ICR TREATMENT STUDY ANALYSIS

Base Analysis and Data Review Comments

Treatment Study ID 4008

Study Protocol Two-Stage Pilot-Scale Membrane Study

Plant ICR Number 317

PWS Name Pinellas County Utilities

City, State, Zip Largo, FL 34648

General Comments:

1. This study was grandfathered into the ICR, and therefore does not meet all of the specific requirements listed in the ICR and rule-by-reference manuals. This pilot-scale study (study ID 4008) was conducted in conjunction another pilot-scale study (study ID 4007). Study 4008 was conducted from July 1989 through January 1990 while Study ID 4007 was conducted from February 1990 through April 1991.

2. During this study, the FilmTec NF70 was evaluated. The membrane system was operated at 15 gfd and 75% recovery throughout this study. The experimental design for this study is listed in Table 6 of the Summary Report.

3. Cartridge filtration (5µm) with acid addition was used as the membrane pretreatment. A summary of membrane operation is listed in Table 9 of the Summary Report. Section IV contains a description of the operation of the membrane system.

4. Cost estimates for 10 and 50 MGD groundwater nanofiltration plants are provided in Section IV.

Water Quality Comments:

1. Nine water quality outliers were identified and removed prior to base analysis.

2. The SDS conditions are summarized in the Analytical Methods section of the Summary Report. The reported target chlorination conditions were to dose the permeate and feed samples at 5 and 12.5 mg/L, respectively, at a pH of 7.6, and incubate the samples for 96 hours at 20^{o}C. Although these conditions were chosen to represent SDS conditions, they were probably more similar to a Formation Potential test, as the reported residual ranged from 0.2 to 5.2 mg/L.

3. The following parameters were not measured during this study: ammonia, bromide, UV_{254} and BCAA (thus HAA6).

Productivity Comments:

1. Two productivity outliers were identified and removed prior to base analysis.

2. Figure 3 shows the flux decline trends observed during this study.

3. According to the Summary Report, page 9, the membrane system was not cleaned during this study.

Pinellas County Utilities | **Pilot-Scale Membrane Treatment Study Summary** | **Session:** 1

ICR Information

ID / ICR#: FL6521405 / 317
ICR Contact: Robert Powell
Phone No.: 813-582-2302
Period: 7/19/89 - 1/10/90 (175 days)

Membrane Information

Manufacturer:	DOW USA, (FilmTec)
Trade Name:	NF-70
Membrane Model:	NF-70, 4040
MWCO:	200 Daltons
Element Size:	4" x 40"
Element Area:	80.0 ft^2
Design Flux:	15.0 gfd
Mfr. NDP:	70.0 psi
Mfr. MTC_W:	0.350 (gfd/psi)
Mfr. Temp:	25.0 °C
Maximum Flow:	16.0 gpm
Minimum Flow:	4.0 gpm
Total Width :	12.0 ft
Feed Spacer Thickness:	0.0025 ft
840 Element Area	400.0 ft^2
840 Purchase Price:	$500

Design Parameters

Norm Temp:	24.0 °C
Temp Norm MTC-w:	0.340 TavgC
Design Recovery:	0.75
Avg Sys Flux F_W:	15.0 gfd
# of Elem in P.V.:	3
# Pres Ves in Stg 1:	2
# Pres Ves in Stg 2:	1
Pres Ves in Stg 3:	NA
Design Flux:	15.0 gfd
Recycle Ratio:	0.00
Osmotic P Stage 1:	4.3 psi
Osmotic P Stage 2:	7.0 psi
Osmotic P Stage 3:	NA

