Permeate Throttling (Variable), Concentrate Recirculation

Project name	Cray Barn				
Calculated by	Stefan Massingham				
HP Pump flow	3.07	m3/h	Permeate flow/train	0.40	m3/h
Feed pressure	5.5	bar	Raw water flow/train	0.57	m3/h
Feed temperature	25.0	°C(77.0°F)	Permeate recovery	13.03	%
Concentrate recirculation	2.50	m3/h	Total system recovery	70.00	%
Feed water pH	8.40		Element age	0.0	years
Chem dose, mg/l, -	H2SO4		Flux decline %, per year	5.0	
Specific energy	1.47	kwh/m3	Fouling factor	1.00	
Pass NDP	2.3	bar	SP increase, per year	7.0	%
Average flux rate	17.9	lmh			

Feed type: Brackish Well Non-Fouling

Pass - Stage	Perm. Flow m3/h	Flow / Vessel Feed m3/h	Flow / Vessel Conc m3/h	Flux lmh	DP bar	Flux Max lmh	Beta	Stagewise Pressure Perm. bar	Stagewise Pressure Boost bar	Stagewise Pressure Conc bar	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	0.4	1	0.9	18	0.1	18	1.13	1	0	5.4	120.1	ESPA4-LD-4040	3	3 x 1M

Ion (mg/l)	Raw Water	Feed Water	Permeate Water	Concentrate 1
Hardness, as CaCO3	0.00	0.00	0.000	0.0
Ca	0.00	0.00	0.000	0.0
Mg	0.00	0.00	0.000	0.0
Na	380.00	1018.82	46.386	1164.5
K	0.00	0.00	0.000	0.0
NH4	0.70	1.08	0.079	1.2
Ba	0.000	0.000	0.000	0.0
Sr	0.000	0.000	0.000	0.0
H	0.00	0.00	0.000	0.0
CO3	0.00	0.02	0.000	0.0
HCO3	0.10	0.26	0.012	0.3
SO4	2.00	5.78	0.026	6.6
Cl	585.45	1571.37	71.619	1796.1
F	0.00	0.00	0.000	0.0
NO3	0.00	0.00	0.000	0.0
PO4	0.00	0.00	0.000	0.0
OH	0.04	0.10	0.005	0.1
SiO2	6.70	18.69	0.444	21.4
B	1.58	1.58	1.581	1.6
CO2	0.00	0.00	0.00	0.00
NH3	0.10	0.36	0.36	0.36
TDS	**976.53**	**2617.59**	**120.15**	**2991.78**
pH	**8.40**	**8.78**	**7.50**	**8.83**

Saturations	**Raw Water**	**Feed Water**	**Concentrate**	**Limits**
CaSO4 / ksp * 100, %	0	0	0	400
SrSO4 / ksp * 100, %	0	0	0	1200
BaSO4 / ksp * 100, %	0	0	0	10000
SiO2 saturation, %	4	10	11	140
CaF2 / ksp * 100, %	0	0	0	50000
Ca3(PO4)2 saturation index	0.0	0.0	0.0	2.4
CCPP, mg/l	0.00	0.00	0.00	850
Langelier saturation index	0.00	0.00	0.00	2.8
Ionic strength	0.02	0.04	0.05	
Osmotic pressure, bar	0.8	2.1	2.3	

Permeate Throttling (Variable), Concentrate Recirculation

Project name	Cray Barn			Permeate flow/train	0.40 m3/h
Calculated by	Stefan Massingham			Raw water flow/train	0.57 m3/h
HP Pump flow		3.07	m3/h	Permeate recovery	13.03 %
Feed pressure		5.5	bar	Total system recovery	70.00 %
Feed temperature		25.0	°C(77.0°F)	Element age	0.0 years
Concentrate recirculation		2.50	m3/h	Flux decline %, per year	5.0
Feed water pH		8.40		Fouling factor	1.00
Chem dose, mg/l, -		H2SO4		SP increase, per year	7.0 %
Specific energy		1.47	kwh/m3		
Pass NDP		2.3	bar		
Average flux rate		17.9	lmh		

Feed type: Brackish Well Non-Fouling

Pass - Stage	Perm. Flow m3/h	Flow / Vessel Feed m3/h	Flow / Vessel Conc m3/h	Flux lmh	DP bar	Flux Max lmh	Beta	Stagewise Pressure Perm. bar	Boost bar	Conc bar	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	0.4	1	0.9	18	0.1	18	1.13	1	0	5.4	120.1	ESPA4-LD-4040	3	3 x 1M

