



Hydranautics – Nitto **DESIGN SOFTWARE and SUPPORTING TOOL**

SEMINARIO

WATER TREATMENT – L'impiego della Tecnologia delle Membrane nel Trattamento e Riciclo delle Acque Reflue

Genova - TICASS · 21 ottobre 2016

Solutions You Need. Technologies You Trust.

Hydranautics- Nitto

Proprietary Design Software

<http://membranes.com/solutions/software/>

- ✓ **IMSDesign-2016:** (Integrated Membrane Solutions Design) is the latest version of Hydranautics **RO** membrane projection software
- ✓ **RODataXL:** **normalization** program tracking your RO system performance by inputting reference and operational data. Graphs of operational and normalized parameters automatically updated with each input.
- ✓ **HYDRAcap MAX web simulator:** **UF** membrane simulator is Hydranautics' first web based program to fully design the operation and the control logics of a new system
- ✓ **HYDRAsub system design:** an easy tool for Hydranautics **MBR** membrane system projection

Before:

Review of Project Specs Requirements

- Permeate capacity
- Filtrate / Permeate quality (NTU, TDS ..)
- Specifications
- Recovery rate
- Max Feed Pressure
- Average permeate flux rate
- Membrane type
- Size of trains or Number of units
- Qualifications (equipment, OEM)
- Pilot unit verification
- Technical support
- Delivery schedule
- Performance warranty
- Penalties

Feed Water Infos

- Source
- Salinity and composition of individual ions and possibly specific contaminants
- pH
- Temperature (min, max)
- Turbidity (NTU)
- Suspended solids concentration
- Silt density index (SDI)
- Total organic carbon (TOC)
- Bacterial count



- ❖ Calcium
- ❖ Magnesium
- ❖ Sodium
- ❖ Potassium
- ❖ Barium
- ❖ Strontium
- ❖ Bicarbonate
- ❖ Chloride
- ❖ Sulphate
- ❖ Nitrate
- ❖ Fluoride
- ❖ Boron
- ❖ Silica
- ❖ Hydrogen sulfide
- ❖ ...

IMS Design Features

- Detailed Water Analysis – including Custom Ions, Multiple Analysis, Saturations
- Chemical Pre-treatment – pH adjustment
- RO Design - system configuration (number of stages, passes, recirculation, ERD, booster ..) and membrane selection
- Preliminary Calculation Results
- Full System Printout
- Additional features
 - Flow diagrams
 - Summary Calculation (easy Graphs of output vs operating parameters)
- Custom Flow Diagram
- Summary Calculation
- Chemical Post-treatment – Degasser, LSI adjustment
- Power Calculations – pumping specific energy kwh/m³
- Cost Calculations

Water Analysis

Project: TEST **Calculated by:** AMF **Temperature:** 25.0 °C **Water Type:** Brackish Well Non-Fouling **Date:** 10/18/2016

pH: 7.00 **CO3:** 0.000 mg/l **CO2:** 0.011 mg/l **E Conductivity:** 16654.6 µs/cm

Cations		Anions			
	mg/l	mg/l CaCO3			
Ca	0.00	0.00	HC03	0.10	0.08
Mg	5000.00	20491.80	S04	0.00	0.00
Na	0.00	0.00	Cl	0.00	0.00
K	0.00	0.00	F	0.00	0.00
NH4	0.00	0.00	N03	0.00	0.00
Ba	0.000	0.00	P04	0.00	0.00
Sr	0.000	0.00	Si02	0.00	0.00
	0.000	0.00	B	0.00	0.00
	0.000	0.00		0.000	0.00
	0.000	0.00		0.000	0.00
	meq/l	409.84		meq/l	0.00

Saturations

Calculated TDS	5000	mg/l	Ca504	0.0	%
Osmotic pressure	4.5	bar	Ba504	0.0	%
Ca3(P04)2 SI	0.00		Sr504	0.0	%
CCPP	0.00	mg/l	CaF2	0.0	%
Langlier SI	0.0		Silica	0.0	%

Warning :

- Diff: 100% Ions out of balance by over 10%. Adjust concentration or Autobalance by clicking underlined ions.

Fields Required to Complete Data Set

RO Design

Trains

	Pass 1	Pass 2		Pass 1	Pass 2
Feed pH	8.10	6.80	Chemical	None	None
Permeate recovery %	40.00	90.00	Solution concentration, %	100	100
Permeate flow/train, m3/h	184.00	60.00	Chemical concentration, mg/l	0.000	0.000
Average flux, lmh	14.0	34.9	Membrane age, years	3.0	3.0
Feed flow, m3/h	460.00	66.67	Flux decline %, per year	5.00	3.00
Reject flow, m3/h	276.00	6.67	Fouling factor	0.857	0.913
Recirculation flow, m3/h		6.67	SP increase % per year	7.0	5.0

System Specification

Stage 1

Element type	SWCS MAX
Elements / Vessel	7
No. of Vessels	46
Permeate pressure, bar	1.0

Stage 2

Element type	ESPA2 MAX
Elements / Vessel	7
No. of Vessels	4
Permeate pressure, bar	1.0

System

Total plant product flow, m3/h	177.33
Number of Trains	1
P1 Permeate to P2 feed, %	36.2
Pass 2 bypass (% m3/h)	66 117.33

