

# ICR TREATMENT STUDY ANALYSIS

## Base Analysis and Data Review Comments

|                           |                                      |
|---------------------------|--------------------------------------|
| <b>Treatment Study ID</b> | 1024                                 |
| <b>Study Protocol</b>     | Single Element Bench-Scale Test      |
| <b>Plant ICR Number</b>   | 380                                  |
| <b>PWS Name</b>           | Water District No. 1, Johnson County |
| <b>City, State, Zip</b>   | Kansas City, KS 66106                |

### General Comments:

1. This study was part of larger cooperative project that also involved Kansas City Missouri Water Services Dept (KCMWSD). KCMWSD conducted a pilot-scale membrane study (study ID 1021), and the SEBST study conducted by Johnson County served as a membrane screening study for this pilot study. The Johnson County SEBST study was conducted at the KCMWSD plant. These two plants use similar treatment, the same source water and are less than 20 river-miles apart.
2. During this SEBST study 4 different membranes were evaluated, including the Hydranautics ESNA, Osmonics MS, FilmTec NF200, and Osmonics-Desal PPCB22-1. Each membrane was evaluated for two sessions (34 – 47 days), from 1/11/98 through 7/1/98.
3. Some operational information (i.e., downtime, cleaning events) is provided in Appendix D of the Summary Report.
4. Feed TDS was not monitored during first three sessions of this study. Osmotic pressure was estimated based available feed TDS data collected during Session 4.
5. Estimates of plant construction and water production costs are provided in the Results and Discussion section of the Summary Report.

### Water Quality Comments:

1. Fifty-one water quality outliers were identified and removed prior to base analysis.
2. SDS conditions are partially summarized in Table 6 of the Summary Report. They included a target free chlorine residual ranging from 0.5 to 1.0 mg/L, after 48 hours incubation at a pH of 7.0. Samples were incubated at 7 °C during the Sessions 1 and 2 (November through early

April), 13°C during Session 3 (April to May), and 15°C during Session 4 (mid-May through early July).

3. Influent alkalinity fluctuations in the membrane feed led to pH control problems, as observed in the erratic feed, permeate and concentrate pH values.
4. The reported permeate and feed bromide data was erratic over the entire study (e.g., feed bromide ranged from < 10µg/L to 110 µg/L). As a result, some of this data was not used during data analysis.
5. Atrazine removal by nanofiltration was also evaluated during this study and the results are summarized in the Results and Discussion section of the Summary Report.
6. Ammonia was not measured during this study.

### **Productivity Comments:**

1. Twelve productivity outliers were identified and removed prior to base analysis.
2. Alkalinity and corresponding pH fluctuations may have resulted in membrane fouling.
3. Membrane cleaning procedures are summarized in Appendix C of the Summary Report and typically included a caustic cleaning followed by an acid wash.

## ICR Information

ID / ICR#: KS 2009110 / 380  
 ICR Contact: Mr. Thomas F. Schrempp  
 Phone No.: (913) 895-5820  
 Period: 1/11/98 - 2/25/98 (45 days)

## Membrane Information

Manufacturer: Hydranautics  
 Trade Name: ESNA  
 Membrane Model: ESNA-4040  
 MWCO: 200-300 Daltons  
 Element Size: 3.94" x 40"  
 Element Area: 85.0 ft<sup>2</sup>  
 Design Flux: 12.0 gfd  
 Mfr. NDP: 75.0 psi  
 Mfr. MTC<sub>w</sub>: 0.140 (gfd/psi)  
 Mfr. Temp: 25.0 °C  
 Max Flow: 16.0 gpm  
 Min Flow: 4.0 gpm  
 Total Width: 14.0 ft  
 Feed Sp Thickness: 0.0010 ft  
 840 Element Area: 400.0 ft<sup>2</sup>  
 840 Purchase Price: \$950

## Design Parameters

Norm Temp: 15.0 °C  
 Temp Norm MTC-w: 0.104 TavGC  
 Design Recovery: 0.75  
 Design Flux: 12.0 gfd  
 Recycle Ratio: 4.08  
 Manuf rep Rej<sub>TDS</sub>: 85%  
 TDS<sub>F</sub>: 1000.0 mg/L

## Water Quality Summary

|         | Mean  | SD   | Feed Count | Min/Max       | Mean  | SD   | Permeate Count | Min/Max       | Mean                               | SD    | Concentrate Count | Min/Max       |
|---------|-------|------|------------|---------------|-------|------|----------------|---------------|------------------------------------|-------|-------------------|---------------|
| pH      | 6.2   | 0.8  | 4          | 5.3 - 6.9     | 6.4   | 0.2  | 4              | 6.2 - 6.6     | 6.6                                | 0.4   | 4                 | 6.2 - 7.1     |
| Temp    | 7.1   | 0.5  | 4          | 6.6 - 7.7     | 7.1   | 0.5  | 4              | 6.6 - 7.7     | 7.1                                | 0.5   | 4                 | 6.6 - 7.7     |
| Alk     | 21    | 5    | 4          | 18 - 28       | 9     | 2    | 4              | 7 - 11        | NA                                 | NA    | 0                 | 0 - 0         |
| TDS     | NA    | NA   | 0          | 0 - 0         | 34    | 20   | 4              | 17 - 60       | 1239                               | 294   | 4                 | 940 - 1580    |
| TotHard | 173   | 19   | 4          | 145 - 184     | 1     | 2    | 4              | 0 - 4         | NA                                 | NA    | 0                 | 0 - 0         |
| CaHard  | 124   | 15   | 4          | 109 - 141     | 1     | 2    | 4              | 0 - 3         | NA                                 | NA    | 0                 | 0 - 0         |
| Turb    | 1.46  | 1.47 | 4          | 0.20 - 3.30   | 0.04  | 0.03 | 4              | 0.00 - 0.05   | NA                                 | NA    | 0                 | 0.00 - 0.00   |
| Amm     | NA    | NA   | 0          | 0.0 - 0.0     | NA    | NA   | 0              | 0.0 - 0.0     | NA                                 | NA    | 0                 | 0.0 - 0.0     |
| TOC     | 2.0   | 0.1  | 4          | 1.9 - 2.1     | 0.3   | 0.0  | 4              | 0.3 - 0.3     | NA                                 | NA    | 0                 | 0.0 - 0.0     |
| UV254   | 0.044 | 0.0  | 4          | 0.033 - 0.048 | 0.018 | 0.0  | 4              | 0.005 - 0.030 | NA                                 | NA    | 0                 | 0.000 - 0.000 |
| SUVA    | 2.18  | 0.34 | 4          | 1.70 - 2.52   | 7.35  | 4.28 | 4              | 1.80 - 12.00  | NA                                 | NA    | 0                 | NA            |
| Bromide | 64    | 45   | 4          | 10 - 110      | 23    | 25   | 4              | 10 - 60       |                                    |       |                   |               |
| TOX     | 63    | 14   | 4          | 47 - 80       | 13    | 0    | 4              | 13 - 13       |                                    |       |                   |               |
| CHCl3   | 6.2   | 3.5  | 4          | 1.4 - 9.1     | 0.3   | 0.5  | 4              | 0.0 - 1.1     | Mass Balance<br>Closure Errors (%) |       |                   |               |
| BDCM    | 6.8   | 2.9  | 4          | 2.8 - 9.2     | 0.0   | 0.0  | 4              | 0.0 - 0.0     |                                    |       |                   |               |
| DBCM    | 5.0   | 3.6  | 4          | 0.0 - 8.5     | 0.4   | 0.8  | 4              | 0.0 - 1.5     | WQP                                | Count | Avg               | SD/RD         |
| CHBr3   | 0.3   | 0.7  | 4          | 0.0 - 1.3     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Alk                                | 0     | n/a               | n/a           |
| THM4    | 18.3  | 8.6  | 4          | 8.7 - 28.1    | 0.6   | 1.3  | 4              | 0.0 - 2.6     | TDS                                | 0     | n/a               | n/a           |
| MCAA    | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | TotHard                            | 0     | n/a               | n/a           |
| DCAA    | 3.8   | 2.5  | 4          | 0.0 - 5.3     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | CaHard                             | 0     | n/a               | n/a           |
| TCAA    | 4.3   | 2.2  | 4          | 1.4 - 6.4     | 0.5   | 1.0  | 4              | 0.0 - 2.1     | Turb                               | 0     | n/a               | n/a           |
| MBAA    | 1.2   | 2.5  | 4          | 0.0 - 4.9     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Amm                                | 0     | n/a               | n/a           |
| DBAA    | 1.1   | 1.5  | 4          | 0.0 - 3.2     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | TOC                                | 0     | n/a               | n/a           |
| BCAA    | 2.7   | 0.6  | 4          | 1.9 - 3.3     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | UV254                              | 0     | n/a               | n/a           |
| TBAA    | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | TDS <sub>t</sub>                   | 0     | #####             | #DIV/0!       |
| CDBAA   | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Comments:                          |       |                   |               |
| DCBAA   | 1.8   | 2.3  | 4          | 0.0 - 4.8     | 0.0   | 0.0  | 4              | 0.0 - 0.0     |                                    |       |                   |               |
| HAA5    | 10.3  | 3.3  | 4          | 6.6 - 14.6    | 0.5   | 1.0  | 4              | 0.0 - 2.1     |                                    |       |                   |               |
| HAA6    | 13.0  | 3.9  | 4          | 8.5 - 17.9    | 0.5   | 1.0  | 4              | 0.0 - 2.1     |                                    |       |                   |               |
| HAA9    | 14.8  | 4.5  | 4          | 8.5 - 18.3    | 0.5   | 1.0  | 4              | 0.0 - 2.1     |                                    |       |                   |               |

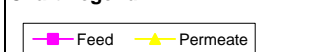
## SDS Conditions

| WQP       | Avg  | SD   | Count | Min - Max   |
|-----------|------|------|-------|-------------|
| Res (0)   | 0.62 | 0.14 | 8     | 0.50 - 0.90 |
| Temp (°C) | 7.0  | 0.0  | 8     | 7.0 - 7.0   |
| pH (unit) | 7.4  | 0.3  | 8     | 7.0 - 7.9   |
| Time (hr) | 48.0 | 0.0  | 8     | 48.0 - 48.0 |

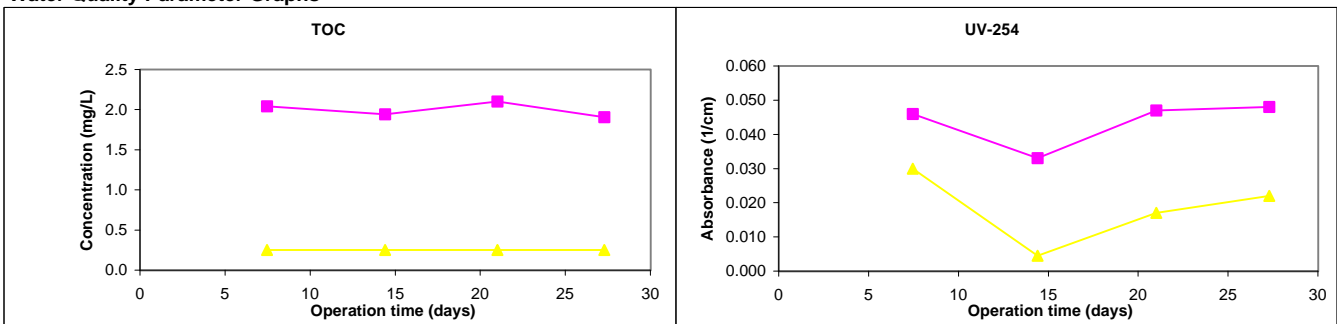
## Pretreatment Information

| Process   | Description                                    | Scale       |
|---|--|-------------|
| Ferric Sulfate (Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ) | 107.8 pounds per M.G. net filtered as Fe       | Full-Scale  |
| Potassium Perm. (KMnO <sub>4</sub> )                              | 1.9 pounds per M.G. net filtered               | Full-Scale  |
| Polymer   | 5.5 pounds per M.G. net filtered               | Full-Scale  |
| Carbon  | 14.6 pounds per M.G. net filtered              | Full-Scale  |
| Sand filtration   |  | Pilot-Scale |
| Pre-filter  | 5 mm inline cartridge filter                   | Pilot-Scale |
| Acid addition   | 93% H <sub>2</sub> SO <sub>4</sub> ; 0.33 ml/L | Pilot-Scale |
| Antiscalant addition  | mg/L Sodium Hexametaphosphate; 1.3 r           | Pilot-Scale |