Water Quality Summary

	Feed (System)				Permeate (System)				Concentrate (System)			
Summary	**Mean**	**SD**	**Count**	**Min/Max**	**Mean**	**SD**	**Count**	**Min/Max**	**Mean**	**SD**	**Count**	**Min/Max**
pH	6.1	0.2	5	5.8 - 6.4	5.5	0.2	5	5.2 - 5.8	6.4	0.2	5	6.1 - 6.6
Temp	24.0	0.0	5	24.0 - 24.0	NA	NA	0	0.0 - 0.0	NA	NA	0	0.0 - 0.0
Alk	125	32	5	95 - 159	61	21	5	40 - 89	281	84	5	180 - 380
TDS	**324**	**20**	**5**	**300 - 347**	**97**	**24**	**5**	**70 - 130**	**1025**	**68**	**5**	**925 - 1100**
TotHard	227	8	5	218 - 238	67	15	5	50 - 81	698	57	5	633 - 780
CaHard	203	6	5	200 - 213	52	15	5	38 - 72	615	52	5	559 - 680
Turb	0.44	0.4	5	0.18 - 1.00	0.35	0.3	5	0.13 - 0.90	0.50	0.3	5	0.26 - 0.82
Amm	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	0.0 - 0.0
TOC	**3.6**	**0.2**	**5**	**3.4 - 3.9**	**0.3**	**0.0**	**5**	**0.3 - 0.3**	**13.5**	**1.4**	**5**	**11.5 - 15.0**
UV254	NA	NA	0	0.000 - 0.000	NA	NA	0	0.000 - 0.000	NA	NA	0	0.000 - 0.000
SUVA	NA	NA	0	NA	NA	NA	0	NA	NA	NA	0	NA
Bromide	**NA**	**NA**	**0**	**0 - 0**	**NA**	**NA**	**0**	**0 - 0**				
TOX	**541**	**69**	**5**	**444 - 600**	**35**	**9**	**5**	**26 - 45**				
CHCl3	113.4	51.9	5	67.0 - 201.0	7.6	6.5	5	0.0 - 17.0				
BDCM	24.6	10.3	5	14.0 - 41.0	7.2	2.2	5	4.0 - 9.0				
DBCM	2.4	1.8	5	0.0 - 4.6	5.8	0.5	5	5.0 - 6.4				
CHBr3	0.0	0.0	5	0.0 - 0.0	1.0	1.0	5	0.0 - 2.2				
THM4	**140.4**	**62.0**	**5**	**92.6 - 246.6**	**21.6**	**7.0**	**5**	**12.8 - 30.0**				
MCAA	6.4	6.5	5	0.0 - 16.0	2.2	3.0	5	0.0 - 6.0				
DCAA	33.0	11.4	5	17.0 - 45.0	2.4	1.8	5	0.0 - 5.0				
TCAA	34.2	11.4	5	21.0 - 47.0	1.2	0.8	5	0.0 - 2.0				
MBAA	0.6	0.9	5	0.0 - 2.0	0.0	0.0	5	0.0 - 0.0				
DBAA	0.4	0.5	5	0.0 - 1.0	0.8	0.8	5	0.0 - 2.0				
BCAA	NA	NA	0	NA	NA	NA	0	NA				
TBAA	NA	NA	0	NA	NA	NA	0	NA				
CDBAA	NA	NA	0	NA	NA	NA	0	NA				
DCBAA	NA	NA	0	NA	NA	NA	0	NA				
HAA5	**74.6**	**28.8**	**5**	**38.0 - 108.0**	**6.6**	**6.2**	**5**	**0.0 - 15.0**				
HAA6	**NA**	**NA**	**0**	**NA**	**NA**	**NA**	**0**	**NA**				
HAA9	**NA**	**NA**	**0**	**NA**	**NA**	**NA**	**0**	**NA**				

Mass Balance Closure Errors (%)

WQP	Count	Avg	SD/RD
Alk	5	-25	36
TDS	5	-6	16
TotHard	5	-10	14
CaHard	5	-16	19
Turb	5	-102	635
Amm	0	n/a	n/a
TOC	4	-5	13
UV254	0	n/a	n/a
TDSt	99	3	10

Comments:

SDS Conditions

WQP	**Avg**	**SD**	**Count**	**Min - Max**
Res (0)	2.29	1.64	10	0.20 - 4.50
Temp (°C)	20.0	0.0	10	20.0 - 20.0
pH (unit)	7.6	0.0	10	7.6 - 7.6
Time (hr)	96.0	0.0	10	96.0 - 96.0

Pretreatment Information

Process	**Description**	**Scale**
Cartridge filtration	5 mm exclusion size	Pilot-scale
Sulfuric acid addition	approx. = 110 mg/L to pH = 6.0	Pilot-scale
(or) Flocon 100, anti-scalent	2 ppm	Pilot-scale

Mass Balance Errors

Pressure	**RPD**	**SD**	**Flow**	**RPD**	**SD**	**TDS**	**RPD**	**SD**
System Inf - Stg 1 Inf	0.0%	0.0%	System Inf - Stg 1 Inf	3.1%	4.5%	System Inf - Stg 1 Inf	0.2%	1.2%
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	1.6%	4.8%	Stg 1 Conc - Stg 2 Inf	2.8%	4.1%
Sys Perm - Avg Stg Perm	0.0%	0.0%	Sys Perm - Sum Stg Pe	5.2%	7.6%	Sys Perm - Avg Stg Perm	-31.3%	10.4%

Stage Summary

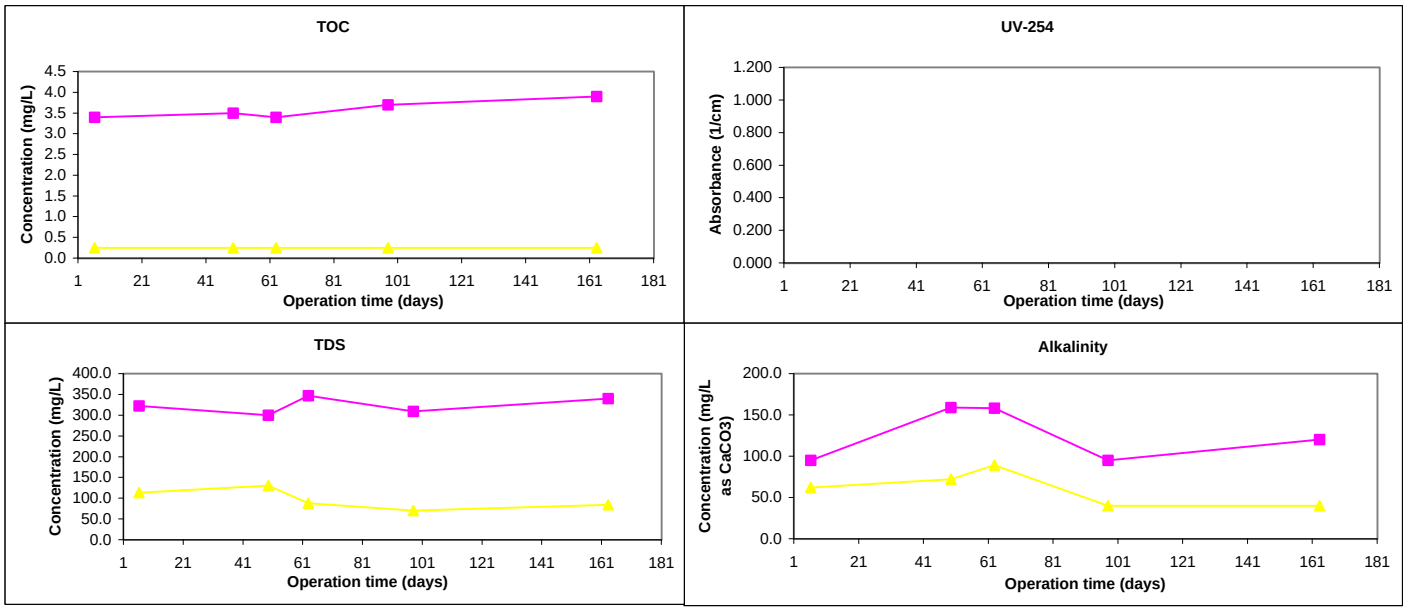
	Stage 1 Influent						Stage 1 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery			**0.58**	**0.04**	**5**	**0.52 - 0.62**					
pH	6.1	6.4	6.1	0.2	5	5.8 - 6.4	5.5	5.5	0.2	5	5.3 - 5.8
Temp	24.0	NA	24.0	0.0	5	24.0 - 24.0	NA	NA	NA	0	0.0 - 0.0
Alk	125	281	125	32	5	95 - 159	61	40	17	5	28 - 63
TDS	**324**	**1025**	324	**20**	**5**	**300 - 347**	**97**	**78**	**27**	**5**	**48 - 116**
TotHard	227	698	227	8	5	218 - 238	67	48	20	5	35 - 80
CaHard	203	615	203	6	5	200 - 213	52	42	18	5	30 - 73
Turb	0.44	0.50	0.44	0	5	0.18 - 1.00	0.35	0.38	0.43	5	0 - 1
TOC	**3.6**	**13.5**	3.6	**0.2**	**5**	**3.4 - 3.9**	**0.3**	**0.3**	**0.0**	**5**	**0.3 - 0.3**
UV254	NA	**NA**	NA	NA	0	0.000 - 0.000	NA	NA	NA	0	0.000 - 0.000
SUVA	NA	**NA**	NA	NA	0	NA	NA	NA	NA	0	NA

