



Project Name: Shiraz Utility & Offsite Project
Projected By: Matthew Jeon
Company: Woongjin Chemical
Version: 1
Date: 2011-10-10
Project(Case) Note: 2nd 40%_25C_2Yr

Feed 1
Water Source: Surface Water SD01c3
TDS mg/l as Ion: 2,574.57
Temperature: 25.00 C
Feed: 73.90 m³/hr 100 %

mg/l as Ion	ppm as CaCO ₃	meq/l	Output Unit
Na	272.85	593.87	11.83 as Ion
K	0.00	0.00	0.00 as Ion
Mg	0.00	0.00	0.00 as Ion
Ca	373.18	932.95	18.66 as Ion
Mg	81.34	333.49	6.67 as Ion
Fe	0.00	0.00	0.00 as Ion
Ba	0.00	0.00	0.00 as Ion
Sr	591.47	832.97	16.66 as Ion
Cl	0.00	0.00	0.00 as Ion
NO ₃	0.00	0.00	0.00 as Ion
SO ₄	74.51	77.49	1.55 as Ion
F	0.00	0.00	0.00 as Ion
HCO ₃	1,547.53	940.97	18.82 as Ion
CO ₃	6.90	18.92	0.38 as Ion
CO ₂	28.37	32.34	0.64 as Ion
B	0.00	0.00	0.00 as Ion
SiO ₂	34.49	0.00	0.00 as CaCO ₃
Total Alkalinity	952.43	0.00	0.00 as CaCO ₃

Unit	Feed1	Feed2	Overall
SDI	15 min		
Turbidity	NTU		
TOC	mg/l as O ₂		
CO ₂	mg/l as O ₂		
BOD	mg/l as O ₂		
Cl ₂	mg/l as Cl		
etc			
E cond	4,917.89 US/cm	Feed pH	7.74
Total Carbon	37.135	Auto Balance	
Total Anion	37.024	Adjust Na	Adjust NaCl
Extra Ion	0.111	Adjust Cl	Reset to Zero

RO System Design & CSMPRO 4.1 ver.

Presenter : Matthew Jeon

CONTENTS

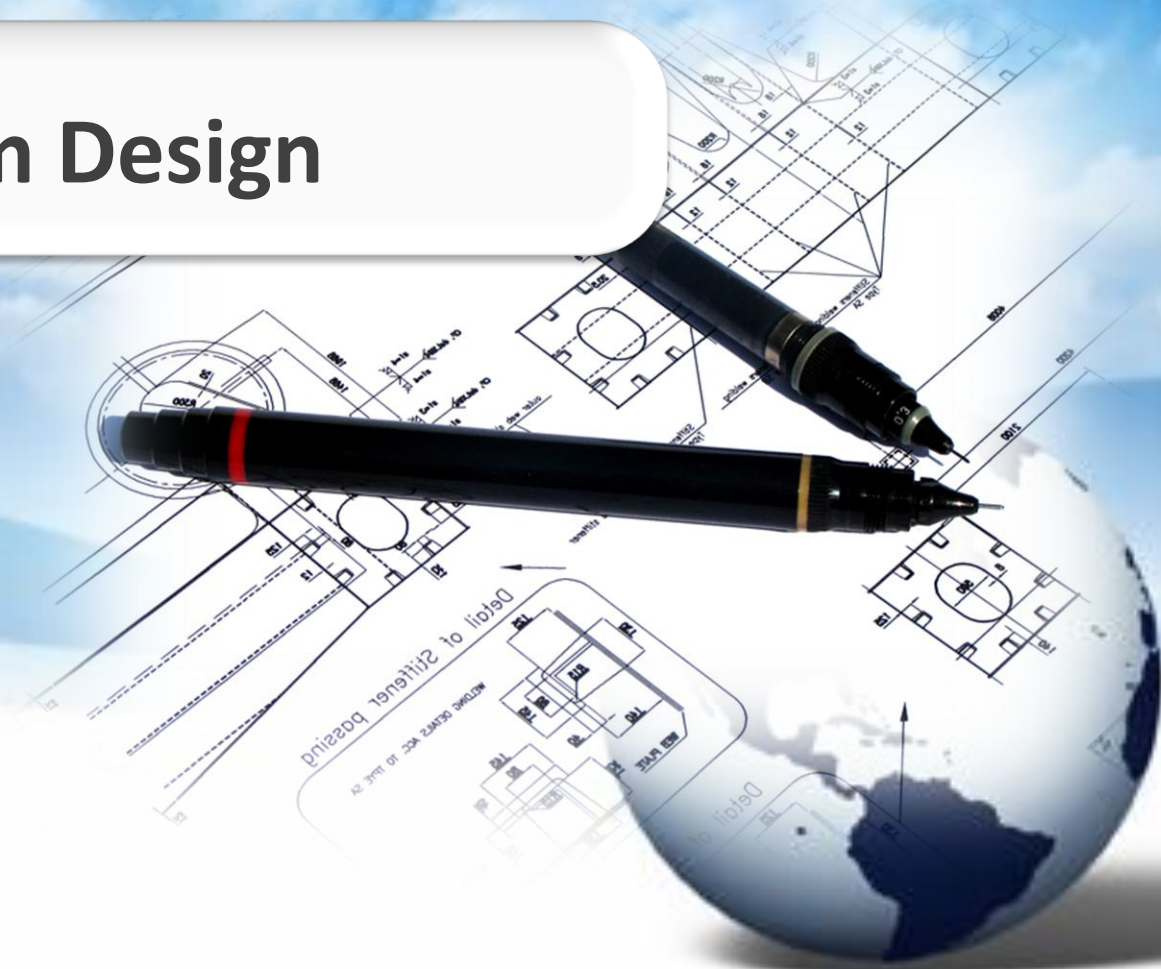
I. System Design

II. CSMPRO Introduction

III. CSMPRO 4.1 Features



I. System Design



*The membrane system design depends on
Feed Source, Feed Quality, Feed/Product Flow, and Required Product Quality.*

- **Water Source**
 - Well Water / Softened Water / Surface Water / Sea Water / Effluent Water
- **Feed Quality**
 - Pretreatment System / Feed Water Quality
- **Feed / Product flow**
 - Required Product Flow Rate / Recovery
- **Required product quality**
 - Application / Specify Water Quality Needed after RO Treatment

Selection of configuration and No. Passes

- **Plug flow**
 - The standard flow configuration, where the feed water is passed once through the system.
- **Concentrate Recirculation**
 - Common system used in commercial application, as well as in larger systems when the number of elements is too small to achieve a sufficiently high system recovery with plug flow.
- **Double Pass system**
 - Combination system of two conventional RO system where permeate of the first system becomes the feed for the second system. It is used to produce ultra pure water for semi-conductor and pharmaceutical and sea water desalination.
- **Permeate Blending**
 - The system, where some ratio of feed water or permeate of 1st pass is mixed to final product. The smaller system can be achieved.