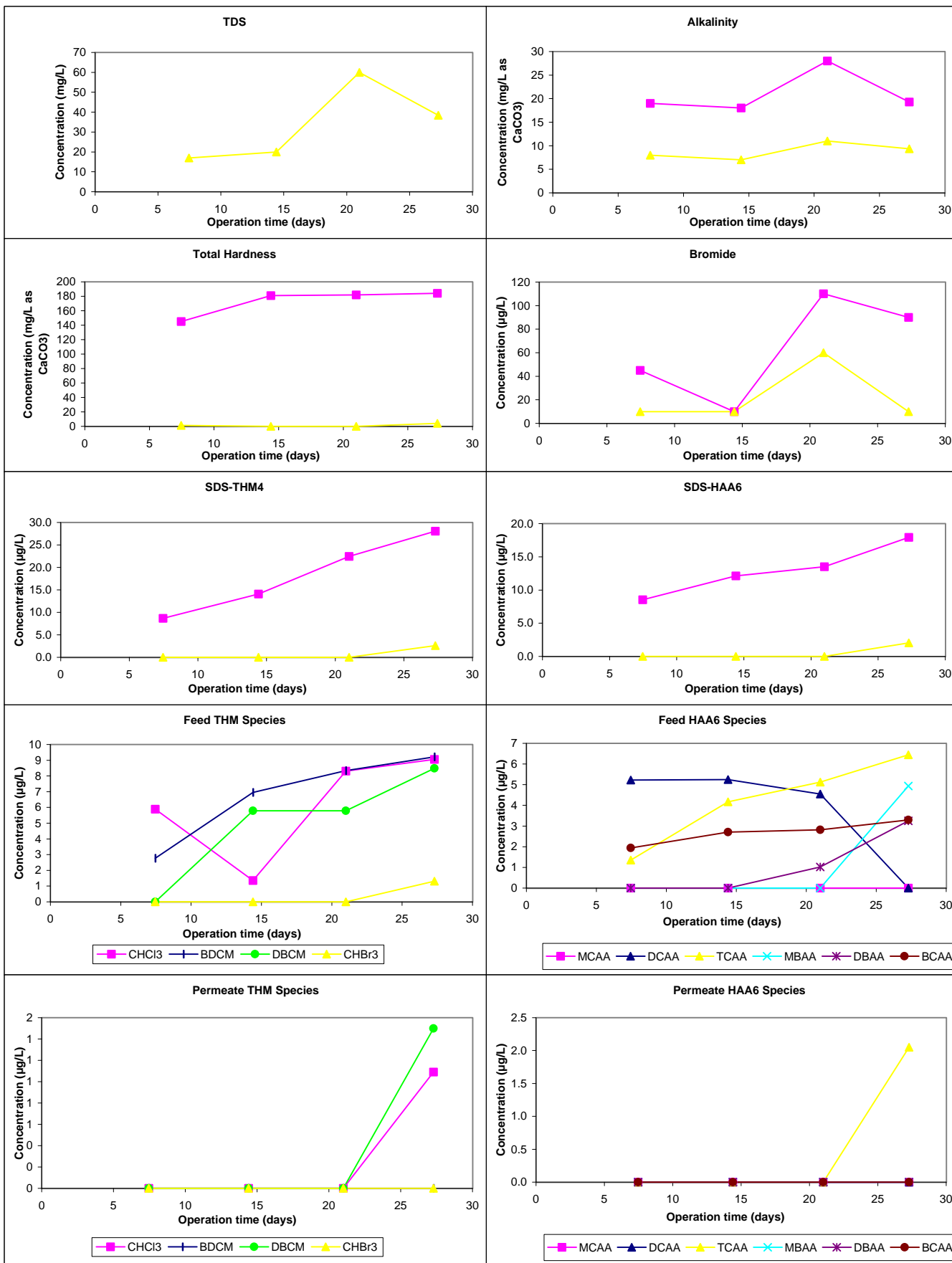
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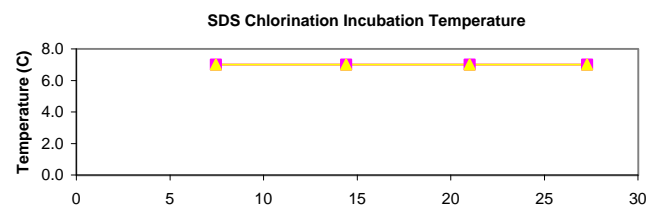
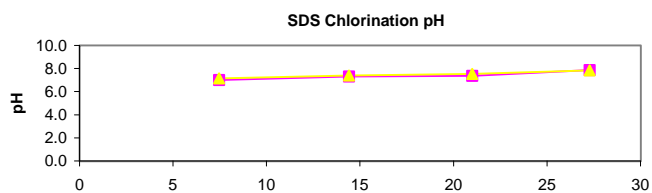
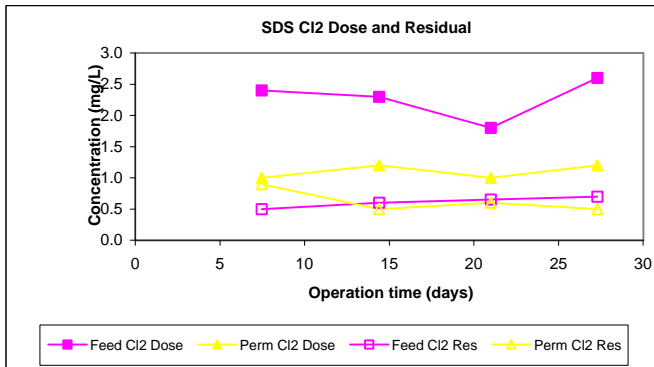
## Water Quality Parameter Graphs



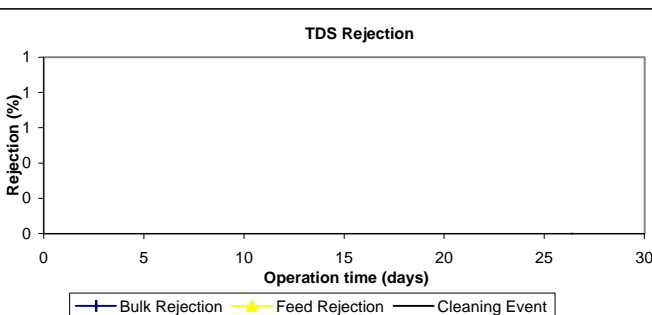
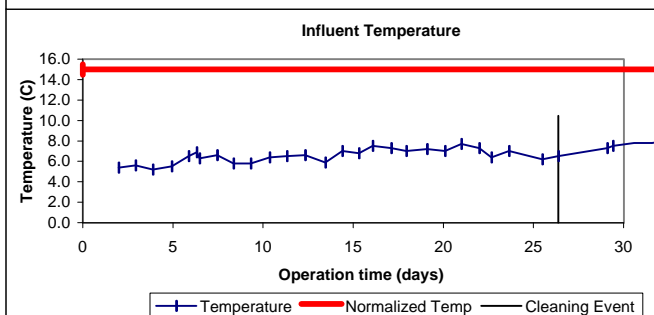
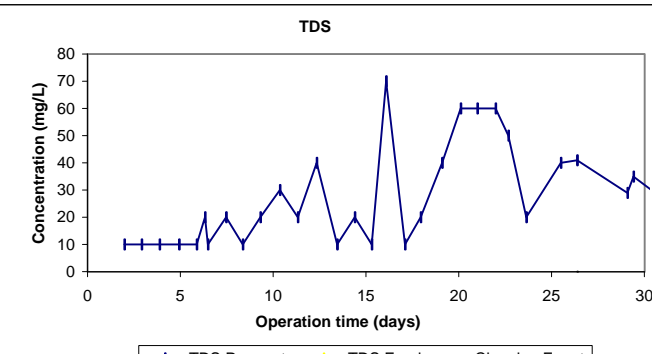
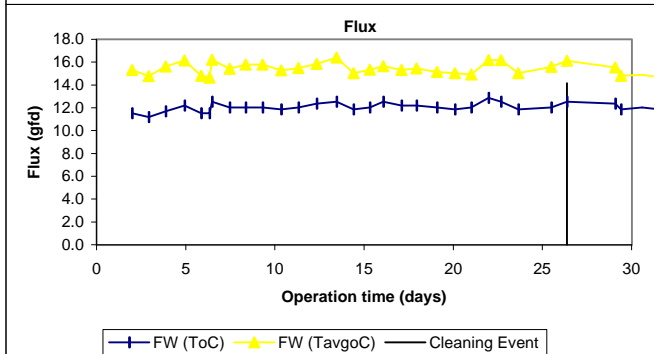
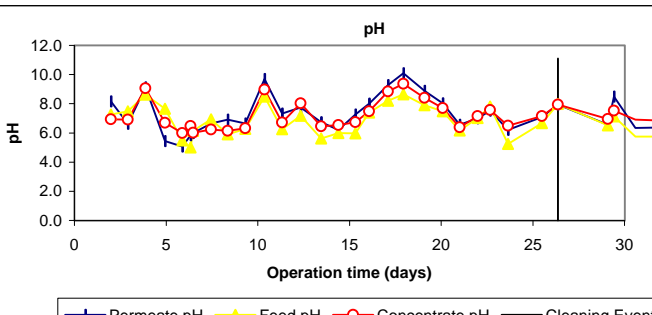
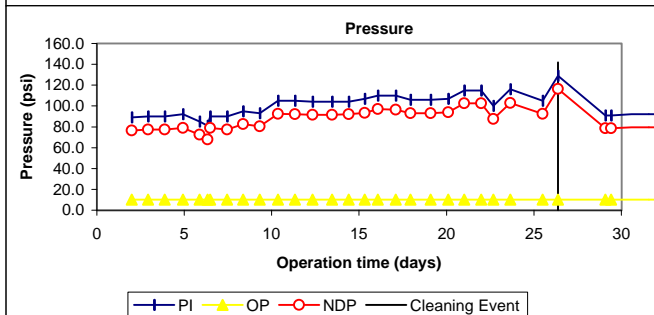
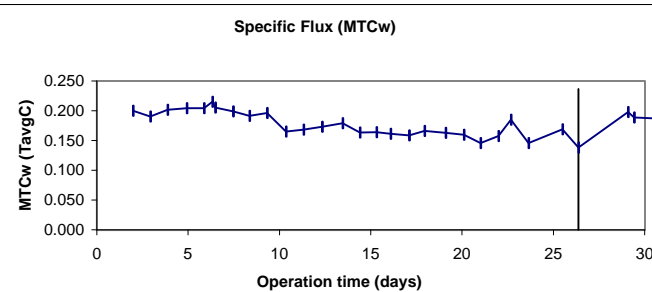
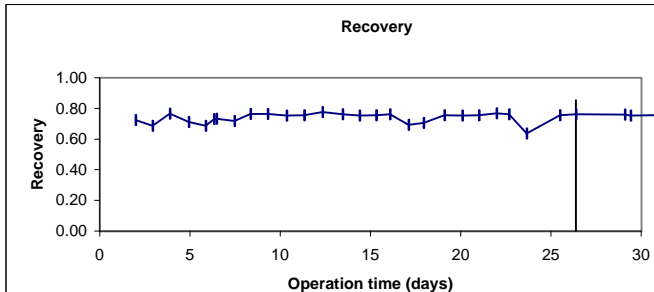
## Water Quality Parameter Graphs (Continued)



## Water Quality Parameter Graphs (Continued)



## Productivity Graphs



## ICR Information

ID / ICR#: KS 2009110 / 380  
 ICR Contact: Mr. Thomas F. Schrempp  
 Phone No.: (913) 895-5820  
 Period: 2/27/98 - 4/6/98 (38 days)

## Membrane Information

Manufacturer: Osmonics  
 Trade Name: MS  
 Membrane Model: S4040  
 MWCO: < 300 Daltons  
 Element Size: 3.9" x 40"  
 Element Area: 85.0 ft<sup>2</sup>  
 Design Flux: 22.0 gfd  
 Mfr. NDP: 220.0 psi