	Stage 2 Influent						Stage 2 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery			**0.43**	**0.04**	**5**	**0.37 - 0.48**					
pH	6.1	6.4	6.2	0.2	5	6.0 - 6.5	5.5	5.8	0.2	5	5.5 - 6.1
Temp	24.0	NA	NA	NA	0	0.0 - 0.0	NA	NA	NA	0	0.0 - 0.0
Alk	125	281	206	59	5	129 - 270	61	93	23	5	65 - 129
TDS	**324**	**1025**	640	**42**	**5**	**584 - 700**	**97**	**176**	**32**	**5**	**152 - 221**
TotHard	227	698	444	42	5	392 - 500	67	120	37	5	86 - 181
CaHard	203	615	398	51	5	347 - 470	52	109	37	5	76 - 172
Turb	0.44	0.50	**0.93**	1	5	0.22 - 1.90	0.35	0.88	0.85	5	0 - 2
TOC	**3.6**	**13.5**	7.8	**0.9**	**5**	**6.8 - 8.9**	**0.3**	**0.4**	**0.3**	**5**	**0.3 - 0.9**
UV254	NA	**NA**	NA	NA	0	0.000 - 0.000	NA	NA	NA	0	0.000 - 0.000
SUVA	NA	**NA**	NA	NA	0.00	NA	NA	NA	NA	0.00	NA

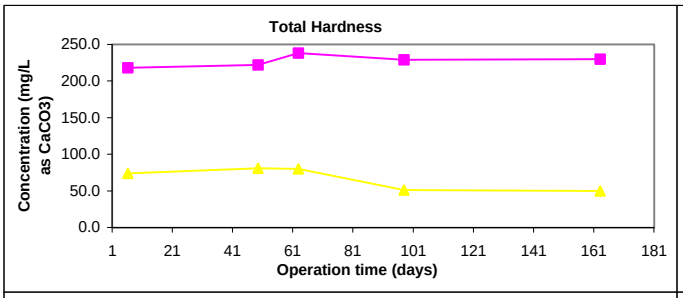
	Stage 3 Influent						Stage 3 Permeate				
WQP	**Sys Feed**	**Sys Conc**	**Mean**	**SD**	**Count**	**Min/Max**	**Sys Perm**	**Mean**	**SD**	**Count**	**Min/Max**
Recovery											
pH											
Temp											
Alk	This	was	**only**	a	two	stage	study.				
TDS											
TotHard											
CaHard											
Turb											
TOC											
UV254											
SUVA											

