A Guide to ROSA 6.0

09/2004

ROSA 6.0 Information

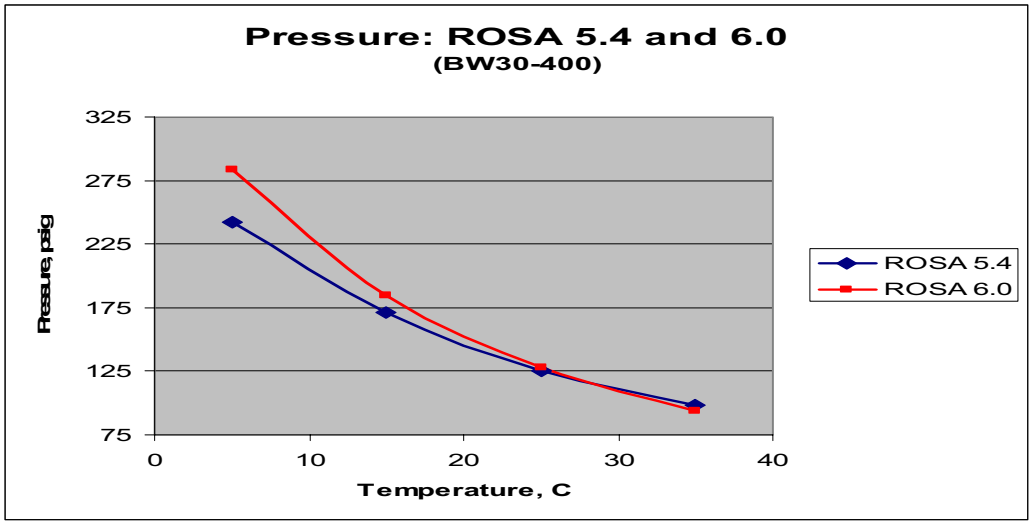
- http://www.dow.com/liquidseps/design/rosa.htm
  - Download program
  - Installation instructions
  - ROSA FAQs (Frequently Asked Questions) – ANSWER CENTER
  - A Guide to ROSA 6.0 program
  - ROSA version history

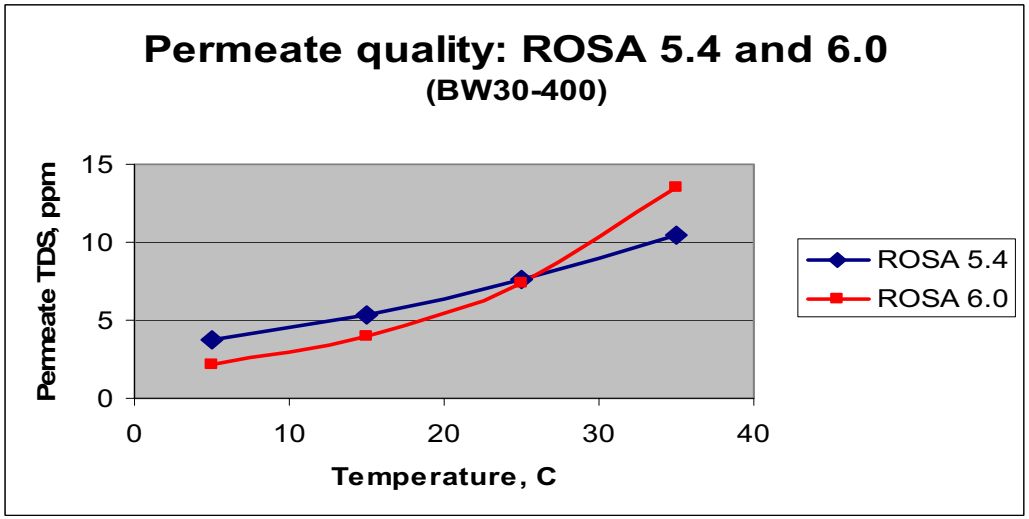
New Temperature Correction Factor (TCF)

- Incorporated new TCF
- Based on tests carried out by FilmTec (2003-2004)

  Note: The published TCF documents will be updated.

Effect of Temperature

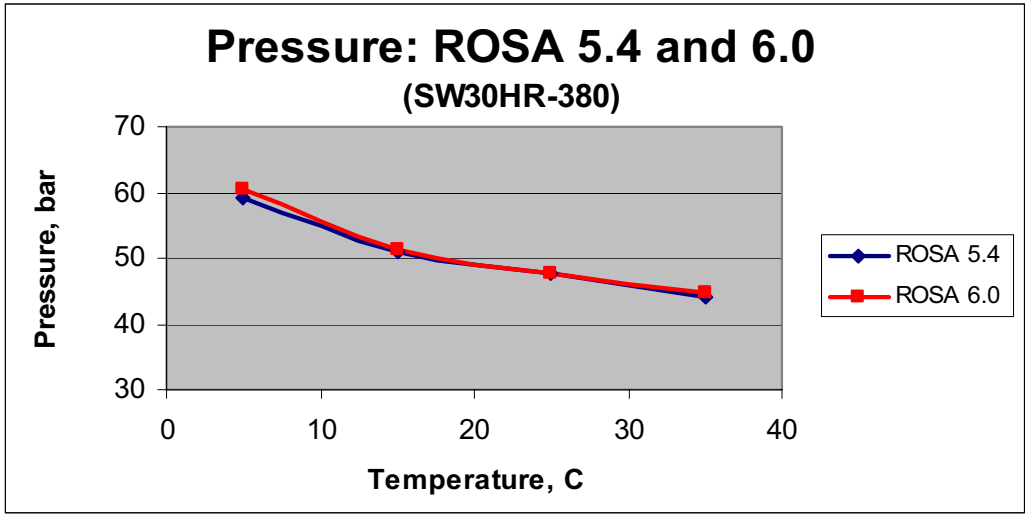


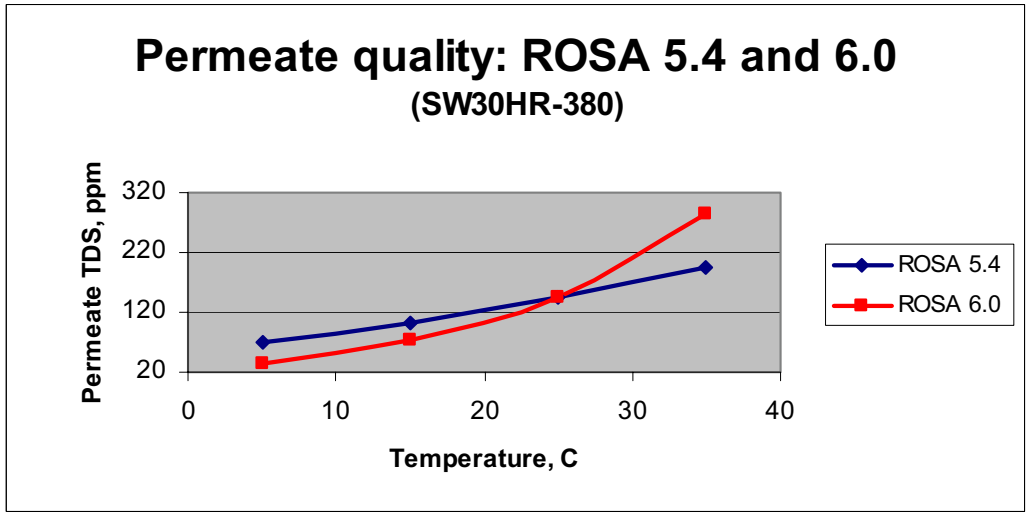


Brackish Water

- ROSA 6.0 predicts a higher feed pressure at temperatures < 25°C
- ROSA 6.0 predicts lower permeate TDS at temperatures < 25°C
- ROSA 6.0 predicts higher permeate TDS at temperatures > 25°C

Effect of Temperature

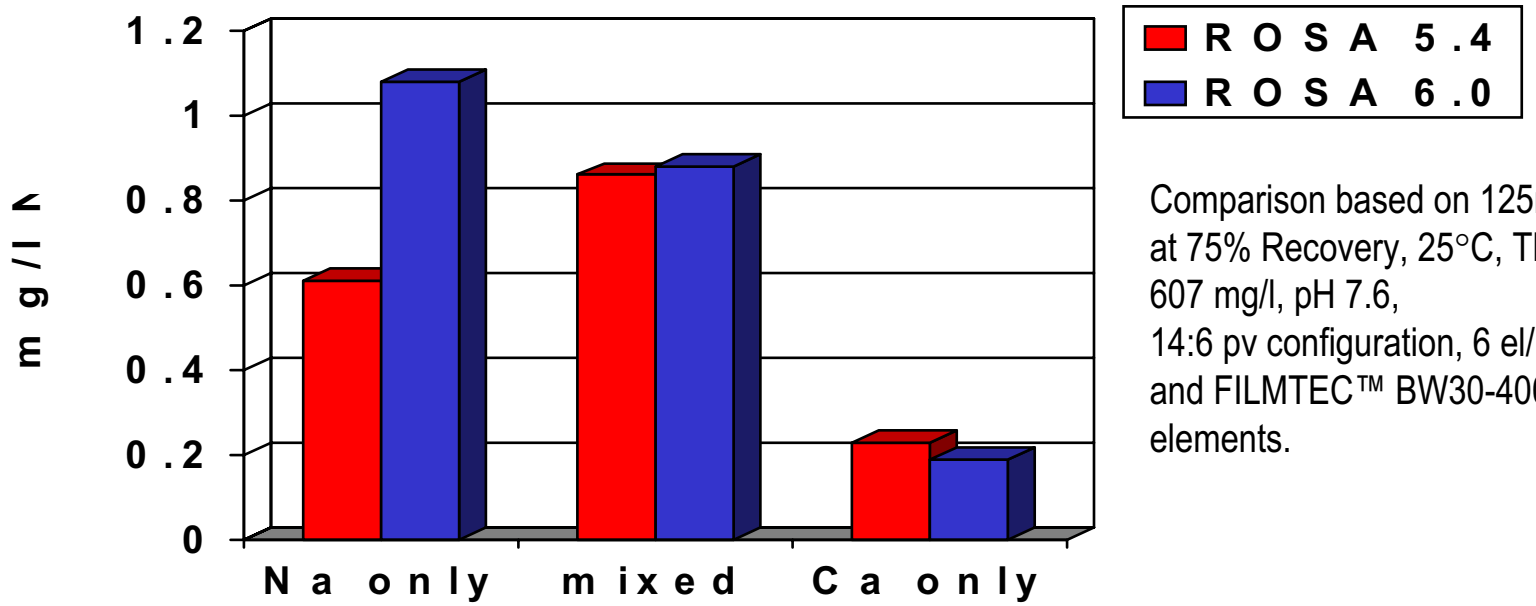




Seawater

- Both show similar pressure trend
- ROSA 6.0 predicts lower permeate TDS at temperatures < 25°C
- ROSA 6.0 predicts significantly higher permeate TDS at temperatures > 25°C