Membrane Type Selection

Membranes are selected by Feed Concentration, Fouling Tendency, Required Rejection and Energy Requirements.

- **Feed Concentration**

- Under 1,000 mg/L ; BL series
- Under 10,000 mg/L ; BN, BE
- Under 50,000 mg/L ; SHN, SHA, SHF

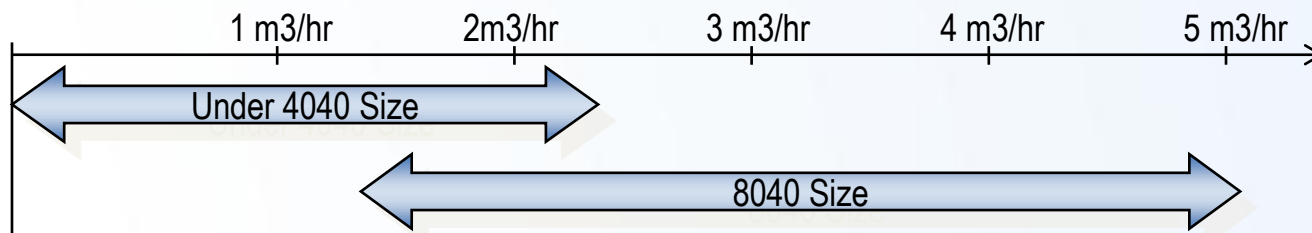
- **Application**

- Softening, Concentration, 1st Pass of Seawater ; NF
- Wastewater reuse, Zero discharge ; FEn, FL, FLR
- Ultra pure water, HERO System ; HUE, UL

- **Energy Requirements**

- Low pressure requirement ; BL, FL, UL
- Normal pressure requirement ; BE, FEn, HUE
- High pressure requirement ; BR, SHN, SHA, SHF

- **Membrane Dimension**



Determining of Average Flux

The average permeate flux should be determined by the Feed Water Quality (SDI) as well as Feed Water Sources

Kinds of feed water source	RO Permeate	Well Water	Surface Water	Filtered Municipal Effluent (Wastewater)		Seawater		
				MF or UF Pretreatment	Conventional	Well or MF	Open intake	
SDI	< 1	< 3	< 3	< 5	< 3	< 5	< 3	< 5
Average Flux (gfd)	21-25	16-20	13-17	12-16	10-14	8-12	8-12	7-10

The Number of Elements and Pressure Vessels needed

$$N_E = \frac{Q_p}{f * S_E}$$

$$N_v = \frac{N_E}{N_{E/PV}}$$

N_E : The number of elements

Q_p : The design permeate flowrate

f : The design flux

N_v : The number of pressure vessel

$N_{E/PV}$: The number of elements per pressure vessel

For the Surface Feed Water (SDI < 5), to get 100 m³/hr of the product water

- Determine the average flux
 - from the data for design guide lines : 12- 16 gfd
 - In this calculation, we select the target flux to be 12 gfd
- Determine the module size and grade
 - In this case, we select RE8040-BE module (Effective area is 400ft²)
- Calculation
 - 400 ft²/element x 12 gfd = 4,800gpd / element = 757ℓ/hr,elements
- To get 100m³/hr, how many RE 8040-BE elements are required ?
 - 100,000 ℓ/hr ÷ 757ℓ/hr/element = 132.1 elements
 - 133 elements are required
- How many vessels (6 elements/vessel) are required ?
 - 133 elements ÷ 6elements/vessel = 22.2 ▶ 23 vessels

The number of stages is a function of the planned system recovery, the number of elements per vessel and the feed water quality.

- **Designed system recovery depends on feed water source and quality in general**
 - For the Sea water feed : 30 - 60%
 - For the Brackish water feed : 75 - 85%
 - For the RO permeate feed : 85 - 95%

- **Array on system recovery**
 - Less than the 50% Recovery : one array
 - Less than the 80% Recovery : two array
 - over 80% Recovery : three array

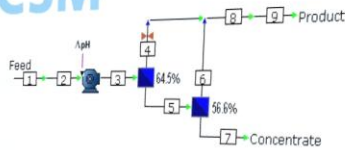
- ❖ For the RO permeate : System is designed to get 90% recovery with 2 array
- ❖ For the Waste water : System is designed to get 75% recovery with 3 array

Consideration in Design

- **Improve product quality**
 - Use part or all seawater elements for brackish feed water
 - Use seawater elements in one or both stages of double pass system
 - Recycle permeate of last stage into feed
 - Use Split partial blending in double pass system
- **Increase system recovery**
 - Feed the concentrate to a second system, after specific pretreatment
 - Recycle the concentrate to feed stream
- **Obtain high system recovery and uniform permeate flow**
 - Use booster pumps between stages to compensate for osmotic pressure increase
 - Use permeate back pressure from first to last stage
 - Use Hybrid system design with tighter membranes in the first stage than in the second stage
- **Reduce the plant capacity to obtain just the required permeate quality**
 - Blend the permeate with feed water

II. CSMPRO Introduction

CSM



		1	2	3	4	5	6	7	8	9
Flow	m ³ /hr	73.93	73.93	73.93	47.71	26.22	14.84	11.38	62.55	62.55
TDS	mg/l	2,574.57	2,574.57	2,340.38	24.59	6,553.59	126.89	4,929.61	48.86	48.86
Press	Bar	0.00	0.00	13.13	2.00	12.15	0.00	11.24	0.00	0.00
Water	g/m	0.00	0.00	13.13	5.00	15.12	0.00	11.24	0.00	0.00
DO	mg/l	5.21421	5.21421	5.24038	54.20	9.22328	139.88	4.85897	48.86	48.86
Wt%	g/100g	17.83	13.93	13.93	41.37	59.33	14.84	11.38	85.22	85.22
		1	2	3	4	5	6	7	8	9



II. CSMPRO Introduction **Major Features**

1. Live up to date

- ◆ Automatically download new files via internet before execution of the program
- ◆ All data files and program files are included

2. Support to multiple language

- ◆ English, Korean, Chinese, Japanese are supported
- ◆ Able to add new languages

3. Easy Design

- ◆ Automatic array design
- ◆ Must be reviewed by an expert engineer

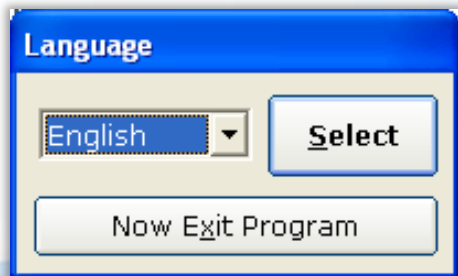
4. Various Output Print

- ◆ Save in PDF, RTF (Editable by MS Word) format
- ◆ Copy into a clipboard and paste on any program which support OLE

5. Improved User interface

- ◆ Support a multicas design in a single file
- ◆ Divinatory designs a layout to find what user wants