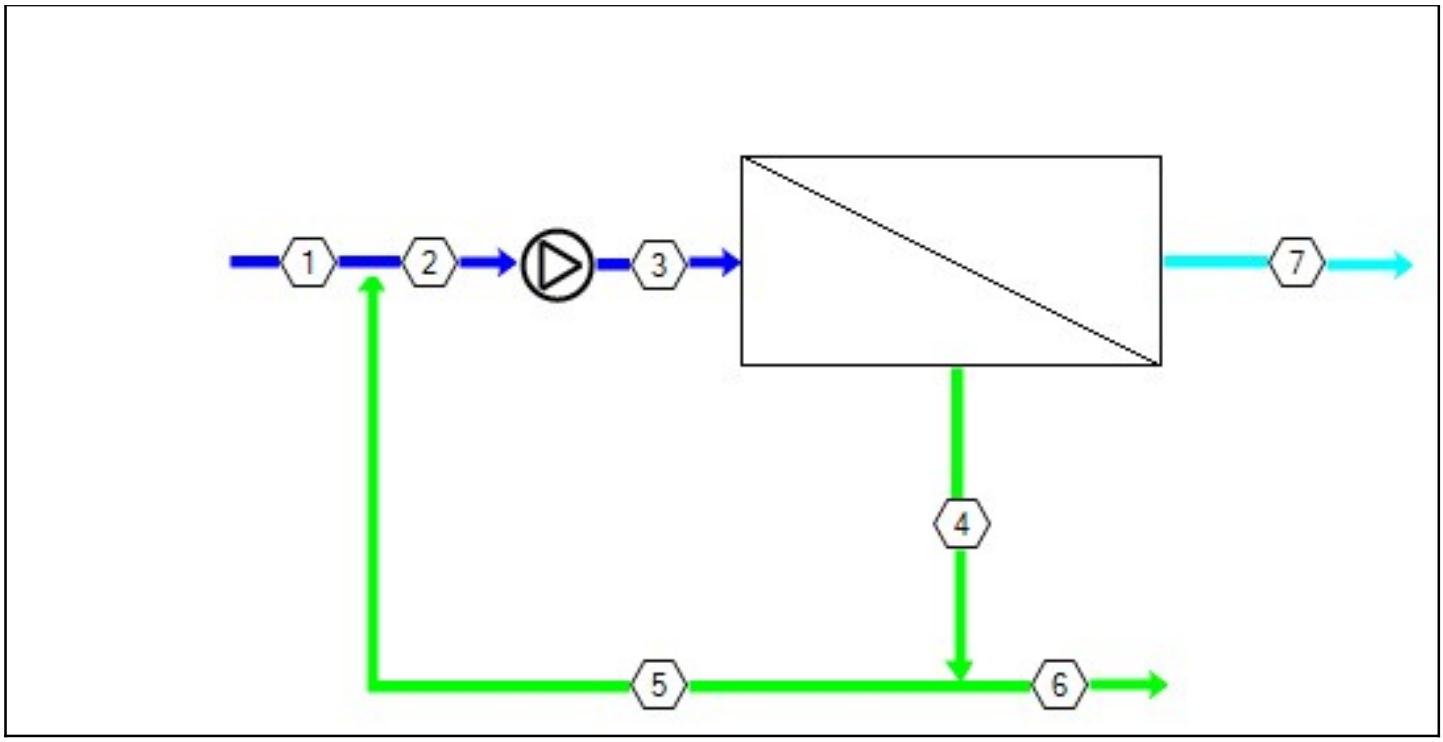
Pass - Stage	Element no.	Feed Pressure bar	Pressure Drop bar	Conc Osmo. bar	NDP bar	Permeate Water Flow m3/h	Permeate Water Flux lmh	Beta	Permeate (Stagewise cumulative) TDS	Ca	Mg	Na	Cl
1-1	1	5.5	0.08	2.3	2.3	0.1	18	1.13	120.1	0	0	46.361	71.58

Permeate Throttling (Variable), Concentrate Recirculation

Project name Cray Barn

Temperature : 25.0 °C

Element age, P1 : 0.0 years



Stream No.	Flow (m3/h)	Pressure (bar)	TDS (mg/l)	pH	Econd (µs/cm)
1	0.570	0	977	8.40	2010
2	3.07	0	2618	8.78	4842
3	3.07	5.47	2618	8.78	4842
4	2.67	5.40	2992	8.83	5465
5	2.50	0	2992	8.83	5465
6	0.170	0	2992	8.83	5465
7	0.400	1.00	120	7.50	257