

ICR TREATMENT STUDY ANALYSIS

Base Analysis and Data Review Comments

Treatment Study ID	1001
Study Protocol	Full-Scale System
Plant ICR Number	310
PWS Name	Palm Beach County Water Utilities
City, State, Zip	West Pam Beach, FL 33406

General Comments:

1. This study was conducted at a full-scale 9.3 MGD nanofiltration softening plant located in Palm Beach Florida. A summary of the full-scale process design is supplied in Table 1 of the Summary Report.
2. Under normal operation, the effluent from the membrane process train is blended with the effluent from the lime softening process train, and the blended water is disinfected with chloramines in the clearwell. During this study, feed and permeate samples from the membrane process were collected and chlorinated under SDS conditions using a free chlorine residual.

Water Quality Comments:

1. Ninety-eight water quality outliers were identified and removed prior to base analysis.
2. The SDS-pH for the permeate samples was adjusted to the distribution system pH (ranged from 8.6 to 9.6). The SDS-pH for the feed sample was maintained at the pH of the feed to the membrane system (ranged from 5.7 to 6.5). There was also some variability in SDS chlorine dose and temperature. The feed dose ranged from 6.9 to 12.7 mg/L while the permeate doses ranged from 1.3 to 6.8 mg/L. All reported free chlorine residuals were less than 2 mg/L after 72 hours. The incubation temperature ranged from 17 to 27°C.
3. During Weeks 44, 48 and 50, the permeate TOC, UV and SDS-DBP values were higher than observed during previous weeks. However, the data was consistent, i.e., high TOC values corresponded with high UV and DBP values. Thus, these data were not classified as outliers.

Productivity Comments:

1. One productivity outlier was identified and removed prior to base analysis.

2. Membrane cleaning events at this full-scale plant are based on pressure drop and flux decline criteria specified by the manufacturer. Membrane productivity was relatively stable during the year-long monitoring period, and no cleaning events were performed. Thus, an estimate of cleaning efficiency is not available from this study.
3. During analysis of the productivity data, cleaning intervals of 746 days, 1173 days and 2554 days were calculated for the system, stage 1 and stage 2, respectively. Since the projected cleaning interval exceeded one-year, the upper bound of 365 days was used as the cleaning interval for both stages and the system. This upper-bound of one year serves as the minimum cleaning frequency necessary to mitigate problems beyond flux loss that can result from membrane fouling.

ICR Information

ID / ICR#: FL4501047 / 310
 ICR Contact: Mr. Hector R. Rodriguez
 Phone No.: 561 641 3455
 Period: 3/12/98 - 5/30/98 (79 days)

Membrane Information

Manufacturer: Koch Membrane Systems
 Trade Name: Fluid Systems
 Membrane Model: TFCS 8921-400
 MWCO: 200 Daltons
 Element Size: 8in dia., 40in.length
 Element Area: 400.0 ft²
 Design Flux: 15.0 gfd
 Mfr. NDP: 80.0 psi
 Mfr. MTC_w: 0.130 (gfd/psi)
 Mfr. Temp: 30.0 °C
 Maximum Flow: 50.0 gpm
 Minimum Flow: 20.0 gpm
 Total Width : 72.0 ft
 Feed Spacer Thickness: 0.0028 ft
 840 Element Area 400.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 25.0 °C
 Temp Norm MTC-w: 0.112 TavGC
 Design Recovery: 0.85
 Avg Sys Flux F_w: 14.9 gfd
 # of Elem in P.V.: 7
 # Pres Ves in Stg 1: 36
 # Pres Ves in Stg 2: 20
 Pres Ves in Stg 3: NA
 Design Flux: 14.9 gfd
 Recycle Ratio: 0.00
 Osmotic P Stage 1: 2.8 psi
 Osmotic P Stage 2: 13.7 psi
 Osmotic P Stage 3: NA

Water Quality Summary

Summary	Feed (System)				Permeate (System)				Concentrate (System)			
	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max
pH	5.8	0.0	5	5.8 - 5.9	5.5	0.1	5	5.5 - 5.6	6.4	0.1	5	6.3 - 6.5
Temp	24.1	2.2	5	20.2 - 25.7	24.9	0.3	5	24.4 - 25.2	25.3	0.6	5	24.7 - 26.0
Alk	62	4	5	55 - 68	33	3	5	30 - 37	287	21	5	268 - 309
TDS	310	16	5	298 - 338	59	1	5	58 - 59	1311	77	5	1227 - 1389
TotHard	270	11	5	262 - 290	36	5	5	31 - 41	1556	22	5	1520 - 1570
CaHard	243	7	5	238 - 254	31	2	5	29 - 33	1418	38	5	1390 - 1460
Turb	0.08	0.0	5	0.06 - 0.10	0.02	0.0	5	0.01 - 0.02	0.39	0.0	5	0.34 - 0.42
Amm	1.30	0.00	5	1.30 - 1.30	0.88	0.38	5	0.60 - 1.30	7.00	0.00	5	7.0 - 7.0
TOC	12.0	0.1	5	11.8 - 12.1	0.5	0.0	5	0.5 - 0.6	72.5	1.5	5	71.1 - 74.5
UV254	0.469	0.0	5	0.460 - 0.483	0.034	0.0	5	0.017 - 0.049	3.088	0.1	5	2.960 - 3.240
SUVA	3.92	0.09	5	3.82 - 4.06	6.43	1.79	5	3.40 - 8.17	4.26	0.18	5	3.97 - 4.42
Bromide	188	8	5	180 - 200	57	6	5	51 - 64				
TOX	1339	595	5	385 - 1910	18	13	5	13 - 42				
CHCl3	267.5	122.8	4	150.0 - 430.0	4.2	6.6	5	1.1 - 16.0	Mass Balance			
BDCM	33.7	15.7	5	9.6 - 48.0	1.0	1.7	5	0.0 - 3.9	Closure Errors (%)			
DBCM	3.6	1.3	5	1.5 - 4.7	0.0	0.0	5	0.0 - 0.0	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Alk	5	22	13
THM4	311.4	130.6	4	180.3 - 479.7	5.2	8.2	5	1.1 - 19.9	TDS	5	-33	13
MCAA	6.1	2.9	5	2.8 - 8.3	0.0	0.0	5	0.0 - 0.0	TotHard	5	-3	4
DCAA	77.4	31.1	5	29.0 - 100.0	3.0	1.8	5	1.5 - 5.8	CaHard	5	-2	5
TCAA	192.4	110.0	5	22.0 - 270.0	1.1	0.7	5	0.0 - 1.7	Turb	5	-7	30
MBAA	1.6	1.0	5	0.0 - 2.8	0.0	0.0	5	0.0 - 0.0	Amm	5	47	31
DBAA	1.4	0.2	5	1.1 - 1.7	0.0	0.0	5	0.0 - 0.0	TOC	5	-6	2
BCAA	14.1	5.5	5	5.4 - 18.0	0.5	0.7	5	0.0 - 1.4	UV254	5	5	4
TBAA	42.0	93.9	5	0.0 - 210.0	0.0	0.0	5	0.0 - 0.0	Comments:			
CDBAA	3.5	2.1	5	0.0 - 5.1	0.0	0.0	5	0.0 - 0.0				
DCBAA	41.7	24.1	5	5.4 - 62.0	0.2	0.4	5	0.0 - 1.0	TDS	79	-47	11
HAA5	279.0	144.3	5	55.6 - 381.6	4.0	2.2	5	1.5 - 7.5				
HAA6	293.1	149.7	5	61.0 - 399.6	4.6	2.5	5	2.8 - 8.9				
HAA9	380.3	175.6	5	66.4 - 465.4	4.8	2.5	5	2.8 - 8.9				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process		Description		Scale			
Res (0)	0.90	0.76	10	0.40 - 2.40	sulfuric acid addition		I.M.C.-Agric Co. /CF Industries , 93% conce		full scale			
Temp (°C)	23.3	2.0	10	20.0 - 25.7	scale inhibitor addition		Aqua Feed 600, 35%, manufacturer B.F. G		full scale			
pH (unit)	7.5	1.6	10	5.9 - 9.3	cartridge filtration		5 micron exclusion size		full scale			
Time (hr)	72.0	0.0	10	72.0 - 72.0								

Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	4.6%	2.8%	System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	0.1%	0.9%
Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	0.1%	0.9%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	-0.1%	0.5%
Sys Perm - Avg Stg Perr	0.0%	0.1%	Sys Perm - Sum Stg Per	0.0%	0.0%	Sys Perm - Avg Stg Perm	-44.6%	10.3%

Stage Summary

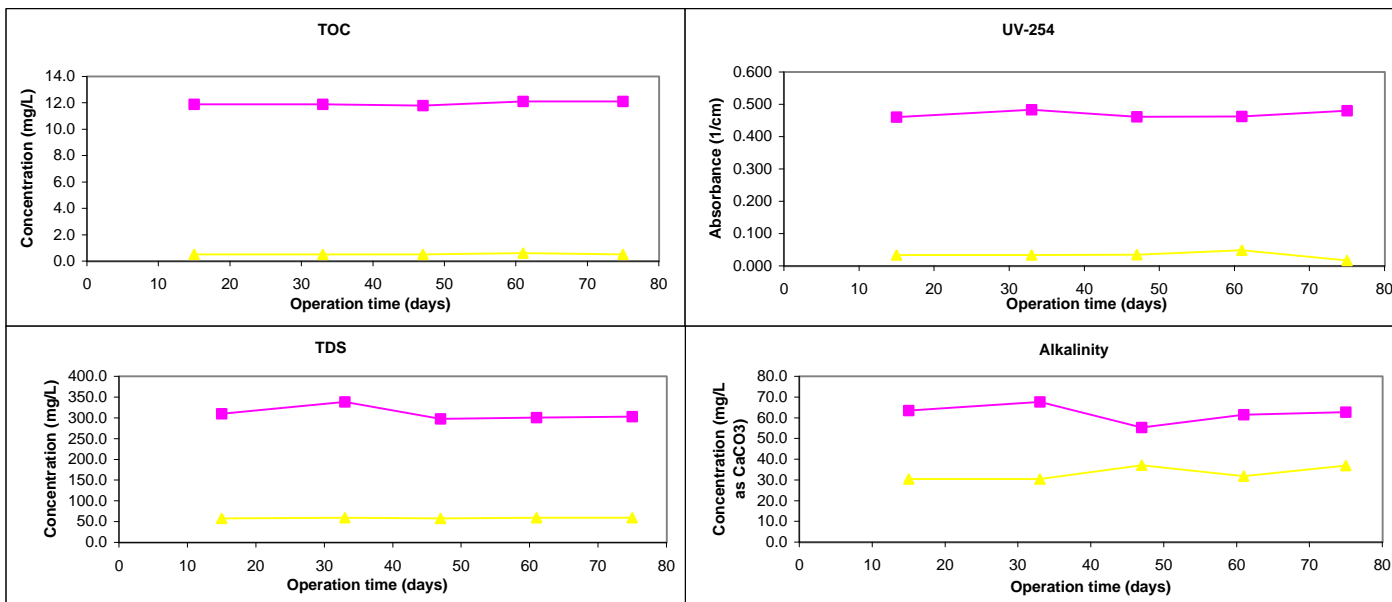
	Stage 1 Influent						Stage 1 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.55	0.00	5	0.55 - 0.55					
pH	5.8	6.4	5.8	0.0	5	5.7 - 5.8	5.5	5.3	0.1	5	5.2 - 5.4
Temp	24.1	25.3	24.0	2.2	5	20.2 - 25.7	24.9	25.0	0.7	5	24.4 - 26.1
Alk	62	287	62	4	5	55 - 68	33	17	0	5	16 - 17
TDS	310	1311	331	17	5	301 - 339	59	59	6	5	54 - 68
TotHard	270	1556	270	11	5	262 - 290	36	19	3	5	17 - 24
CaHard	243	1418	243	7	5	238 - 254	31	16	1	5	16 - 18
Turb	0.08	0.39	0.08	0	5	0.06 - 0.10	0.02	0.01	0.00	5	0 - 0
TOC	12.0	72.5	12.0	0.1	5	11.8 - 12.1	0.5	0.8	0.1	5	0.7 - 0.9
UV254	0.469	3.088	0.469	0.011	5	0.460 - 0.483	0.034	0.007	0.004	5	0.005 - 0.011
SUVA	3.92	4.26	3.92	0.09	5	3.82 - 4.06	6.43	0.97	0.55	5	0.50 - 1.57
	Stage 2 Influent						Stage 2 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.66	0.00	5	0.66 - 0.66					
pH	5.8	6.4	6.0	0.1	5	5.9 - 6.1	5.5	5.5	0.1	5	5.5 - 5.6
Temp	24.1	25.3	25.3	0.6	5	24.7 - 26.0	24.9	25.1	0.5	5	24.7 - 25.8
Alk	62	287	134	7	5	126 - 141	33	33	1	5	32 - 34
TDS	310	1311	725	7	5	716 - 733	59	123	10	5	115 - 139
TotHard	270	1556	687	10	5	671 - 695	36	54	1	5	52 - 55
CaHard	243	1418	624	5	5	621 - 633	31	49	2	5	47 - 52
Turb	0.08	0.39	0.21	0	5	0.17 - 0.35	0.02	0.01	0.01	5	0 - 0
TOC	12.0	72.5	30.2	0.6	5	29.6 - 30.8	0.5	1.2	0.2	5	1.0 - 1.4
UV254	0.469	3.088	1.260	0.014	5	1.240 - 1.270	0.034	0.019	0.003	5	0.016 - 0.022
SUVA	3.92	4.26	4.17	0.12	5.00	4.03 - 4.29	6.43	1.65	0.37	5.00	1.14 - 2.00
	Stage 3 Influent						Stage 3 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery											
pH											
Temp											
Alk											
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

This was **only** a two stage study.