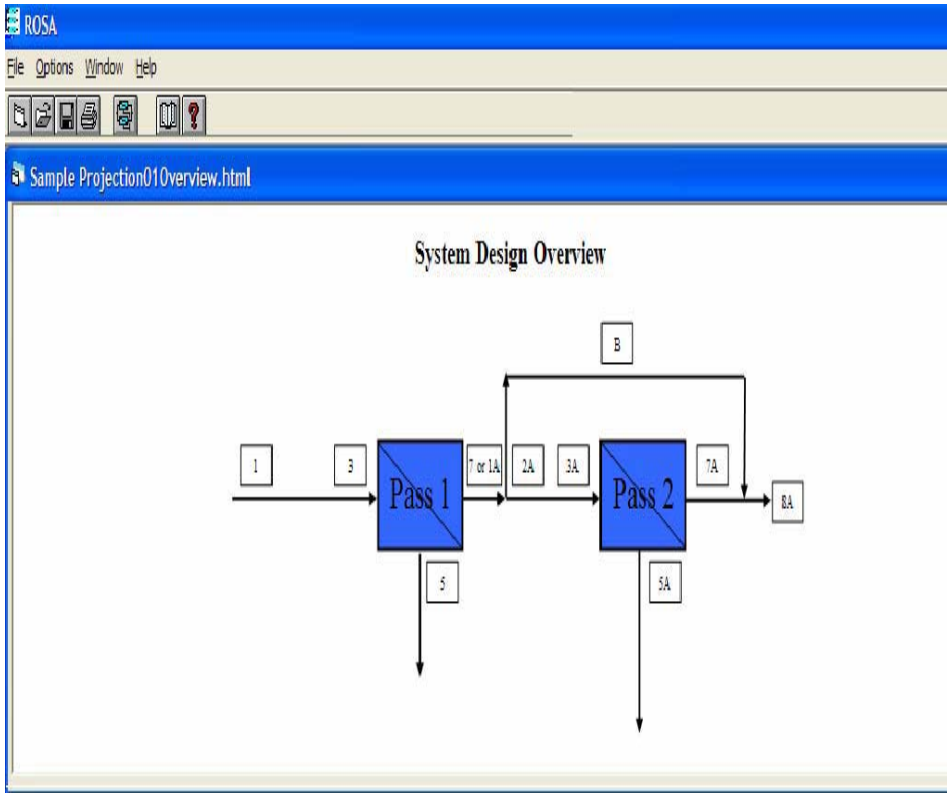
Improved Calculation Model for NO_3 Rejection

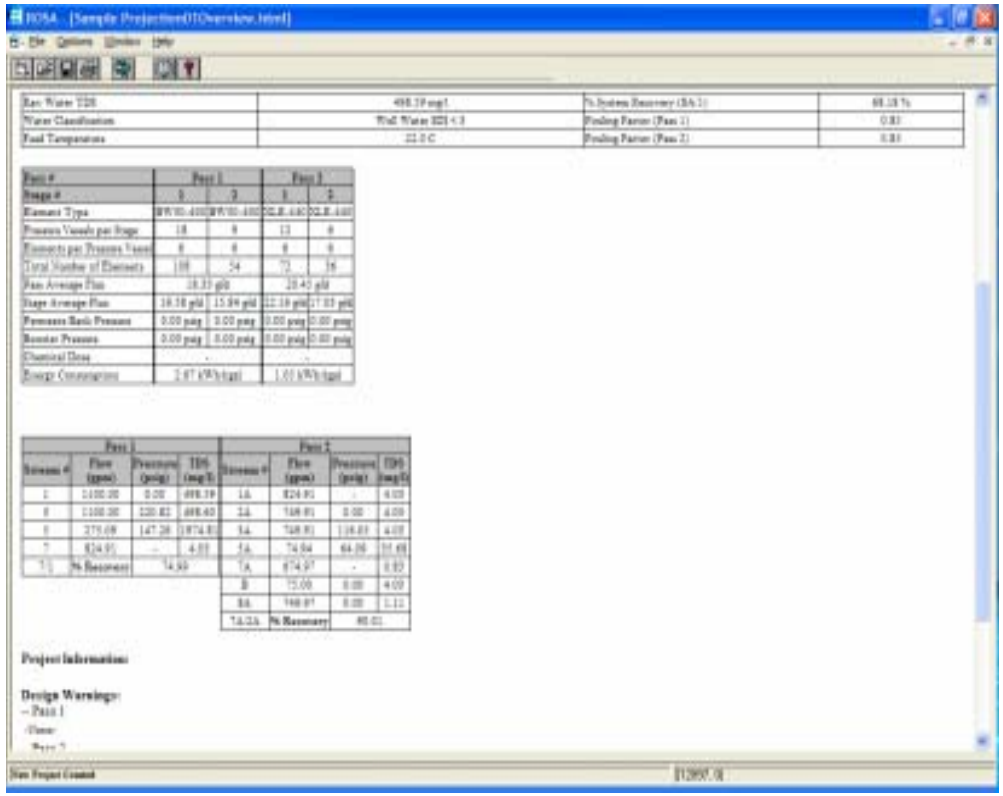


Comparison based on 125m^3/hr at 75% Recovery, 25°C, TDS 607 mg/l, pH 7.6, 14:6 pv configuration, 6 el/pv, and FILMTEC™ BW30-400 elements.

- More hardness improves the NO3 rejection while more sodium has the opposite effect.
- Based on tests carried out at FilmTec (2003).
- It applies to XLE, LE, BW30LE, BW30, SG, and LP membranes.

Print Out: System Design Overview



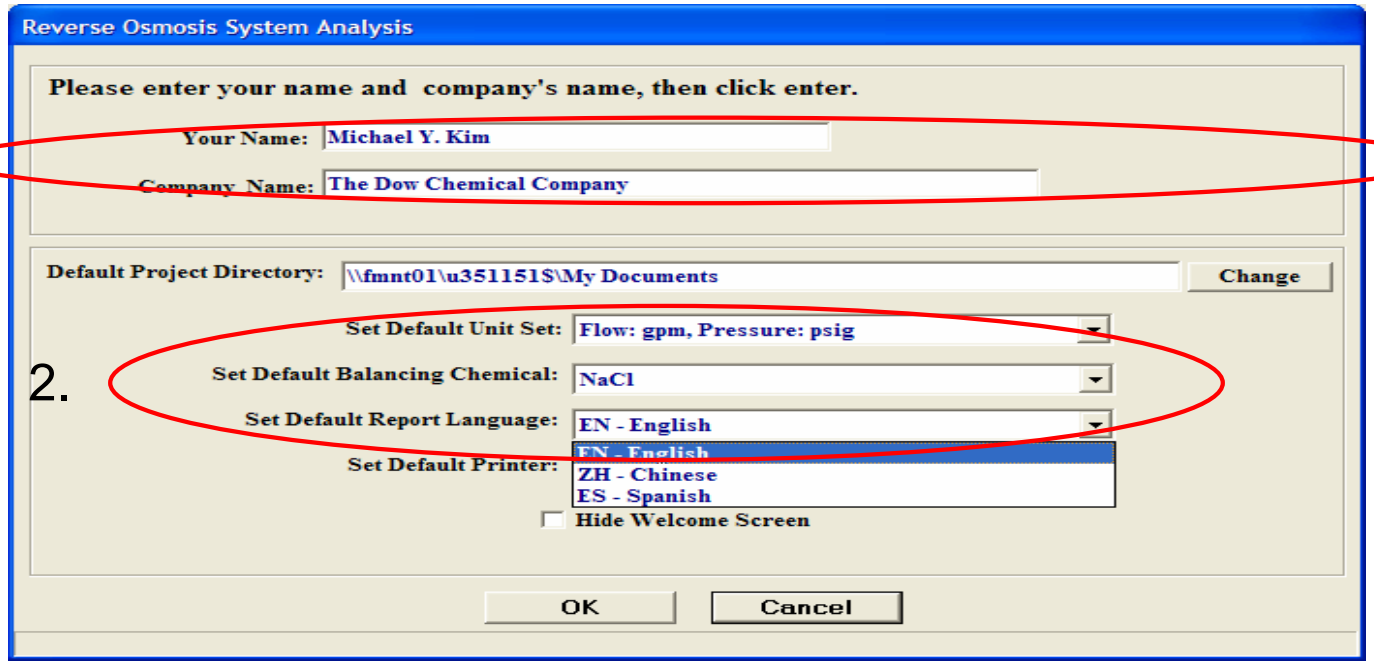


Two reports are available in ROSA 6.0:

- **System Design Overview:** Contains system design diagram with each stream clearly numbered, and summary of key system design parameters.
- **Detailed Report:** Contains detailed information on system design.