Floating Diagram

Element Selection

Element Selection

Recommended Membranes

		Model	Nominal production (gpd)	Salt rejection, %	Element type	Size (IN X IN)	Area (Sq.Ft.)	Spacer (mil)	Test Pressure (psi)	Feed Pressure (psi)	Permeate TDS
C	<input checked="" type="checkbox"/>	SWC4-LD	6500	99.8	SWRO High Rejection Bios...	8 X 40	400	34	800	947	9.42
T	<input type="checkbox"/>	SWC5	9000	99.8	SWRO High Rejection	8 X 40	400	28	800		
C	<input type="checkbox"/>	SWC5 MAX	9900	99.8	SWRO High Rejection	8 X 40	440	28	800		
C	<input checked="" type="checkbox"/>	SWC5-LD	9000	99.8	SWRO High Rejection Bios...	8 X 40	400	34	800	824	12.2
C	<input type="checkbox"/>	SWC6 MAX	6600	99.6	SWRO Highest Flow	8 X 40	440	28	600		
C	<input checked="" type="checkbox"/>	SWC6-LD	6000	99.6	SWRO High Flow Biostatic	8 X 40	400	34	600	756	18.9

- Element pre-selection by software based on the feed type
- Feed pressure and permeate TDS shown on selected elements

Reset
Show All
Water Type

OK
Cancel

RUN and Preliminary Results

IMSDesign

About Online Help Design Guidelines

Analysis Design Calculation Post Treatment

New Open Save Perm. Blending Perm. Pressure Conc. Recirculation Hybrid ERD Return FloatingDiagram Summary Calc. Print Flow Diagram Basic Partial Split Partial Tools Standard Calculator

Project file Options Actions Two Pass Tools

Project: TEST Calculated by: AMF Temperature: 30.0 °C Water Type: Sea Surface MF/UF Date: 10/18/2016

Trains

	Pass 1	Pass 2	Pass 1	Pass 2
Feed pH	8.10	6.80	None	None
Permeate recovery %	40.00	90.00	Solution concentration, %	100
Permeate flow/train, m3/h	184.00	60.00	Chemical dosing rate mg/l	0.000
Average flux lmh	14.0	34.9	Membrane age, years	3.0
Feed flow, m3/h	460.00	66.67	Flux decline %, per year	5.00
Reject flow, m3/h	276.00	6.67	Fouling factor	0.857
Recirculation flow, m3/h		6.67	SP increase % per year	7.0

System

Total plant product flow, m3/h	177.33
Number of Trains	1
P1 Permeate to P2 feed, %	36.2
Pass 2 bypass (% m3/h)	66 117.33

Calculation Results

(All flows are per vessels)

Array	Vessels	Feed (bar)	Conc (bar)	Feed (m3/h)	Conc (m3/h)	Flux (lmh)	Highest flux (lmh)	Highest beta
1-1	46	75.2	73.5	10	6	13.9	31.9	1.05
2-1	4	10.8	8.1	16.67	4.72	41.8	51.4	1.26
2-2	2	7.9	6.6	9.44	3.31	21.4	29.9	1.15

Permeate Concentration

Ca	0.767	K	3.704	Sr	0.001	Cl	156.339	P04	0.000	CO2	8.105
Mg	1.832	NH4	0.000	HCO3	28.467	NO3	1.854	SiO2	0.026	CO3	0.013
Na	110.225	Ba	0.000	S04	7.210	F	0.016	B	0.241	pH	6.7
						Br	0.491			TDS	311.19 mg/l

Concentrate saturations and parameters

CaSO4, %	7.4	SrSO4, %	8	Osmotic pressure	66.3 bar	pH	8.3
BaSO4, %	0	SiO2, %	6	CCPP	2002.18 mg/l	TDS	91369.6 mg/l
Ca3(PO4)2	0.00	CaF2, %	52.1				

Analysis: New | Design: Ayoun Moussa -141016 | Version: 1.216.73.5 | Email: imsd-support@hydranauticsprojections.net | Screen resolution: 1920 X 1080 | Font Size: 100 % (96 DPI) | Calculated successfully

Chemical Post Treatment

IMSDesign

About Online Help Design Guidelines

Analysis Design Calculation Post Treatment

New Open Save Restore Dosing Degasser Print

Project file Options

Project: TEST Calculated by: AMF Temperature: 30.0 °C Water Type: RO Permeate Date: 10/18/2016

pH 6.70 CO3 0.0 mg/l CO2 8.1 mg/l E Conductivity 629.3 µs/cm

Cations		Anions			
	mg/l	mg/l CaCO3			
Ca	0.77	1.92	HCO3	28.47	23.33
Mg	1.83	7.51	SO4	7.21	7.51
Na	110.23	239.62	Cl	156.34	220.51
K	3.70	4.74	F	0.02	0.04
NH4	0.00	0.00	NO3	1.85	1.50
Ba	0.000	0.00	PO4	0.00	0.00
Sr	0.001	0.00	SiO2	0.03	
			B	0.24	
			Br	0.491	0.31
Total, meq/l		5.08	Total, meq/l		5.06

Dosing Rate of Chemicals, mg/l (100% Concentration)							
NaOH	NaHCO3	Na2CO3	Ca(OH)2	H2SO4	HCl	CO2	NaOCl
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Saturations					
Calculated TDS	311.2	mg/l	CaSO4	0.00	%
Osmotic pressure	0.24	bar	BaSO4	0.00	%
Ca3(PO4)2 SI	0.00		SrSO4	0.00	%
CCPP	-18.58	mg/l	CaF2	0.00	%
Saturation index	-3.41	Langelier	Silica	0.02	%