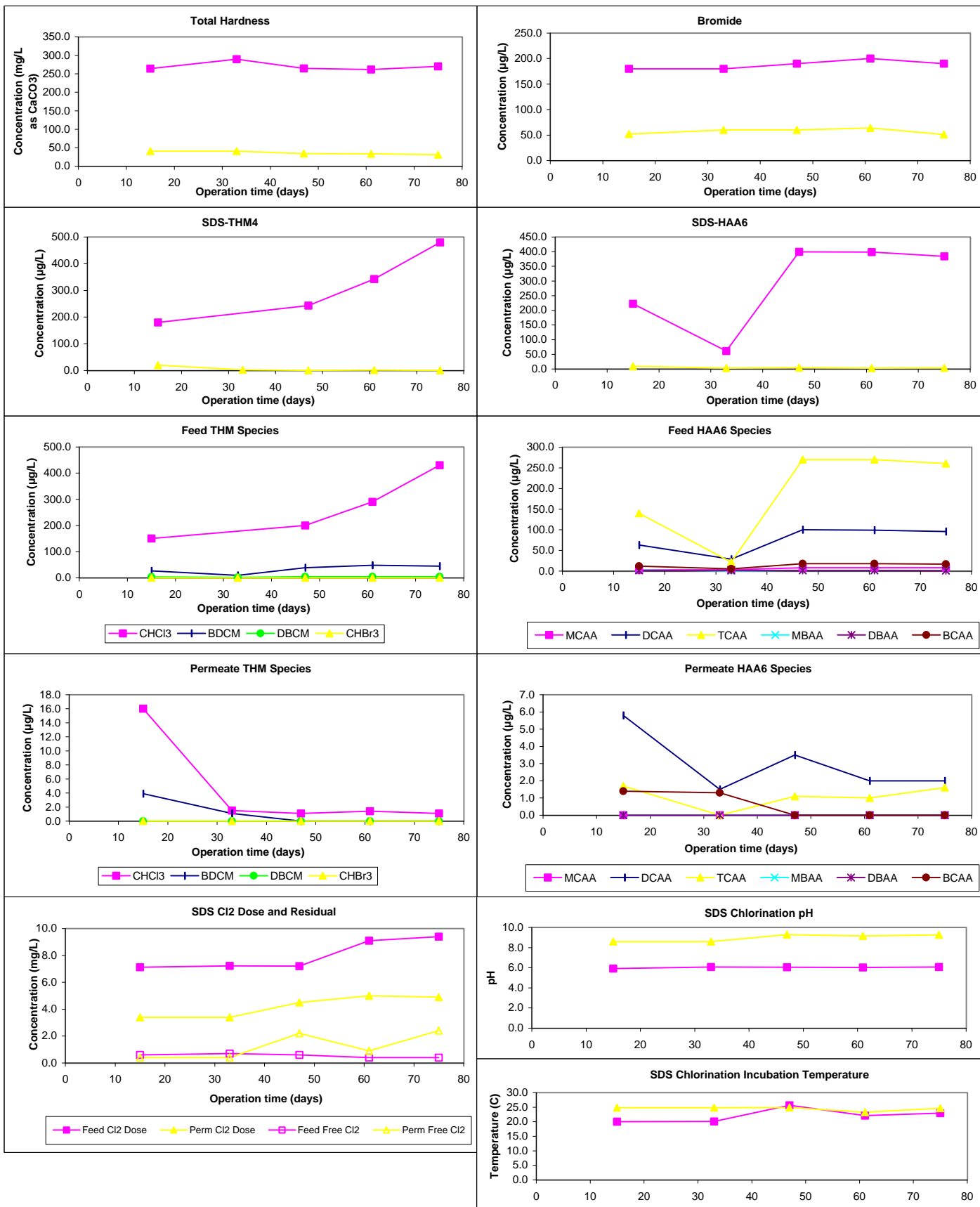
Chart Legend:

- Feed (System)
- Permeate (System)

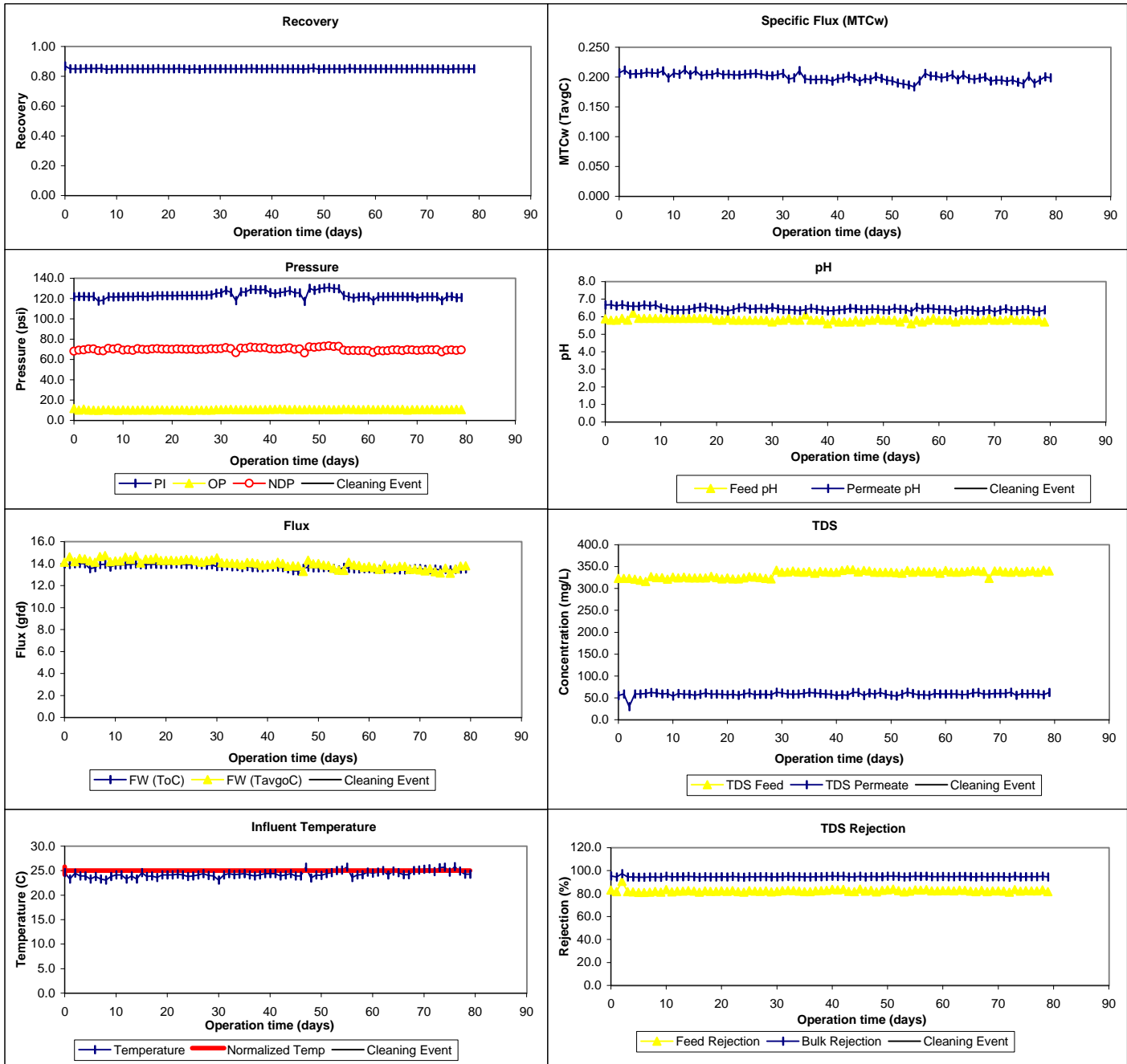
Water Quality Parameter Graphs



Water Quality Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: FL4501047 / 310
 ICR Contact: Mr. Hector R. Rodriguez
 Phone No.: 561 641 3455
 Period: 5/31/98 - 8/29/98 (90 days)

Membrane Information

Manufacturer: Koch Membrane Systems
 Trade Name: Fluid Systems
 Membrane Model: TFCS 8921-400
 MWCO: 200 Daltons
 Element Size: 8 in dia. 40 in length
 Element Area: 400.0 ft²
 Design Flux: 15.0 gfd
 Mfr. NDP: 80.0 psi
 Mfr. MTC_w: 0.130 (gfd/psi)
 Mfr. Temp: 30.0 °C
 Maximum Flow: 50.0 gpm
 Minimum Flow: 20.0 gpm
 Total Width: 72.0 ft
 Feed Spacer Thickness: 0.0028 ft
 840 Element Area: 400.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 25.0 °C
 Temp Norm MTC-w: 0.112 TavGC
 Design Recovery: 0.85
 Avg Sys Flux F_w: 14.9 gfd
 # of Elem in P.V.: 7
 # Pres Ves in Stg 1: 36
 # Pres Ves in Stg 2: 20
 Pres Ves in Stg 3: NA
 Design Flux: 14.9 gfd
 Recycle Ratio: 0.00
 Osmotic P Stage 1: 2.8 psi
 Osmotic P Stage 2: 13.7 psi
 Osmotic P Stage 3: NA

Water Quality Summary

Summary	Feed (System)				Permeate (System)				Concentrate (System)			
	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max
pH	7.2	0.1	5	7.1 - 7.2	5.4	0.1	5	5.3 - 5.5	6.5	0.1	5	6.4 - 6.6
Temp	24.6	0.5	5	24.2 - 25.4	25.3	0.1	5	25.2 - 25.4	25.6	0.5	5	24.7 - 26.1
Alk	77	14	5	63 - 92	38	5	5	32 - 44	322	96	5	178 - 393
TDS	299	3	5	294 - 302	60	1	5	59 - 62	1362	26	5	1326 - 1383
TotHard	272	9	5	258 - 282	44	18	5	29 - 75	1658	171	5	1450 - 1900
CaHard	248	5	5	240 - 254	30	3	5	26 - 34	1442	129	5	1220 - 1550
Turb	0.10	0.0	5	0.08 - 0.12	0.06	0.0	5	0.01 - 0.09	0.37	0.0	5	0.32 - 0.42
Amm	1.30	0.00	5	1.30 - 1.30	0.60	0.00	5	0.60 - 0.60	7.00	0.00	5	7.0 - 7.0
TOC	12.5	0.5	5	12.1 - 13.1	0.6	0.2	5	0.5 - 1.0	74.9	3.1	5	71.3 - 78.3
UV254	0.485	0.0	5	0.477 - 0.497	0.046	0.0	5	0.034 - 0.070	3.074	0.0	5	3.040 - 3.120
SUVA	3.88	0.10	5	3.73 - 3.97	7.80	1.48	5	6.80 - 10.40	4.11	0.15	5	3.92 - 4.29
Bromide	210	26	4	180 - 240	57	18	5	34 - 74				
TOX	1634	139	5	1500 - 1800	51	86	5	13 - 205				
CHCl3	298.0	24.9	5	280.0 - 340.0	8.5	15.9	5	1.1 - 37.0	Mass Balance			
BDCM	44.8	4.0	5	39.0 - 49.0	2.3	4.4	5	0.0 - 10.0	Closure Errors (%)			
DBCM	5.5	0.6	5	5.0 - 6.5	0.6	1.3	5	0.0 - 2.8	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	Alk	5	6	16
THM4	348.3	27.8	5	329.2 - 394.4	11.3	21.5	5	1.1 - 49.8	TDS	5	-21	3
MCAA	7.8	1.7	5	5.2 - 9.4	0.7	1.6	5	0.0 - 3.6	TotHard	5	4	16
DCAA	96.4	4.1	5	90.0 - 100.0	6.9	10.7	5	1.7 - 26.0	CaHard	5	-3	7
TCAA	252.0	11.0	5	240.0 - 260.0	2.3	3.3	5	0.0 - 7.9	Turb	5	3	27
MBAA	1.8	0.2	5	1.5 - 2.1	0.0	0.0	5	0.0 - 0.0	Amm	5	25	0
DBAA	2.1	0.2	5	1.9 - 2.3	0.3	0.6	5	0.0 - 1.3	TOC	5	-7	4
BCAA	18.0	1.0	5	17.0 - 19.0	1.3	2.3	5	0.0 - 5.3	UV254	5	3	2
TBAA	1.1	2.2	4	0.0 - 4.3	0.0	0.0	4	0.0 - 0.0	Comments:			
CDBAA	3.8	0.2	5	3.7 - 4.1	0.0	0.0	5	0.0 - 0.0				
DCBAA	48.0	2.9	5	43.0 - 50.0	0.5	1.0	5	0.0 - 2.3				
HAA5	360.1	8.9	5	349.4 - 372.0	10.2	16.1	5	1.7 - 38.8				
HAA6	378.1	8.3	5	368.4 - 390.0	11.4	18.3	5	1.7 - 44.1				
HAA9	429.7	7.0	4	422.2 - 436.8	13.7	21.8	4	1.7 - 46.4				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process		Description		Scale			
Res (0)	0.85	0.16	10	0.70 - 1.20	sulfuric acid addition		I.M.C.-Agric Co. /CF Industries , 93% conce		full scale			
Temp (°C)	24.3	1.9	10	19.3 - 25.4	scale inhibitor		Aqua Feed 600, 35%, manufacturer B.F. Gr		full scale			
pH (unit)	6.8	2.5	10	1.3 - 9.4	cartridge filtration		5 micron exclusion size		full scale			
Time (hr)	72.0	0.0	10	72.0 - 72.0								

Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	4.6%	3.2%	System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	-0.6%	5.6%
Sys Conc - Stg 2 Conc	0.0%	0.3%	Sys Conc - Stg 2 Conc	0.0%	0.1%	Sys Conc - Stg 2 Conc	-0.4%	3.8%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perr	0.0%	0.2%	Sys Perm - Sum Stg Per	0.0%	0.0%	Sys Perm - Avg Stg Perm	-31.9%	4.6%

Stage Summary

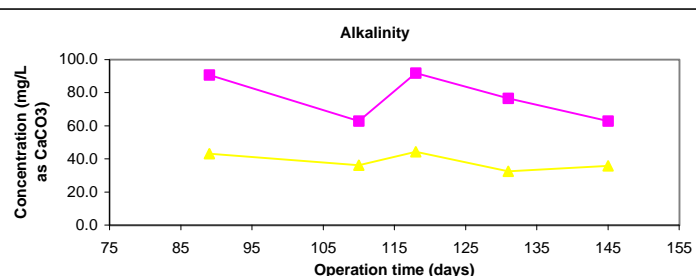
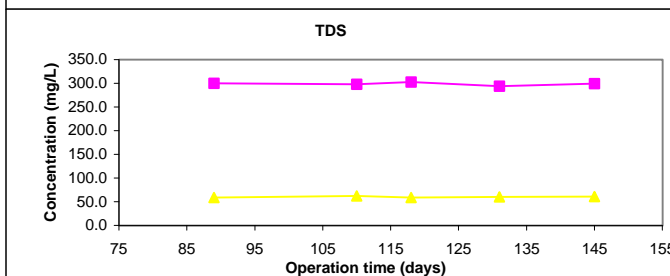
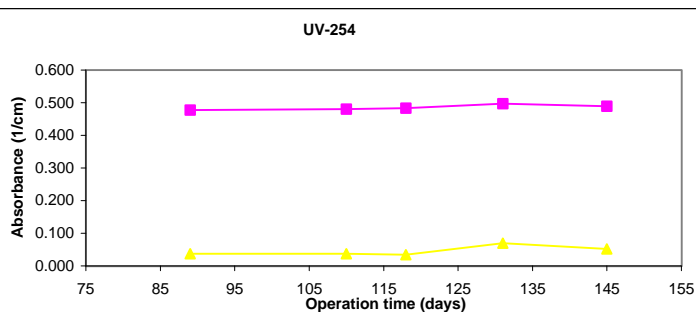
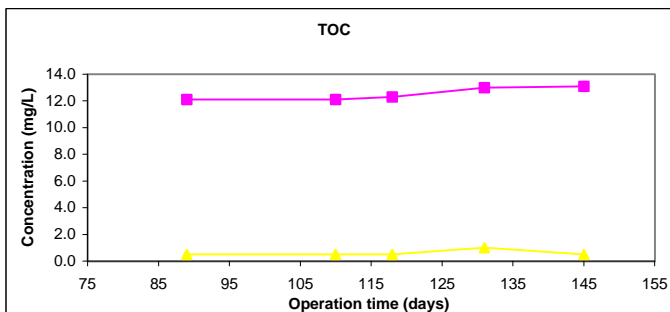
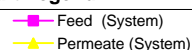
WQP	Stage 1 Influent						Stage 1 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.55	0.00	5	0.55 - 0.55					
pH	7.2	6.5	5.8	0.0	5	5.7 - 5.8	5.4	5.3	0.0	5	5.3 - 5.4
Temp	24.6	25.6	24.8	0.2	5	24.5 - 25.1	25.3	25.5	1.0	5	24.8 - 27.2
Alk	77	322	77	14	5	63 - 92	38	19	2	5	16 - 20
TDS	299	1362	348	16	5	335 - 375	60	53	2	5	50 - 55
TotHard	272	1658	272	9	5	258 - 282	44	29	9	5	21 - 42
CaHard	248	1442	248	5	5	240 - 254	30	19	3	5	14 - 22
Turb	0.10	0.37	0.10	0	5	0.08 - 0.12	0.06	0.04	0.02	5	0 - 0
TOC	12.5	74.9	12.5	0.5	5	12.1 - 13.1	0.6	0.8	0.2	5	0.5 - 0.9
UV254	0.485	3.074	0.485	0.008	5	0.477 - 0.497	0.046	0.005	0.002	5	0.005 - 0.009
SUVA	3.88	4.11	3.88	0.10	5	3.73 - 3.97	7.80	0.74	0.35	5	0.50 - 1.29

WQP	Stage 2 Influent						Stage 2 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.67	0.00	5	0.66 - 0.67					
pH	7.2	6.5	6.0	0.0	5	6.0 - 6.1	5.4	5.5	0.1	5	5.4 - 5.6
Temp	24.6	25.6	25.4	0.5	5	24.7 - 26.1	25.3	25.3	0.2	5	24.9 - 25.5
Alk	77	322	185	34	5	143 - 236	38	37	3	5	34 - 40
TDS	299	1362	728	4	5	722 - 734	60	114	1	5	113 - 115
TotHard	272	1658	694	11	5	682 - 704	44	61	12	5	54 - 81
CaHard	248	1442	576	136	5	338 - 653	30	51	4	5	46 - 55
Turb	0.10	0.37	0.23	0	5	0.15 - 0.34	0.06	0.04	0.03	5	0 - 0
TOC	12.5	74.9	31.2	2.1	5	28.8 - 34.2	0.6	0.9	0.2	5	0.7 - 1.1
UV254	0.485	3.074	1.296	0.018	5	1.270 - 1.320	0.046	0.016	0.004	5	0.013 - 0.022
SUVA	3.88	4.11	4.17	0.23	5.00	3.86 - 4.41	7.80	1.84	0.46	5.00	1.30 - 2.43

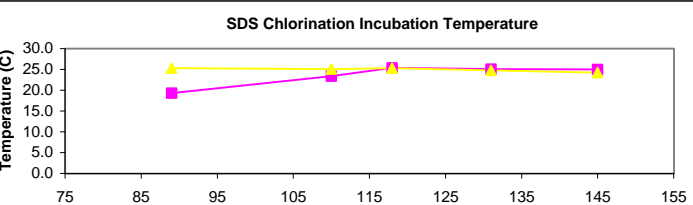
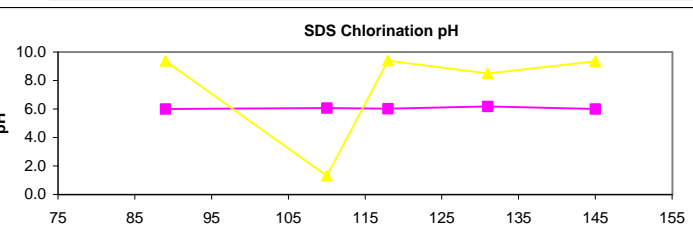
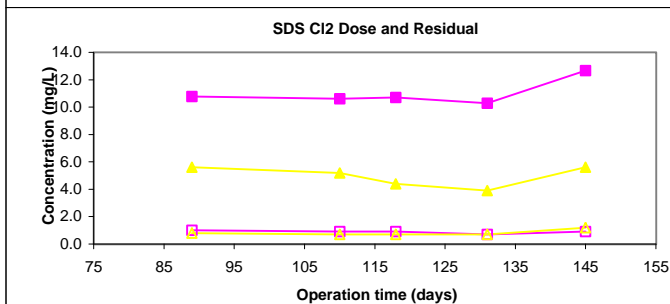
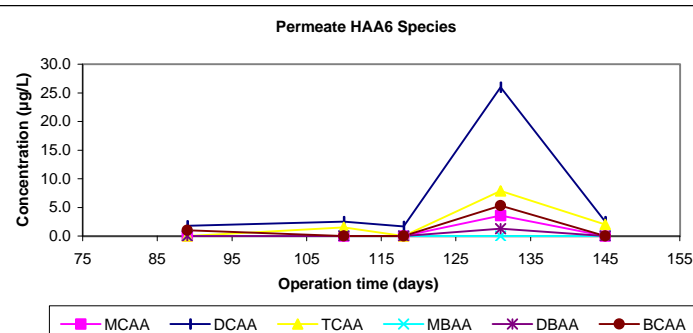
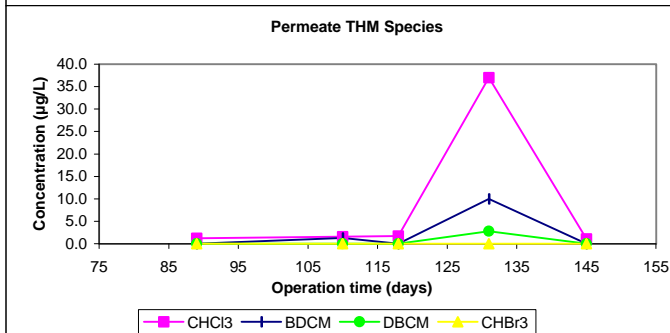
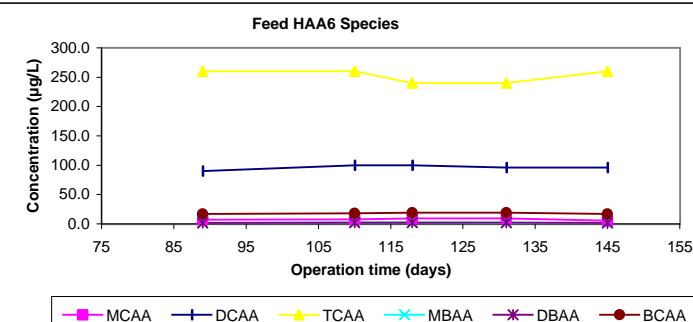
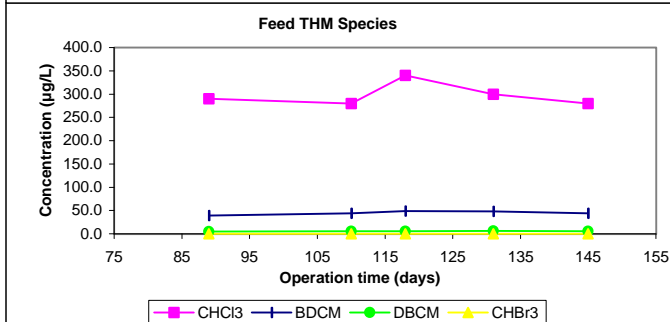
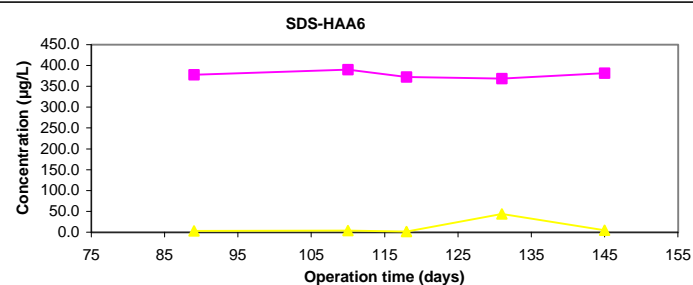
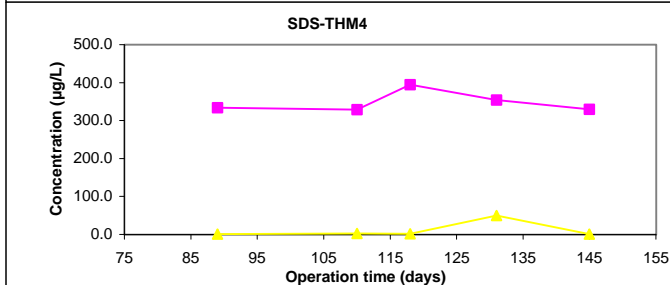
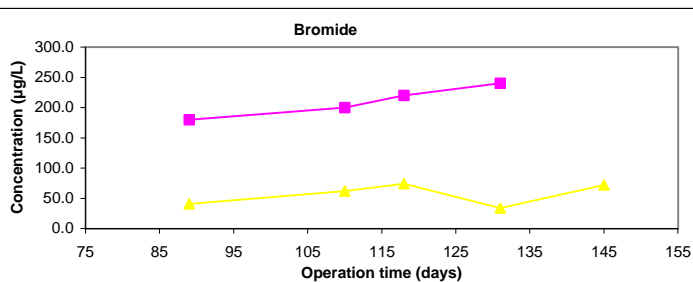
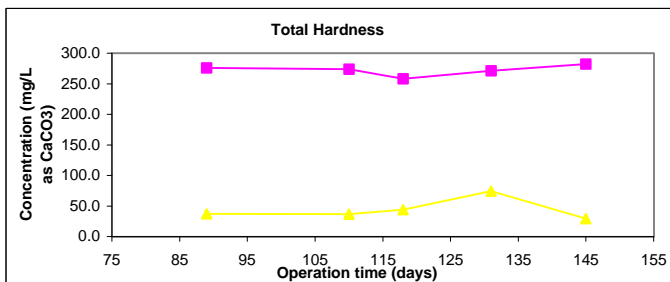
WQP	Stage 3 Influent						Stage 3 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery											
pH											
Temp											
Alk											
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