Mfr. MTC<sub>w</sub>: 1.000 (gfd/psi)  
 Mfr. Temp: 25.0 °C  
 Max Flow: 15.0 gpm  
 Min Flow: NA gpm  
 Total Width: 16.5 ft  
 Feed Sp Thickness: 0.0020 ft  
 840 Element Area NA ft<sup>2</sup>  
 840 Purchase Price: NA

## Design Parameters

Norm Temp: 15.0 °C  
 Temp Norm MTC-w: 0.744 TavGC  
 Design Recovery: 0.75  
 Design Flux: 12.0 gfd

Recycle Ratio: 4.08  
 Manuf rep Rej<sub>TDS</sub>: NA  
 TDS<sub>F</sub>: NA mg/L

## Water Quality Summary

|         | Mean  | SD   | Feed Count | Min/Max       | Mean  | SD   | Permeate Count | Min/Max       | Mean               | SD    | Concentrate Count | Min/Max       |
|---------|-------|------|------------|---------------|-------|------|----------------|---------------|--------------------|-------|-------------------|---------------|
| pH      | 7.2   | 1.0  | 4          | 5.9 - 8.3     | 7.5   | 1.2  | 4              | 6.2 - 9.1     | 7.3                | 1.0   | 4                 | 6.7 - 8.8     |
| Temp    | 11.1  | 4.4  | 4          | 7.0 - 15.7    | 11.1  | 4.4  | 4              | 7.0 - 15.7    | 11.1               | 4.4   | 4                 | 7.0 - 15.7    |
| Alk     | 28    | 10   | 2          | 21 - 35       | 1     | 2    | 2              | 0 - 3         | 121                | 23    | 2                 | 104 - 137     |
| TDS     | NA    | NA   | 0          | 0 - 0         | 4     | 2    | 4              | 3 - 7         | 768                | 194   | 4                 | 512 - 979     |
| TotHard | 226   | 64   | 4          | 186 - 321     | 2     | 3    | 4              | 0 - 7         | 501                | 92    | 4                 | 424 - 629     |
| CaHard  | 177   | 55   | 4          | 137 - 257     | 1     | 2    | 4              | 0 - 4         | 399                | 96    | 4                 | 317 - 537     |
| Turb    | 1.35  | 0.42 | 4          | 0.90 - 1.90   | 0.06  | 0.03 | 4              | 0.03 - 0.10   | NA                 | NA    | 0                 | 0.00 - 0.00   |
| Amm     | 0.1   | 0.0  | 3          | 0.1 - 0.1     | 0.0   | 0.0  | 3              | 0.0 - 0.0     | 0.2                | 0.1   | 3                 | 0.1 - 0.2     |
| TOC     | 2.4   | 0.3  | 4          | 2.2 - 2.9     | 0.3   | 0.1  | 4              | 0.3 - 0.5     | 11.1               | 11.9  | 4                 | 3.1 - 28.8    |
| UV254   | 0.055 | 0.0  | 4          | 0.047 - 0.070 | 0.018 | 0.0  | 4              | 0.016 - 0.023 | 0.114              | 0.0   | 4                 | 0.065 - 0.137 |
| SUVA    | 2.23  | 0.13 | 4          | 2.12 - 2.39   | 6.42  | 2.55 | 4              | 3.08 - 9.20   | 1.68               | 0.82  | 4                 | 0.46 - 2.25   |
| Bromide | 33    | 26   | 4          | 10 - 60       | 10    | 0    | 4              | 10 - 10       |                    |       |                   |               |
| TOX     | 89    | 32   | 4          | 50 - 126      | 13    | 0    | 4              | 13 - 13       |                    |       |                   |               |
| CHCl3   | 9.6   | 1.4  | 2          | 8.6 - 10.6    | 0.0   | 0.0  | 2              | 0.0 - 0.0     | Mass Balance       |       |                   |               |
| BDCM    | 7.2   | 0.1  | 2          | 7.2 - 7.2     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | Closure Errors (%) |       |                   |               |
| DBCM    | 4.8   | 0.5  | 2          | 4.5 - 5.2     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | WQP                | Count | Avg               | SD/RD         |
| CHBr3   | 0.0   | 0.0  | 2          | 0.0 - 0.0     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | Alk                | 1     | 23                | n/a           |
| THM4    | 21.6  | 1.0  | 2          | 20.9 - 22.3   | 0.0   | 0.0  | 2              | 0.0 - 0.0     | TDS                | 0     | n/a               | n/a           |
| MCAA    | 1.5   | 2.1  | 2          | 0.0 - 3.0     | 1.7   | 2.3  | 2              | 0.0 - 3.3     | TotHard            | 1     | -86               | n/a           |
| DCAA    | 8.5   | 1.7  | 2          | 7.3 - 9.7     | 1.6   | 0.2  | 2              | 1.4 - 1.7     | CaHard             | 1     | -75               | n/a           |
| TCAA    | 5.7   | 0.7  | 2          | 5.2 - 6.2     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | Turb               | 0     | n/a               | n/a           |
| MBAA    | 0.0   | 0.0  | 2          | 0.0 - 0.0     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | Amm                | 3     | -96               | 137           |
| DBAA    | 0.0   | 0.0  | 2          | 0.0 - 0.0     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | TOC                | 4     | -28               | 82            |
| BCAA    | 3.0   | 0.3  | 2          | 2.8 - 3.2     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | UV254              | 4     | -35               | 30            |
| TBAA    | 3.1   | 4.4  | 2          | 0.0 - 6.2     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | TDS <sub>t</sub>   | 0     | #####             | #DIV/0!       |
| CDBAA   | 0.0   | 0.0  | 2          | 0.0 - 0.0     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | Comments:          |       |                   |               |
| DCBAA   | 4.6   | 0.5  | 2          | 4.3 - 4.9     | 0.0   | 0.0  | 2              | 0.0 - 0.0     |                    |       |                   |               |
| HAA5    | 15.8  | 4.5  | 2          | 12.6 - 19.0   | 3.2   | 2.6  | 2              | 1.4 - 5.1     |                    |       |                   |               |
| HAA6    | 18.7  | 4.8  | 2          | 15.3 - 22.2   | 3.2   | 2.6  | 2              | 1.4 - 5.1     |                    |       |                   |               |
| HAA9    | 26.4  | 9.7  | 2          | 19.6 - 33.3   | 3.2   | 2.6  | 2              | 1.4 - 5.1     |                    |       |                   |               |

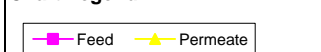
## SDS Conditions

| WQP       | Avg  | SD   | Count | Min - Max   |
|-----------|------|------|-------|-------------|
| Res (0)   | 0.67 | 0.17 | 8     | 0.50 - 1.00 |
| Temp (°C) | 7.0  | 0.0  | 8     | 7.0 - 7.0   |
| pH (unit) | 7.2  | 0.1  | 8     | 7.0 - 7.4   |
| Time (hr) | 48.0 | 0.0  | 8     | 48.0 - 48.0 |

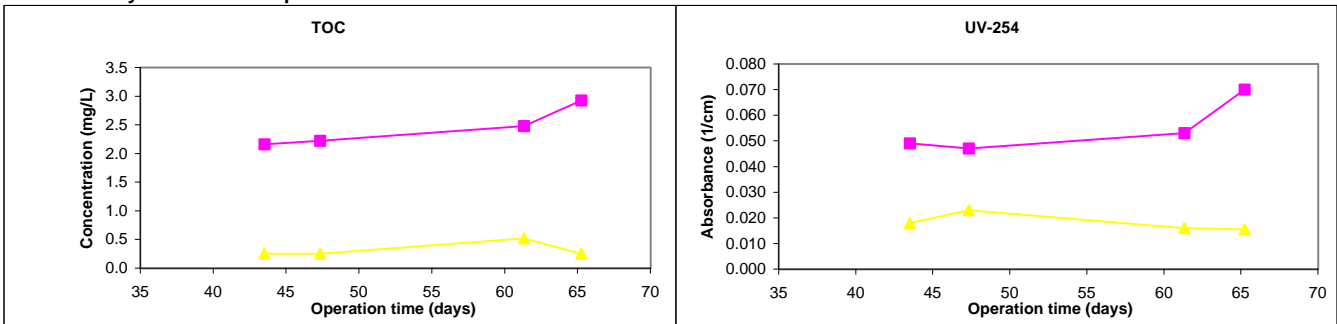
## Pretreatment Information

| Process   | Description                                    | Scale       |
|---|--|-------------|
| Ferric Sulfate (Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ) | 107.8 pounds per M.G. net filtered as Fe       | Full-Scale  |
| Potassium Perm. (KMnO <sub>4</sub> )                              | 1.9 pounds per M.G. net filtered               | Full-Scale  |
| Polymer   | 5.5 pounds per M.G. net filtered               | Full-Scale  |
| Carbon  | 14.6 pounds per M.G. net filtered              | Full-Scale  |
| Sand filtration   |  | Pilot-Scale |
| Pre-filter  | 5 mm inline cartridge filter                   | Pilot-Scale |
| Acid addition   | 93% H <sub>2</sub> SO <sub>4</sub> ; 0.33 ml/L | Pilot-Scale |
| Antiscalant addition  | mg/L Sodium Hexametaphosphate; 1.3 r           | Pilot-Scale |