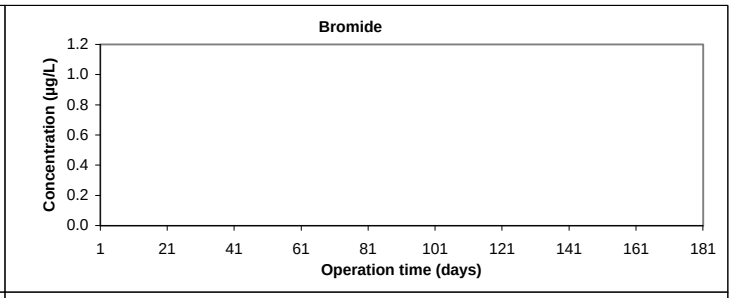
Chart Legend:
- Feed (System)
- Permeate (System)

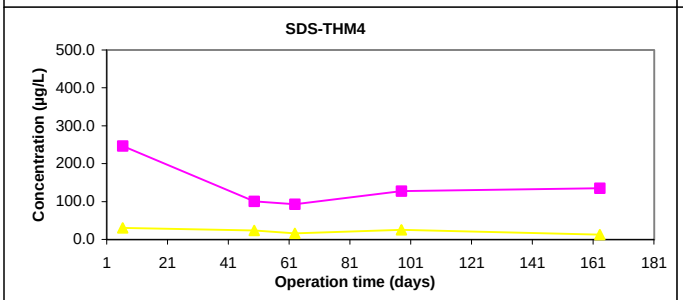
Water Quality Parameter Graphs

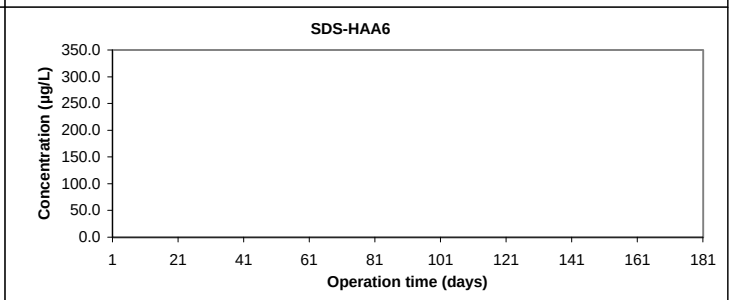


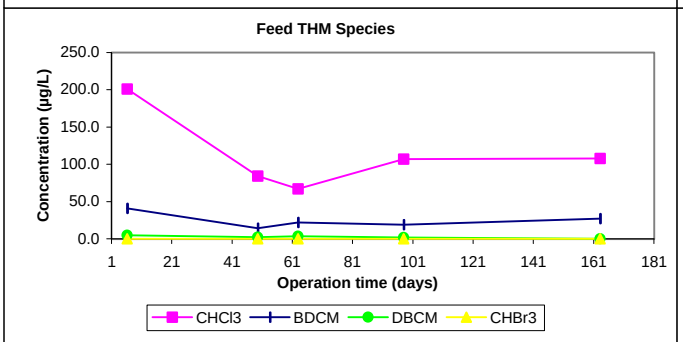
Water Quality Graphs (Continued)