Water Quality Parameter Graphs

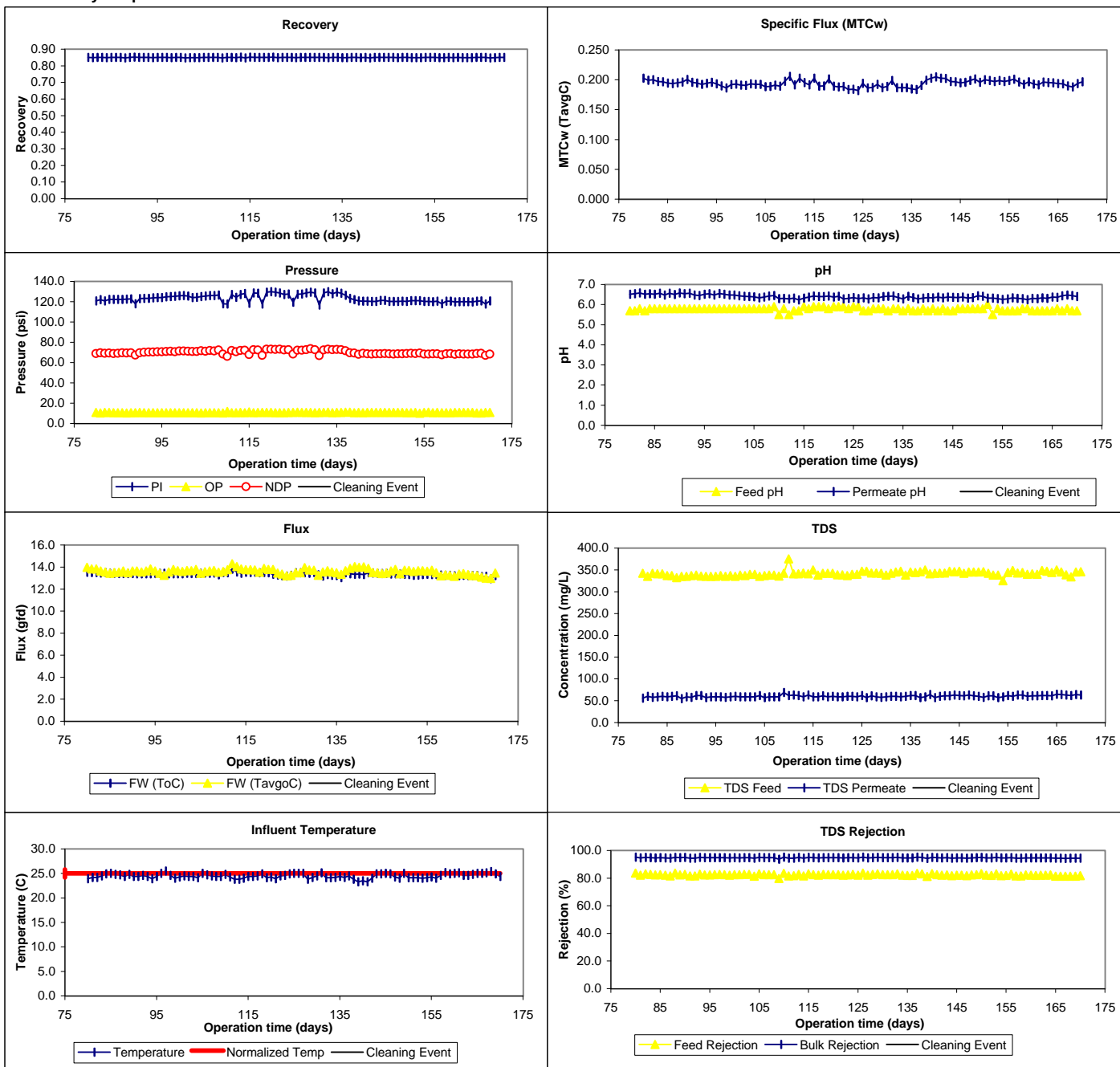
Chart Legend:



Water Quality Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: FL4501047 / 310
 ICR Contact: Mr. Hector R. Rodriguez
 Phone No.: 561 641 3455
 Period: 8/30/98 - 10/31/98 (62 days)

Membrane Information

Manufacturer: Koch Membrane Systems
 Trade Name: Fluid Systems
 Membrane Model: TFCS8921S-400
 MWCO: 200 Daltons
 Element Size: 8 in dia. 40 in length
 Element Area: 400.0 ft²
 Design Flux: 15.0 gfd
 Mfr. NDP: 80.0 psi
 Mfr. MTC_w: 0.130 (gfd/psi)
 Mfr. Temp: 30.0 °C
 Maximum Flow: 50.0 gpm
 Minimum Flow: 20.0 gpm
 Total Width : 72.0 ft
 Feed Spacer Thickness: 0.0028 ft
 840 Element Area 400.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 25.0 °C
 Temp Norm MTC-w: 0.112 TavGC
 Design Recovery: 0.85
 Avg Sys Flux F_w: 14.9 gfd
 # of Elem in P.V.: 7
 # Pres Ves in Stg 1: 36
 # Pres Ves in Stg 2: 20
 Pres Ves in Stg 3: NA
 Design Flux: 14.9 gfd
 Recycle Ratio: 0.00
 Osmotic P Stage 1: 2.8 psi
 Osmotic P Stage 2: 13.7 psi
 Osmotic P Stage 3: NA

Water Quality Summary

Summary	Feed (System)				Permeate (System)				Concentrate (System)			
	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max
pH	7.2	0.0	5	7.2 - 7.2	5.5	0.0	5	5.4 - 5.5	6.3	0.0	5	6.3 - 6.3
Temp	24.4	0.2	5	24.1 - 24.7	24.8	0.6	5	23.8 - 25.3	25.1	0.3	5	24.8 - 25.4
Alk	61	13	5	38 - 69	35	2	5	32 - 37	228	88	5	138 - 347
TDS	302	4	5	299 - 308	62	1	5	60 - 64	1319	94	5	1213 - 1426
TotHard	269	3	5	264 - 272	34	2	5	32 - 36	1221	478	5	686 - 1590
CaHard	251	5	5	243 - 256	32	2	5	30 - 34	1141	451	5	638 - 1500
Turb	0.09	0.0	5	0.08 - 0.10	0.03	0.0	5	0.01 - 0.09	0.34	0.1	5	0.19 - 0.48
Amm	1.30	0.00	5	1.30 - 1.30	0.60	0.00	5	0.60 - 0.60	7.00	0.00	5	7.0 - 7.0
TOC	12.9	0.7	5	12.0 - 13.6	0.5	0.0	5	0.5 - 0.6	78.9	4.7	5	74.0 - 84.8
UV254	0.484	0.0	5	0.473 - 0.495	0.030	0.0	5	0.014 - 0.053	2.378	1.0	5	1.300 - 3.200
SUVA	3.78	0.24	5	3.48 - 4.07	5.69	2.74	5	2.80 - 8.83	3.04	1.31	5	1.59 - 4.12
Bromide	220	10	5	210 - 230	71	9	5	59 - 80				
TOX	1766	188	5	1600 - 2090	25	17	5	13 - 45				
CHCl3	278.0	99.8	5	160.0 - 390.0	2.3	1.0	5	1.0 - 3.4	Mass Balance Closure Errors (%)			
BDCM	48.6	18.8	5	22.0 - 66.0	2.0	2.3	5	0.0 - 5.6				
DBCM	4.8	1.7	5	2.3 - 6.4	2.5	4.1	5	0.0 - 9.7	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	5	0.0 - 0.0	1.6	3.6	5	0.0 - 8.0	Alk	5	-2	56
THM4	331.4	118.9	5	184.3 - 462.0	8.5	10.4	5	1.0 - 26.3	TDS	5	-26	8
MCAA	7.9	2.4	5	5.6 - 11.0	0.0	0.0	5	0.0 - 0.0	TotHard	5	-54	71
DCAA	112.0	8.4	5	100.0 - 120.0	2.2	0.6	5	1.6 - 2.8	CaHard	5	-53	70
TCAA	284.0	28.8	5	240.0 - 320.0	1.2	1.6	5	0.0 - 3.0	Turb	5	-46	88
MBAA	2.1	0.3	5	1.8 - 2.5	0.0	0.0	5	0.0 - 0.0	Amm	5	25	0
DBAA	2.3	0.2	5	2.1 - 2.5	0.9	1.4	5	0.0 - 3.3	TOC	5	-5	1
BCAA	18.6	1.7	5	16.0 - 20.0	1.0	1.0	5	0.0 - 2.1	UV254	5	-55	80
TBAA	0.0	0.0	3	0.0 - 0.0	0.0	0.0	3	0.0 - 0.0				
CDBAA	4.8	0.9	5	3.7 - 5.6	0.5	1.0	5	0.0 - 2.3	TDS	62	-49	11
DCBAA	54.6	13.0	5	38.0 - 69.0	0.6	0.8	5	0.0 - 1.5	Comments:			
HAA5	408.2	36.6	5	351.2 - 449.6	4.2	2.2	5	1.6 - 6.7				
HAA6	426.8	36.5	5	371.2 - 468.6	5.2	3.1	5	1.6 - 8.3				
HAA9	473.5	63.2	3	419.2 - 542.9	6.3	3.6	3	2.1 - 8.5				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process		Description		Scale			
Res (0)	0.74	0.32	10	0.20 - 1.20	sulfuric acid addition		I.M.C.-Agric Co. /CF Industries , 93% conce		full scale			
Temp (°C)	24.0	2.5	10	17.9 - 27.0	scale inhibitor		Aqua Feed 600, 35%, manufacturer B.F. G		full scale			
pH (unit)	7.3	1.9	10	4.1 - 9.5	cartridge filtration		5 micron exclusion size		full scale			
Time (hr)	72.0	0.0	10	72.0 - 72.0								

Mass Balance Errors

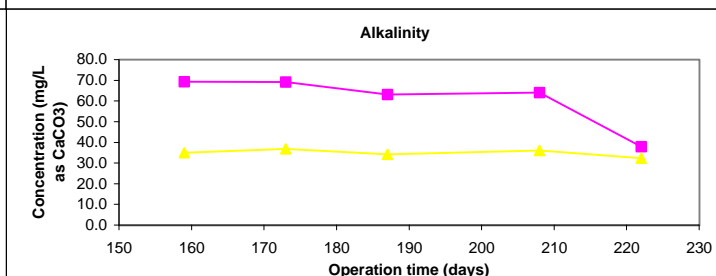
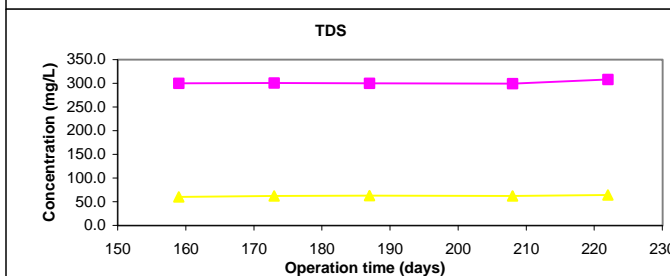
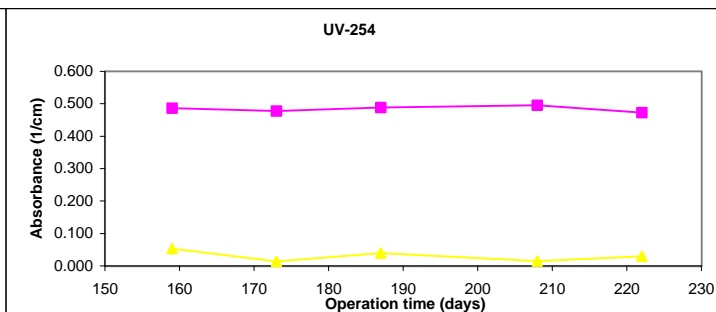
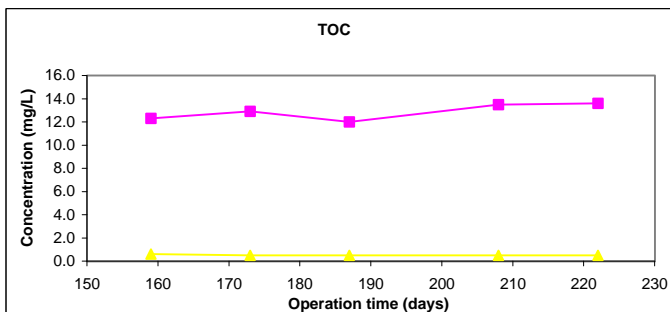
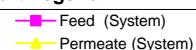
Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	2.8%	1.1%	System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	0.0%	0.0%
Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	0.0%	0.0%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	-0.2%	1.2%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perr	0.0%	0.0%	Sys Perm - Sum Stg Per	-0.1%	0.7%	Sys Perm - Avg Stg Perm	-25.7%	5.3%