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Power Calculations

IMSDesign

About Online Help Design Guidelines

Analysis Design Calculation Post Treatment

New Open Save PowerRequirement Chemical Requirement Cost Print DefaultValues USD - USA Select Currency

Project file Calculations Options

Project: TEST Calculated by: AMF Temperature: 30.0 °C Water Type: Sea Surface MF/UF

Power Calculation

		Pass 1	Pass 2
Pump / Boost pressure	bar	75.2	10.8
Product flow	m ³ /h	184.0	60.0
Pump flow	m ³ /h	460.0	66.6
Pump efficiency	%	83.0	83.0
Motor efficiency	%	93.0	93.0
VFD Efficiency	%	97.0	97.0
Power/Stage/Pass	kw	1258.5	23.8
	BHP	1686.9	31.9
Total pumping power	kw	1284.7	
Pumping specific energy	kwh/m³	7.24	

Nitto HYDRANAUTICS Nitto Group Company

Analysis : New | Design : Ayoun Moussa - 141016 |

Chemical Requirement

IMSDesign

About Online Help Design Guidelines

Analysis Design Calculation Post Treatment

New Open Save PowerRequirement Chemical Requirement Cost Print DefaultValues USD - USA Select Currency

Project file Calculations Options

Project: TEST Calculated by: AMF Temperature: 30.0 °C Water Type: Sea Surface MF/UF

System	Pass 1	Pass 2
Feed flow,m3/h	460.00	66.67
Permeate flow,m3/h	184.00	60.00
Total Product flow,m3/h	183.92	177.33

Summary of Chemical Cost	Permeate Pass 1	Permeate Pass 2	Total Product
USD/m3	0.000	0.000	0.000
USD/kgal	0.000	0.000	0.000
USD/Mega litres	0.000	0.000	0.000
USD/Mega usgal	0.000	0.000	0.000
USD/Mega m3	0.000	0.000	0.000
USD/Acre.ft	0.000	0.000	0.000

SMBS Dosing Feed		
Solution conc.	%	10.0
Specific gravity		1.10
Solution cost	USD/l of 10% sol.	0.0
Dose, mg/l	100% basis	0.0
Consumption	kg/h	0.0

Antiscalant Dosing Feed		
Solution conc.	%	40.0
Specific gravity		1.00
Solution cost	USD/l of 10% sol.	0.0
Dose, mg/l	100% basis	0.0
Consumption	kg/h	0.0

NaOCl Dosing Feed		
Solution conc.	%	10.0
Specific gravity		1.30
Solution cost	USD/l of 10% sol.	0.0
Dose, mg/l	100% basis	0.0
Consumption	kg/h	0.0

Nitto HYDRANAUTICS Nitto Group Company

COST Calculation

IMSDesign

About Online Help Design Guidelines

Analysis Design Calculation Post Treatment

New Open Save PowerRequirement Chemical Requirement Cost Print DefaultValues USD - USA Select Currency

Project file Calculations Options

Project: TEST Calculated by: AMF Temperature: 30.0 °C Water Type: Sea Surface MF/UF

Cost Calculation

Plant capacity	m ³ /h	60.00	Plant life, years	15.0
Specific investment, USD/m ³ /h		22151.96	Membrane life, years	5.0
Investment, USD		1329114	Membrane cost, USD/element	500
Interest rate, %		4.5	Number of elements	364
Plant factor, %		90.0	Inhibitor cost	USD/kg 2.20
Power cost, USD/kwhr		0.200	Inhibitor dosing	mg/l 3.0
Power consumption	kwhr/m ³	7.24	Acid cost	USD/kg 1.50
Maintenance(% of investment)		3.0	Acid dosing	mg/l 0.0

Cost Calculation Results

Capital cost	USD/m ³	0.17
Power cost	USD/m ³	1.45
Chemicals cost	USD/m ³	0.02
Membrane replacement cost	USD/m ³	0.08
Maintenance cost	USD/m ³	0.08
Total water cost	USD/m³	1.80

Analysis: New | Design: Ayoun Moussa - 141016 |

Nitto HYDRANAUTICS Nitto Group Company

ROData - normalization tool

- ✓ Data log sheet

Collect daily operating data (At least one set of data per shift)

