





Ap. A / Membrane Unit Configurations



Location	1	2	3	4	5	6	7
Flow m ³ /h (gpm)	657.4 (2893)	490.6 (2159)	166.8 (734)	490.6 (2159)	73.5 (323)	416.7 (1833)	583.5 (2567)
Pressure bar (psi)				8 (116)	3.3 (48)		
TDS, ppm	647	647	647	647	4107	41	215

RO train	
Feed pressure, bar (psi)	8 (116)
Concentrate pressure, bar (psi)	3.3 (48)
Pump flow, m ³ /h (gpm)	490.6 (2159)
Pump efficiency, %	82
Motor efficiency, %	94
Pumping power, kW (hp)	138.4 (186)
Recovered power, kW (hp)	
Total power requirement, kW (hp)	138.4 (186)
Pumping energy, kWh/m ³ (kWh/kgal)	0.23 (0.87)