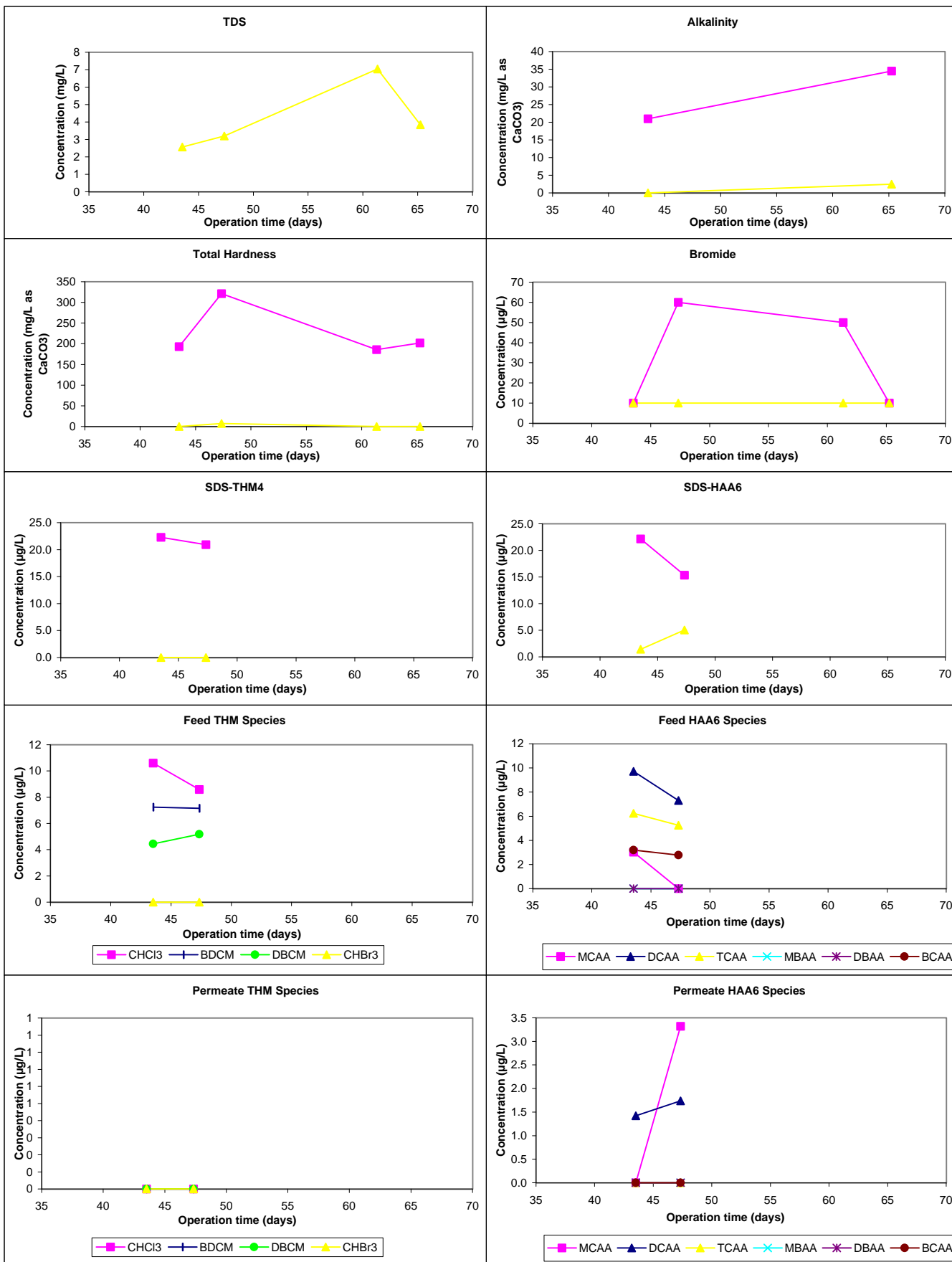
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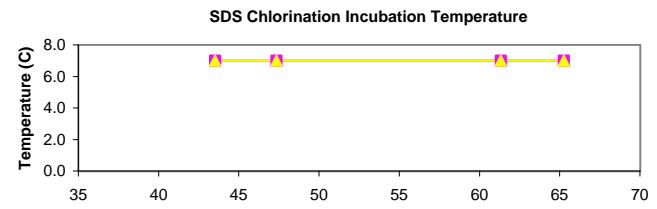
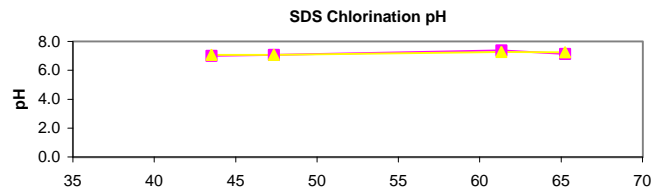
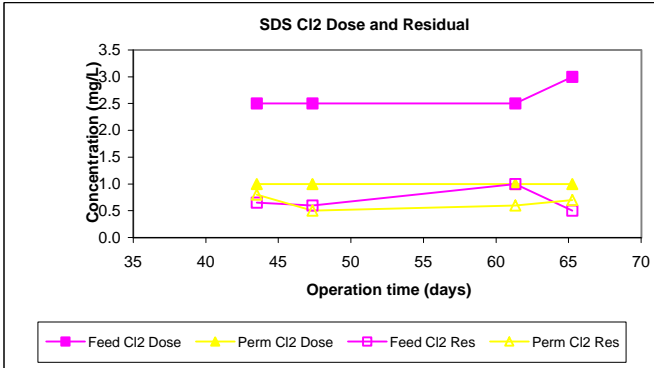
## Water Quality Parameter Graphs



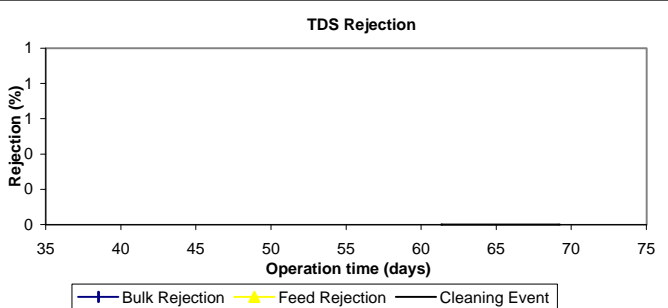
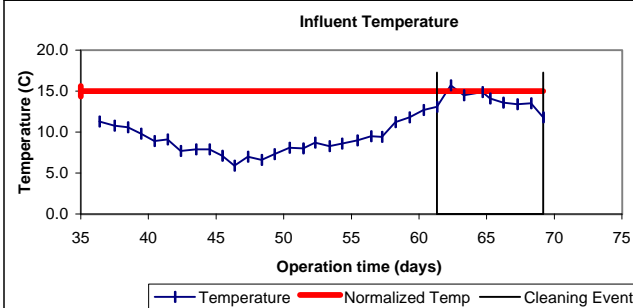
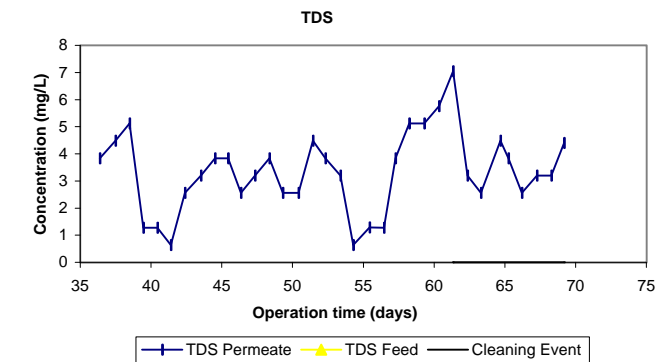
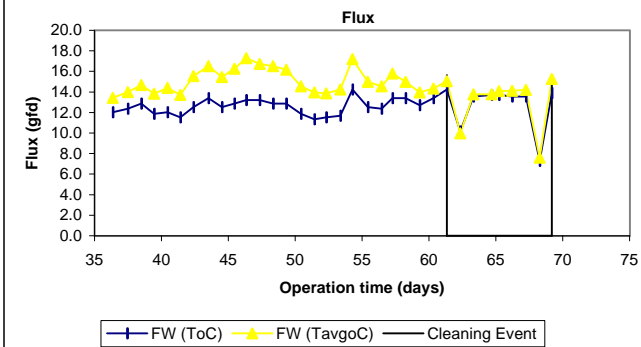
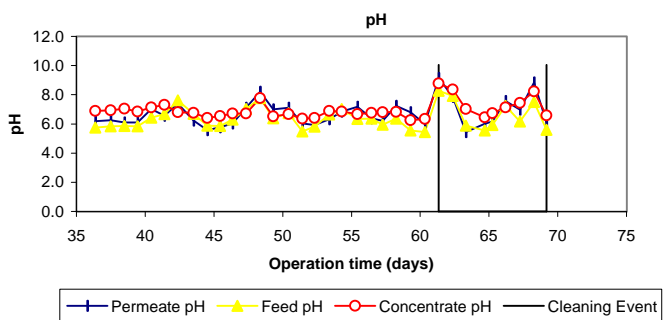
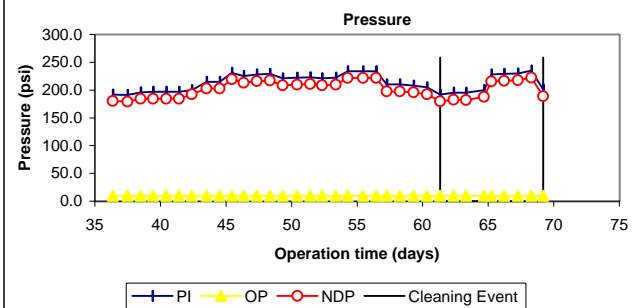
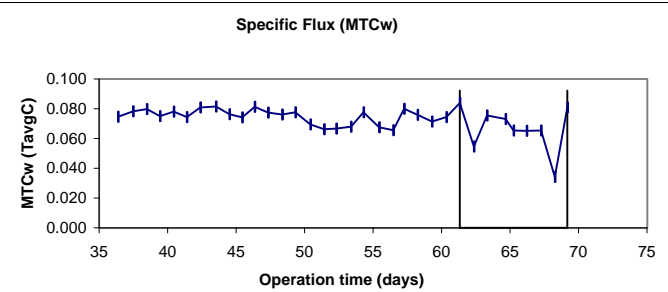
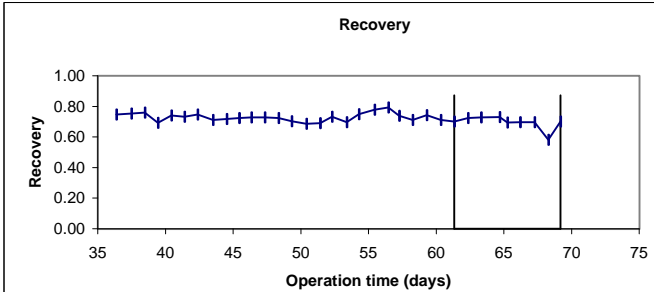
## Water Quality Parameter Graphs (Continued)



## Water Quality Parameter Graphs (Continued)



## Productivity Graphs





## ICR Information

ID / ICR#: KS 2009110 / 380  
 ICR Contact: Mr. Thomas F. Schrempp  
 Phone No.: (913) 895-5820  
 Period: 4/11/98 - 5/15/98 (34 days)

## Membrane Information

Manufacturer: Hydranautics  
 Trade Name: ESNA  
 Membrane Model: ESNA-4040  
 MWCO: 200-300 Daltons  
 Element Size: 3.94" x 40"  
 Element Area: 85.0 ft<sup>2</sup>  
 Design Flux: 12.0 gfd  
 Mfr. NDP: 75.0 psi

Mfr. MTC<sub>w</sub>: 0.140 (gfd/psi)  
 Mfr. Temp: 25.0 °C  
 Max Flow: 16.0 gpm  
 Min Flow: 4.0 gpm  
 Total Width: 14.0 ft  
 Feed Sp Thickness: 0.0010 ft  
 840 Element Area: 400.0 ft<sup>2</sup>  
 840 Purchase Price: \$950

## Design Parameters

Norm Temp: 15.0 °C  
 Temp Norm MTC-w: 0.104 TavGC  
 Design Recovery: 0.75  
 Design Flux: 12.0 gfd

Recycle Ratio: 4.08  
 Manuf rep Rej<sub>TDS</sub>: 85%  
 TDS<sub>F</sub>: 1000.0 mg/L