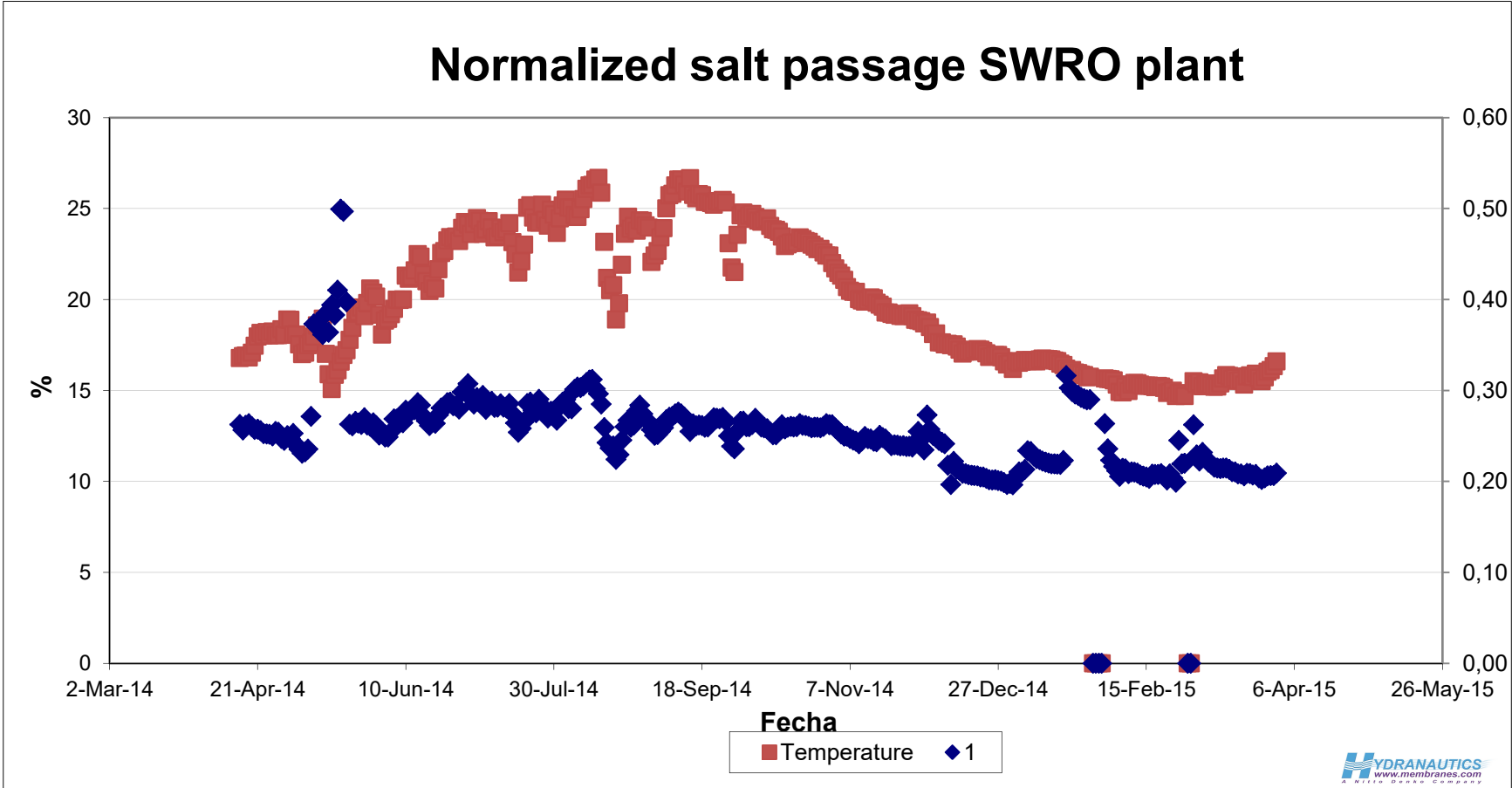
- ✓ Normalization to a given reference performance

to identify the effects of fouling and membrane degradation vs. normal changes in plant performance