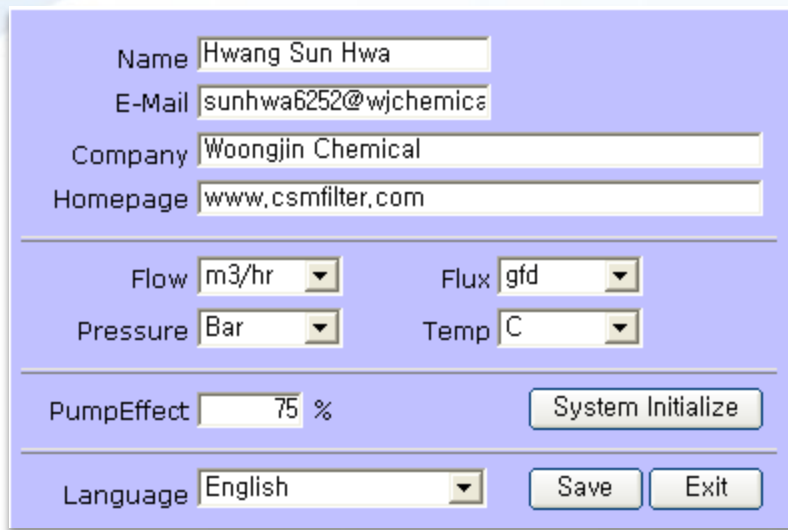
II. CSMPRO Introduction Registration



1. Language select box will appear at Initial execution.
English / Korean / Chinese(Simpl.) / Japanese are now available



2. CSMPRO live update agent will appear on the screen to download recent version



3. User can set a preference as left dialog box to use this program easily.
User information, preferred units, and languages are able to set and/or change with this windows.
[Option] – [Preference] on the head menus

CSMPRO Introduction Registration

CSMPRO v3.06 - [DESIGN]

File Option Help Update

Project Name: _____

Projected By: _____

E-Mail: _____

Project(Case)Note: _____

Case: 1 [+] [-]

Version: 1.0

Date: 2007-03-28

[OPEN] [SAVE]

Unit

Flow: m3/hr

Pressure: Bar

Flux: l/mh

Temp: C

Result

Feed Scale Calculation System

Number of Feed: 1 Date: 2007-03-28

Feed 1

Water Source: Well Water SDI<3 Feed: 6.81 m3/hr 100.00 %

TDS mg/l as Ion: 0.00 Temperature: 25.00 c

Ion Analysis

	mg/l as Ion	ppm as CaCO3	meq/l	Output Unit
Na	0.00	0.00	0.00	as Ion
K	0.00	0.00	0.00	as Ion
NH4	0.00	0.00	0.00	as Ion
Ca	0.00	0.00	0.00	as Ion
Mg	0.00	0.00	0.00	as Ion
Fe	0.00	0.00	0.00	as Ion
Ba	0.00	0.00	0.00	as Ion
Sr	0.00	0.00	0.00	as Ion
Cl	0.00	0.00	0.00	as Ion
NO3	0.00	0.00	0.00	as Ion
SO4	0.00	0.00	0.00	as Ion
F	0.00	0.00	0.00	as Ion
HCO3	0.00	0.00	0.00	as Ion
CO3	0.00	0.00	0.00	as Ion
CO2	0.00	0.00	0.00	as Ion
B	0.00	0.00	0.00	as Ion
SiO2	0.00	0.00	0.00	as Ion
Total Alkalinity	0.00	0.00	0.00	as CaCO3

	Unit	Feed1	Feed2	Overall
SDI	15 min			
Turbidity	NTU			
	mg/l as O2			
	mg/l as O2			
	mg/l as O2			
Cl2	mg/l as Cl2			
etc				
E cond	uS/Cm	0		
Feed pH		7.0		
Total Cation		0.00		
Total Anion		0.00		
Extra Ion		0.00		

Auto Balance

[Adjust Na] [Adjust NaCl]

[Adjust Cl] [Reset to Zero]

Project Information Area

Unit Area

Projection Area

II. CSMPRO Introduction System Design - Feed

1. Using this if there are multiple feed water sources

2. Select feed water source.

- Tertiary Effluent SDI<3
- Well Water SDI<3
- Surface Water SDI<3
- Surface Water SDI<5
- Tertiary Effluent SDI<3
- Tertiary Effluent SDI<5
- Sea Water SDI<3
- Sea Water SDI<5
- RO/UF Permeate SDI<1

1 Number of Feed 1

2 Feed 1 Water Source Tertiary Effluent SDI<3

4 Feed 340.17 m3/hr 100.00 %

3 TDS mg/l as Ion 1,578.04

5 Temperature 22.00 c

6

	Unit	Feed1	Feed2	Overall
SDI	15 min			
Turbidity	NTU			
TOC	mg/l as O2			
COD	mg/l as O2			
BOD	mg/l as O2			
Cl2	mg/l as Cl2			

7 etc E cond 3,079.26 uS/Cm Feed pH 7.9

8

Total Cation	25.662	Auto Balance	
Total Anion	25.662	Adjust Na	Adjust NaCl
Extra Ion	0.000	Adjust Cl	Reset to Zero

	mg/l as Ion	ppm as CaCO3	meq/l	Output Unit
Na	424.20	924.76	18.44	as Ion
K	34.00	43.52	0.87	as Ion
NH4	0.80	2.35	0.05	as Ion
Ca	46.00	115.00	2.30	as Ion
Mg	48.60	199.26	3.99	as Ion
Fe	0.20	0.36	0.01	as Ion
Ba	0.00	0.00	0.00	as Ion
Sr	0.00	0.00	0.00	as Ion
Cl	725.34	1,022.72	20.43	as Ion
NO3	5.90	4.78	0.09	as Ion
SO4	75.00	78.00	1.56	as Ion
F	0.00	0.00	0.00	as Ion
HCO3	218.00	178.76	3.58	as Ion
CO3	1.42	2.37	0.47	as Ion
CO2	3.88	4.42	0.09	as Ion
B	0.00			as Ion
SiO2	0.00			as Ion
Total Alkalinity	186.54			as CaCO3

3. Feed water concentration. Using TDS term or Ionic concentration

4. Feed flow for each feed source. This is used for multiple feed waters

5. Temperature of feed water

6. Additional feed water quality. No use for calculation but for understand the feed water condition

7. Conductivity will be calculated automatically, but it's not exact. There is no exact conversion factor between TDS and Conductivity. And input feed water pH.