## Water Quality Summary

|         | Mean  | SD   | Feed Count | Min/Max       | Mean  | SD   | Permeate Count | Min/Max       | Mean                               | SD    | Concentrate Count | Min/Max       |
|---------|-------|------|------------|---------------|-------|------|----------------|---------------|------------------------------------|-------|-------------------|---------------|
| pH      | 6.5   | 0.6  | 4          | 5.6 - 7.0     | 7.1   | 0.7  | 4              | 6.3 - 7.7     | 7.2                                | 0.4   | 4                 | 6.8 - 7.7     |
| Temp    | 15.7  | 2.9  | 4          | 13.7 - 19.9   | 15.7  | 2.9  | 4              | 13.7 - 19.9   | 15.7                               | 2.9   | 4                 | 13.7 - 19.9   |
| Alk     | 33    | 16   | 4          | 25 - 58       | 9     | 1    | 4              | 7 - 11        | 85                                 | 26    | 4                 | 56 - 114      |
| TDS     | NA    | NA   | 0          | 0 - 0         | 69    | 8    | 4              | 58 - 77       | 880                                | 87    | 4                 | 774 - 966     |
| TotHard | 187   | 16   | 4          | 171 - 204     | 2     | 2    | 4              | 0 - 5         | 484                                | 54    | 4                 | 407 - 532     |
| CaHard  | 167   | 24   | 4          | 139 - 196     | 2     | 2    | 4              | 0 - 4         | 430                                | 67    | 4                 | 330 - 477     |
| Turb    | 0.61  | 0.29 | 4          | 0.34 - 0.95   | 0.05  | 0.00 | 4              | 0.05 - 0.05   | 0.70                               | 0.39  | 3                 | 0.45 - 1.15   |
| Amm     | 0.1   | 0.0  | 4          | 0.0 - 0.1     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | 0.1                                | 0.0   | 4                 | 0.1 - 0.2     |
| TOC     | 2.7   | 0.4  | 4          | 2.3 - 3.2     | 0.3   | 0.0  | 4              | 0.3 - 0.3     | 5.9                                | 0.3   | 4                 | 5.7 - 6.4     |
| UV254   | 0.060 | 0.0  | 4          | 0.055 - 0.068 | 0.023 | 0.0  | 4              | 0.018 - 0.033 | 0.112                              | 0.0   | 4                 | 0.100 - 0.118 |
| SUVA    | 2.26  | 0.15 | 4          | 2.13 - 2.42   | 9.05  | 2.79 | 4              | 7.20 - 13.20  | 1.90                               | 0.24  | 4                 | 1.56 - 2.07   |
| Bromide | 69    | 40   | 4          | 10 - 95       | 10    | 0    | 4              | 10 - 10       |                                    |       |                   |               |
| TOX     | 127   | 14   | 4          | 107 - 141     | 13    | 0    | 4              | 13 - 13       |                                    |       |                   |               |
| CHCl3   | 22.9  | 4.1  | 4          | 19.3 - 28.4   | 0.6   | 0.7  | 4              | 0.0 - 1.2     | Mass Balance<br>Closure Errors (%) |       |                   |               |
| BDCM    | 12.9  | 0.8  | 4          | 12.0 - 13.9   | 0.6   | 0.7  | 4              | 0.0 - 1.3     |                                    |       |                   |               |
| DBCM    | 5.0   | 0.8  | 4          | 3.9 - 5.6     | 0.5   | 0.6  | 4              | 0.0 - 1.1     | WQP                                | Count | Avg               | SD/RD         |
| CHBr3   | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Alk                                | 4     | -11               | 40            |
| THM4    | 40.8  | 4.0  | 4          | 37.5 - 45.6   | 1.7   | 2.0  | 4              | 0.0 - 3.5     | TDS                                | 0     | n/a               | n/a           |
| MCAA    | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | TotHard                            | 3     | -35               | 17            |
| DCAA    | 10.3  | 2.7  | 4          | 7.8 - 14.2    | 1.4   | 0.1  | 4              | 1.3 - 1.5     | CaHard                             | 3     | -36               | 17            |
| TCAA    | 9.8   | 3.6  | 4          | 6.5 - 14.8    | 0.3   | 0.6  | 4              | 0.0 - 1.1     | Turb                               | 3     | -342              | 313           |
| MBAA    | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Amm                                | 3     | 19                | 19            |
| DBAA    | 0.6   | 0.7  | 4          | 0.0 - 1.2     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | TOC                                | 4     | -42               | 23            |
| BCAA    | 5.1   | 1.0  | 4          | 4.3 - 6.5     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | UV254                              | 4     | -38               | 20            |
| TBAA    | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | TDS <sub>t</sub>                   | 0     | #####             | #DIV/0!       |
| CDBAA   | 0.6   | 1.2  | 4          | 0.0 - 2.4     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Comments:                          |       |                   |               |
| DCBAA   | 7.8   | 2.4  | 4          | 5.8 - 11.1    | 0.0   | 0.0  | 4              | 0.0 - 0.0     |                                    |       |                   |               |
| HAA5    | 20.7  | 5.8  | 4          | 15.5 - 29.0   | 1.7   | 0.6  | 4              | 1.3 - 2.5     |                                    |       |                   |               |
| HAA6    | 25.7  | 6.8  | 4          | 19.8 - 35.5   | 1.7   | 0.6  | 4              | 1.3 - 2.5     |                                    |       |                   |               |
| HAA9    | 34.1  | 10.3 | 4          | 25.6 - 49.0   | 1.7   | 0.6  | 4              | 1.3 - 2.5     |                                    |       |                   |               |

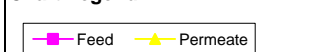
## SDS Conditions

| WQP       | Avg  | SD   | Count | Min - Max   |
|-----------|------|------|-------|-------------|
| Res (0)   | 0.66 | 0.14 | 8     | 0.50 - 0.90 |
| Temp (°C) | 13.0 | 0.0  | 8     | 13.0 - 13.0 |
| pH (unit) | 7.3  | 0.1  | 8     | 7.2 - 7.4   |
| Time (hr) | 48.0 | 0.0  | 8     | 48.0 - 48.0 |

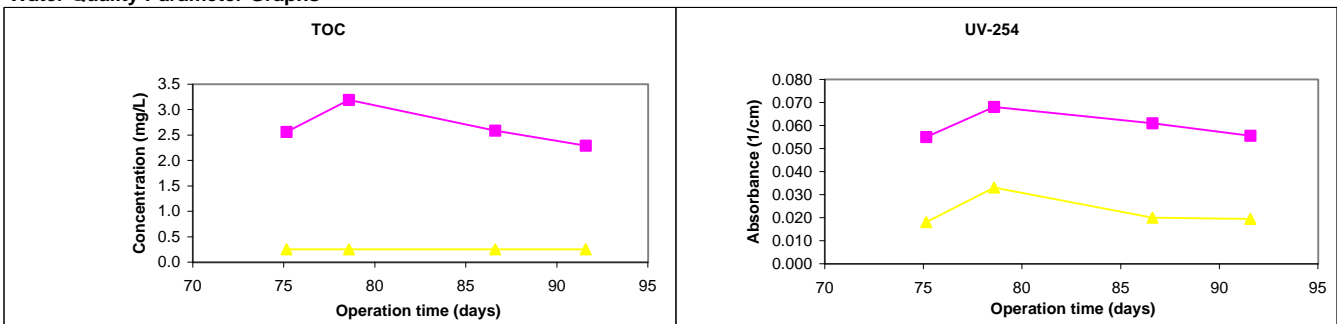
## Pretreatment Information

| Process   | Description                                    | Scale       |
|---|--|-------------|
| Ferric Sulfate (Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ) | 107.8 pounds per M.G. net filtered as Fe       | Full-Scale  |
| Potassium Perm. (KMnO <sub>4</sub> )                              | 1.9 pounds per M.G. net filtered               | Full-Scale  |
| Polymer   | 5.5 pounds per M.G. net filtered               | Full-Scale  |
| Carbon  | 14.6 pounds per M.G. net filtered              | Full-Scale  |
| Sand filtration   |  | Pilot-Scale |
| Pre-filter  | 5 mm inline cartridge filter                   | Pilot-Scale |
| Acid addition   | 93% H <sub>2</sub> SO <sub>4</sub> ; 0.33 ml/L | Pilot-Scale |
| Antiscalant addition  | mg/L Sodium Hexametaphosphate; 1.3 r           | Pilot-Scale |

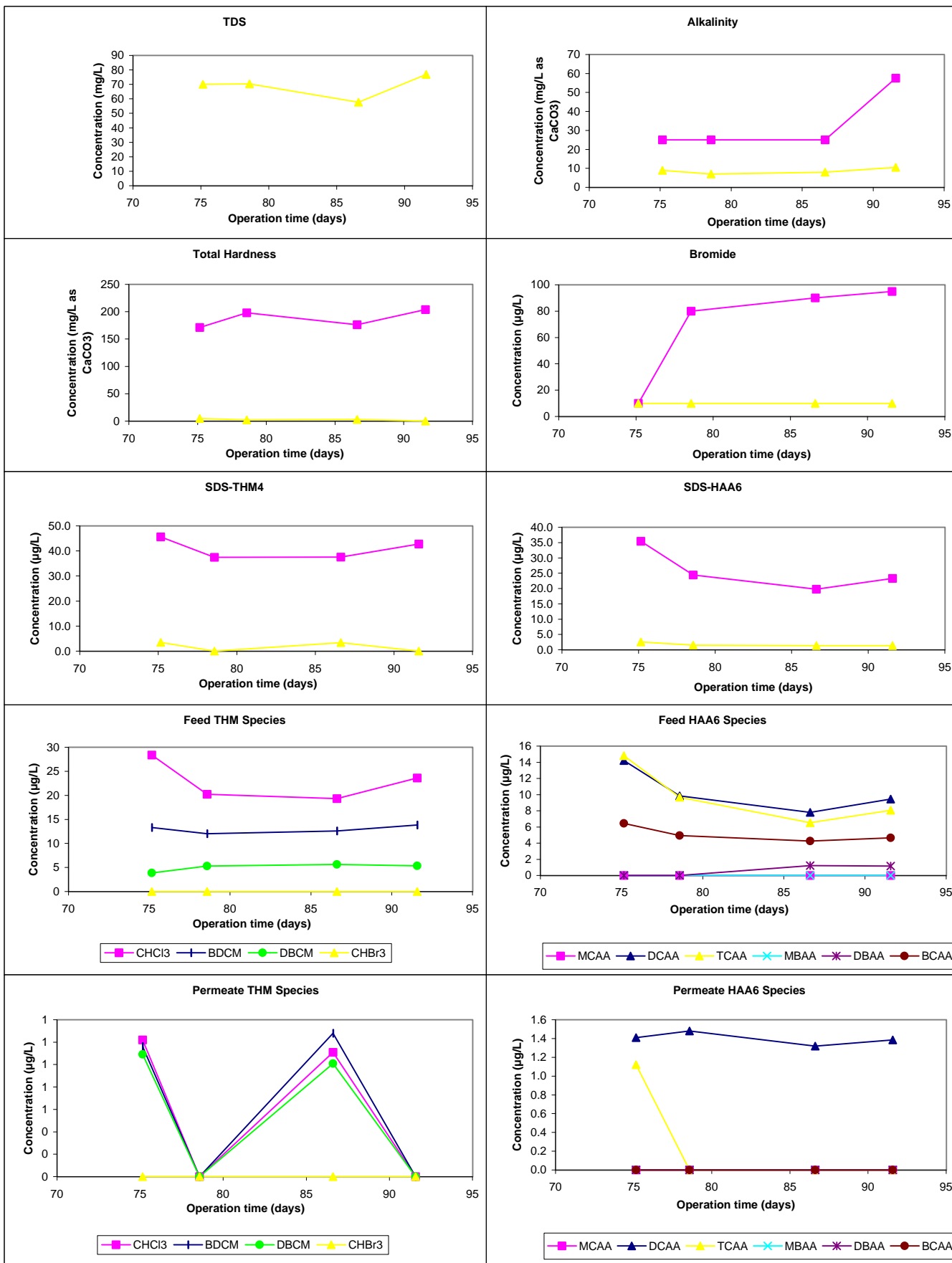
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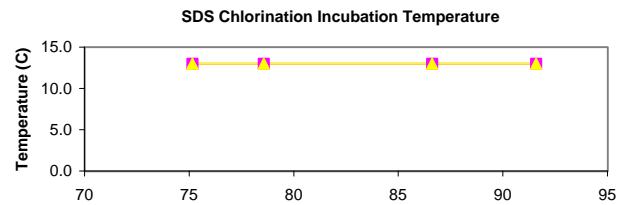
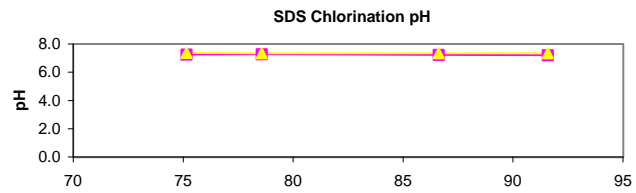
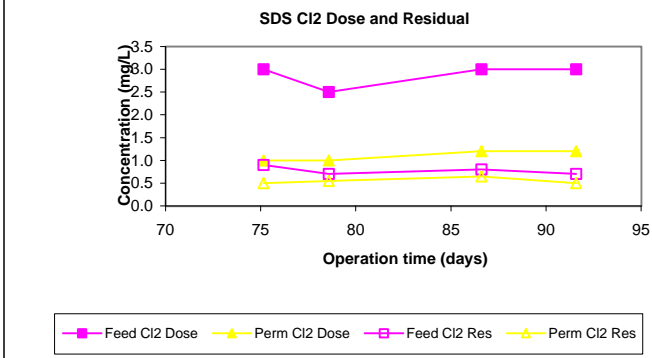
## Water Quality Parameter Graphs