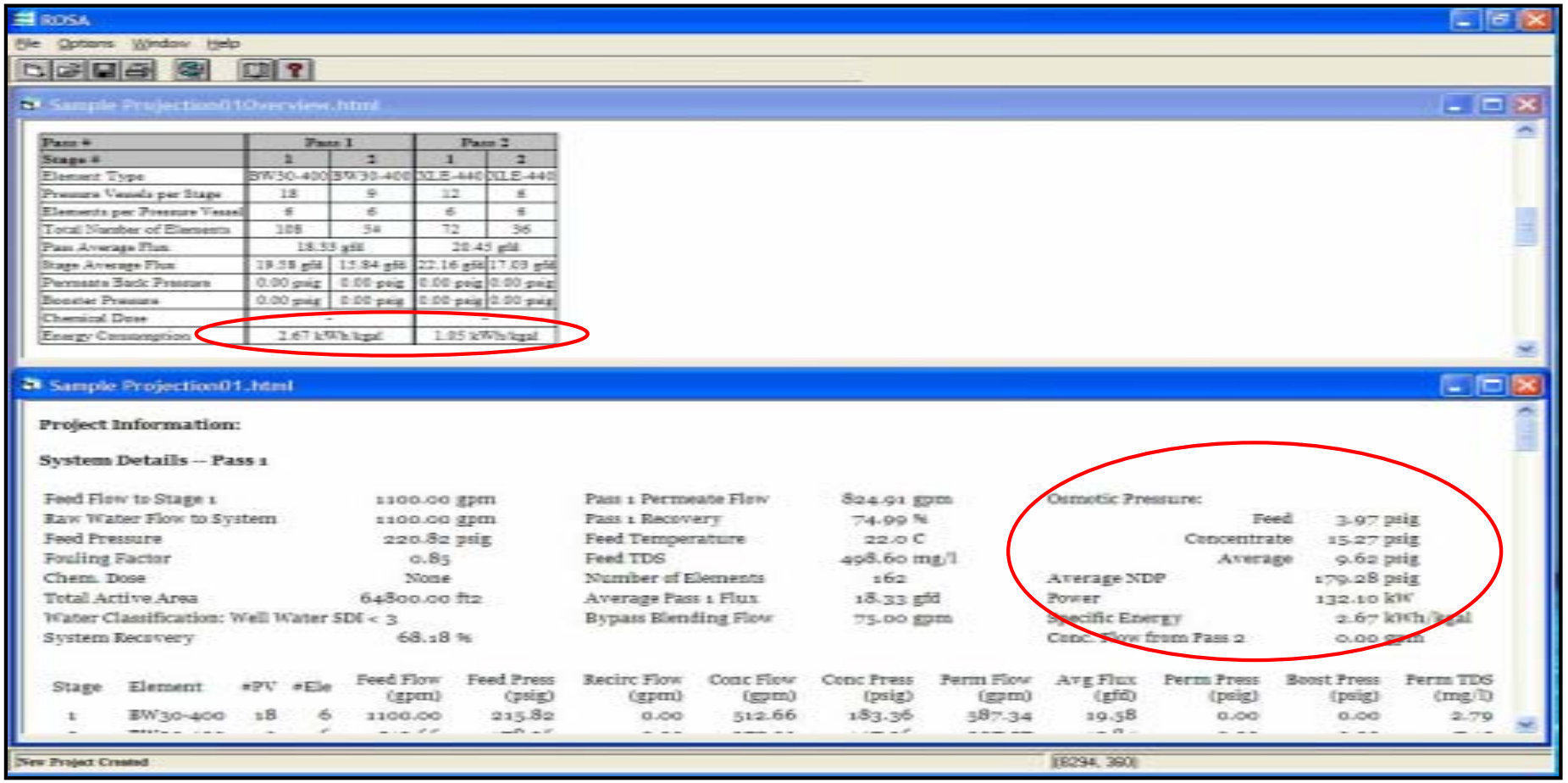
Both reports can be printed and/or emailed separately.

User Data:
ROSA menu → Options → User data



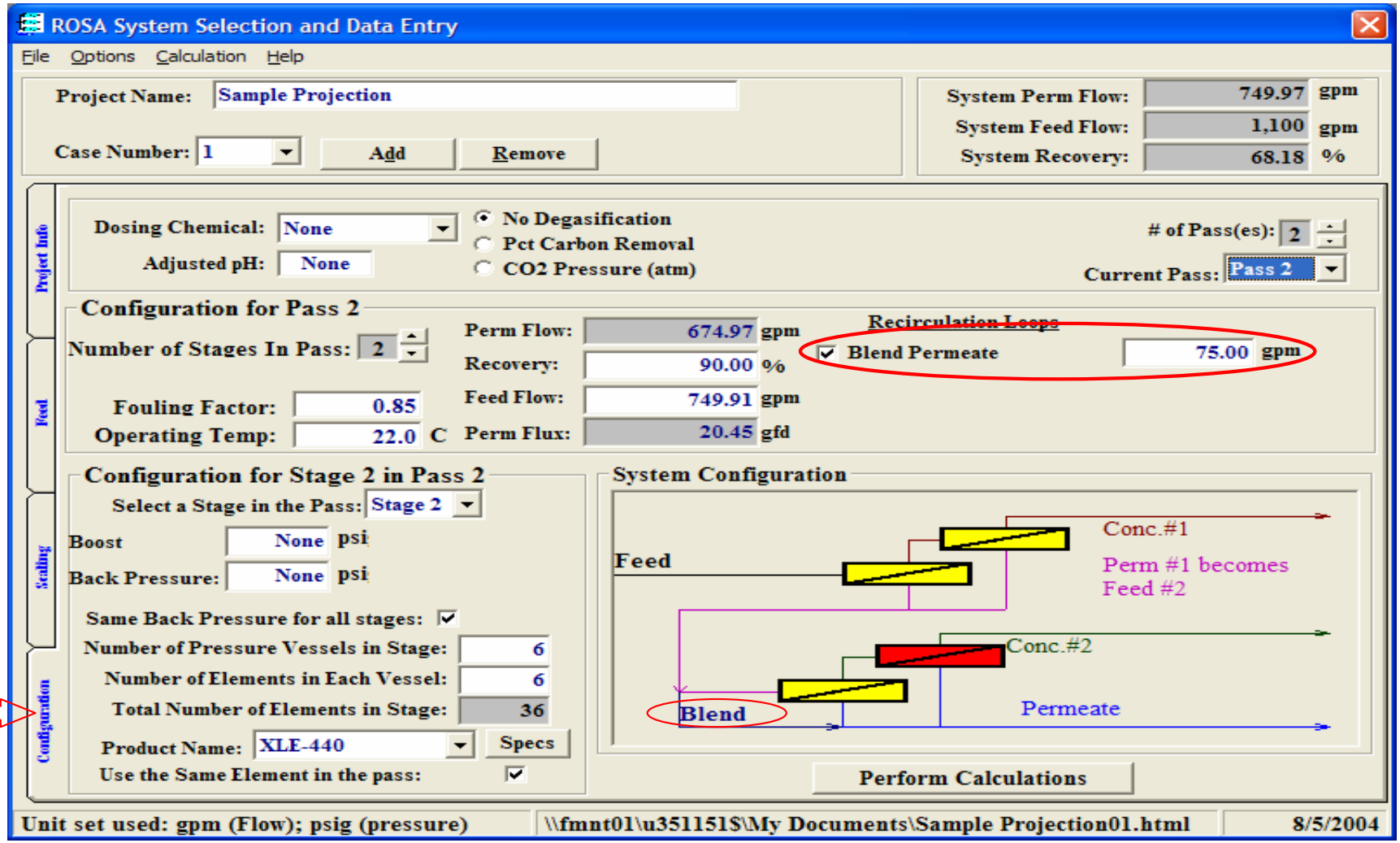
1. To save all three files (.rosa, .html, overview.html), select default project directory by clicking on "**Change**" and select **folder destination**.
2. ROSA reports can now be printed in English, Chinese or Spanish by selecting it as your default report language in the User Data section.

System Design Overview & Detailed Report:



Energy and power consumption, osmotic pressure and net driving pressures are included in the System design overview and Detailed report

Configuration Section: Blending option has been added for both single and double pass systems.



Detailed Report: Total blended product = permeate + blended flow
% system recovery = (total blended flow / raw feed flow) x 100%

ROSA - [Sample Projection01.html]

File Options Window Help

Project Information:

System Details -- Pass 2

Feed Flow to Stage 1	749.91 gpm	Pass 2 Permeate Flow	674.97 gpm	Osmotic Pressure:	
Raw Water Flow to System	1100.00 gpm	Pass 2 Recovery	90.01 %	Feed	0.03 psig
Feed Pressure	116.05 psig	Feed Temperature	22.0 C	Concentrate	0.30 psig
Fouling Factor	0.85	Feed TDS	4.03 mg/l	Average	0.16 psig
Chem. Dose	None	Number of Elements	108	Average NDP	90.53 psig
Total Active Area	47520.00 ft2	Average Pass 2 Flux	22.15 gfd	Power	47.33 kW
Water Classification: RO Permeate SDI < 1		Bypass Blending Flow	75.00 gpm	Specific Energy	1.05 kWh/kgal
System Recovery	68.18 %	Total Blended Product	749.97 gpm		

Stage	Element	#PV	#Ele	Feed Flow (gpm)	Feed Press (psig)	Recirc Flow (gpm)	Conc Flow (gpm)	Conc Press (psig)	Perm Flow (gpm)	Avg Flux (gfd)	Perm Press (psig)	Boost Press (psig)	Perm TDS (mg/l)
1	XLE-440	12	6	749.91	111.05	0.00	262.31	84.21	487.60	22.16	0.00	0.00	0.70
2	XLE-440	6	6	262.31	79.21	0.00	74.94	64.09	187.37	17.03	0.00	0.00	1.19

Pass Streams (mg/l as Ion)

Name	Feed	Adjusted Feed	Concentrate		Permeate			
			Stage 1	Stage 2	Stage 1	Stage 2	Total	Blended Total
NH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K	0.25	0.25	0.57	1.54	0.07	0.18	0.10	0.12
Na	0.88	0.88	2.45	8.31	0.04	0.11	0.05	0.14
Mg	0.02	0.02	0.04	0.15	0.00	0.00	0.00	0.00
Ca	0.03	0.03	0.09	0.31	0.00	0.00	0.00	0.00
Sr	0.01	0.01	0.02	0.06	0.00	0.00	0.00	0.00
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HCO3	1.88	1.88	5.11	17.27	0.46	0.57	0.49	0.59
NO3	0.37	0.37	0.85	2.26	0.11	0.28	0.16	0.18
Cl	0.29	0.29	0.81	2.75	0.01	0.03	0.02	0.04

New Project Created (1443, 15)

Detailed Report: Permeate quality contains extra column which displays the blended permeate quality.