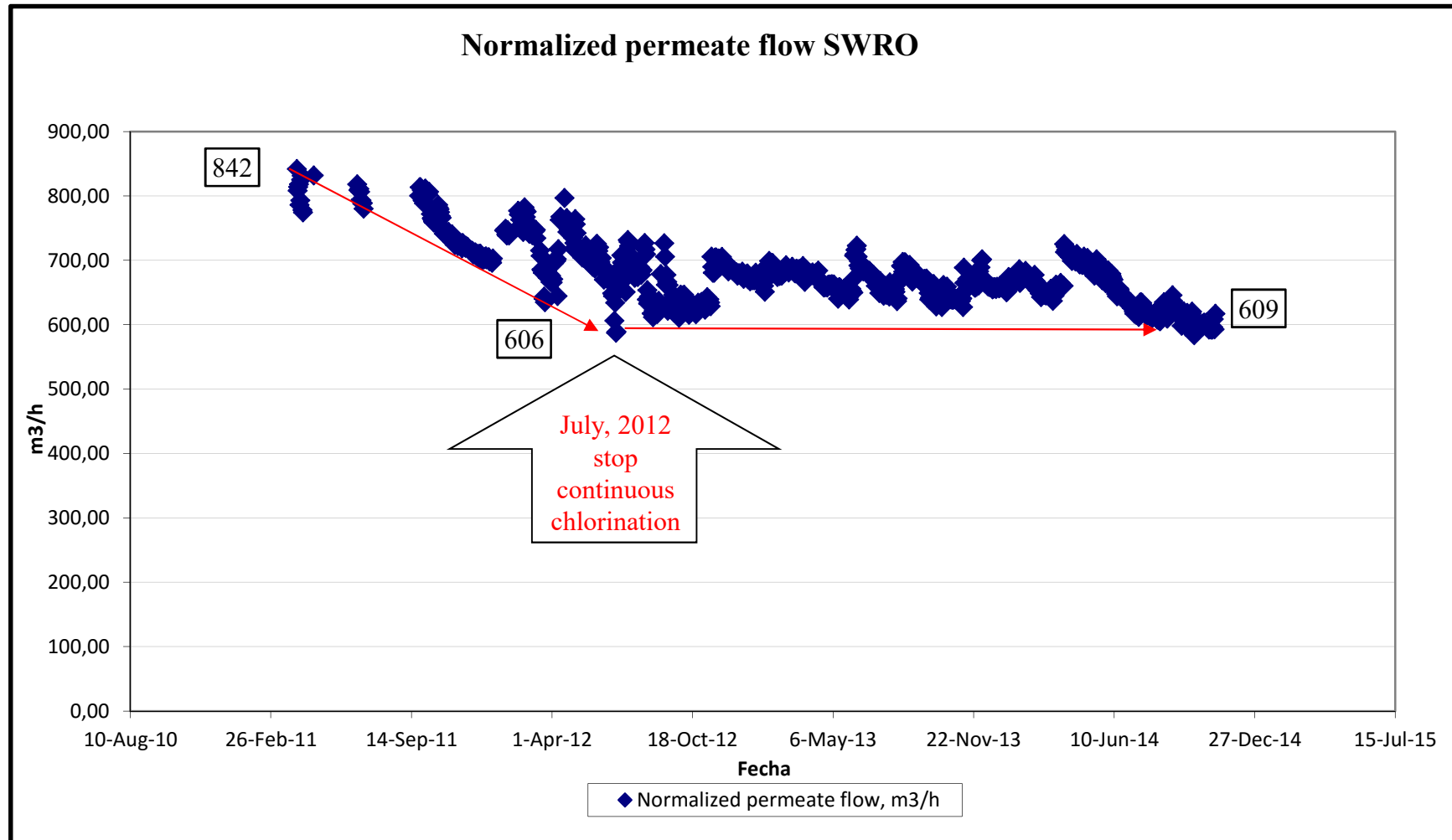
→ Early detection of performance upset

The screenshot displays the ROData software interface. At the top, it shows 'System Rack 1' with 'Train Element Selection' set to 'SVC4 MAX'. The HYDRANAUTICS Nitto Group Company logo and address (401 Jones Rd., Oceanside, CA 92054) are visible in the top right. The main area is a data log sheet with columns for Date, Hour, Tubidity, SOI, pH, T, Feed (C, Cl, Cp), Permeate (Cp), Flows (Qc, Qp), Pressures (Pi, Pc, Pp), % Salt Passage, Permeate Flow (QSPn), Normalized Data (DpN, VTCn), Differential Water Transport Coefficient, and Salt Transport (STCn). A 'ROData' window is open in the foreground, allowing for data entry and normalization. It includes fields for Project Name (Rack 1), Train (1), Date (11-Feb-2015), and Hour (13,5). The window is divided into Reference Data, Operation Data, and Optional Data sections, with an 'Add Data' button at the bottom.