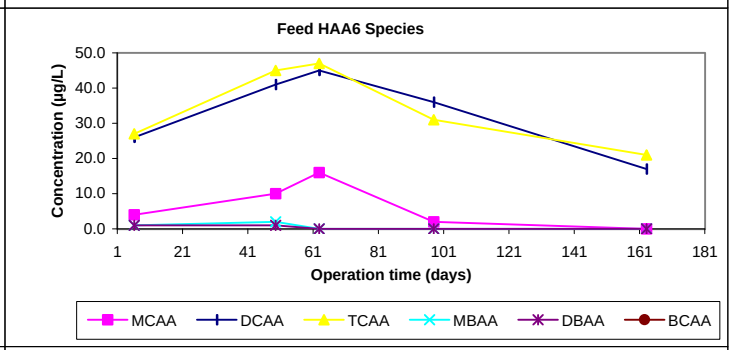


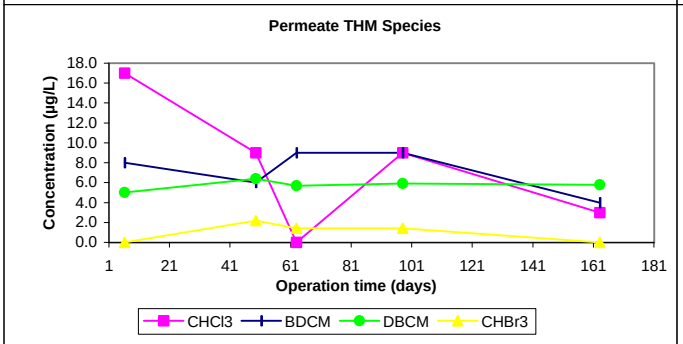


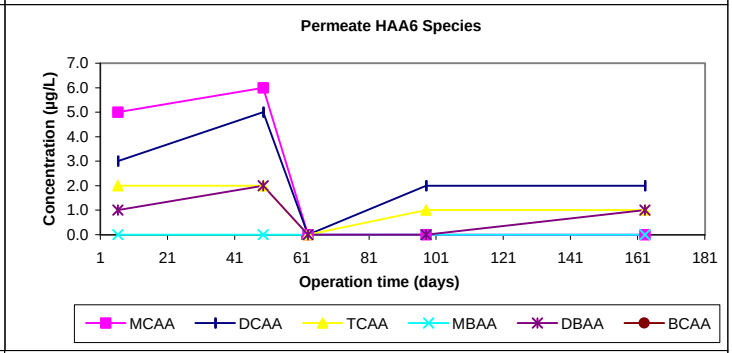


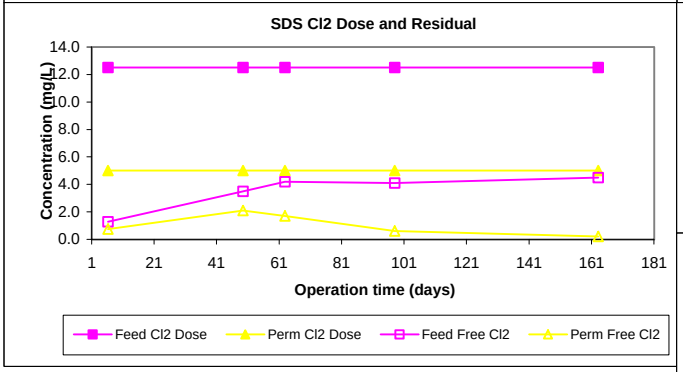


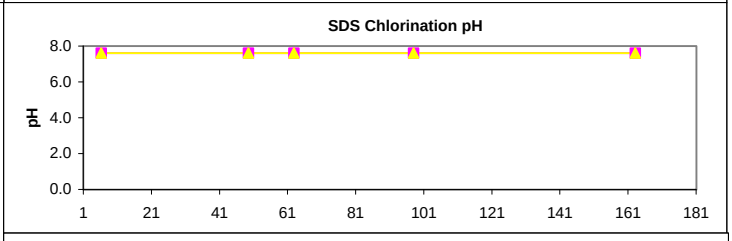


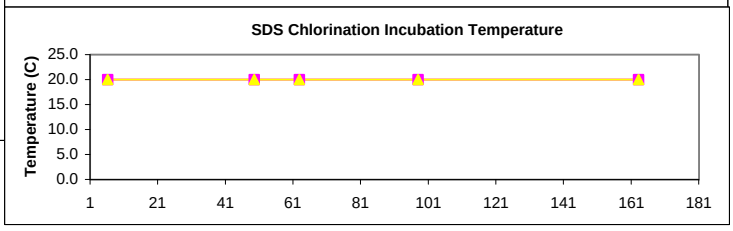












Productivity Graphs