Stage Summary

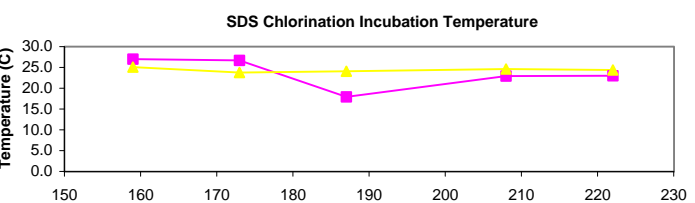
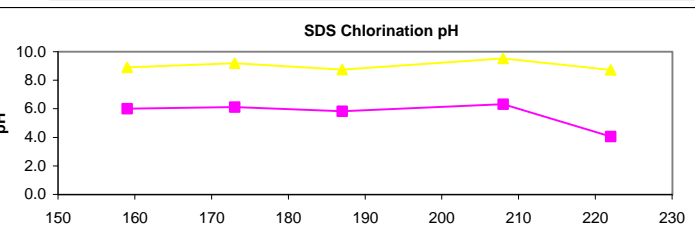
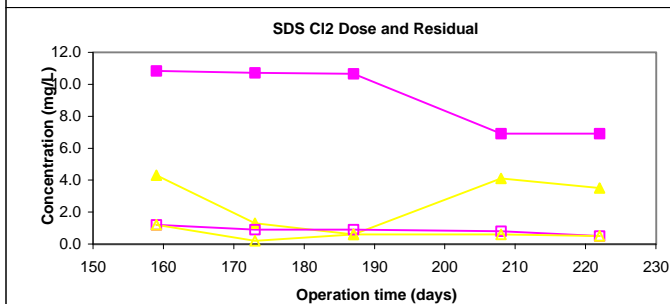
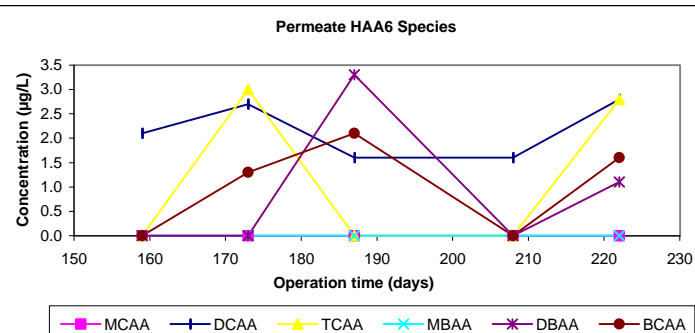
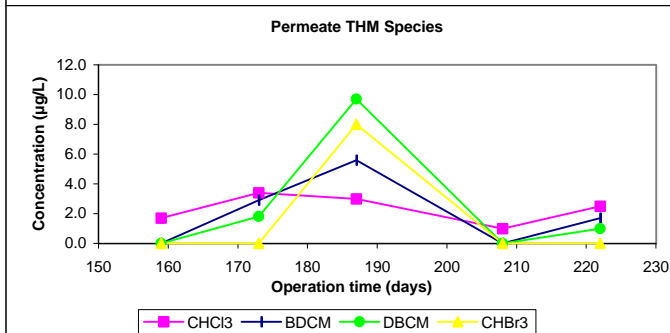
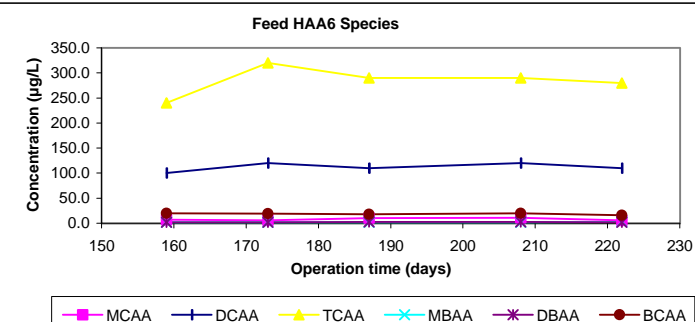
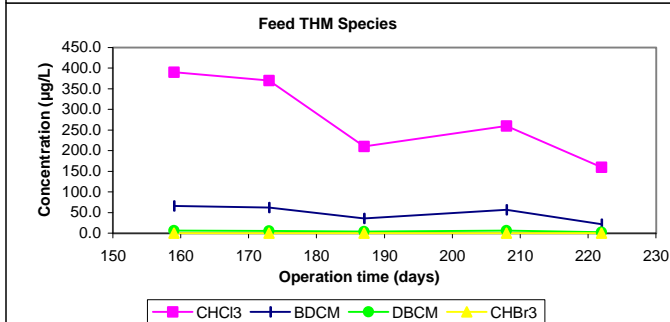
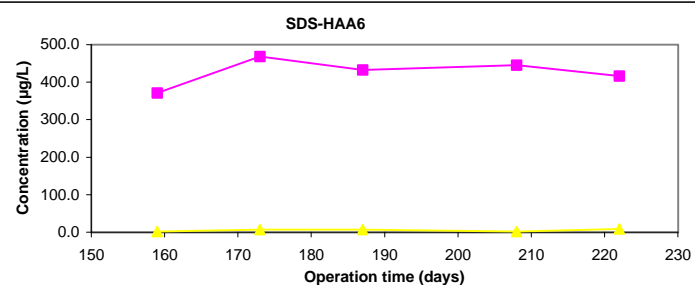
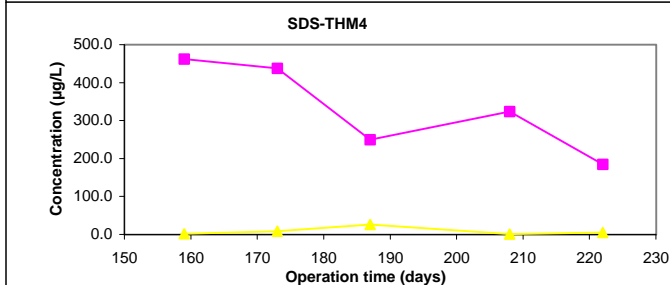
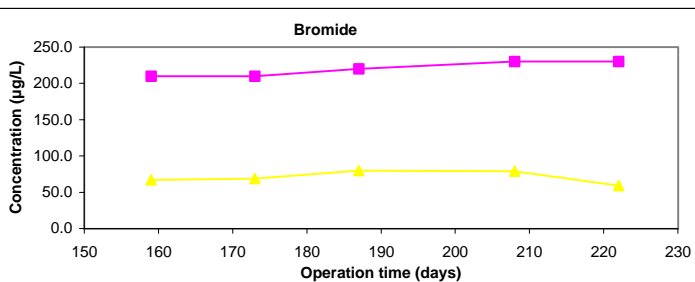
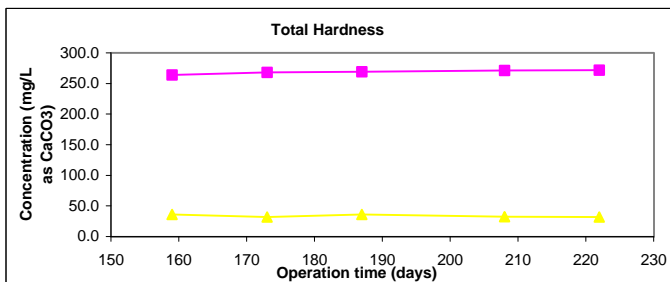
	Stage 1 Influent						Stage 1 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.55	0.00	5	0.55 - 0.55					
pH	7.2	6.3	5.8	0.1	5	5.8 - 5.9	5.5	5.3	0.0	5	5.3 - 5.3
Temp	24.4	25.1	24.9	0.1	5	24.8 - 25.0	24.8	25.1	0.1	5	24.9 - 25.2
Alk	61	228	61	13	5	38 - 69	35	18	1	5	16 - 20
TDS	302	1319	348	15	5	340 - 374	62	47	2	5	45 - 50
TotHard	269	1221	269	3	5	264 - 272	34	18	1	5	17 - 20
CaHard	251	1141	251	5	5	243 - 256	32	15	1	5	13 - 16
Turb	0.09	0.34	0.09	0	5	0.08 - 0.10	0.03	0.02	0.02	5	0 - 0
TOC	12.9	78.9	12.9	0.7	5	12.0 - 13.6	0.5	0.8	0.1	5	0.7 - 0.9
UV254	0.484	2.378	0.484	0.009	5	0.473 - 0.495	0.030	0.005	0.000	5	0.005 - 0.005
SUVA	3.78	3.04	3.78	0.24	5	3.48 - 4.07	5.69	0.57	0.05	5	0.50 - 0.64
	Stage 2 Influent						Stage 2 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.66	0.01	5	0.66 - 0.67					
pH	7.2	6.3	6.0	0.1	5	5.9 - 6.1	5.5	5.5	0.1	5	5.4 - 5.6
Temp	24.4	25.1	25.0	0.5	5	24.3 - 25.7	24.8	25.2	0.1	5	25.2 - 25.4
Alk	61	228	143	18	5	116 - 159	35	34	5	5	25 - 39
TDS	302	1319	720	2	5	718 - 722	62	113	0	5	113 - 113
TotHard	269	1221	701	23	5	682 - 738	34	57	4	5	51 - 63
CaHard	251	1141	650	12	5	637 - 662	32	51	2	5	47 - 54
Turb	0.09	0.34	0.21	0	5	0.17 - 0.26	0.03	0.02	0.03	5	0 - 0
TOC	12.9	78.9	33.6	1.4	5	31.8 - 35.3	0.5	1.2	0.1	5	1.0 - 1.3
UV254	0.484	2.378	1.318	0.035	5	1.300 - 1.380	0.030	0.013	0.005	5	0.005 - 0.017
SUVA	3.78	3.04	3.93	0.18	5.00	3.68 - 4.12	5.69	1.10	0.43	5.00	0.45 - 1.55
	Stage 3 Influent						Stage 3 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery											
pH											
Temp											
Alk											
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

Water Quality Parameter Graphs

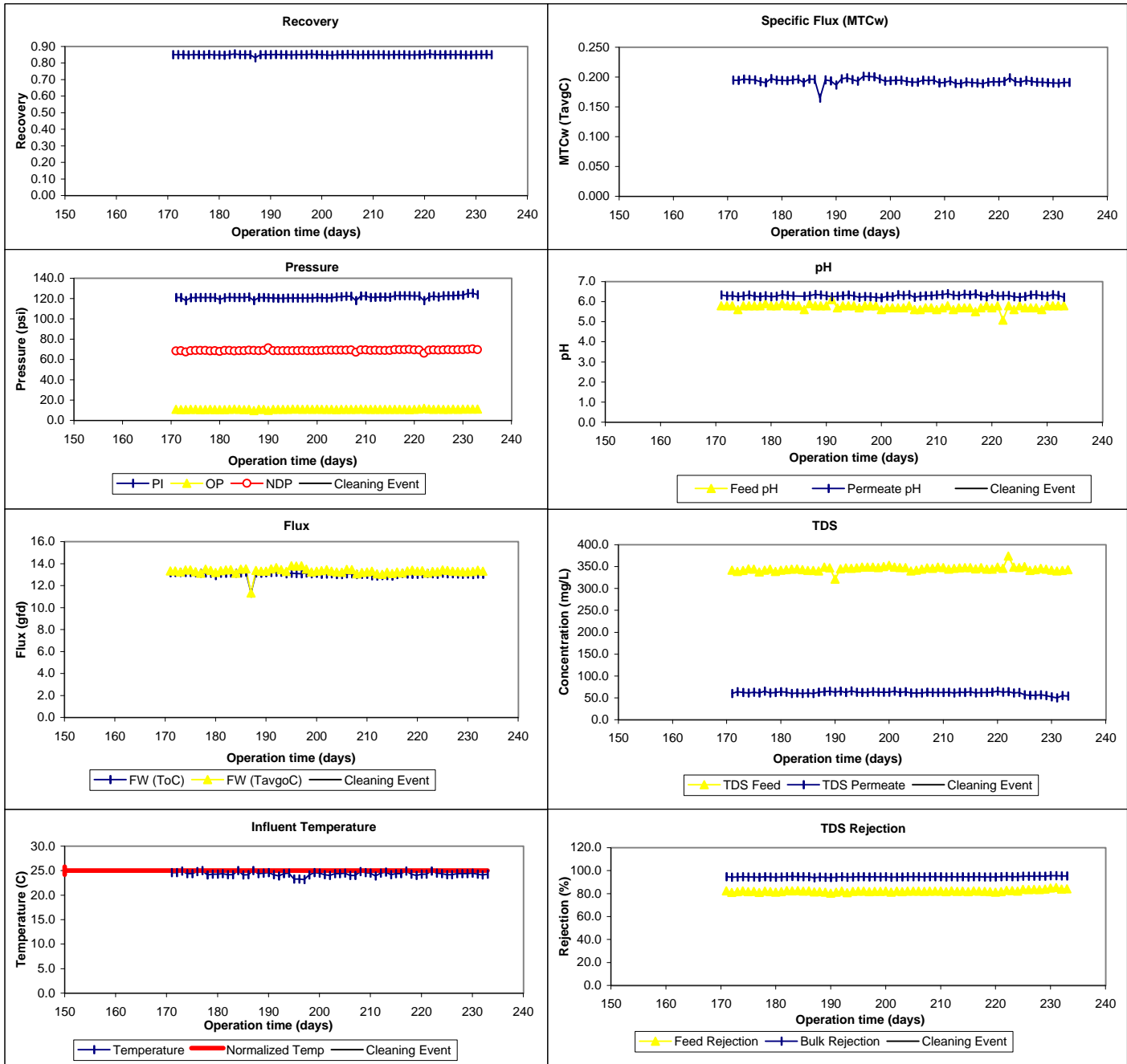
Chart Legend:



Water Quality Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: FL4501047 / 310
 ICR Contact: Mr. Hector R. Rodriguez
 Phone No.: 561 641 3455
 Period: 11/1/98 - 1/9/99 (69 days)

Membrane Information

Manufacturer: Koch Membrane Systems
 Trade Name: Fluid Systems
 Membrane Model: TFCS 8921S-400
 MWCO: 200 Daltons
 Element Size: 8 in dia. 40 in length
 Element Area: 400.0 ft²
 Design Flux: 15.0 gfd
 Mfr. NDP: 80.0 psi
 Mfr. MTC_w: 0.130 (gfd/psi)
 Mfr. Temp: 30.0 °C
 Maximum Flow: 50.0 gpm
 Minimum Flow: 20.0 gpm
 Total Width : 72.0 ft
 Feed Spacer Thickness: 0.0028 ft
 840 Element Area 400.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 25.0 °C
 Temp Norm MTC-w: 0.112 TavGC
 Design Recovery: 0.85
 Avg Sys Flux F_w: 14.9 gfd
 # of Elem in P.V.: 7
 # Pres Ves in Stg 1: 36
 # Pres Ves in Stg 2: 20
 Pres Ves in Stg 3: NA
 Design Flux: 14.9 gfd
 Recycle Ratio: 0.00
 Osmotic P Stage 1: 2.8 psi
 Osmotic P Stage 2: 13.7 psi
 Osmotic P Stage 3: NA