ROSA - [Sample Projection01.html]

File Options Window Help

Stage	Element	#PV	#Ele	Feed Flow (gpm)	Feed Press (psig)	Recirc Flow (gpm)	Conc Flow (gpm)	Conc Press (psig)	Perm Flow (gpm)	Avg Flux (gfd)	Perm Press (psig)	Boost Press (psig)	Perm TDS (mg/l)
1	XLE-440	12	6	749.91	111.05	0.00	262.31	84.21	487.60	22.16	0.00	0.00	0.70
2	XLE-440	6	6	262.31	79.21	0.00	74.94	64.09	187.37	17.03	0.00	0.00	1.19

Pass Streams (mg/l as Ion)

Name	Feed	Adjusted Feed	Concentrate		Permeate			
			Stage 1	Stage 2	Stage 1	Stage 2	Total	Blended Total
NH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K	0.25	0.25	0.57	1.54	0.07	0.18	0.12	0.12
Na	0.88	0.88	2.45	8.31	0.04	0.11	0.05	0.14
Mg	0.02	0.02	0.04	0.15	0.00	0.00	0.00	0.00
Ca	0.03	0.03	0.09	0.31	0.00	0.00	0.00	0.00
Sr	0.01	0.01	0.02	0.06	0.00	0.00	0.00	0.00
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HCO3	1.88	1.88	5.11	17.27	0.46	0.57	0.49	0.59
NO3	0.37	0.37	0.85	2.26	0.11	0.28	0.16	0.18
Cl	0.29	0.29	0.81	2.75	0.01	0.03	0.02	0.04
F	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
SO4	0.25	0.25	0.71	2.44	0.00	0.01	0.01	0.03
Boron	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SiO2	0.06	0.06	0.17	0.57	0.00	0.01	0.00	0.01
CO2	6.59	6.59	6.64	6.67	6.33	6.40	6.35	6.41
TDS	4.03	4.03	10.81	35.68	0.70	1.19	0.83	1.11
pH	5.69	5.69	6.12	6.63	5.11	5.20	5.13	5.21

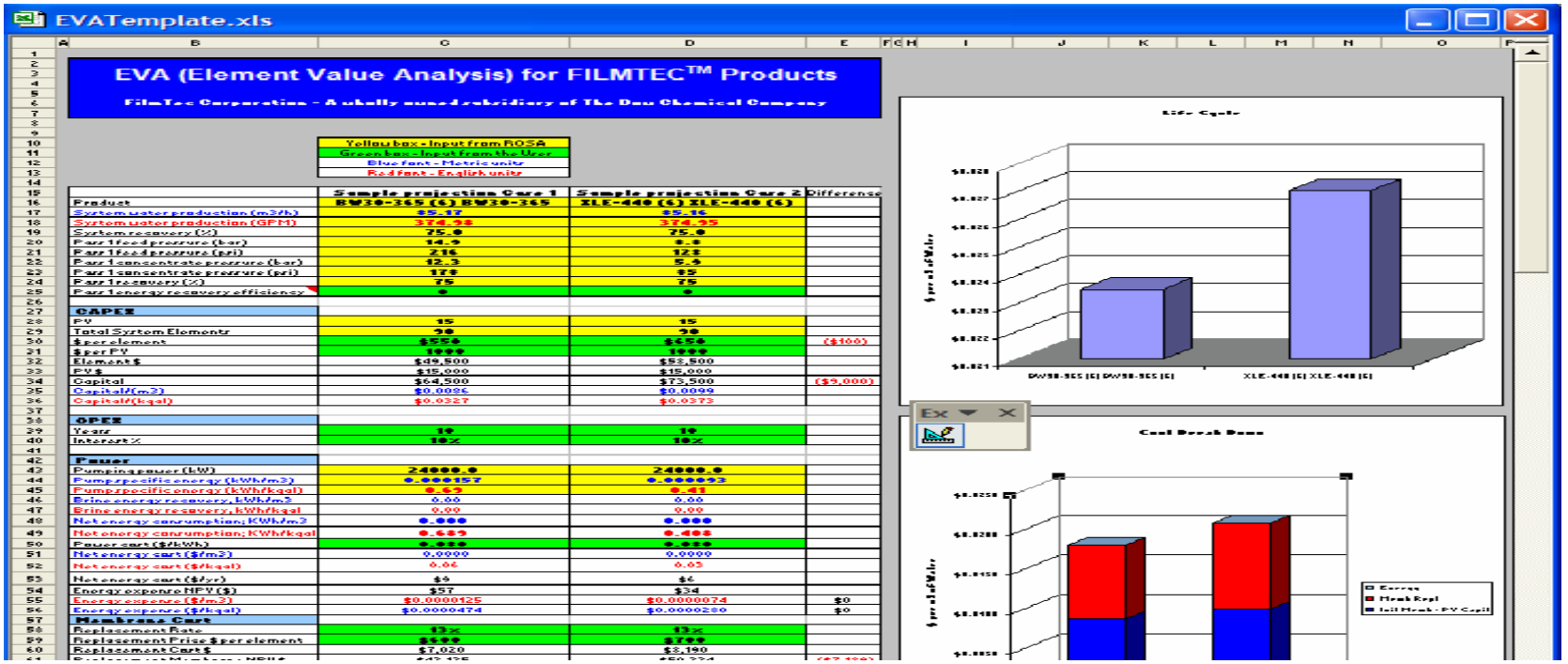
Design Warnings -- Pass 2

-None-

Solubility Warnings -- Pass 2

New Project Created (1443, 15)

EVA (Element Value Analysis) Spreadsheet is Incorporated into ROSA 6.0. (ROSA menu → Options → EVA)



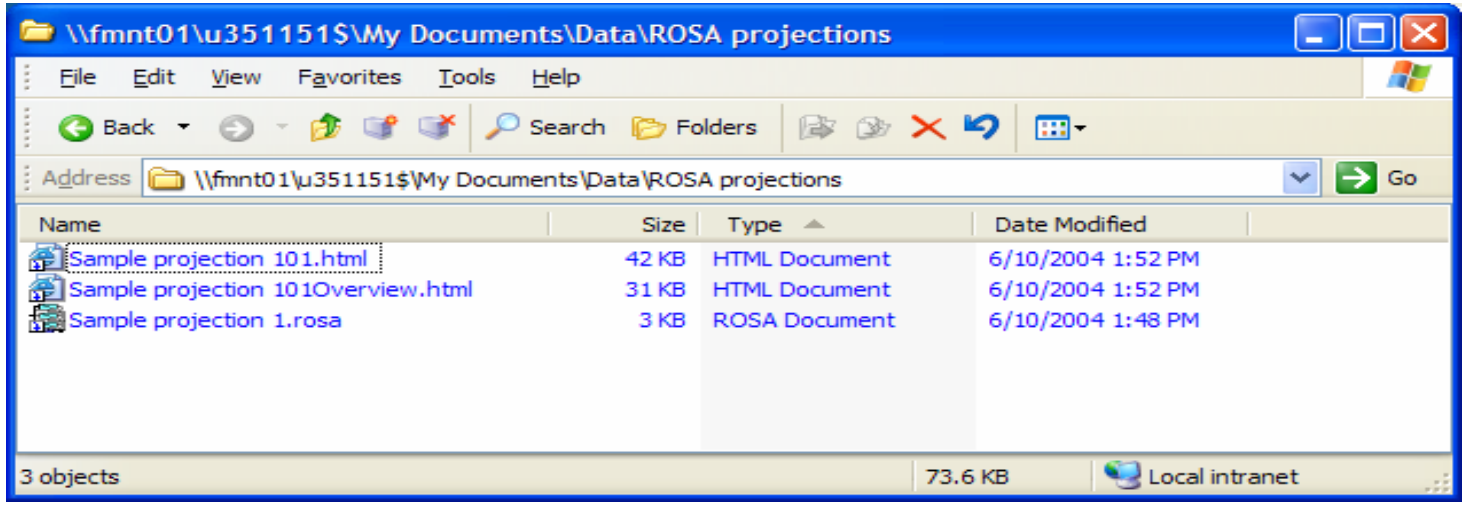
EVA is an Excel spreadsheet which allows you to compare the economics of two membrane systems.

How to Use EVA Spreadsheet

1. Go to the **ROSA menu**
2. Choose "**options**"
3. Choose "**Element Value Analysis (EVA)**"
4. Choose "**new**"
5. Choose **column one or two** if you want this particular projection to be summarized in column **one or two** of EVA
6. Save it as **.xls file**
7. Create another case or projection in ROSA and perform calculations
8. Repeat **Steps 1 through 3**
9. Choose "**open**" and select **column one or two** depending on which column you chose in Step 5. If you chose column one in step 5, then choose column two and visa versa.
10. Find the Excel spreadsheet you saved your EVA in "**My documents**" and **open** it.
11. You should be able to see the two ROSA projection cases in column one and two.