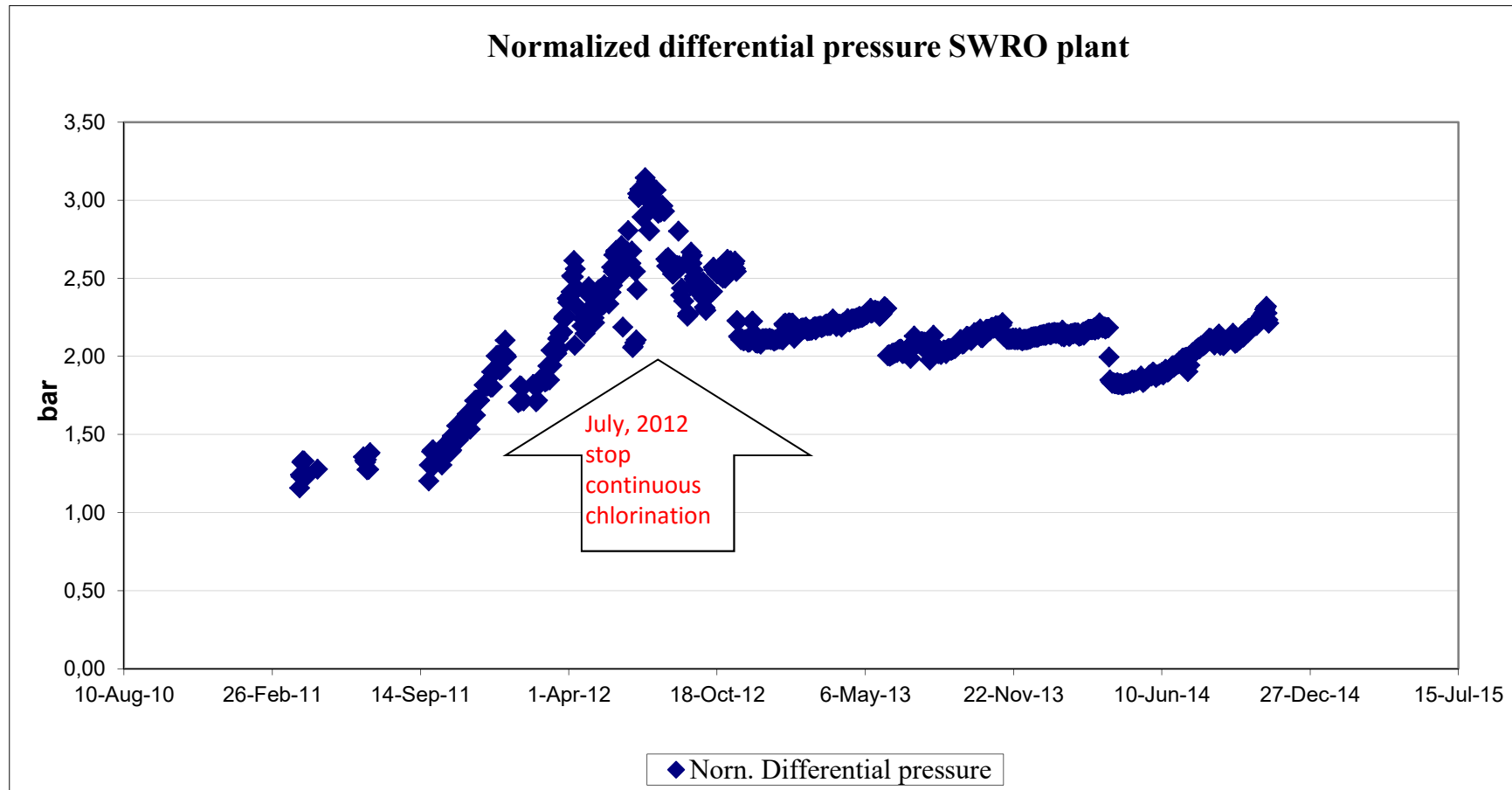
Normalized salt passage



Normalized permeate flow



Normalized differential pressure



HYDRAcap[®] MAX – Web simulator

- First web based program always updated and easy to share
- Please contact us to receive a key to access the web simulator
- Full membrane system design and operation, including
 - Membrane system details
 - Chemicals consumptions
 - Ancillary Equipment Sizing (pumps, blowers, tanks, ...)
 - Sequence Tables
- Mozilla or Chrome are preferred Internet browser

Input Section

The screenshot shows the 'Input Section' of the HYDRAcap MAX web application. The browser address bar shows the URL: <https://www.hydranauticsprojections.net/mf/en/Projection/Input>. The page header includes the Nitto and HYDRANAUTICS logos, a user welcome message for 'aferro@hydranautics.es', and a 'SECURE' badge. The navigation menu contains 'Home', 'New Projection', 'Documents', 'Contact Us', and 'Help'. A 'Calculate Design' button is located at the top of the main content area. The 'Mandatory Data Input' section contains the following fields:

Field Name	Value	Unit
System of Measurement	Metric	
Project Title		
Application	RO Pretreatment	
Client Name		
Source	Sea Water	
Minimum Temperature	20	°C
Turbidity	2	NTU
Module type	HYDRAcap® MAX 80	
Design Volume is Feed or Filtrate?	Filtrate	
Design volume	0	m ³ /d
Design Basis	Constant Flux	

Below the mandatory data input is the 'Other Feed Water Inputs' section, which is currently empty.

DESIGN SUMMARY

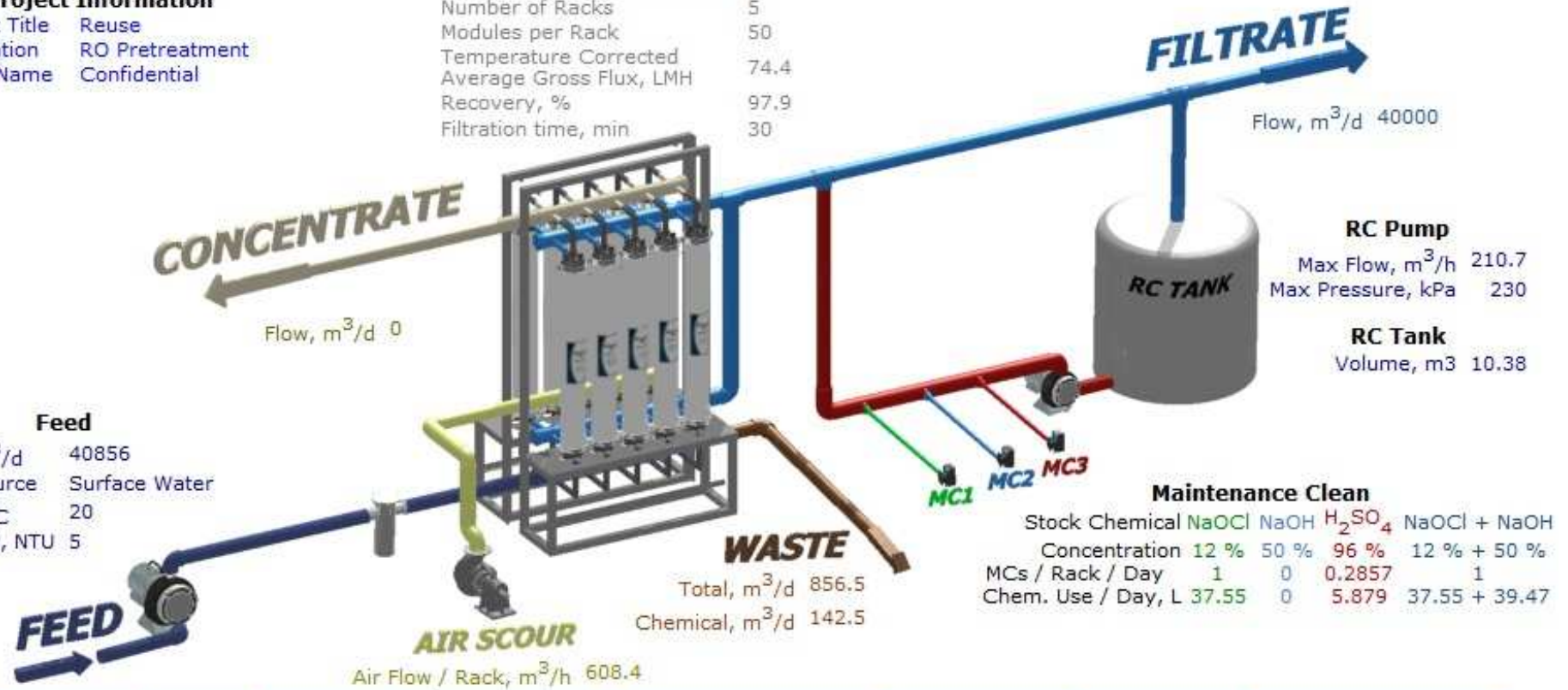
HYDRAcap® MAX 80 Process Overview

Project Information

Project Title Reuse
 Application RO Pretreatment
 Client Name Confidential

Membrane System

Number of Racks 5
 Modules per Rack 50
 Temperature Corrected Average Gross Flux, LMH 74.4
 Recovery, % 97.9
 Filtration time, min 30