8. Using this button to balance ion concentration between anion and cation

CSMPRO Introduction System Design – Scale Calculation

Feed		Scale Calculation			System	
System Recovery <input type="text" value="93 %"/>		Temp <input type="text" value="22.00 C"/>				
	Raw Feed	Adjusted Feed	Concentrate			
pH	7.90	7.00	8.05		<input checked="" type="checkbox"/> I/E Softening	
LSI	0.27	-0.70	2.2		<input checked="" type="checkbox"/> pH Adjustment	
SDSI	-0.114	-1.085	1.697		<input checked="" type="checkbox"/> Anti-Scalant Dosing	
I/S	0.0296	0.0299	0.4275		<input type="checkbox"/> I/E Softening	
TDS (mg/l)	1,578.0	1,576.3	22,499.0		Ca++ Leakage <input type="text" value="0.1 mg/l"/>	
HCO ₃ ⁻	248.0	180.7	2,067.0		Mg++ Leakage <input type="text" value="0 mg/l"/>	
CO ₂	0.0	0.1	0.1		<input type="checkbox"/> pH Adjustment	
CO ₃ ²⁻	0.0	27.5	27.5		Dosing Chemical <input type="text" value="H2SO4"/>	
SrSO ₄ %	0.7	0.9	27.8		Chemical Concentration <input type="text" value="96 %"/>	
BaSO ₄ %	0.0	0.0	0.0		Chemical Dosing rate <input type="text" value="28.21 mg/l"/>	
SrSO ₄	0.0	0.0	0.0		<input type="checkbox"/> Anti-Scalant	
CaF ₂	0.0	0.0	0.0		Manufacture <input type="text"/>	
SiO ₂	0.0	0.0	0.0		Model Name <input type="text"/>	
					Dosing rate <input type="text" value="0 mg/l"/>	
<input type="button" value="Reset"/>		<input type="button" value="Calculation"/>				

1. Important information to evaluate scale calculation

2. System Saturation Information
pH is able to adjust with option [pH Adjustment]

4. Softening
By using this option, almost Ca⁺⁺, Mg⁺⁺ will be changed into Na⁺

5. pH Adjustment
By using this option, Chemical consumption can be calculated

6. Anti-scalent
Only used for chemical consumption to evaluate operating cost

3. Execution Buttons
[Calculation] button must be clicked to activate, after all kinds of acting

CSMPRO Introduction System Design – System

1. Choose a single pass / double pass

4. Concentrate recirculation

5. Options

The screenshot shows the CSMPRO software interface with several key sections highlighted by numbered callouts:

- 1. Choose a single pass / double pass:** Located in the 'Feed' section, showing 'Number of Pass' set to 2 and 'Temp.' set to 25.00 C.
- 2. Design parameters:** A table listing various parameters for Pass 1 and Pass 2, such as Permeate, Recovery, Feed, Flux Decline, Salt Passage, Membrane Age, Average Permeate Flux, Permeate Blending, and Number of Array.
- 3. Array Configurations:** A table showing configurations for three arrays (Array 1, Array 2, Array 3) with columns for Model Name, No. of Press. Vessel, Elements per PV, Boost Pump Press., Perm. Back Press., and Hybrid.
- 4. Concentrate recirculation:** A table for 'Array Recycle' with columns for From Array, To Array, and Quantity.
- 5. Options:** A list of checkboxes for options like Auto Array Design, Same Back pressure, No H/Pump in 2nd Pass, Hybrid, Same Element type within Pass, and Same Vessel length within Pass.
- 6. pH Adjustment for 2nd pass feed and/or final product:** A section for '2nd Pass pH Adjustment' and 'Post Treatment' with input fields for Chemical, Concentration, and Adjusted pH.
- 7. Brief block diagram:** A schematic diagram showing the flow from feed (F) through pumps and membranes to permeate (P) and concentrate (C) streams.

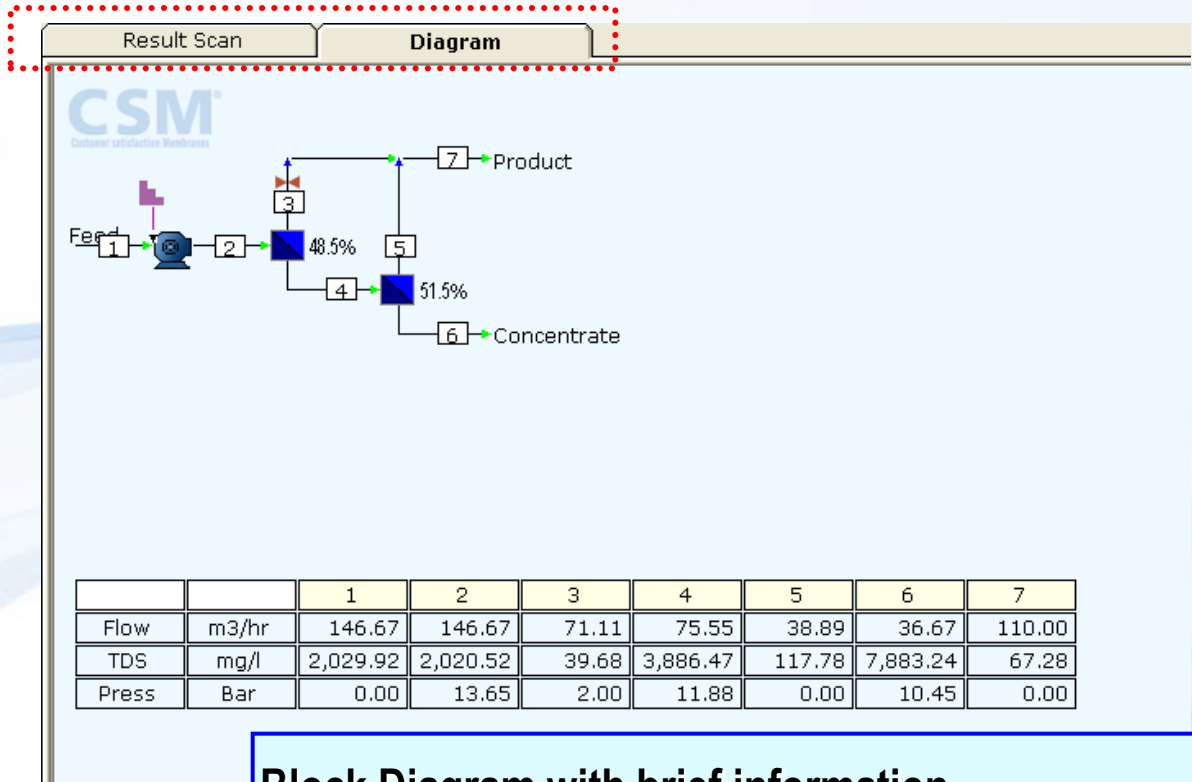
6. pH Adjustment for 2nd pass feed and/or final product

2. Design parameters

3. Array Configurations

7. Brief block diagram

II. CSMPRO Introduction Diagram



Block Diagram with brief information

After click a [RESULT], the program will show a this diagram. Some information including flow, TDS, pressure, flow diagram and recovery is demonstrated on the results.

For more details, choose a [Result Scan] Tab.