Ability to Save ROSA Projections in Any Folder on Your Computer

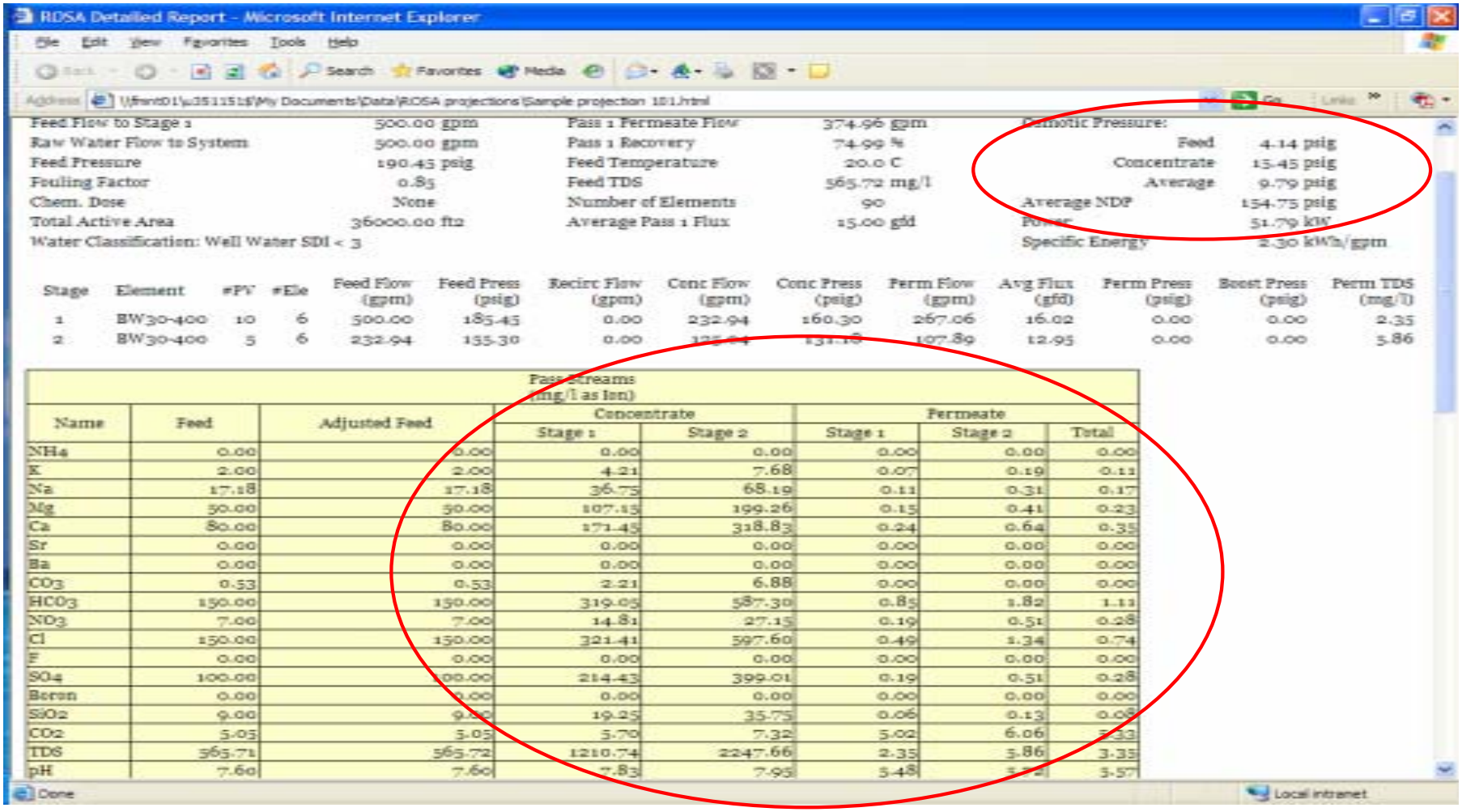
- **Overview.html** – An html file that contains the system design overview which includes the system design diagram and projection summary information. This is a read-only file and can be emailed to others.
- **.html** - An html file that contains the ROSA Detailed Report. This is a read-only file and can be emailed to customers.
- **.rosa** - A ROSA project file. When the User double clicks on a .rosa file, it will actually use the ROSA program to open the projection file, and the User can modify or run projections from here. This can be emailed to the others; it can be opened and modified as long as the ROSA 6.0 program is in their computer.



ROSA Projections

- Save multiple (10) case outputs (.html and overview.html)
- Ability to rename each case
- View each case in .html (Detailed report) and overview.html (System design overview and flowchart)
- Open ROSA projection with multiple cases by opening ROSA program

Detailed Report: Individual stage composition of permeate and concentrate have been added. Osmotic pressure and NDP have been included in the Detailed Report.



RDSA Detailed Report - Microsoft Internet Explorer

Feed Flow to Stage 1	500.00 gpm	Pass 1 Permeate Flow	374.96 gpm	Osmotic Pressure:	
Raw Water Flow to System	500.00 gpm	Pass 1 Recovery	74.99 %	Feed	4.14 psig
Feed Pressure	190.45 psig	Feed Temperature	20.0 C	Concentrate	15.45 psig
Fouling Factor	0.85	Feed TDS	565.72 mg/l	Average	9.79 psig
Chem. Dose	None	Number of Elements	90	Average NDP	154.75 psig
Total Active Area	36000.00 ft2	Average Pass 1 Flux	15.00 gfd	Power	51.79 kW
Water Classification: Well Water SDI < 3				Specific Energy	2.30 kWh/gpm

Stage	Element	#PV	#Ele	Feed Flow (gpm)	Feed Press (psig)	Recirc Flow (gpm)	Conc Flow (gpm)	Conc Press (psig)	Perm Flow (gpm)	Avg Flux (gfd)	Perm Press (psig)	Boost Press (psig)	Perm TDS (mg/l)
1	BW30-400	10	6	500.00	185.45	0.00	232.94	160.30	267.06	16.02	0.00	0.00	2.35
2	BW30-400	5	6	232.94	155.30	0.00	[illegible]	[illegible]	107.89	12.95	0.00	0.00	5.86

Pass Streams (mg/l as Ion)

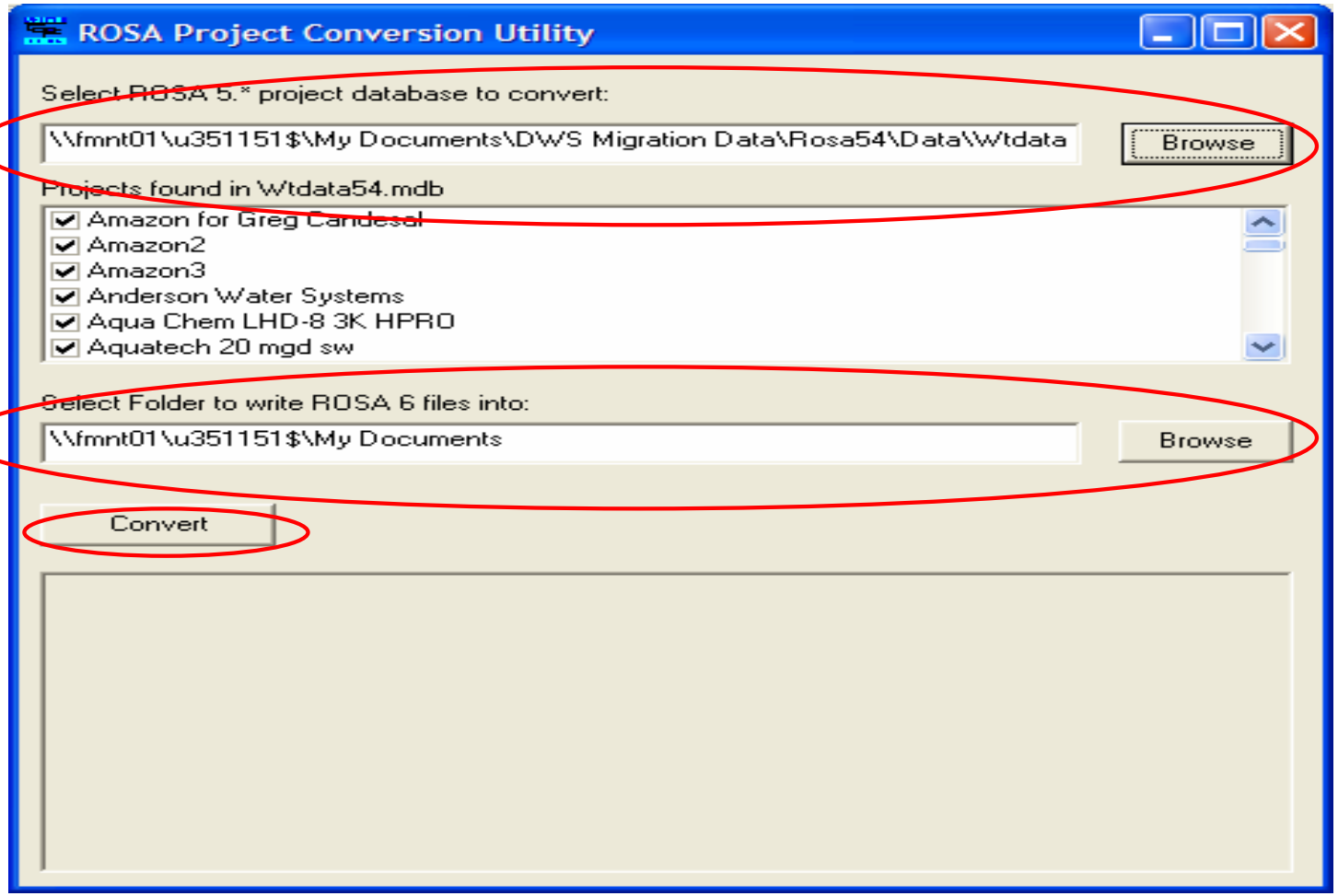
Name	Feed	Adjusted Feed	Concentrate		Permeate		
			Stage 1	Stage 2	Stage 1	Stage 2	Total
NH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K	2.00	2.00	4.21	7.68	0.07	0.19	0.11
Na	17.18	17.18	36.75	68.19	0.11	0.31	0.17
Mg	50.00	50.00	107.15	199.26	0.15	0.41	0.23
Ca	80.00	80.00	171.45	318.83	0.24	0.64	0.35
Sr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO3	0.53	0.53	2.21	6.88	0.00	0.00	0.00
HCO3	150.00	150.00	319.05	587.30	0.85	1.82	1.11
NO3	7.00	7.00	14.81	27.15	0.19	0.51	0.28
Cl	150.00	150.00	321.41	597.60	0.49	1.34	0.74
F	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO4	100.00	100.00	214.43	399.01	0.19	0.51	0.28
Boron	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SiO2	9.00	9.00	19.25	35.75	0.06	0.13	0.08
CO2	5.05	5.05	5.70	7.32	5.02	6.06	[illegible]
TDS	565.71	565.72	1210.74	2247.66	2.35	5.86	3.35
pH	7.60	7.60	7.83	7.95	5.48	[illegible]	5.57