Water Quality Summary

Summary	Feed (System)				Permeate (System)				Concentrate (System)			
	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max
pH	7.1	0.1	5	7.1 - 7.2	5.3	0.0	5	5.2 - 5.3	6.3	0.0	5	6.2 - 6.3
Temp	24.0	0.1	5	23.8 - 24.1	25.2	0.1	5	25.0 - 25.2	24.5	0.7	5	23.3 - 25.0
Alk	57	4	5	49 - 60	34	6	5	25 - 39	250	32	5	208 - 297
TDS	299	6	5	291 - 306	59	4	5	52 - 63	1356	18	5	1340 - 1383
TotHard	271	10	5	263 - 287	35	3	5	31 - 40	1596	46	5	1550 - 1670
CaHard	250	7	5	240 - 258	31	4	5	24 - 34	1494	40	5	1440 - 1550
Turb	0.08	0.0	5	0.02 - 0.12	0.02	0.0	5	0.01 - 0.08	0.37	0.2	5	0.03 - 0.61
Amm	1.30	0.00	5	1.30 - 1.30	0.60	0.00	5	0.60 - 0.60	7.00	0.00	5	7.0 - 7.0
TOC	12.7	0.1	5	12.6 - 12.9	0.5	0.0	5	0.5 - 0.5	76.9	1.5	5	74.4 - 78.2
UV254	0.489	0.0	5	0.473 - 0.509	0.045	0.0	5	0.039 - 0.053	3.070	0.1	5	3.000 - 3.180
SUVA	3.85	0.14	5	3.67 - 4.04	9.08	1.06	5	7.80 - 10.60	4.00	0.12	5	3.84 - 4.13
Bromide	226	13	5	220 - 250	69	13	5	47 - 80				
TOX	1704	89	5	1600 - 1840	56	52	5	13 - 135				
CHCl3	256.0	50.8	5	210.0 - 330.0	5.5	6.4	5	1.3 - 16.0	Mass Balance			
BDCM	44.4	5.0	5	36.0 - 49.0	3.2	4.2	5	0.0 - 9.7	Closure Errors (%)			
DBCM	5.1	0.6	5	4.2 - 5.9	1.7	2.5	5	0.0 - 5.5	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	5	0.0 - 0.0	0.4	0.5	5	0.0 - 1.0	Alk	5	26	19
THM4	305.5	54.2	5	250.2 - 382.4	10.9	13.7	5	1.4 - 32.2	TDS	5	-22	3
MCAA	7.7	1.2	5	6.3 - 9.5	0.0	0.0	5	0.0 - 0.0	TotHard	5	-1	1
DCAA	95.6	15.3	5	76.0 - 110.0	3.9	3.6	5	1.4 - 9.7	CaHard	5	0	2
TCAA	270.0	35.4	5	220.0 - 320.0	2.6	2.5	5	0.0 - 6.6	Turb	5	-21	68
MBAA	1.7	0.1	5	1.6 - 1.9	0.0	0.0	5	0.0 - 0.0	Amm	5	25	0
DBAA	2.1	0.7	5	1.2 - 3.0	0.9	1.3	5	0.0 - 2.5	TOC	5	-6	2
BCAA	17.2	2.6	5	14.0 - 21.0	2.0	2.4	4	0.0 - 5.0	UV254	5	2	2
TBAA	0.0	0.0	3	0.0 - 0.0	0.0	0.0	2	0.0 - 0.0	Comments:			
CDBAA	3.9	2.3	5	0.0 - 5.7	0.0	0.0	4	0.0 - 0.0				
DCBAA	35.4	20.0	5	0.0 - 47.0	1.5	1.1	4	0.0 - 2.7				
HAA5	377.1	49.7	5	305.2 - 443.0	7.4	7.2	5	1.4 - 18.8				
HAA6	394.3	51.2	5	319.2 - 460.0	10.9	9.8	4	2.9 - 23.8				
HAA9	457.8	9.5	3	447.4 - 466.0	15.1	16.2	2	3.6 - 26.5				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process	Description	Scale					
Res (0)	0.58	0.19	10	0.30 - 0.90	sulfuric acid addition	I.M.C.-Agric Co. /CF Industries , 93% conce	full scale					
Temp (°C)	22.9	2.2	10	17.0 - 24.4	scale inhibitor	Aqua Feed 600, 35%, manufacturer B.F. G	full scale					
pH (unit)	7.4	1.6	10	5.6 - 9.2	cartridge filtration	5 micron exclusion type	full scale					
Time (hr)	72.0	0.0	10	72.0 - 72.0								

Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	5.1%	3.3%	System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	0.0%	0.0%
Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	0.0%	0.0%
Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perr	0.0%	0.0%	Sys Perm - Sum Stg Per	0.0%	0.0%	Sys Perm - Avg Stg Perm	-25.8%	6.8%

Stage Summary

WQP	Stage 1 Influent						Stage 1 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.55	0.00	5	0.55 - 0.55					
pH	7.1	6.3	5.8	0.1	5	5.7 - 5.9	5.3	5.3	0.0	5	5.3 - 5.3
Temp	24.0	24.5	24.6	0.1	5	24.4 - 24.7	25.2	25.2	0.1	5	25.0 - 25.2
Alk	57	250	57	4	5	49 - 60	34	18	1	5	17 - 20
TDS	299	1356	346	1	5	345 - 348	59	45	0	5	45 - 45
TotHard	271	1596	271	10	5	263 - 287	35	17	1	5	15 - 18
CaHard	250	1494	250	7	5	240 - 258	31	16	1	5	14 - 18
Turb	0.08	0.37	0.08	0	5	0.02 - 0.12	0.02	0.01	0.00	5	0 - 0
TOC	12.7	76.9	10.4	5.1	5	1.3 - 12.9	0.5	1.0	0.1	5	0.8 - 1.1
UV254	0.489	3.070	0.489	0.015	5	0.473 - 0.509	0.045	0.005	0.000	5	0.005 - 0.005
SUVA	3.85	4.00	10.42	14.64	5	3.67 - 36.62	9.08	0.47	0.06	5	0.41 - 0.56

WQP	Stage 2 Influent						Stage 2 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.66	0.00	5	0.66 - 0.66					
pH	7.1	6.3	5.9	0.0	5	5.9 - 6.0	5.3	5.5	0.1	5	5.4 - 5.5
Temp	24.0	24.5	24.7	0.2	5	24.5 - 25.0	25.2	25.2	0.1	5	25.0 - 25.2
Alk	57	250	124	13	5	106 - 137	34	34	1	5	32 - 35
TDS	299	1356	714	3	5	710 - 717	59	112	1	5	110 - 113
TotHard	271	1596	706	22	5	680 - 737	35	54	2	5	51 - 56
CaHard	250	1494	654	14	5	641 - 670	31	49	1	5	48 - 51
Turb	0.08	0.37	0.24	0	5	0.17 - 0.30	0.02	0.02	0.01	5	0 - 0
TOC	12.7	76.9	33.5	0.4	5	33.0 - 33.8	0.5	1.2	0.1	5	1.1 - 1.4
UV254	0.489	3.070	1.308	0.050	5	1.260 - 1.380	0.045	0.014	0.001	5	0.013 - 0.016
SUVA	3.85	4.00	3.91	0.14	5.00	3.74 - 4.08	9.08	1.15	0.13	5.00	1.00 - 1.33

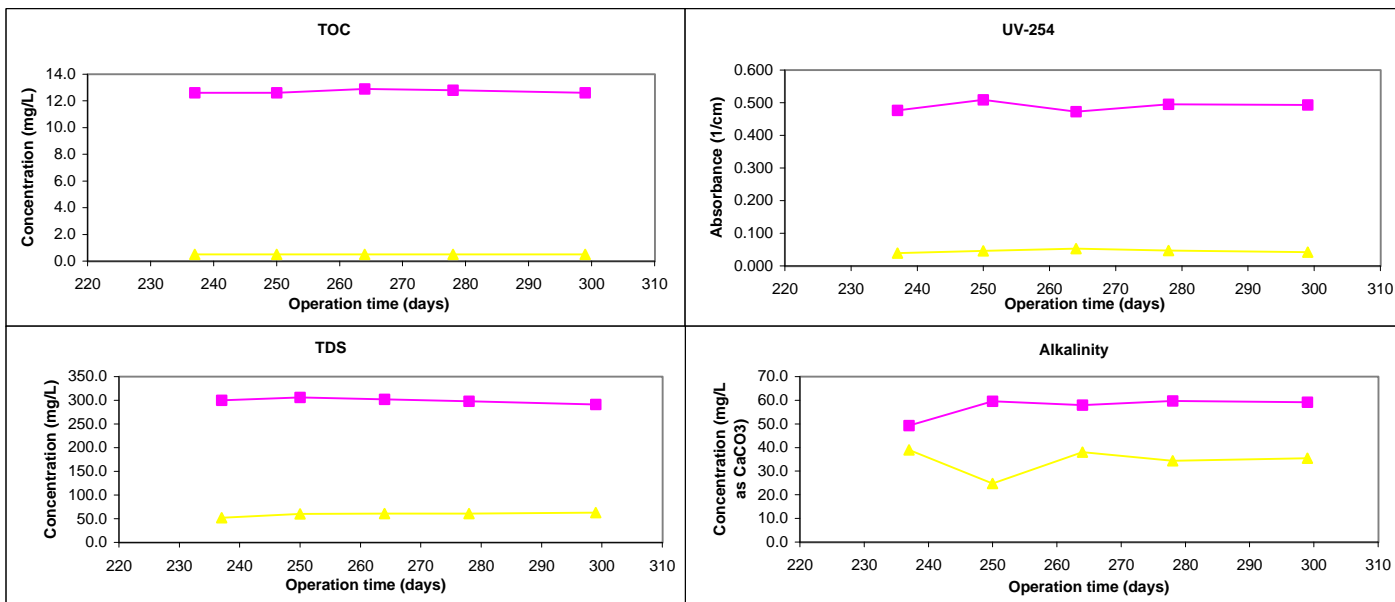
WQP	Stage 3 Influent						Stage 3 Permeate				
	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery											
pH											
Temp											
Alk											
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

This was only a two stage study.

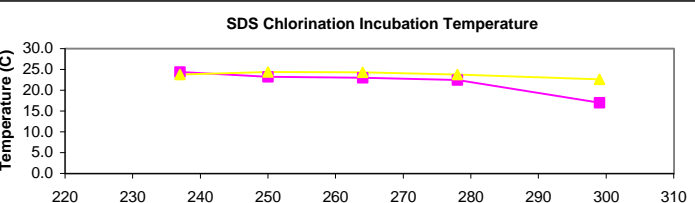
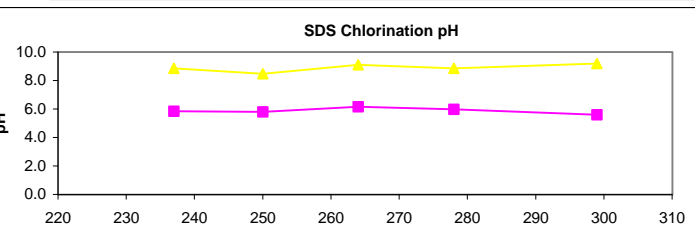
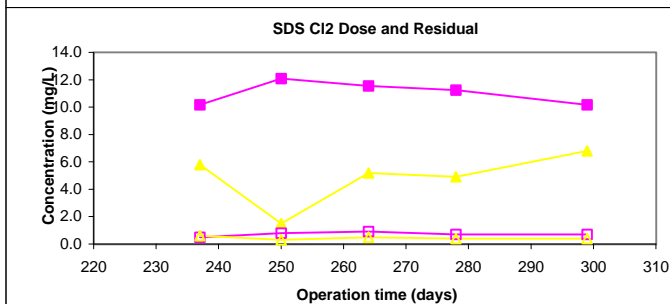
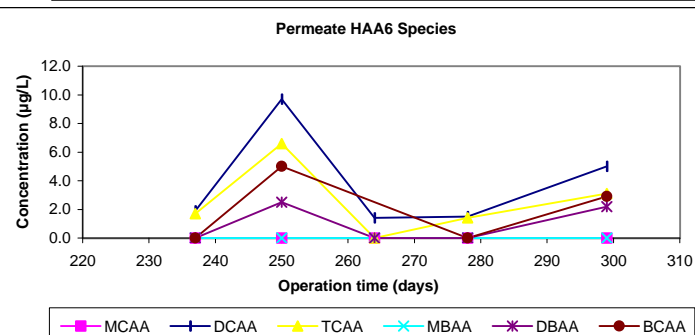
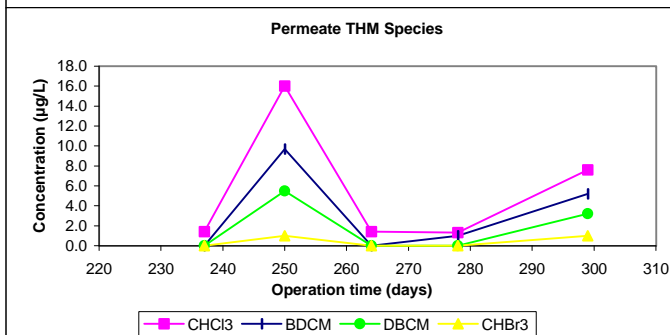
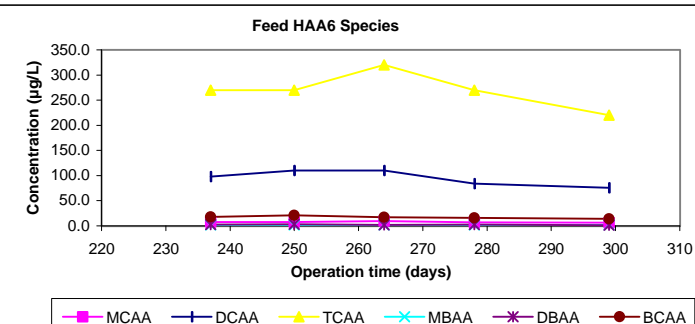
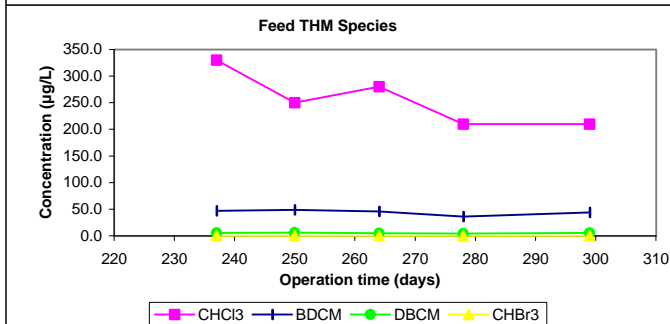
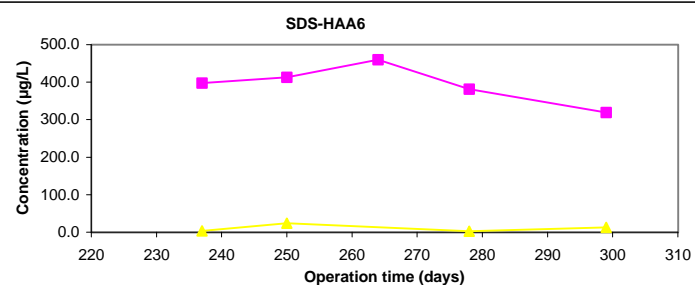
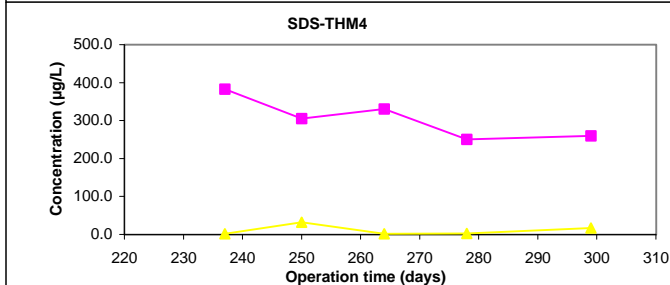
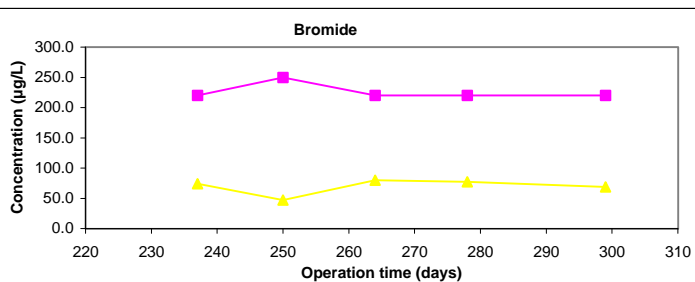
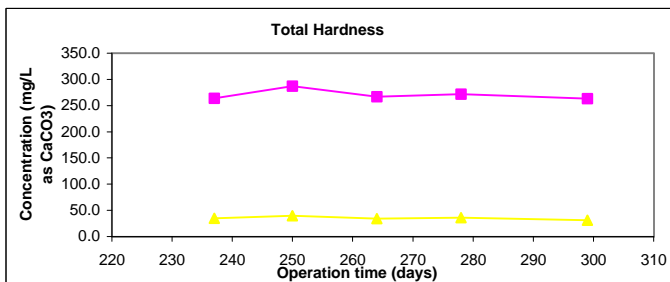
Chart Legend:

- Feed (System)
- Permeate (System)

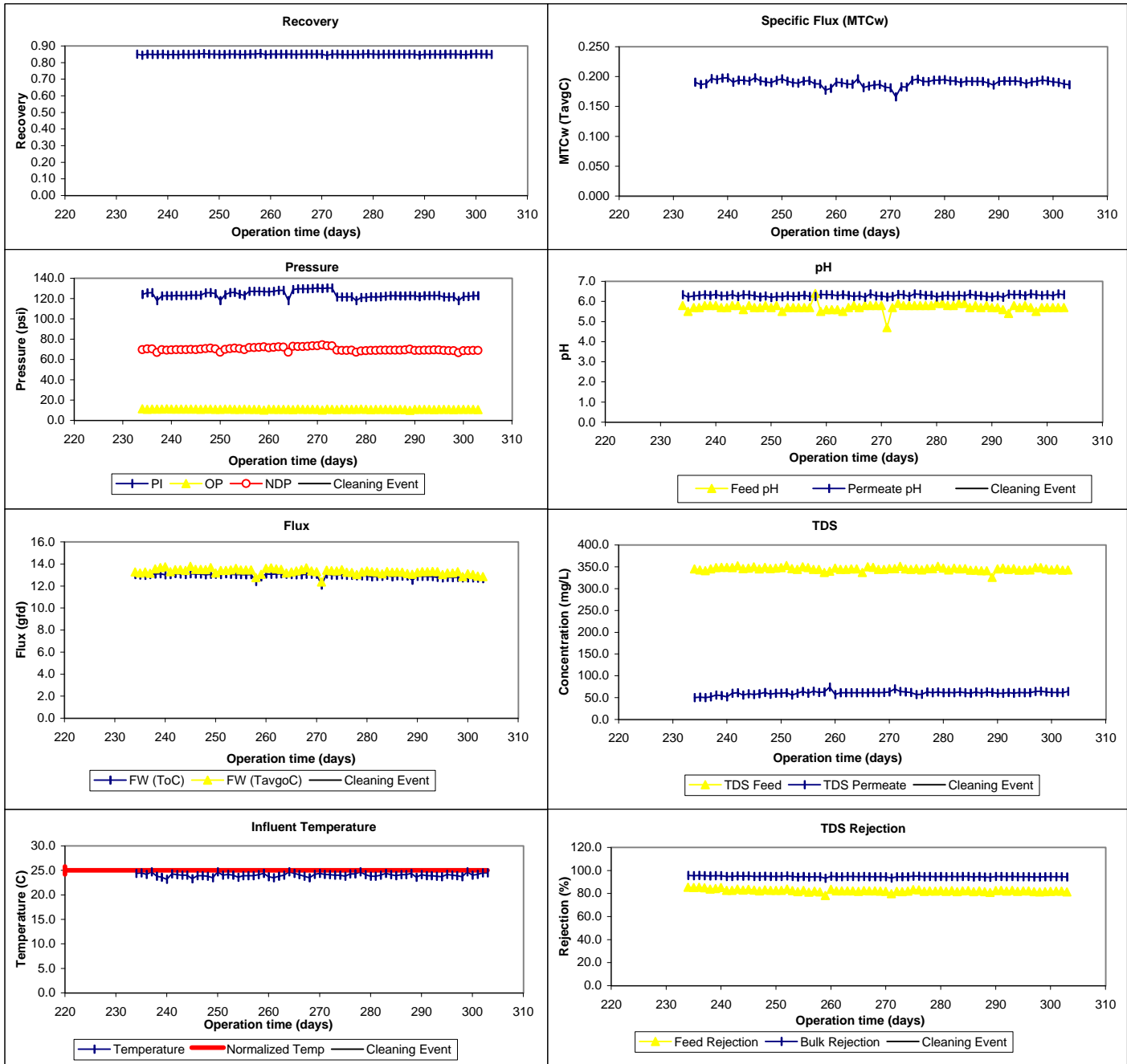
Water Quality Parameter Graphs



Water Quality Graphs (Continued)



Productivity Graphs



ICR Information

ID / ICR#: FL4501047 / 310
 ICR Contact: Mr. Hector R. Rodriguez
 Phone No.: 561 641 3455
 Period: 1/10/99 - 3/16/99 (65 days)

Membrane Information

Manufacturer: Koch Membrane Systems
 Trade Name: Fluid Systems
 Membrane Model: TFCS 8921S-400
 MWCO: 200 Daltons
 Element Size: 8 in dia. 40 in length
 Element Area: 400.0 ft²
 Design Flux: 15.0 gfd
 Mfr. NDP: 80.0 psi
 Mfr. MTC_w: 0.130 (gfd/psi)
 Mfr. Temp: 30.0 °C
 Maximum Flow: 50.0 gpm
 Minimum Flow: 20.0 gpm
 Total Width : 72.0 ft
 Feed Spacer Thickness: 0.0028 ft
 840 Element Area 400.0 ft²
 840 Purchase Price: \$790

Design Parameters

Norm Temp: 25.0 °C
 Temp Norm MTC-w: 0.112 TavGC
 Design Recovery: 0.85
 Avg Sys Flux F_w: 14.9 gfd
 # of Elem in P.V.: 7
 # Pres Ves in Stg 1: 36
 # Pres Ves in Stg 2: 20
 Pres Ves in Stg 3: NA
 Design Flux: 14.9 gfd
 Recycle Ratio: 0.00
 Osmotic P Stage 1: 2.8 psi
 Osmotic P Stage 2: 13.7 psi
 Osmotic P Stage 3: NA

Water Quality Summary

Summary	Feed (System)				Permeate (System)				Concentrate (System)			
	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max	Mean	SD	Count	Min/Max
pH	7.1	0.0	5	7.1 - 7.1	5.4	0.1	5	5.3 - 5.5	6.3	0.0	5	6.3 - 6.3
Temp	23.7	0.7	5	22.6 - 24.2	24.7	0.8	5	23.3 - 25.2	23.0	1.3	5	21.0 - 24.3
Alk	68	4	5	63 - 72	36	3	5	32 - 40	302	35	5	240 - 325
TDS	296	4	5	292 - 301	62	1	5	61 - 63	1316	16	5	1289 - 1330
TotHard	271	9	5	259 - 282	40	6	5	33 - 47	1572	19	5	1550 - 1600
CaHard	251	6	5	243 - 256	35	5	5	28 - 39	1464	30	5	1420 - 1490
Turb	0.06	0.0	5	0.04 - 0.09	0.09	0.1	5	0.01 - 0.26	0.33	0.1	5	0.28 - 0.41
Amm	1.30	0.00	5	1.30 - 1.30	0.60	0.00	5	0.60 - 0.60	7.00	0.00	4	7.0 - 7.0
TOC	12.8	0.3	5	12.5 - 13.2	1.6	1.1	5	0.3 - 2.6	76.4	1.0	5	75.0 - 77.5
UV254	0.475	0.0	5	0.466 - 0.482	0.071	0.0	5	0.032 - 0.102	2.910	0.2	5	2.470 - 3.060
SUVA	3.71	0.08	5	3.64 - 3.85	6.39	3.89	5	3.80 - 12.80	3.81	0.29	5	3.29 - 3.96
Bromide	222	4	5	220 - 230	76	6	5	70 - 82				
TOX	1632	22	5	1600 - 1650	85	67	5	13 - 145				
CHCl3	230.0	26.5	3	210.0 - 260.0	27.0	6.1	3	23.0 - 34.0	Mass Balance			
BDCM	53.3	11.7	3	43.0 - 66.0	5.0	2.9	3	1.8 - 7.6	Closure Errors (%)			
DBCM	6.1	1.2	3	4.9 - 7.3	3.5	3.1	3	1.6 - 7.1	WQP	Count	Avg	SD/RD
CHBr3	0.0	0.0	3	0.0 - 0.0	0.0	0.0	3	0.0 - 0.0	Alk	5	16	8
THM4	289.4	39.2	3	257.9 - 333.3	35.5	7.0	3	30.2 - 43.4	TDS	5	-23	2
MCAA	7.6	1.5	5	6.2 - 9.4	1.1	2.5	5	0.0 - 5.7	TotHard	5	0	4
DCAA	101.4	8.3	5	93.0 - 110.0	10.3	7.4	5	1.5 - 17.0	CaHard	5	-1	3
TCAA	246.0	26.1	5	230.0 - 290.0	4.0	2.9	5	0.0 - 6.9	Turb	5	142	203
MBAA	1.7	0.9	5	0.0 - 2.2	0.0	0.0	5	0.0 - 0.0	Amm	4	25	0
DBAA	2.5	0.5	5	2.0 - 3.2	0.2	0.5	5	0.0 - 1.1	TOC	5	1	7
BCAA	18.4	1.1	5	17.0 - 20.0	2.6	1.9	5	0.0 - 4.4	UV254	5	5	9
TBAA	0.0	0.0	5	0.0 - 0.0	0.0	0.0	5	0.0 - 0.0	TDS	50	-47	7
CDBAA	4.8	1.3	5	3.4 - 6.8	0.0	0.0	5	0.0 - 0.0	Comments:			
DCBAA	45.4	5.4	5	38.0 - 52.0	1.0	0.9	5	0.0 - 1.9				
HAA5	359.2	30.6	5	334.0 - 408.9	15.7	11.5	5	1.5 - 26.0				
HAA6	377.6	30.8	5	351.0 - 426.9	18.3	13.2	5	2.7 - 29.3				
HAA9	427.8	34.2	5	399.5 - 482.3	19.2	14.1	5	2.7 - 30.6				
SDS Conditions					Pretreatment Information							
WQP	Avg	SD	Count	Min - Max	Process	Description	Scale					
Res (0)	0.55	0.26	10	0.20 - 1.00	sulfuric acid addition	I.M.C.-Agric Co. /CF Industries , 93% conce	full scale					
Temp (°C)	23.3	0.9	10	21.7 - 24.4	Scale inhibitor	Aqua Feed 600, 35%, manufacturer B.F. G	full scale					
pH (unit)	7.5	1.7	10	5.8 - 9.3	cartridge filtration	5 micron exclusion size	full scale					
Time (hr)	72.0	0.0	10	72.0 - 72.0								