CSMPRO Introduction Result Scan

1. Overall projection data

FEED	146.67 m3/hr	2,029.92 mg/l	0.00 Bar
PRODUCT	110.00 m3/hr	7,883.24 mg/l	10.45 Bar
CONCENTRATE	36.67 m3/hr	7,883.24 mg/l	10.45 Bar
% RECOVERY	75.00	% REJECTION	96.67

2. Errors and Warnings

0 Errors / 3 Warnings

3. Toggle buttons for pass and each array data

Pass 1 Array 1 Array 2

4. Overall pass information

RAW WATER	146.67 m3/hr	2,029.92 mg/l	0.00 Bar	Flux decline	10.00 %/yr
SIDE STREAM	0.00 m3/hr	0.00 mg/l	0.00 Bar	Salt Passage	increase 10.00 %/yr
BY-PASS(BLENDING)	0.00 m3/hr	0.00 mg/l	0.00 Bar	MEMBRANE Age	3.00 yr
FEED	146.67 m3/hr	2,029.92 mg/l	0.00 Bar	Average Flux	22.61 lmh
PERMEATE	110.00 m3/hr	7,883.24 mg/l	10.45 Bar	(96) Dose	111.42 mg/l
PRODUCT	110.00 m3/hr	7,883.24 mg/l	10.45 Bar	SOFTENER	No
CONCENTRATE	36.67 m3/hr	7,883.24 mg/l	10.45 Bar		
% RECOVERY	75.00	% REJECTION	96.67	TEMPERATURE	30.00 C

5. Each pass or array details

Element/Vessel Data			Flow Rate (m3/hr)				Press. (Bar)			Avg Flux			
Vessel#	Element#	Element Type	Feed	Concentrat	Permeate	% Rec.	Last Beta	Feed	Conc.	DP	(lmh)	Feed	
1	12	72/6	RE8040-BE440	146.67	75.55	71.11	48.48	1.090	13.65	11.88	1.77	24.16	2,020.5
2	8	48/6	RE8040-BE440	75.55	36.67	38.89	51.48	1.090	11.54	10.45	1.09	19.82	3,886.4
Tot	20	120/6	RE8040-BE440	146.67	36.67	110.00	75.00	1.090	13.65	10.45	2.86	22.61	2,020.52

6. Ionic concentration information for selected pass or array

mg/l	Na	K	NH4	Ca	Mg	Fe	Ba	Sr	Cl	NO3	SO4
Feed	610.00	13.00	0.00	13.00	1.00	0.10	0.50	0.50	400.00	0.02	112.2
Perm.	16.43	0.46	0.00	0.20	0.01	0.00	0.00	0.00	10.99	0.00	1.3
Conc.	2,390.70	50.61	0.00	10.00	0.00	0.00	0.00	0.00	10.08	0.00	147.8

7. Saturation Information

LSI	1.088
S & DSI	0.756
CaSO4 (% st.)	2.189
MgSO4 (% st.)	22.664
FeSO4 (% st.)	3716.533
SrSO4 (% st.)	3.766
Ionic Strength	0.114

Errors

- No Error.

Projection Warnings

- Warning! Recommended Element Recovery has been Exceeded (Limit:14.00 %), RE8040-FE at Pass1

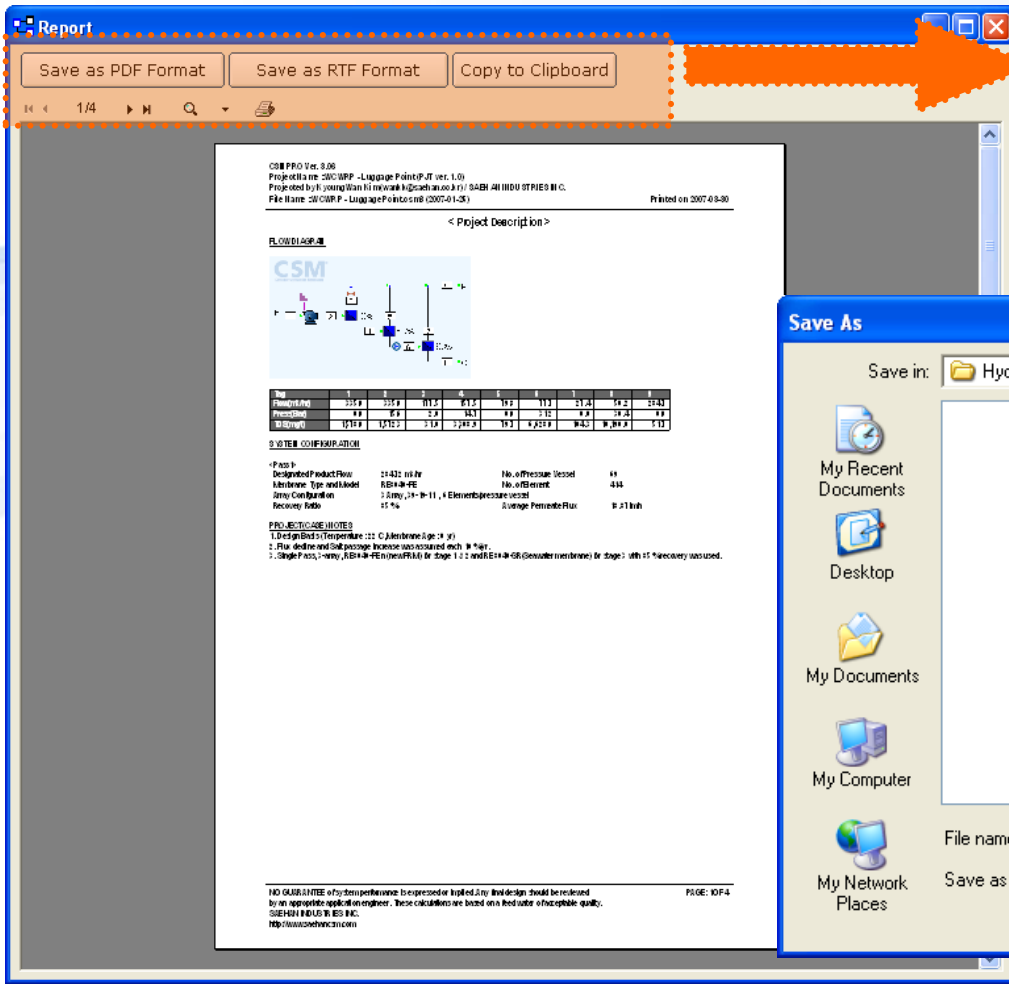
Scale Warnings

- Warning! High LSI, LSI > -0.2 Scale inhibitor and/or pH adjustment is required.
- Warning! High SDSI, SSI > 0.0 Scale inhibitor and/or pH adjustment is required.