ROSA Project Converter Converts Previous ROSA 5.x Data to ROSA 6.0: (Start → ROSA → ROSA Project Converter → Select ROSA 5.x project database to convert → Select folders to write ROSA 6 files into)

1.

2.

3.



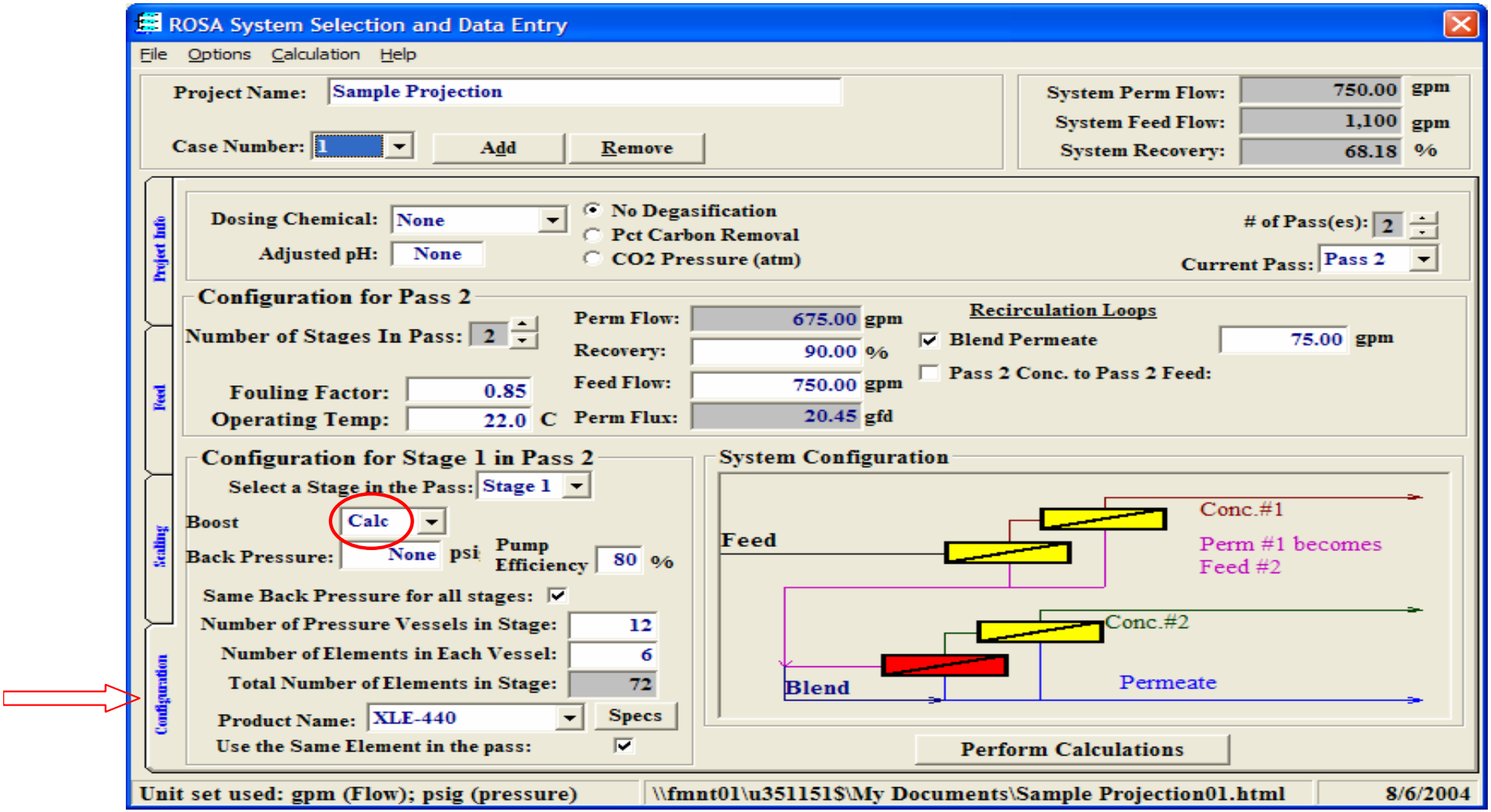
Three Ways to Create Second Pass Feed Pressure

In the Configuration Section:

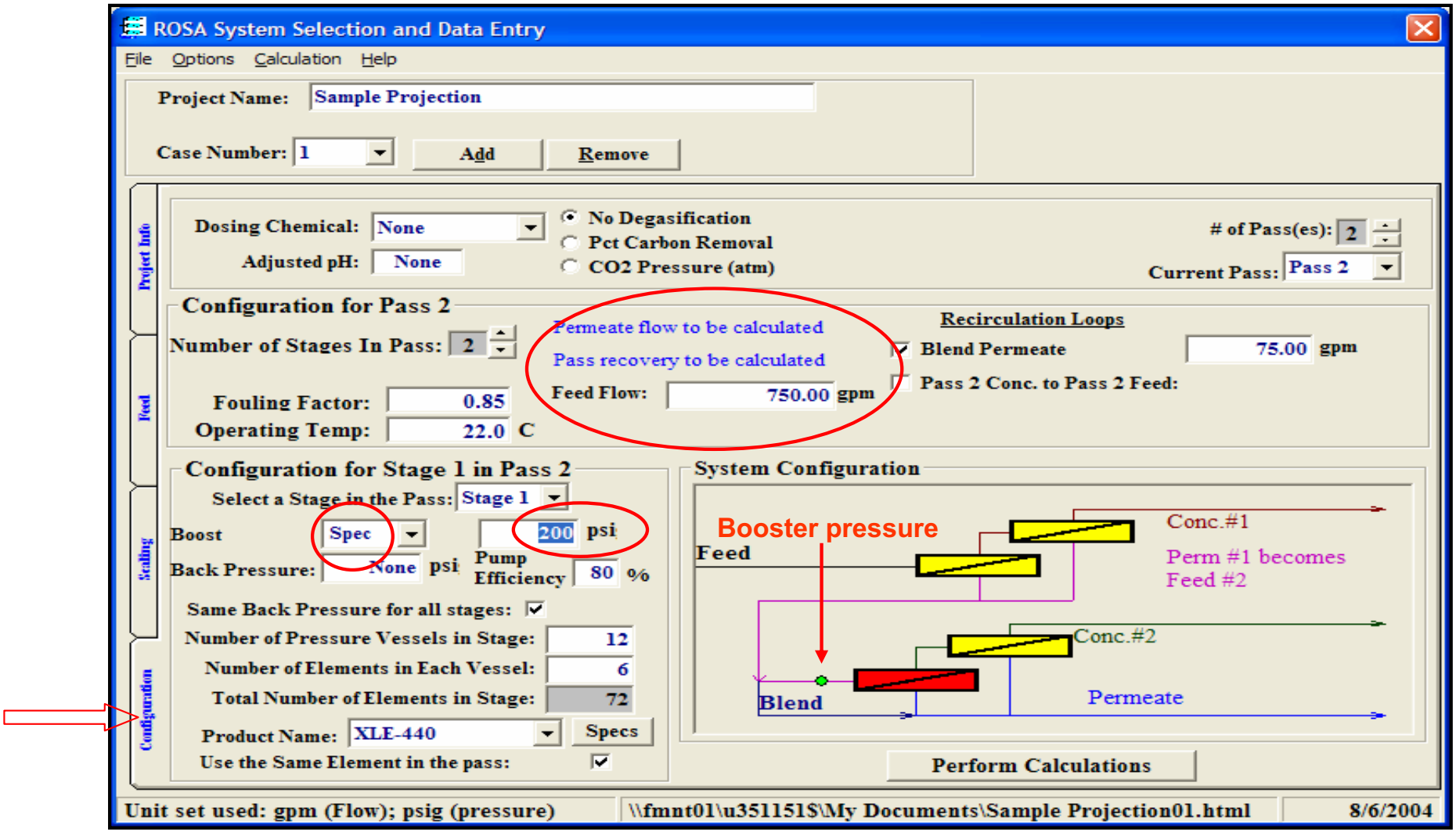
1. **Calc**: ROSA automatically calculates the booster pressure required to produce specified permeate flow.
2. **Spec**: ROSA allows the User to specify the booster pressure.
3. **None**: No booster pressure in the second pass. Need to specify permeate backpressure in the first pass to create feed pressure in the second pass.