Stock Chemical	NaOCl	NaOH	H ₂ SO ₄	NaOCl + NaOH
Concentration	12 %	50 %	96 %	12 % + 50 %
MCs / Rack / Day	1	0	0.2857	1
Chem. Use / Day, L	37.55	0	5.879	37.55 + 39.47

Project	Feed	Filtrate	Concentrate	Membrane System	Feed Pump	Air Scour	Cleaning System	
Update		Design Details		Save A Copy		Save	Print	Timer

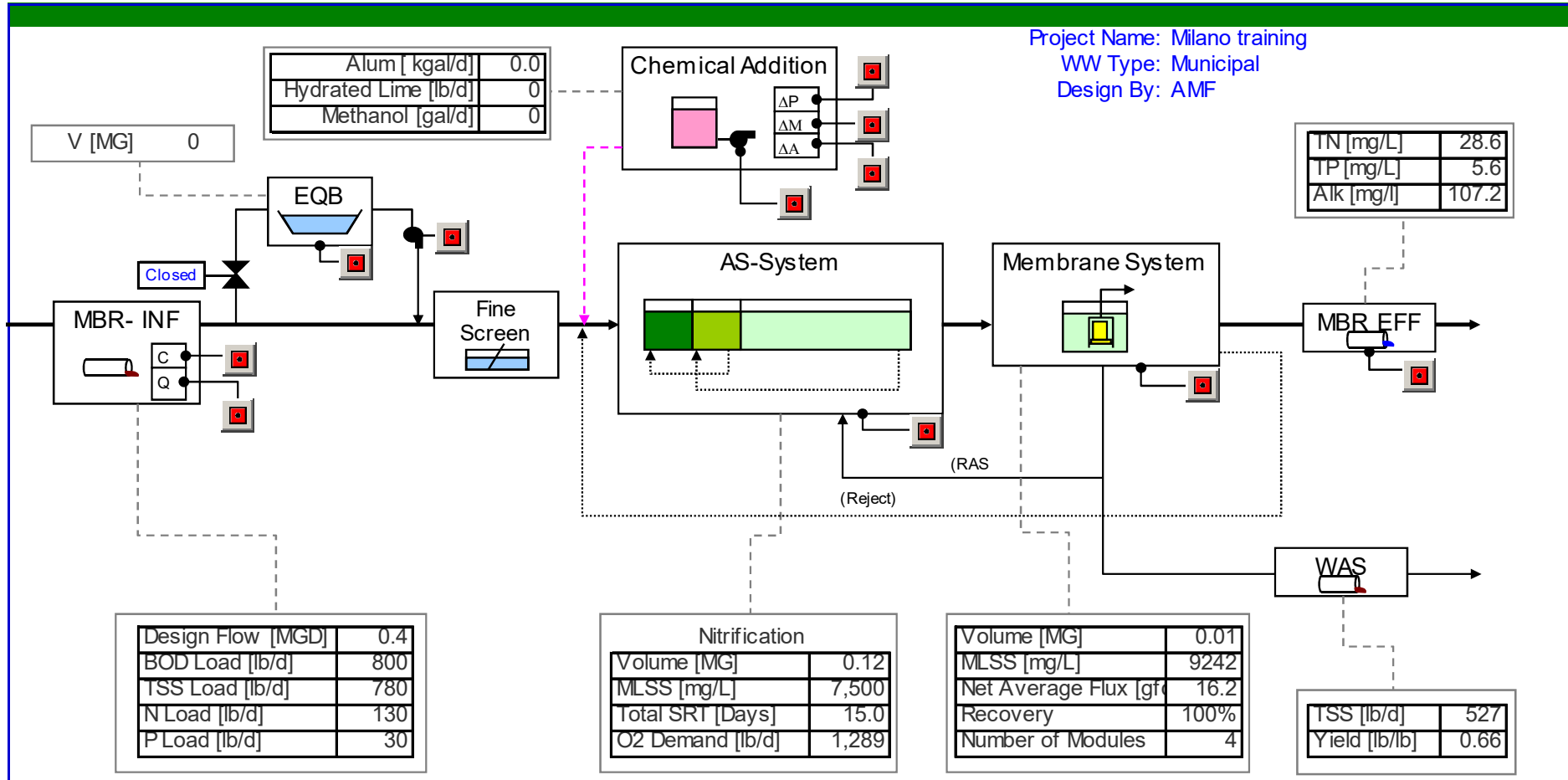
* If changes are not reflected, please click the update button to refresh the page.