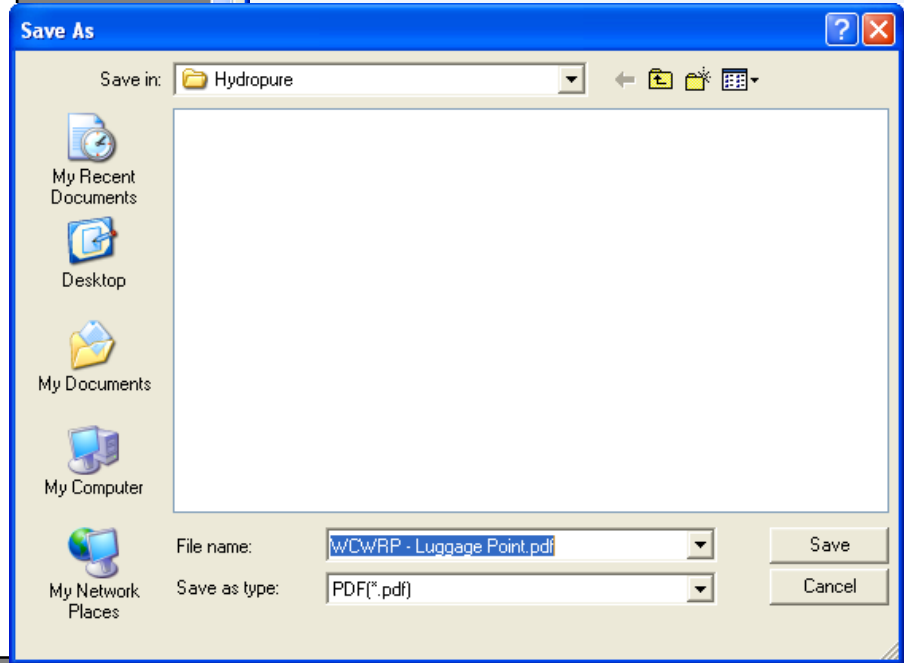
Limitation Warning

Limitation tool tip will be appeared when mouse pointer locate on a **red values** which exceeded than limitation in Each pass or array details (5) and saturation information (7)

II. CSMPRO Introduction **Print Out**



Several Option to use it easily
 Save as PDF format
 Save as RTF format – editable with MS Word
 Copy and paste on any other applications
 Directly print out



III. CSMPRO 4.1 Features



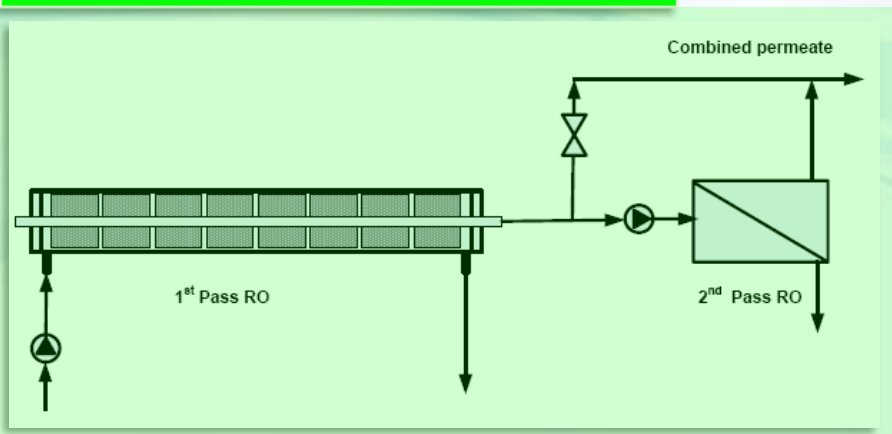
Split Partial Blending

III. CSMPRO 4.1 Feature

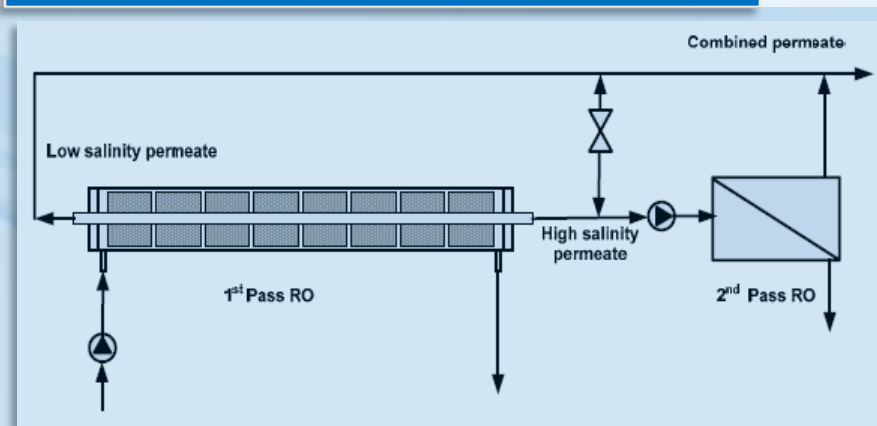
Split Partial Blending?

Permeate is collected from both sides of the pressure vessel. Low TDS front permeate is then sent directly to final product line, while higher TDS back permeate is treated by partial second pass RO plant.

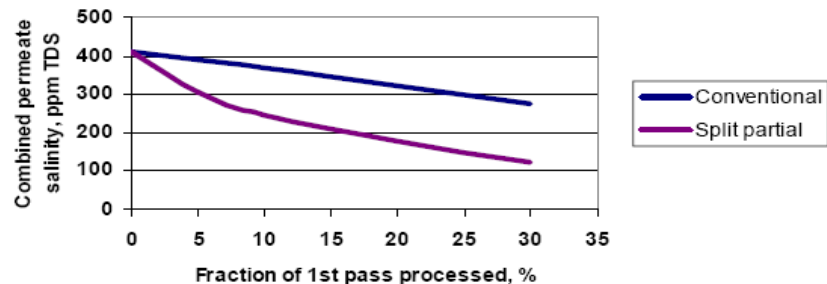
1. "Partial" Double Pass RO System



2. "Split-Partial" Double pass RO System



Partial two pass processing



Advantages of Split Partial

1. Smaller first & second pass RO trains
2. Better permeate quality
3. Reduced capital & operating cost
4. Flexibility in system operation according to actual conditions