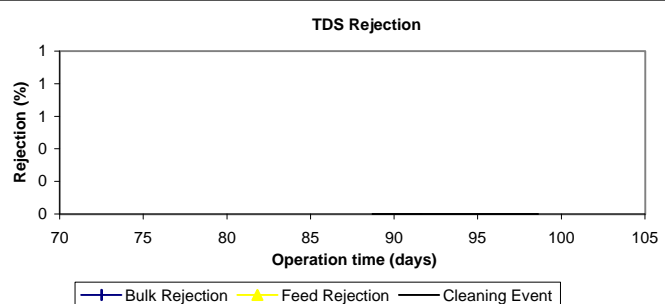
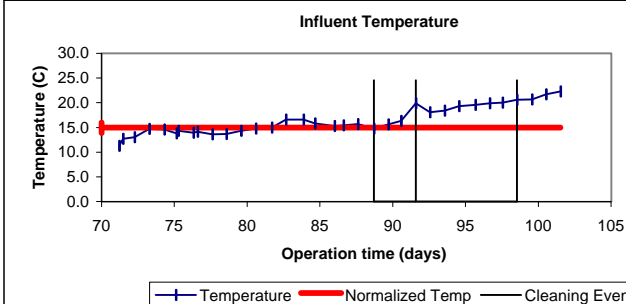
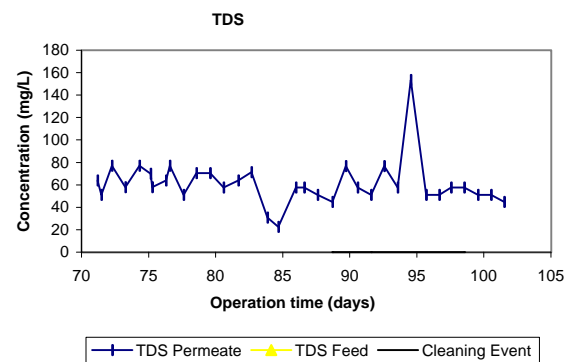
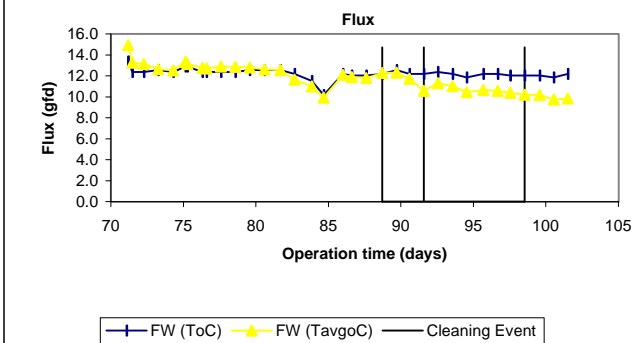
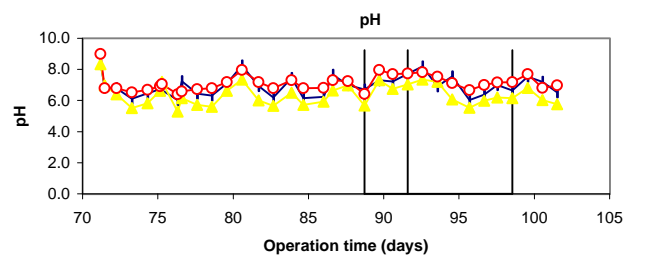
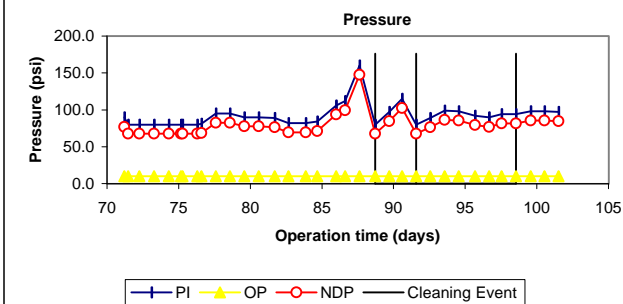
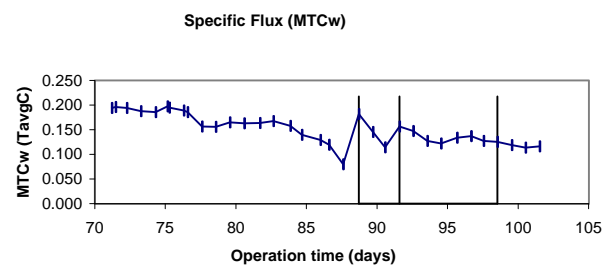
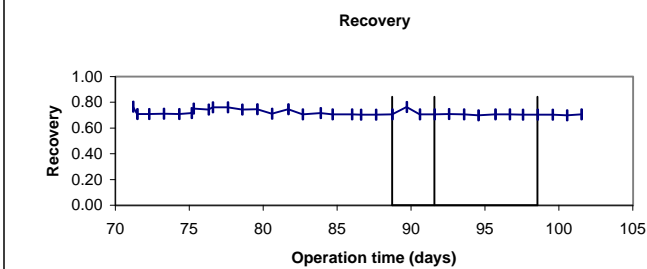
## Water Quality Parameter Graphs (Continued)



## Water Quality Parameter Graphs (Continued)



## Productivity Graphs



## ICR Information

ID / ICR#: KS 2009110 / 380  
 ICR Contact: Mr. Thomas F. Schrempp  
 Phone No.: (913) 895-5820  
 Period: 5/15/98 - 7/1/98 (47 days)

## Membrane Information

Manufacturer: Osmonics  
 Trade Name: MS  
 Membrane Model: S4040  
 MWCO: < 300 Daltons  
 Element Size: 3.9" x 40"  
 Element Area: 85.0 ft<sup>2</sup>  
 Design Flux: 22.0 gfd  
 Mfr. NDP: 220.0 psi  
 Mfr. MTC<sub>w</sub>: 1.000 (gfd/psi)  
 Mfr. Temp: 25.0 °C  
 Max Flow: 15.0 gpm  
 Min Flow: NA gpm  
 Total Width: 16.5 ft  
 Feed Sp Thickness: 0.0020 ft  
 840 Element Area NA ft<sup>2</sup>  
 840 Purchase Price: NA

## Design Parameters

Norm Temp: 15.0 °C  
 Temp Norm MTC-w: 0.744 TavGC  
 Design Recovery: 0.75  
 Design Flux: 15.0 gfd  
 Recycle Ratio: 3.07  
 Manuf rep Rej<sub>TDS</sub>: NA  
 TDS<sub>F</sub>: NA mg/L

## Water Quality Summary

|             | Mean        | SD          | Feed Count | Min/Max            | Mean       | SD         | Permeate Count | Min/Max          | Mean                      | SD         | Concentrate Count | Min/Max           |
|-------------|-------------|-------------|------------|--------------------|------------|------------|----------------|------------------|---------------------------|------------|-------------------|-------------------|
| pH          | 6.6         | 0.9         | 4          | 5.4 - 7.4          | 6.2        | 0.4        | 4              | 5.6 - 6.5        | 7.0                       | 0.4        | 4                 | 6.8 - 7.6         |
| Temp        | 24.3        | 1.9         | 4          | 22.3 - 26.7        | 24.3       | 1.9        | 4              | 22.3 - 26.7      | 24.3                      | 1.9        | 4                 | 22.3 - 26.7       |
| Alk         | 17          | 4           | 4          | 12 - 22            | 1          | 3          | 4              | 0 - 5            | 77                        | 55         | 4                 | 30 - 130          |
| <b>TDS</b>  | <b>223</b>  | <b>23</b>   | <b>2</b>   | <b>206 - 239</b>   | <b>12</b>  | <b>2</b>   | <b>4</b>       | <b>9 - 13</b>    | <b>895</b>                | <b>217</b> | <b>4</b>          | <b>707 - 1101</b> |
| TotHard     | 151         | 20          | 4          | 136 - 180          | 1          | 2          | 4              | 0 - 3            | 501                       | 59         | 4                 | 426 - 569         |
| CaHard      | 139         | 23          | 4          | 119 - 171          | 1          | 2          | 4              | 0 - 3            | 455                       | 63         | 4                 | 382 - 534         |
| Turb        | 1.16        | 0.98        | 4          | 0.50 - 2.60        | 0.03       | 0.03       | 4              | 0.00 - 0.05      | 1.45                      | 1.22       | 4                 | 0.35 - 2.70       |
| Amm         | 0.0         | 0.0         | 4          | 0.0 - 0.1          | 0.0        | 0.0        | 4              | 0.0 - 0.0        | 0.1                       | 0.1        | 4                 | 0.0 - 0.2         |
| <b>TOC</b>  | <b>2.2</b>  | <b>0.5</b>  | <b>4</b>   | <b>1.7 - 2.9</b>   | <b>0.3</b> | <b>0.0</b> | <b>4</b>       | <b>0.3 - 0.3</b> | <b>7.1</b>                | <b>1.1</b> | <b>4</b>          | <b>6.1 - 8.1</b>  |
| UV254       | 0.053       | 0.0         | 4          | 0.048 - 0.059      | 0.018      | 0.0        | 4              | 0.016 - 0.019    | 0.138                     | 0.0        | 4                 | 0.113 - 0.156     |
| SUVA        | 2.53        | 0.48        | 4          | 2.06 - 3.18        | 7.15       | 0.53       | 4              | 6.40 - 7.60      | 1.99                      | 0.47       | 4                 | 1.41 - 2.54       |
| Bromide     | 68          | 13          | 4          | 50 - 80            | 10         | 0          | 4              | 10 - 10          |                           |            |                   |                   |
| <b>TOX</b>  | <b>117</b>  | <b>17</b>   | <b>4</b>   | <b>103 - 138</b>   | <b>13</b>  | <b>0</b>   | <b>4</b>       | <b>13 - 13</b>   |                           |            |                   |                   |
| CHCl3       | 27.9        | 1.8         | 4          | 25.7 - 29.5        | 2.9        | 0.5        | 4              | 2.3 - 3.4        | <b>Mass Balance</b>       |            |                   |                   |
| BDCM        | 12.5        | 2.6         | 4          | 8.7 - 14.6         | 0.0        | 0.0        | 4              | 0.0 - 0.0        | <b>Closure Errors (%)</b> |            |                   |                   |
| DBCM        | 3.8         | 1.7         | 4          | 1.7 - 5.4          | 0.0        | 0.0        | 4              | 0.0 - 0.0        | WQP                       | Count      | Avg               | SD/RD             |
| CHBr3       | 0.0         | 0.0         | 4          | 0.0 - 0.0          | 0.0        | 0.0        | 4              | 0.0 - 0.0        | Alk                       | 1          | 21                | n/a               |
| <b>THM4</b> | <b>44.2</b> | <b>3.5</b>  | <b>4</b>   | <b>39.9 - 48.5</b> | <b>2.9</b> | <b>0.5</b> | <b>4</b>       | <b>2.3 - 3.4</b> | TDS                       | 2          | -69               | 21                |
| MCAA        | 1.4         | 1.7         | 4          | 0.0 - 3.3          | 0.0        | 0.0        | 4              | 0.0 - 0.0        | TotHard                   | 2          | -37               | 4                 |
| DCAA        | 15.4        | 4.3         | 4          | 11.1 - 21.3        | 2.8        | 0.6        | 4              | 2.3 - 3.7        | CaHard                    | 2          | -38               | 4                 |
| TCAA        | 14.0        | 5.1         | 4          | 7.9 - 20.5         | 2.1        | 1.1        | 4              | 1.1 - 3.6        | Turb                      | 4          | -544              | 472               |
| MBAA        | 0.0         | 0.0         | 4          | 0.0 - 0.0          | 0.0        | 0.0        | 4              | 0.0 - 0.0        | Amm                       | 2          | -117              | 49                |
| DBAA        | 0.6         | 0.7         | 4          | 0.0 - 1.3          | 0.3        | 0.6        | 4              | 0.0 - 1.2        | TOC                       | 4          | -32               | 40                |
| BCAA        | 6.4         | 1.2         | 4          | 5.0 - 7.5          | 0.0        | 0.0        | 4              | 0.0 - 0.0        | UV254                     | 4          | -39               | 19                |
| TBAA        | 0.0         | 0.0         | 4          | 0.0 - 0.0          | 0.0        | 0.0        | 4              | 0.0 - 0.0        | TDS                       | 20         | -45               | 27                |
| CDBAA       | 1.2         | 1.5         | 4          | 0.0 - 2.8          | 0.0        | 0.0        | 4              | 0.0 - 0.0        | <b>Comments:</b>          |            |                   |                   |
| DCBAA       | 9.6         | 2.7         | 4          | 7.3 - 12.9         | 0.0        | 0.0        | 4              | 0.0 - 0.0        |                           |            |                   |                   |
| <b>HAA5</b> | <b>31.5</b> | <b>10.3</b> | <b>4</b>   | <b>20.3 - 45.1</b> | <b>5.3</b> | <b>1.9</b> | <b>4</b>       | <b>3.4 - 7.3</b> |                           |            |                   |                   |
| <b>HAA6</b> | <b>37.9</b> | <b>11.1</b> | <b>4</b>   | <b>26.2 - 52.6</b> | <b>5.3</b> | <b>1.9</b> | <b>4</b>       | <b>3.4 - 7.3</b> |                           |            |                   |                   |
| <b>HAA9</b> | <b>48.8</b> | <b>13.1</b> | <b>4</b>   | <b>35.9 - 65.5</b> | <b>5.3</b> | <b>1.9</b> | <b>4</b>       | <b>3.4 - 7.3</b> |                           |            |                   |                   |