Note: This allows ROSA 6.0 to calculate energy/power consumption accurately according to the design parameters.

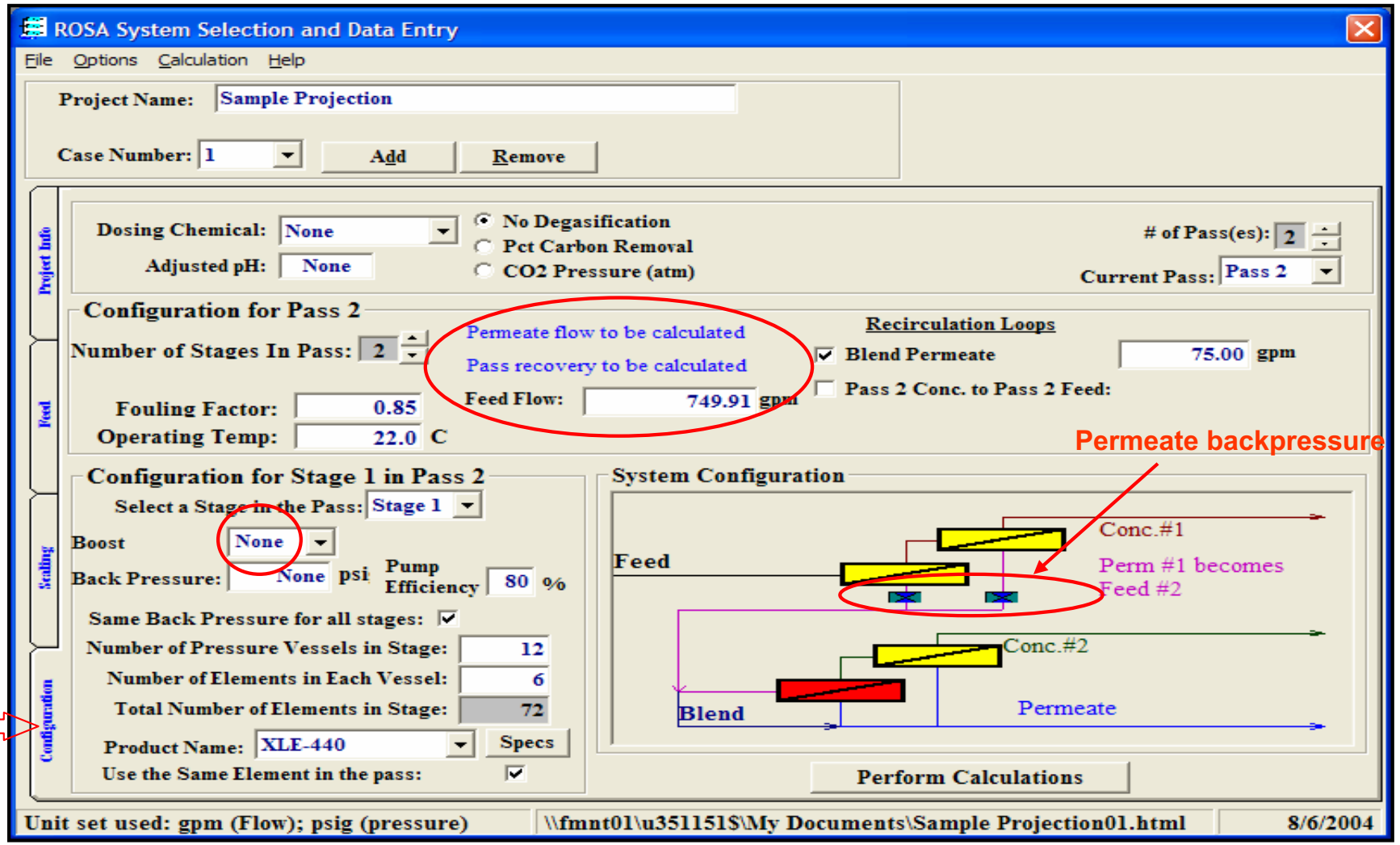
1. Calc: Automatically calculate the booster pump pressure in the second pass. (Default)



2. Spec: Specify a booster pump pressure in the second pass.



3. None: No booster pump in the second pass, but permeate backpressure in the first pass.



Print Out of System Design Overview: Definition of recoveries are clearly defined by stream numbers.

ROSA - [Sample Projection01Overview.html]

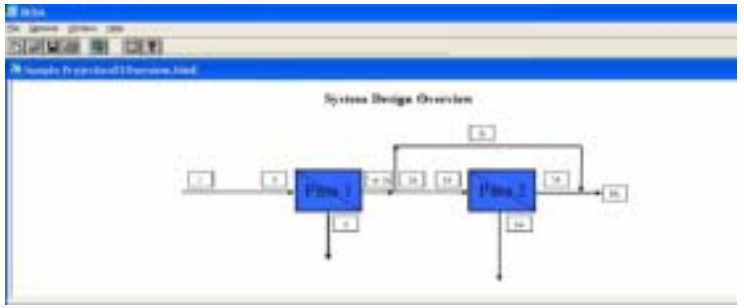
File Options Window Help

Raw Water TDS	498.59 mg/l	% System Recovery (8A/1)	68.18 %
Water Classification	Well Water SDI < 3	Fouling Factor (Pass 1)	0.85
Feed Temperature	22.0 C	Fouling Factor (Pass 2)	0.85

Pass #	Pass 1		Pass 2	
Stage #	1	2	1	2
Element Type	BW30-400	BW30-400	XLE-440	XLE-440
Pressure Vessels per Stage	18	9	12	6
Elements per Pressure Vessel	6	6	6	6
Total Number of Elements	108	54	72	36
Pass Average Flux	18.33 gfd		20.45 gfd	
Stage Average Flux	19.58 gfd	15.84 gfd	22.16 gfd	17.03 gfd
Permeate Back Pressure	0.00 psig	0.00 psig	0.00 psig	0.00 psig
Booster Pressure	0.00 psig	0.00 psig	0.00 psig	0.00 psig
Chemical Dose	-		-	
Energy Consumption	2.67 kWh/kgal		1.05 kWh/kgal	

Pass 1			
Stream #	Flow (gpm)	Pressure (psig)	TDS (mg/l)
1	1100.00	0.00	498.59
3	1100.00	220.82	498.60
5	275.09	147.26	1974.81
7	824.91	-	4.03
7/1	% Recovery	74.99	

Pass 2			
Stream #	Flow (gpm)	Pressure (psig)	TDS (mg/l)
1A	824.91	-	4.03
2A	749.91	0.00	4.03
3A	749.91	116.05	4.03
5A	74.94	64.09	35.68
7A	674.97	-	0.83
B	75.00	0.00	4.03
8A	749.97	0.00	1.11
7A/2A	% Recovery	90.01	

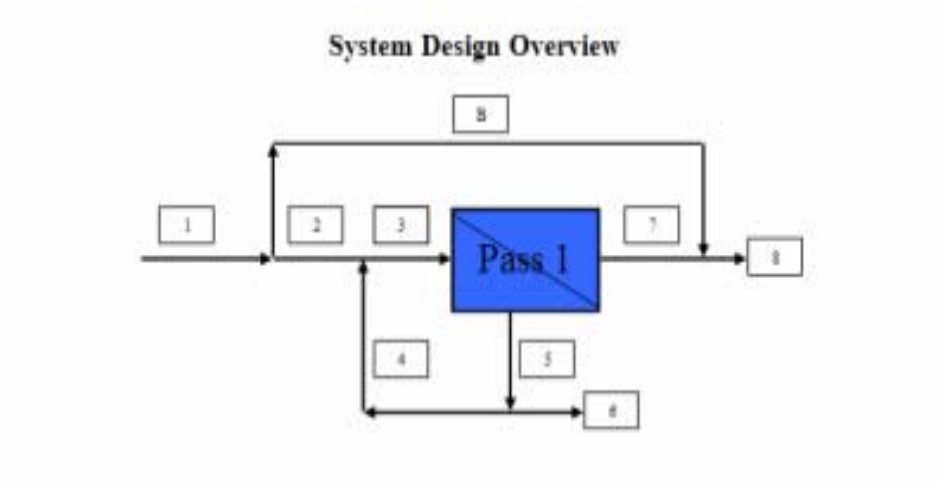


Project Information:

Design Warnings:
-- Pass 1
-None-
Pass 2

New Project Created (12897, 0)

Definition of Recoveries in a *Single Pass System*

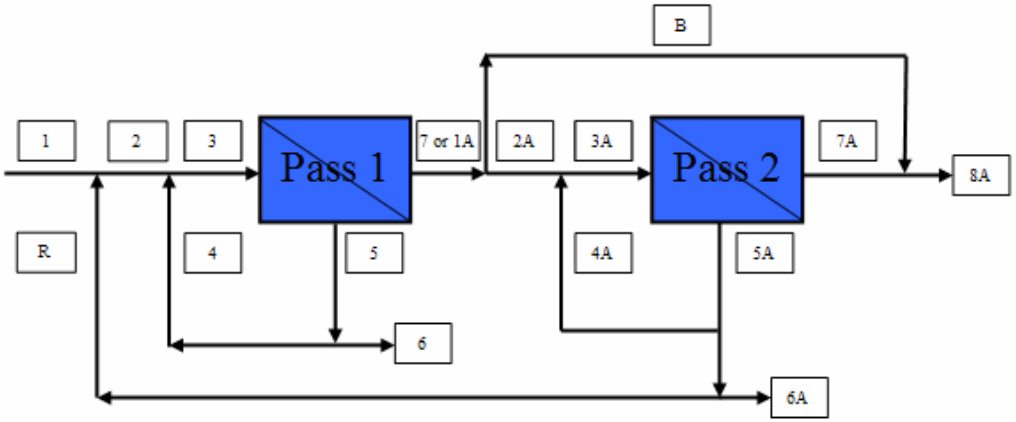


$$\% \text{ Recovery} = \frac{\text{Product flow}}{\text{Feed flow}} \times 100\%$$

without side streams (no B and 4)	Pass recovery = system recovery = 7 / 2 = 8 / 1
with product blending (B) (no 4)	Pass recovery = 7 / 2 = 7 / (1 – B) System recovery = 8 / 1 = (7 + B) / 1
with internal stage recycle (4) and **no** product blending (B)	Pass recovery = system recovery = 7 / 2 = 8 / 1