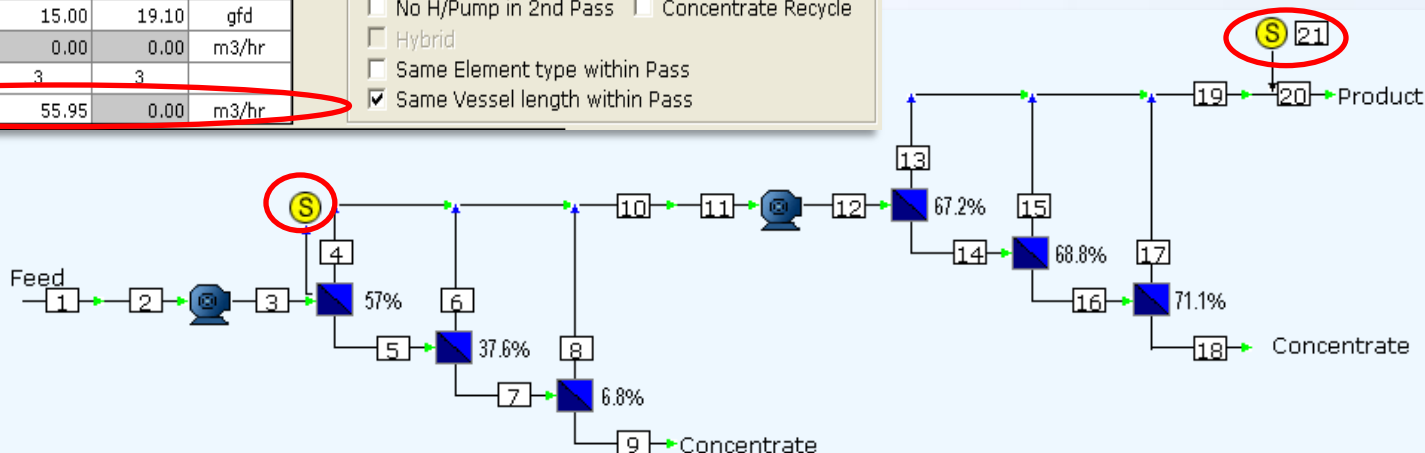
Split Partial Blending

Feed		Scale Calculation		System	
Number of Pass	2	Temp.	25.00 C		
	Pass 1	Pass 2	Unit		
Permeate	444.05	433.39	m3/hr		
Recovery	75.00	85.00	%		
Feed	666.67	444.05	m3/hr		
Flux Decline %/yr	7.00	5.00	%		
Salt Passage Incr. %/yr	10.00	5.00	%		
Membrane Age(yr)	0.00	0.00	yr		
Average Permeate Flux	15.00	19.10	gfd		
Permeate Blending	0.00	0.00	m3/hr		
Number of Array	3	3			
Split	55.95	0.00	m3/hr		

	Array Recycle	Unit
From Array	0	0 Stage
To Array	0	0 Stage
Quantity	0.00	0.00 m3/hr

Option

- Auto Array Design
- Same Back pressure
- No H/Pump in 2nd Pass
- Hybrid
- Same Element type within Pass
- Same Vessel length within Pass
- Permeate Blending
- Split
- Concentrate Recycle



		1	2	3	4	5	6	7	8	9	10
Flow	m3/hr	666.67	666.67	666.67	324.07	286.65	107.79	178.86	12.19	166.67	444.05
TDS	mg/l	2,424.05	2,424.05	2,424.05	11.25	5,623.79	35.87	8,991.39	127.41	9,639.76	20.42
Press	Bar	0.00	0.00	13.53	0.00	10.92	0.00	8.29	0.00	4.11	0.00

		11	12	13	14	15	16	17	18	19	20	21
Flow	m3/hr	444.05	444.05	298.26	145.79	100.33	45.47	32.33	13.14	430.91	486.86	55.95
TDS	mg/l	20.42	20.42	0.25	61.67	1.14	195.24	5.36	662.35	0.84	1.42	5.90
Press	Bar	0.00	8.32	0.00	5.68	0.00	4.03	0.00	3.01	0.00	0.00	0.00

Hybrid

III. CSMPRO 4.1 Feature

Hybrid?

To optimize feed pressure and system salt rejection, several kinds of membranes are installed to one pressure vessel.

	Flux (GPD)	Rejection (%)
RE 8040 SHN	6,000	99.75
RE 8040 SHA	7,500	99.75
RE 8040 SHF	9,000	99.70



Hybrid

III.

CSMPRO 4.1 Feature

Installed Membrane		Permeate Quality TDS (mg/l)	Power Consumption (kw hr/day)
Single	SHN 6EA	140.7	18,158
	SHA 6EA	182.3	16,951
	SHF 6EA	265.9	16,204
Hybrid	A SHN 2EA + SHA 3EA + SHF 2EA	177.1	16,834
	B SHN 4EA + SHF 3EA	182.4	17,237
	C SHF 2EA + SHA 3EA + SHN 2EA	191.2	16,222
	D SHF 4EA + SHN 3EA	229.2	16,379

Hybrid

III. CSMPRO 4.1 Feature

Feed		Scale Calculation	
Number of Pass	2	Temp.	30.00 C
Permeate	186.32	214.32	m3/hr
Recovery	45.00	85.00	%
Feed	538.37	186.32	m3/hr
Flux Decline %/yr	7.00	5.00	%
Salt Passage Incr. %/yr	10.00	5.00	%
Membrane Age(yr)	1.00	1.00	yr
Average Permeate Flux	8.90	21.00	gfd
Permeate Blending	0.00	10.00	m3/hr
Number of Array	1	2	
Split	55.95	0.00	m3/hr

Model select	Array 1
Model Name	RE16040-SHF
No. of Press. Vessel	18
Elements per PV	6
Boost Pump Press.	0.00
Perm. Back Press.	0.00
Hybrid	2

	Array 1	Array 2
Model Name	RE16040-BLR	RE16040-BLR
No. of Press. Vessel	3	2
Elements per PV	6	6
Boost Pump Press.	0.00	0.00
Perm. Back Press.	0.00	0.00
Hybrid	2	1

	Pass 1	Pass 2	Unit
Permeate	186.32	214.32	m3/hr
Recovery	45.00	85.00	%
Feed	538.37	186.32	m3/hr
Flux Decline %/yr	7.00	5.00	%
Salt Passage Incr. %/yr	10.00	5.00	%
Membrane Age(yr)	1.00	1.00	yr
Average Permeate Flux	8.90	21.00	gfd
Permeate Blending	0.00	10.00	m3/hr
Number of Array	1	2	
Split	55.95	0.00	m3/hr

Hybrid	Array 1	Array 1
Model Name	RE16040-SHN	RE16040-SHF
No. of Press. Vessel	18	18
Elements per PV	3	3

	Array 1	Array 1	Array 2
Model Name	RE16040-BE	RE16040-BLR	RE16040-BLR
No. of Press. Vessel	3	3	2
Elements per PV	3	3	6

	From Array	Array Recyc
To Array	1	
Quantity	0.00	0.00

Option

- Auto Array Design
- Same Back pressure
- No LP/Pump in 2nd Pass
- Hybrid
- Same Element type with
- Same Vessel length with