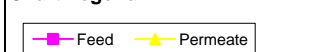
## SDS Conditions

| WQP       | Avg  | SD   | Count | Min - Max   |
|-----------|------|------|-------|-------------|
| Res (0)   | 0.75 | 0.15 | 8     | 0.50 - 0.90 |
| Temp (°C) | 15.0 | 0.0  | 8     | 15.0 - 15.0 |
| pH (unit) | 7.5  | 0.2  | 8     | 7.3 - 7.8   |
| Time (hr) | 48.0 | 0.0  | 8     | 48.0 - 48.0 |

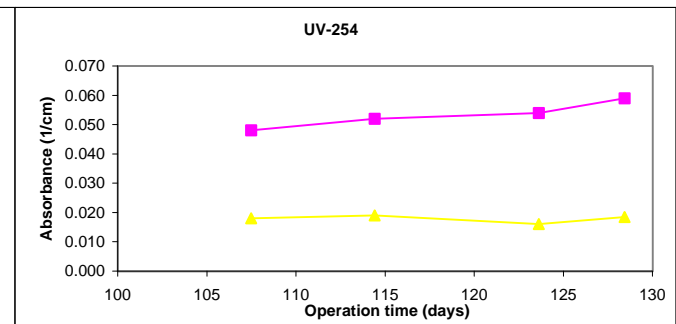
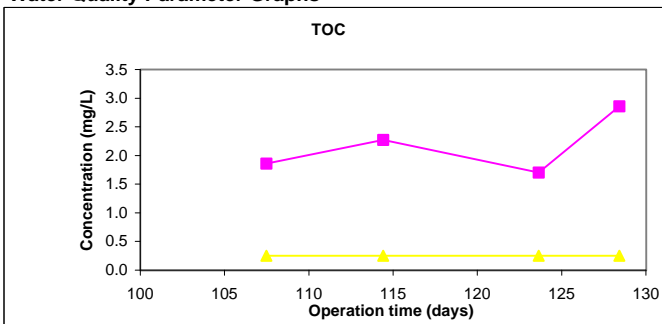
## Pretreatment Information

| Process   | Description                                    | Scale       |
|---|--|-------------|
| Ferric Sulfate (Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ) | 107.8 pounds per M.G. net filtered as Fe       | Full-Scale  |
| Potassium Perm. (KMnO <sub>4</sub> )                              | 1.9 pounds per M.G. net filtered               | Full-Scale  |
| Polymer   | 5.5 pounds per M.G. net filtered               | Full-Scale  |
| Carbon  | 14.6 pounds per M.G. net filtered              | Full-Scale  |
| Sand filtration   |  | Pilot-Scale |
| Pre-filter  | 5 mm inline cartridge filter                   | Pilot-Scale |
| Acid addition   | 93% H <sub>2</sub> SO <sub>4</sub> ; 0.33 ml/L | Pilot-Scale |
| Antiscalant addition  | mg/L Sodium Hexametaphosphate; 1.3 r           | Pilot-Scale |

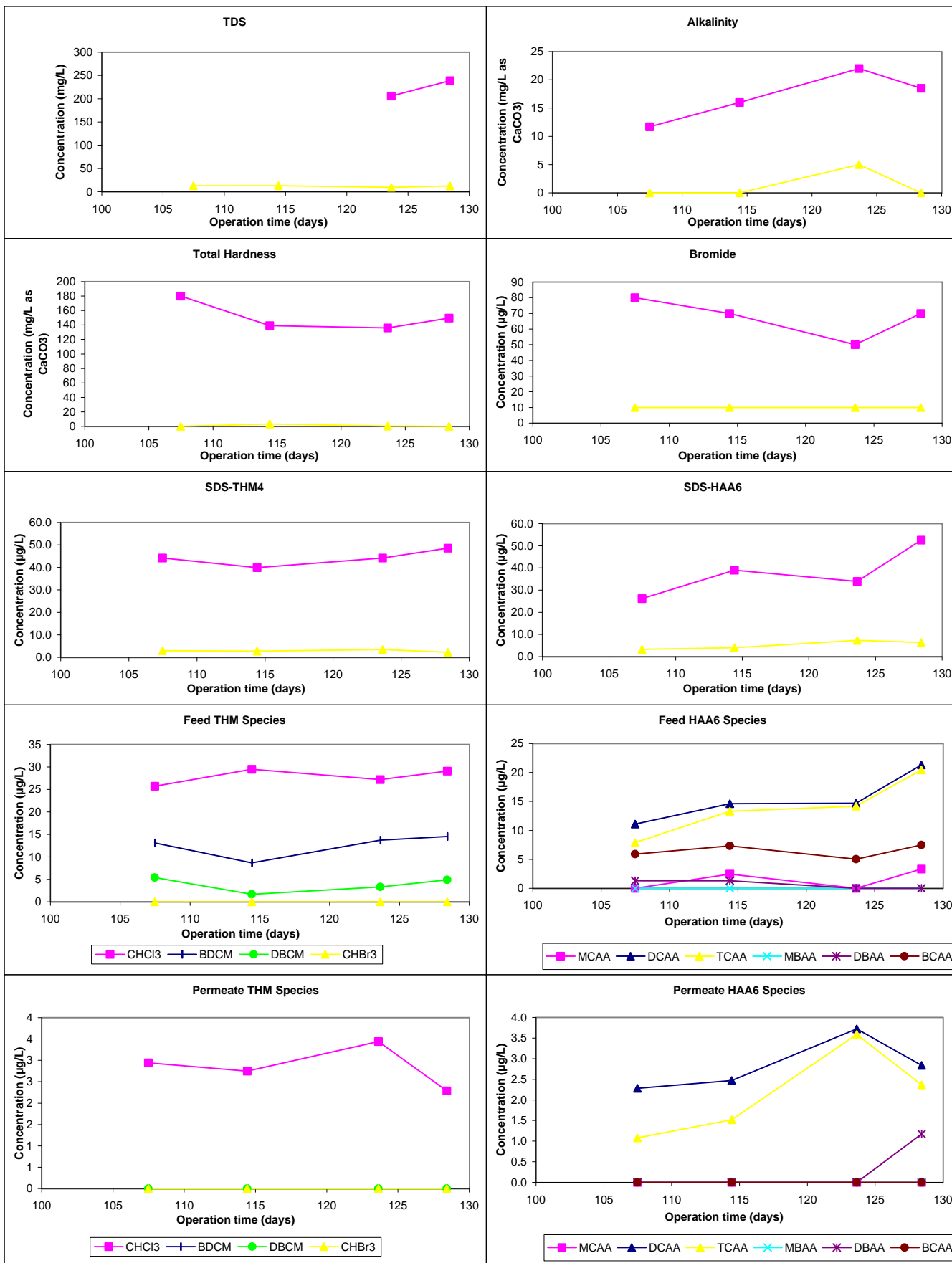
## Chart Legend:



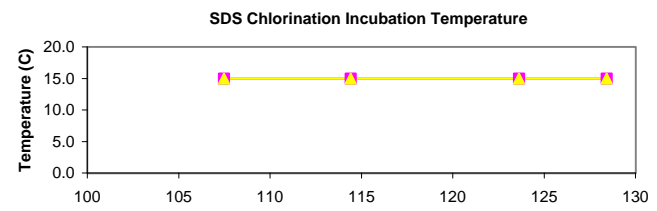
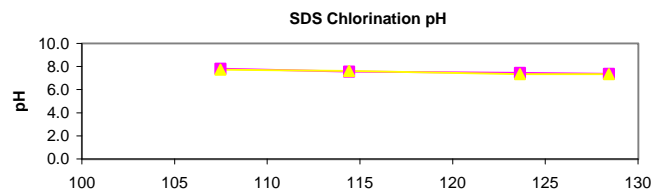
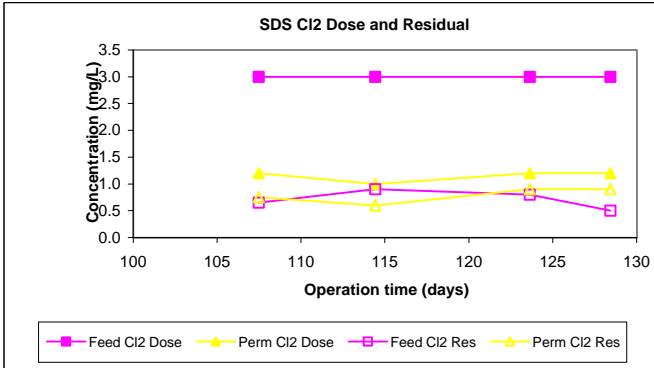
## Water Quality Parameter Graphs



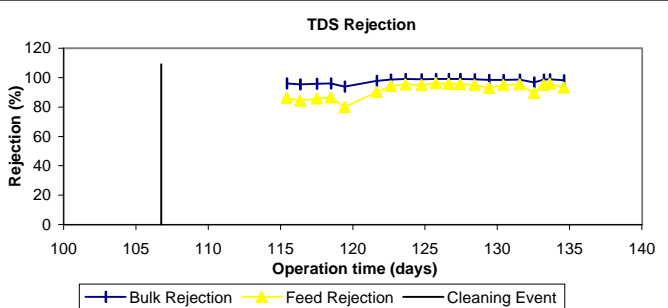
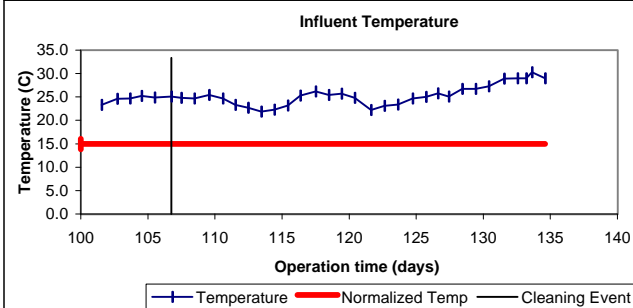
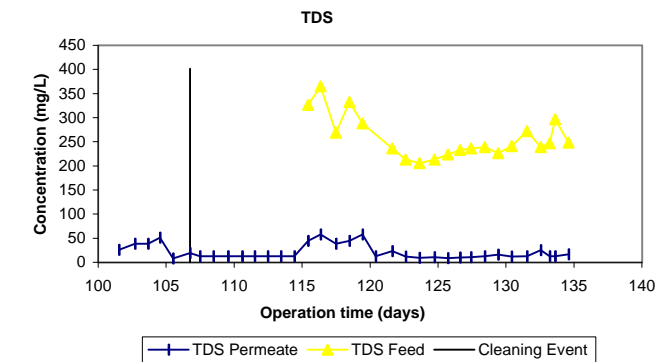
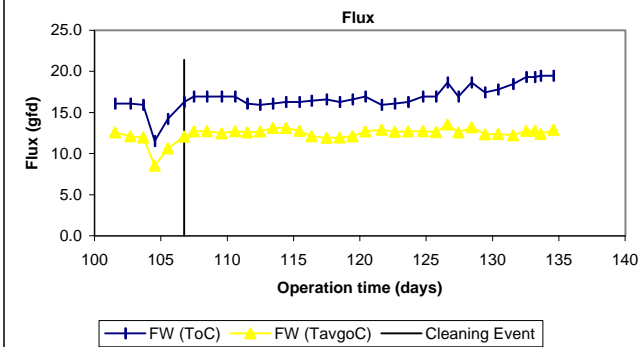
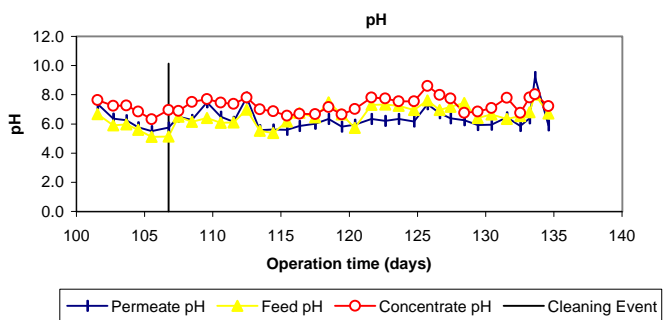
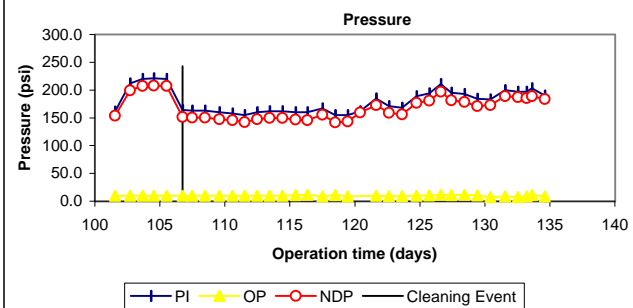
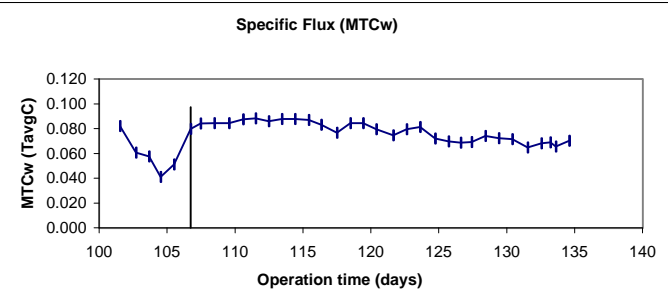
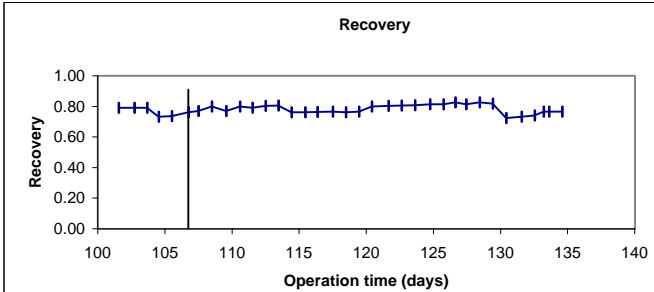
## Water Quality Parameter Graphs (Continued)