Definition of Recoveries in a *Double Pass System*

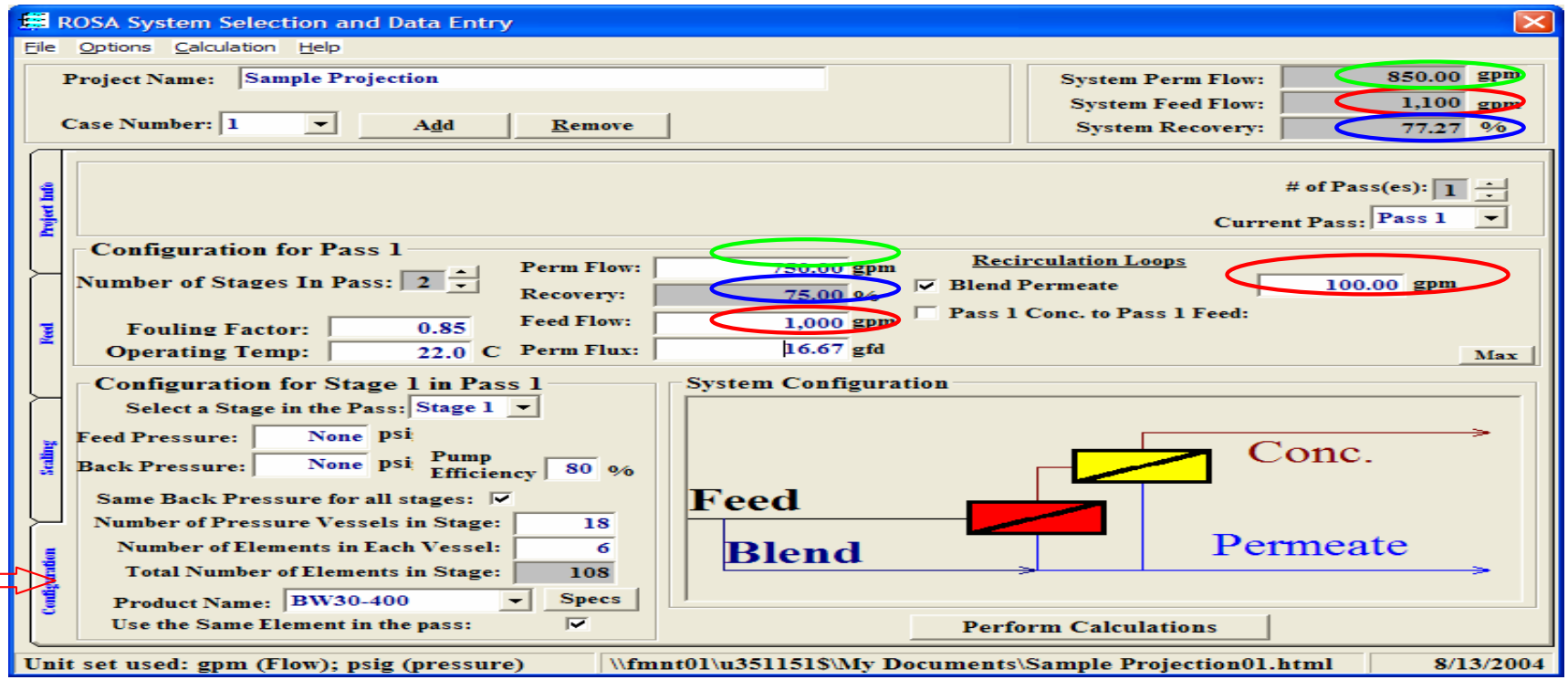
System Design Overview



$$\% \text{ Recovery} = \frac{\text{Product flow}}{\text{Feed flow}} \times 100\%$$

No recycle, no product blending (no R, B, 4, and 4A)	Pass 1 recovery = 7 / 2 = 7 / 1	Pass 2 recovery = 7A / 2A	System recovery = 8A /1
with only product blending (B). (no R, 4 and 4A)	Pass 1 recovery = 7 / 2 = 7 / 1	Pass 2 recovery = 7A / 2A = 7A / (1A – B)	System recovery = 8A / 1 = (7A + B) / 1
with only concentrate flow recycle from 2nd pass to the 1st pass feed (R). (no B, 4, and 4A)	Pass 1 recovery = 7 / 2 = 7 / (1+R) (Pass recovery greater than 100% not possible)	Pass 2 recovery = 7A / 2A	System recovery = 8A / 1
with blending (B) and concentrate flow recycle from 2nd pass to the 1st pass feed (R) (no 4 and 4A)	Pass 1 recovery = 7 / 2 = 7 / (1 + R) (Pass recovery greater than 100% not possible)	Pass 2 recovery = 7A / 2A = 7A / (1A - B)	System recovery = 8A / 1 = (7A + B) / 1

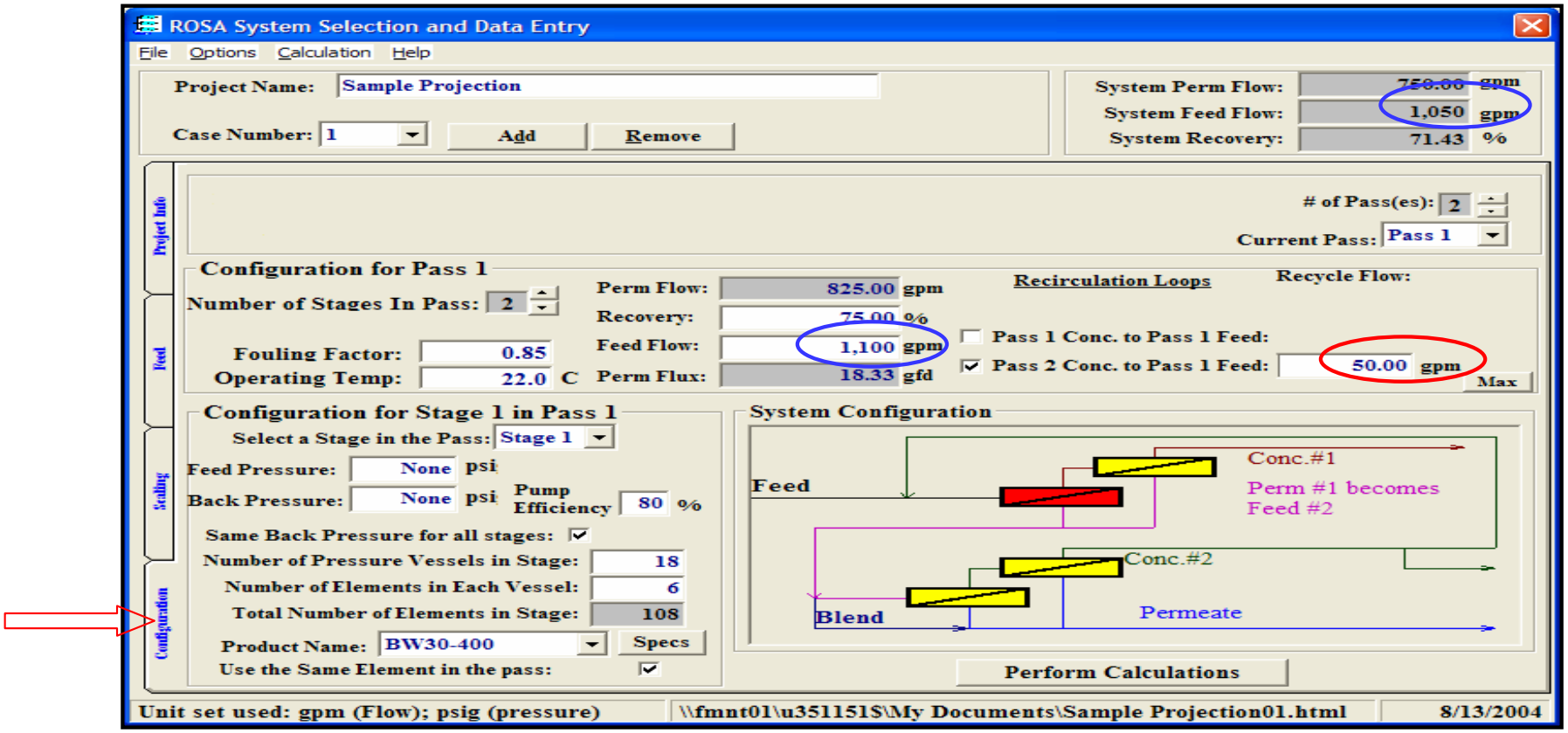
Example of Product Blending



Please Note:

- Pass feed flow (1000 gpm) + blend permeate (100 gpm) = system feed flow (1100 gpm)
- Pass perm flow (750 gpm) + blend permeate (100 gpm) = system perm flow (850 gpm)
- System recovery (%) = system perm flow / system feed flow x 100%

Example of Pass 2 Concentrate Recycle to Pass 1 Feed



Please Note:

- Pass 1 feed flow shown (1100 gpm) includes the pass 2 conc. to pass 1 feed stream (50 gpm)
- Pass 1 feed flow (1100 gpm) = system feed flow (1050 gpm) + pass conc. to pass 1 feed (50 gpm)
- System feed flow (1050 gpm) = pass 1 feed flow (1100 gpm) – pass 2 conc. to pass 1 feed (50 gpm)