◆ System Information

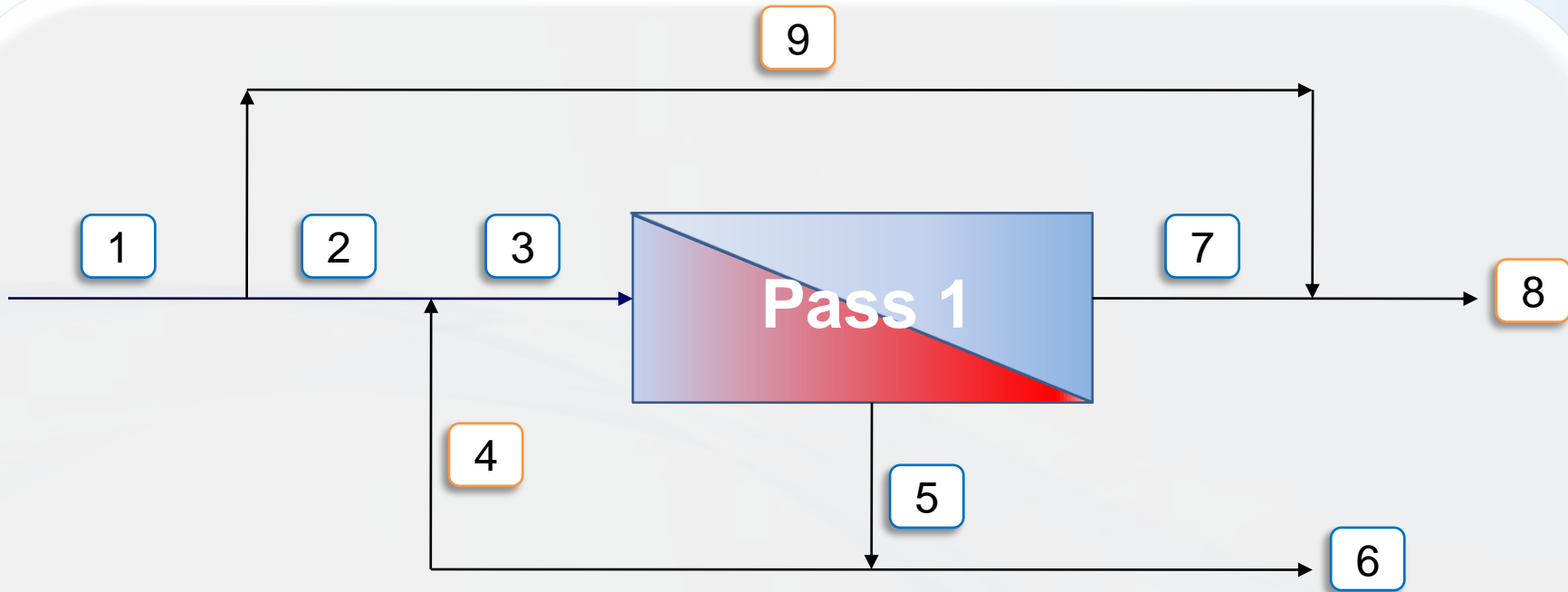
Double Pass (1st pass : 1 array, 2nd pass : 3-2 array, 6 elements/PV)

1st pass : 1st stage : 16040-SHN 3pcs & 16040-SHF 3pcs

2nd pass 1st stage: 16040-BE 3pcs & 3 16040-BLR 3pcs

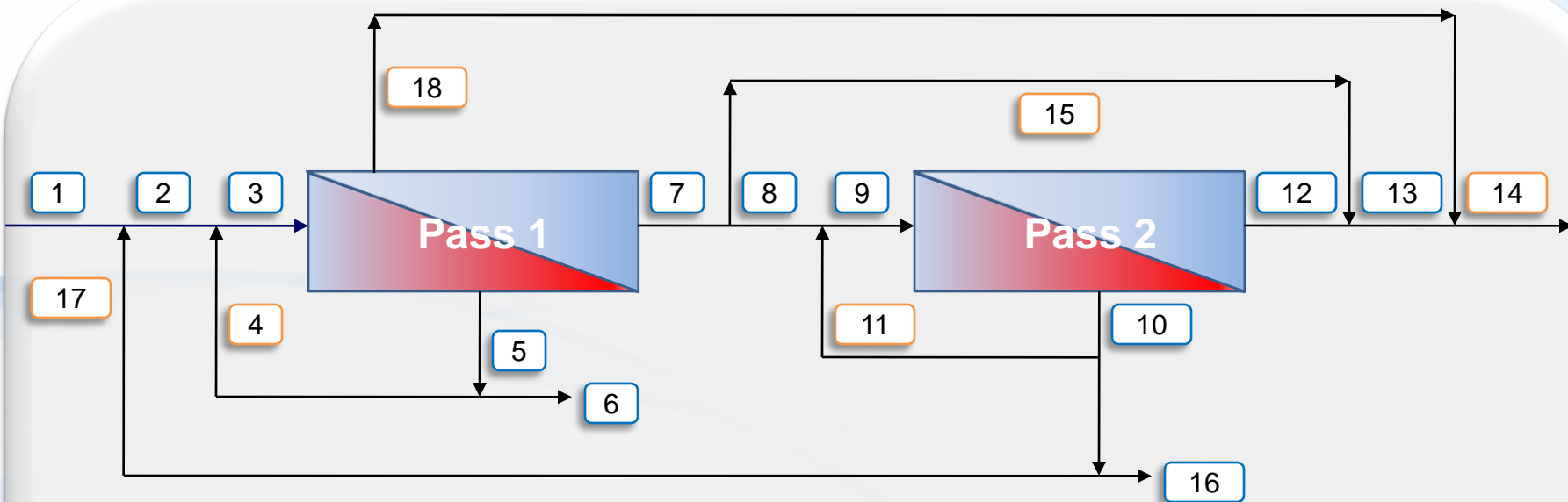
Recovery – Single Pass

III. CSMPRO 4.1 Feature



Case		Pass Recovery	System Recovery
1	No blending, No array recycle (no 4, no 9)	$=7/2 = 8/1$	$=8/1$
2	Blending (9, no 4)	$=7/2 = (8-9)/(1-9)$	$=8/1$
3	Array recycle (4, no 9)	$=7/2 = 8/1$	$=8/1$
4	Blending, array recycle (4, 9)	$=7/2 = (8-9)/(1-9)$	$=8/1$

Recovery – Double Pass



Case		pass 1 recovery	pass 2 recovery	system recovery
5	No recycle, No blending, No split (no 4, 11, 15, 17, 18)	$=7/2 = 7/1$	$=12/8 = 14/8$	$=14/1$
6	blending (15, no 4, 11, 17, 18)	$=7/2 = 7/1$	$=12/8 = (14-15)/(7-15)$	$=14/1$
7	concentrate recycle (17, no 4, 11, 15, 18)	$=7/2 = 7/(1+17)$	$=12/8$	$=14/1$
8	blending, concentrate recycle (15, 17, no 4, 11, 18)	$=7/2 = 7/(1+17)$	$=12/8 = (14-15)/(7-15)$	$=14/1$
9	blending, concentrate & array recycle (4, 11, 15, 17, 18)	$=7/2 = 7/(1+17)$	$=12/8 = (14-15)/(7-15)$	$=14/1$
10	Blending, concentrate & array recycle, Split (4, 11, 15, 17, 18)	$=(7+18)/2 = (7+18)/(1+17)$	$=12/8 = (14-15-18)/(7-15)$	$=14/1$

2011, CSMPRO4.1

- ◆ Correct Aver. Perm. Flux calculation
- ◆ pH adjustment bug was fixed
- ◆ Correct definition of recovery



2012, CSMPRO5.0 is coming soon!

- ◆ Apply correction equation depending on feed water concentration
- ◆ Increase prediction accuracy of perm. TDS & Feed pressure
- ◆ Remove some bugs

Thank You!

WOONGJIN CHEMICAL CO.,LTD

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