Online: <http://hydranauticsprojections.net/Account/Login>

HYDRAsub[®] – Simulator

- Easy Design software for MBR Membrane System
- Full membrane system and ancillary equipment design (no Biological process design)

HYDRAsub[®] System Design



HYDRAsub[®] System Design



Simulator Version: Model 04 3 rev 11FEB14
 Design By: AMF
 WW Type: Municipal

Milano training MBR Membrane System Design Summary

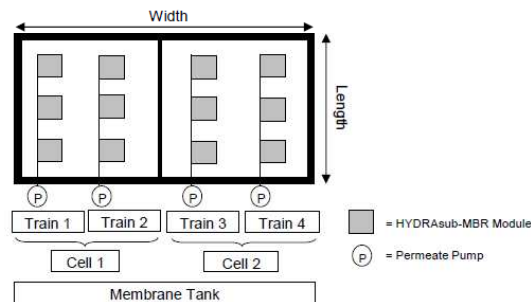
Influent Flows

Average Day	m ³ /day	1320	Maximum Day	m ³ /day	1499
Maximum Month	m ³ /day	1470	Peak Hour	m ³ /day	2400

Membrane Design

Net Peak Flux	lmh	50.0	No. of Cells in Membrane Tank	-	2
Net Max Daily Flux ¹	lmh	31.2	No. of Trains per Cell (x-direction)	-	1
Net Max Monthly Flux	lmh	30.6	Selected Module Class	HSM	500-ES
Net Average Flux	lmh	27.5	Membrane Area per Module	m ²	500
Net Average Flux at N-1 Trains ²	lmh	55.0	Required Modules (min)	-	4
Min Temperature	°C	20	Number of Modules Installed	-	4
Filtration Time	min	7.0	Number of Modules per Cell	-	2
Soak Time	min	1.0	Number of Modules per Train	-	2
Installed Membrane Surface	m ²	2000	Cell Width	m	1.8
Redundancy Required		No	Cell Length	m	2.9
			Cell Volume (Total)	m ³	16.7
			Tank Depth	m	3.20
			Tank Water Level	m	2.70
			Total MT Length (x-direction)	m	5.80
			Total MT Width (a-direction)	m	1.80
			Membrane Tank Volume (Total)	m ³	32.67
			Min Tank Surface (Total)	m ²	10.20
			Permeate Production	m ³ /day	1469.7

Membrane Tank Configuration Example:



¹ For a maximum of 24 hours in any seven day period
² During a maintenance (CEB) or recovery (CIP) cleaning or other maintenance period for a duration of less than 4 hours

Equipment Summary

Equipment sizing is based on a number of assumptions, which may not be accurate to the specific project.

		Backwash (CIP/CEB) Pumps	Membrane Pumps
Design Flow (Total)	m ³ /hr	4.2	114.3
Design Flow (per pump)	m ³ /hr	2.1	57.2
Assumed Static Head Loss	m		
TDH (Design Q)	m	8.3	9.3
Pump Efficiency	%	0.8	0.8
Motor Efficiency	%	0.9	0.9
NPSH Required	m		3.9
Horse Power (Design Q)	HP	0.26	5.8
Horse Power per Pump	HP	0.20	5.00
Number of Pumps	-	3	3
Number of Duty Pumps	-	2	2

HYDRAsub[®] System Design

Chemical Pumps		Citric Acid Pump	Sodium Hypochlorite Pump
Min Injection Flow	L/min	2.3146	0.1630
Max Injection Flow	L/min	4.6292	2.7164
Stock Concentration	%	30%	12.5%
Redundancy Required	-	No	No
Number of Feed Pumps	-	1.0	1.0
Number of Duty Pumps	-	1.0	1.0
Safety Factor	-	1.2	1.2
Design Flow	L/min	5.55	3.26
Turndown Rate	%	58%	95%

Scour Air

Max Specific Air Flow	m ³ /(m ² hr)	0.35
Total Maximum Air Flow (Design)	m ³ /hr	701.1
Total Blower Horse Power	HP	12.18
Number of Duty Blowers	-	3
Blower HP (Each)	HP	5.00
Maximum Air Flow per Module	m ³ /hr	175.3
Nominal Air Flow per Module	m ³ /hr	146.1

Annual Operation Cost Summary

Power Consumption		
Backwash (CIP/CEB) Pumps	MWh	0.004
Membrane Pumps	MWh	10.3
Scour Air	MWh	66
Membrane System Power (Total)	MWh	77
Power Unit Cost	\$/kWh	\$ 0.11
Membrane System Power Cost	\$/yr	\$ 8,429

Chemical Consumption		
Citric Acid	L	83.4
Sodium Hypochlorite	L	848.7
unit cost		
Citric Acid Cost	\$ 4.0	\$ 330
Sodium Hypochlorite	\$ 0.2	\$ 168
Total Chemical Cost		\$ 499

Key Process and Cost Indicators

Annual Scour Air Power	kWh/m ³ pmt	0.12	Scour Air	m ³ air/m ³ pmt	11.45
Annual Membrane System Power	kWh/m ³ pmt	0.14	Membrane Chemicals	\$/m ³ pmt	0.0009

QC Summary

	Unit	Model	Min	Max
Net Peak Flux	lmh	50.0	0.0	50.8
Net Max Daily Flux ¹	lmh	31.2	0.0	40.0
Net Max Monthly Flux	lmh	30.6	0.0	33.3
Net Average Flux	lmh	27.5	0.0	33.3
Net Average Flux at N-1 Trains ²	lmh	55.0	0.0	50.8

¹ For a maximum of 24 hours in any seven day period

² During a maintenance (CEB) or recovery (CIP) cleaning or other maintenance period for a duration of less than 4 hours

Thank you