Mass Balance Errors

Pressure	RPD	SD	Flow	RPD	SD	TDS	RPD	SD
System Inf - Stg 1 Inf	3.9%	1.5%	System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	-0.1%	0.7%
Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	0.0%	0.0%	Sys Conc - Stg 2 Conc	-0.1%	0.7%
Stg 1 Conc - Stg 2 Inf	-1.4%	5.7%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%	Stg 1 Conc - Stg 2 Inf	0.0%	0.0%
Sys Perm - Avg Stg Perr	0.0%	0.0%	Sys Perm - Sum Stg Per	0.0%	0.0%	Sys Perm - Avg Stg Perm	-21.2%	3.0%

Stage Summary

Stage 1 Influent							Stage 1 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.55	0.00	5	0.55 - 0.55					
pH	7.1	6.3	5.8	0.0	5	5.7 - 5.8	5.4	5.3	0.0	5	5.3 - 5.3
Temp	23.7	23.0	24.1	0.8	5	22.7 - 24.6	24.7	25.1	0.1	5	25.0 - 25.2
Alk	68	302	68	4	5	63 - 72	36	19	1	5	18 - 20
TDS	296	1316	342	2	5	338 - 343	62	44	0	5	44 - 44
TotHard	271	1572	271	9	5	259 - 282	40	19	2	5	17 - 22
CaHard	251	1464	251	6	5	243 - 256	35	16	1	5	15 - 16
Turb	0.06	0.33	0.06	0	5	0.04 - 0.09	0.09	0.01	0.00	5	0 - 0
TOC	12.8	76.4	12.8	0.3	5	12.5 - 13.2	1.6	0.9	0.2	5	0.7 - 1.1
UV254	0.475	2.910	0.475	0.007	5	0.466 - 0.482	0.071	0.005	0.002	5	0.005 - 0.009
SUVA	3.71	3.81	3.71	0.08	5	3.64 - 3.85	6.39	0.62	0.12	5	0.50 - 0.82

Stage 2 Influent							Stage 2 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery			0.66	0.00	5	0.66 - 0.67					
pH	7.1	6.3	5.9	0.0	5	5.8 - 5.9	5.4	5.4	0.0	5	5.4 - 5.5
Temp	23.7	23.0	23.0	1.3	5	21.0 - 24.3	24.7	25.1	0.1	5	25.0 - 25.2
Alk	68	302	144	22	5	106 - 158	36	37	2	5	34 - 39
TDS	296	1316	707	2	5	705 - 709	62	109	1	5	107 - 110
TotHard	271	1572	704	5	5	699 - 710	40	56	3	5	52 - 59
CaHard	251	1464	662	15	5	645 - 676	35	52	4	5	46 - 55
Turb	0.06	0.33	0.18	0	5	0.15 - 0.22	0.09	0.01	0.00	5	0 - 0
TOC	12.8	76.4	33.3	0.4	5	32.8 - 33.8	1.6	1.2	0.2	5	1.0 - 1.5
UV254	0.475	2.910	1.272	0.036	5	1.230 - 1.310	0.071	0.018	0.009	5	0.011 - 0.031
SUVA	3.71	3.81	3.82	0.10	5.00	3.67 - 3.89	6.39	1.44	0.55	5.00	0.92 - 2.07

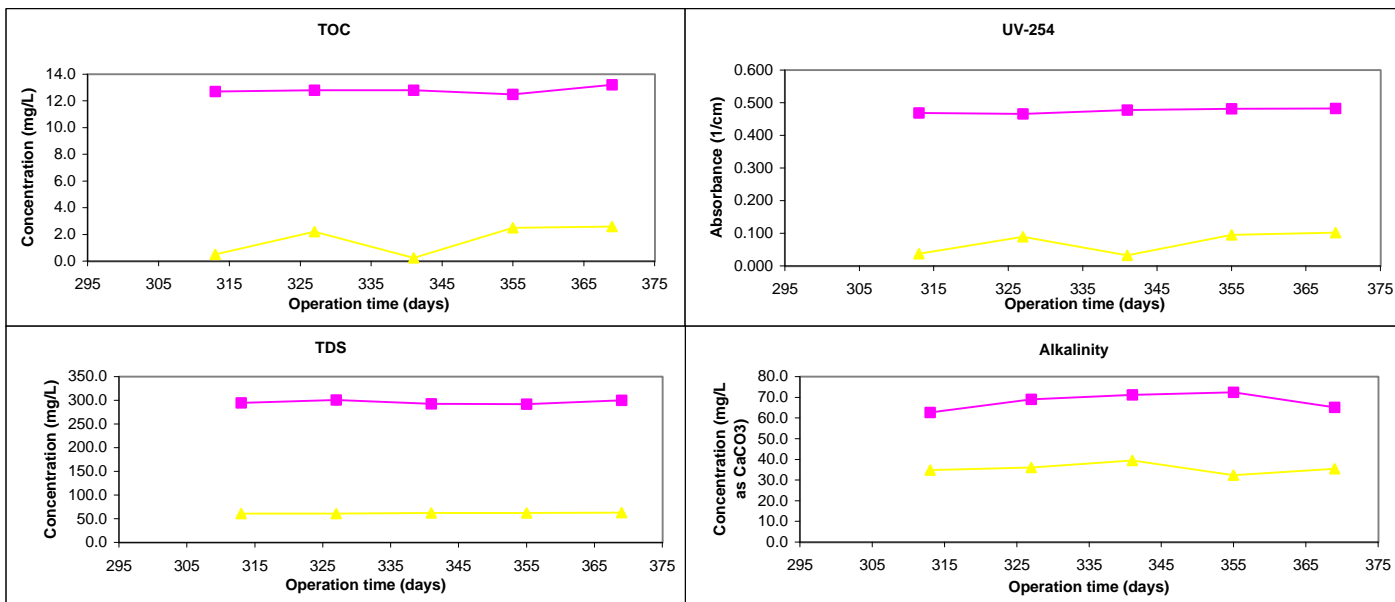
Stage 3 Influent							Stage 3 Permeate				
WQP	Sys Feed	Sys Conc	Mean	SD	Count	Min/Max	Sys Perm	Mean	SD	Count	Min/Max
Recovery											
pH											
Temp											
Alk											
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

This was only a two stage study.

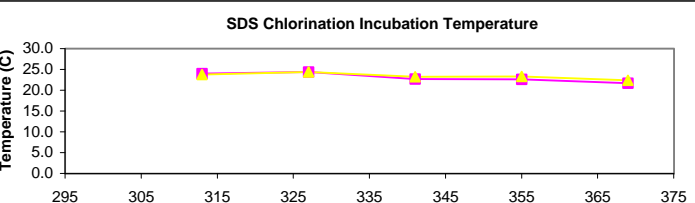
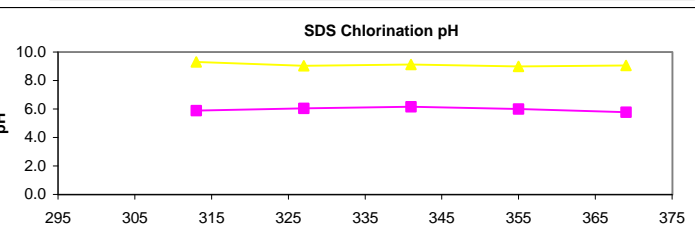
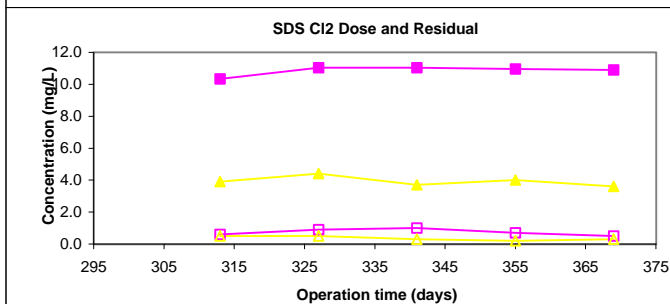
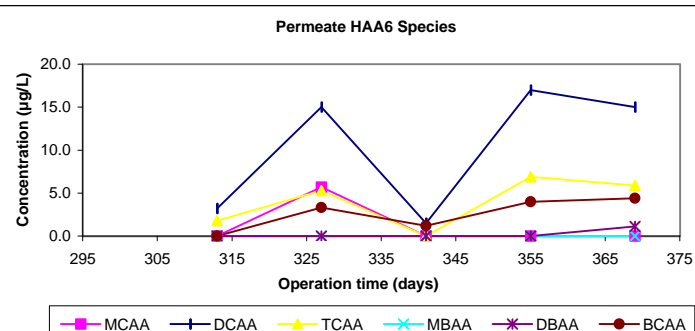
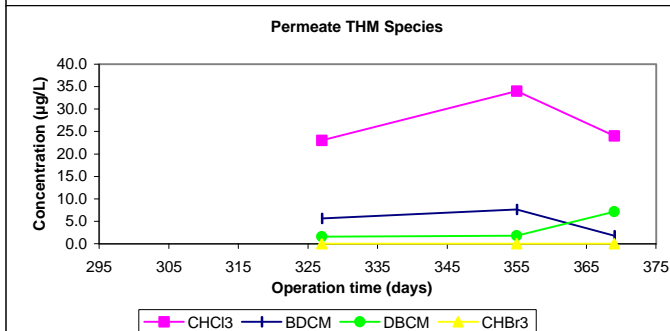
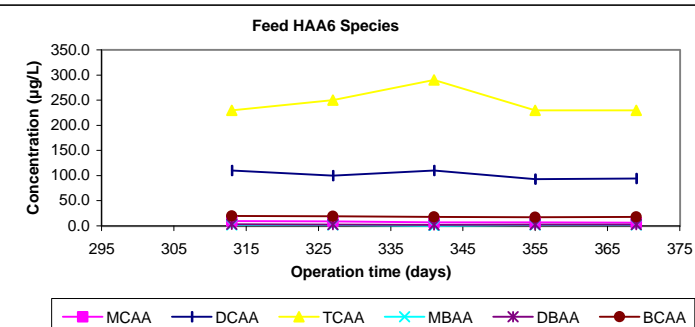
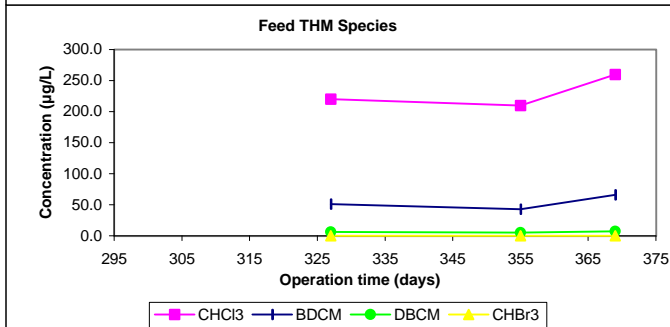
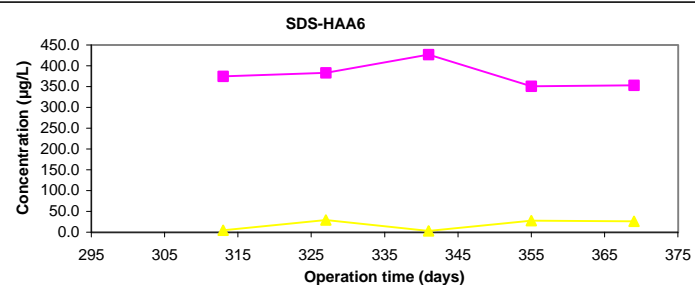
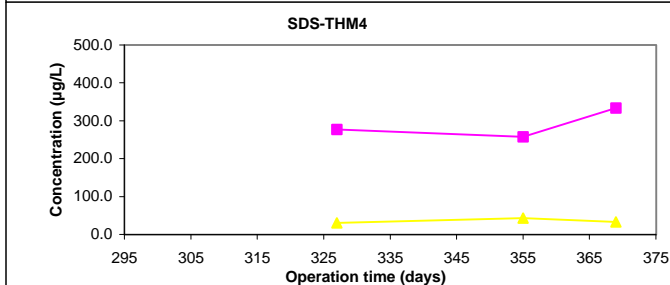
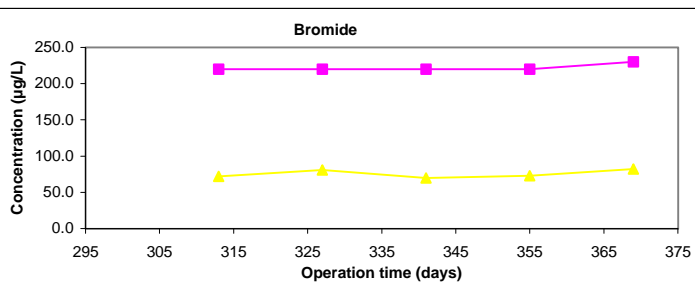
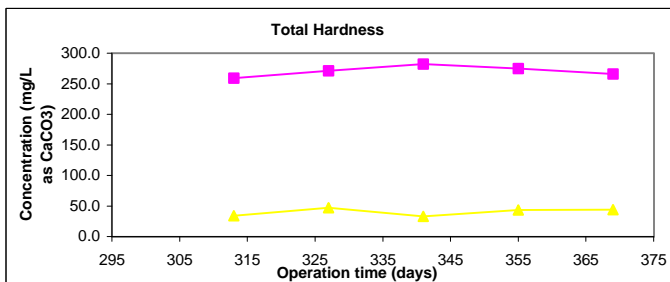
Chart Legend:

- Feed (System)
- Permeate (System)

Water Quality Parameter Graphs



Water Quality Graphs (Continued)



Productivity Graphs