## Water Quality Parameter Graphs (Continued)



## Productivity Graphs



## ICR Information

ID / ICR#: KS 2009110 / 380  
 ICR Contact: Mr. Thomas F. Schrempp  
 Phone No.: (913) 895-5820  
 Period: 1/10/98 - 2/13/98 (34 days)

## Membrane Information

Manufacturer: Dow FilmTec  
 Trade Name: NF200B  
 Membrane Model: NF200B-4040  
 MWCO: 400 Daltons  
 Element Size: 4" x 40"  
 Element Area: 79.0 ft<sup>2</sup>  
 Design Flux: 16.5 gfd  
 Mfr. NDP: 70.0 psi

Mfr. MTC<sub>w</sub>: 0.235 (gfd/psi)  
 Mfr. Temp: 25.0 °C  
 Max Flow: 16.0 gpm  
 Min Flow: 4.0 gpm  
 Total Width: 16.0 ft  
 Feed Sp Thickness: 0.0023 ft  
 840 Element Area: 400.0 ft<sup>2</sup>  
 840 Purchase Price: \$700

## Design Parameters

Norm Temp: 15.0 °C  
 Temp Norm MTC-w: 0.175 TavGC  
 Design Recovery: 0.75  
 Design Flux: 12.0 gfd

Recycle Ratio: 4.13  
 Manuf rep Rej<sub>TDS</sub>: 45%  
 TDS<sub>F</sub>: 900.0 mg/L

## Water Quality Summary

|         | Mean  | SD   | Feed Count | Min/Max       | Mean  | SD   | Permeate Count | Min/Max       | Mean               | SD    | Concentrate Count | Min/Max       |
|---------|-------|------|------------|---------------|-------|------|----------------|---------------|--------------------|-------|-------------------|---------------|
| pH      | 7.1   | 1.3  | 4          | 6.2 - 8.9     | 7.3   | 1.1  | 4              | 6.6 - 9.0     | 7.1                | 1.5   | 4                 | 6.2 - 9.3     |
| Temp    | 8.2   | 0.3  | 4          | 7.9 - 8.5     | 8.2   | 0.3  | 4              | 7.9 - 8.5     | 8.2                | 0.3   | 4                 | 7.9 - 8.5     |
| Alk     | 21    | 9    | 4          | 10 - 29       | 13    | 6    | 4              | 7 - 21        | NA                 | NA    | 0                 | 0 - 0         |
| TDS     | NA    | NA   | 0          | 0 - 0         | 74    | 62   | 4              | 25 - 160      | 983                | 96    | 4                 | 890 - 1075    |
| TotHard | 176   | 35   | 4          | 132 - 217     | 19    | 21   | 4              | 0 - 38        | NA                 | NA    | 0                 | 0 - 0         |
| CaHard  | 126   | 32   | 4          | 97 - 164      | 13    | 14   | 4              | 0 - 28        | NA                 | NA    | 0                 | 0 - 0         |
| Turb    | 0.96  | 0.92 | 4          | 0.25 - 2.30   | 0.04  | 0.03 | 4              | 0.00 - 0.05   | NA                 | NA    | 0                 | 0.00 - 0.00   |
| Amm     | NA    | NA   | 0          | 0.0 - 0.0     | NA    | NA   | 0              | 0.0 - 0.0     | NA                 | NA    | 0                 | 0.0 - 0.0     |
| TOC     | 2.0   | 0.1  | 4          | 1.8 - 2.1     | 0.4   | 0.2  | 4              | 0.3 - 0.7     | NA                 | NA    | 0                 | 0.0 - 0.0     |
| UV254   | 0.043 | 0.0  | 4          | 0.032 - 0.050 | 0.019 | 0.0  | 4              | 0.005 - 0.025 | NA                 | NA    | 0                 | 0.000 - 0.000 |
| SUVA    | 2.20  | 0.48 | 4          | 1.55 - 2.71   | 4.66  | 3.29 | 4              | 1.80 - 9.40   | NA                 | NA    | 0                 | NA            |
| Bromide | 82    | 37   | 4          | 33 - 120      | 60    | 37   | 4              | 10 - 90       |                    |       |                   |               |
| TOX     | 61    | 21   | 4          | 43 - 90       | 13    | 0    | 4              | 13 - 13       |                    |       |                   |               |
| CHCl3   | 9.3   | 2.9  | 4          | 5.3 - 12.2    | 0.3   | 0.6  | 4              | 0.0 - 1.2     | Mass Balance       |       |                   |               |
| BDCM    | 6.4   | 3.0  | 4          | 2.3 - 9.4     | 0.3   | 0.7  | 4              | 0.0 - 1.3     | Closure Errors (%) |       |                   |               |
| DBCM    | 4.4   | 3.0  | 4          | 0.0 - 6.6     | 0.5   | 0.9  | 4              | 0.0 - 1.8     | WQP                | Count | Avg               | SD/RD         |
| CHBr3   | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Alk                | 0     | n/a               | n/a           |
| THM4    | 20.1  | 8.4  | 4          | 7.6 - 25.2    | 1.1   | 1.5  | 4              | 0.0 - 3.1     | TDS                | 0     | n/a               | n/a           |
| MCAA    | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | TotHard            | 0     | n/a               | n/a           |
| DCAA    | 3.8   | 2.6  | 4          | 0.0 - 5.5     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | CaHard             | 0     | n/a               | n/a           |
| TCAA    | 4.4   | 2.3  | 4          | 1.4 - 7.0     | 0.4   | 0.8  | 4              | 0.0 - 1.6     | Turb               | 0     | n/a               | n/a           |
| MBAA    | 1.4   | 2.7  | 4          | 0.0 - 5.5     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Amm                | 0     | n/a               | n/a           |
| DBAA    | 0.9   | 1.9  | 4          | 0.0 - 3.8     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | TOC                | 0     | n/a               | n/a           |
| BCAA    | 3.6   | 2.2  | 4          | 2.1 - 6.8     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | UV254              | 0     | n/a               | n/a           |
| TBAA    | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     |                    |       |                   |               |
| CDBAA   | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | TDS <sub>t</sub>   | 0     | #####             | #DIV/0!       |
| DCBAA   | 1.7   | 2.2  | 4          | 0.0 - 4.5     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Comments:          |       |                   |               |
| HAA5    | 10.5  | 4.1  | 4          | 6.6 - 16.3    | 0.4   | 0.8  | 4              | 0.0 - 1.6     |                    |       |                   |               |
| HAA6    | 14.0  | 6.3  | 4          | 8.7 - 23.1    | 0.4   | 0.8  | 4              | 0.0 - 1.6     |                    |       |                   |               |
| HAA9    | 15.7  | 5.9  | 4          | 8.7 - 23.1    | 0.4   | 0.8  | 4              | 0.0 - 1.6     |                    |       |                   |               |

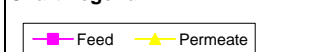
## SDS Conditions

| WQP       | Avg  | SD   | Count | Min - Max   |
|-----------|------|------|-------|-------------|
| Res (0)   | 0.58 | 0.14 | 8     | 0.50 - 0.80 |
| Temp (°C) | 7.0  | 0.0  | 8     | 7.0 - 7.0   |
| pH (unit) | 7.5  | 0.2  | 8     | 7.3 - 7.8   |
| Time (hr) | 48.0 | 0.0  | 8     | 48.0 - 48.0 |

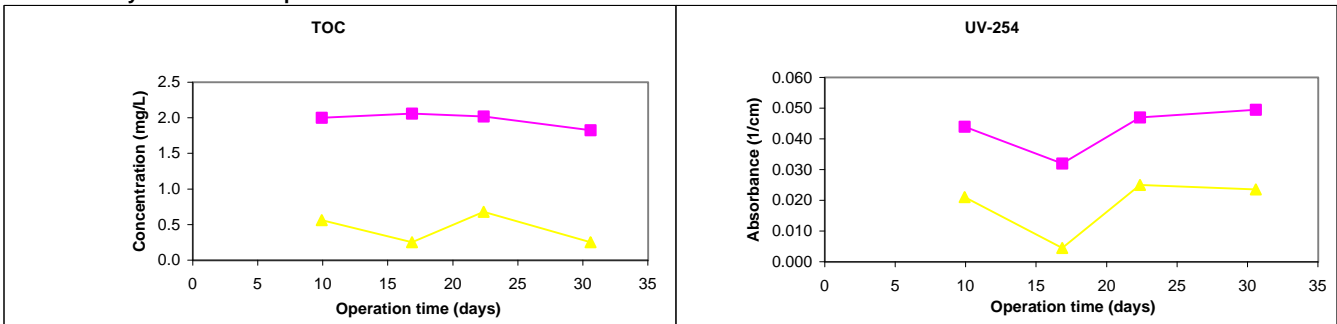
## Pretreatment Information

| Process   | Description                                    | Scale       |
|---|--|-------------|
| Ferric Sulfate (Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ) | 107.8 pounds per M.G. net filtered as Fe       | Full-Scale  |
| Potassium Perm. (KMnO <sub>4</sub> )                              | 1.9 pounds per M.G. net filtered               | Full-Scale  |
| Polymer   | 5.5 pounds per M.G. net filtered               | Full-Scale  |
| Carbon  | 14.6 pounds per M.G. net filtered              | Full-Scale  |
| Sand filtration   |  | Pilot-Scale |
| Pre-filter  | 5 mm inline cartridge filter                   | Pilot-Scale |
| Acid addition   | 93% H <sub>2</sub> SO <sub>4</sub> ; 0.33 ml/L | Pilot-Scale |
| Antiscalant addition  | mg/L Sodium Hexametaphosphate; 1.3 r           | Pilot-Scale |

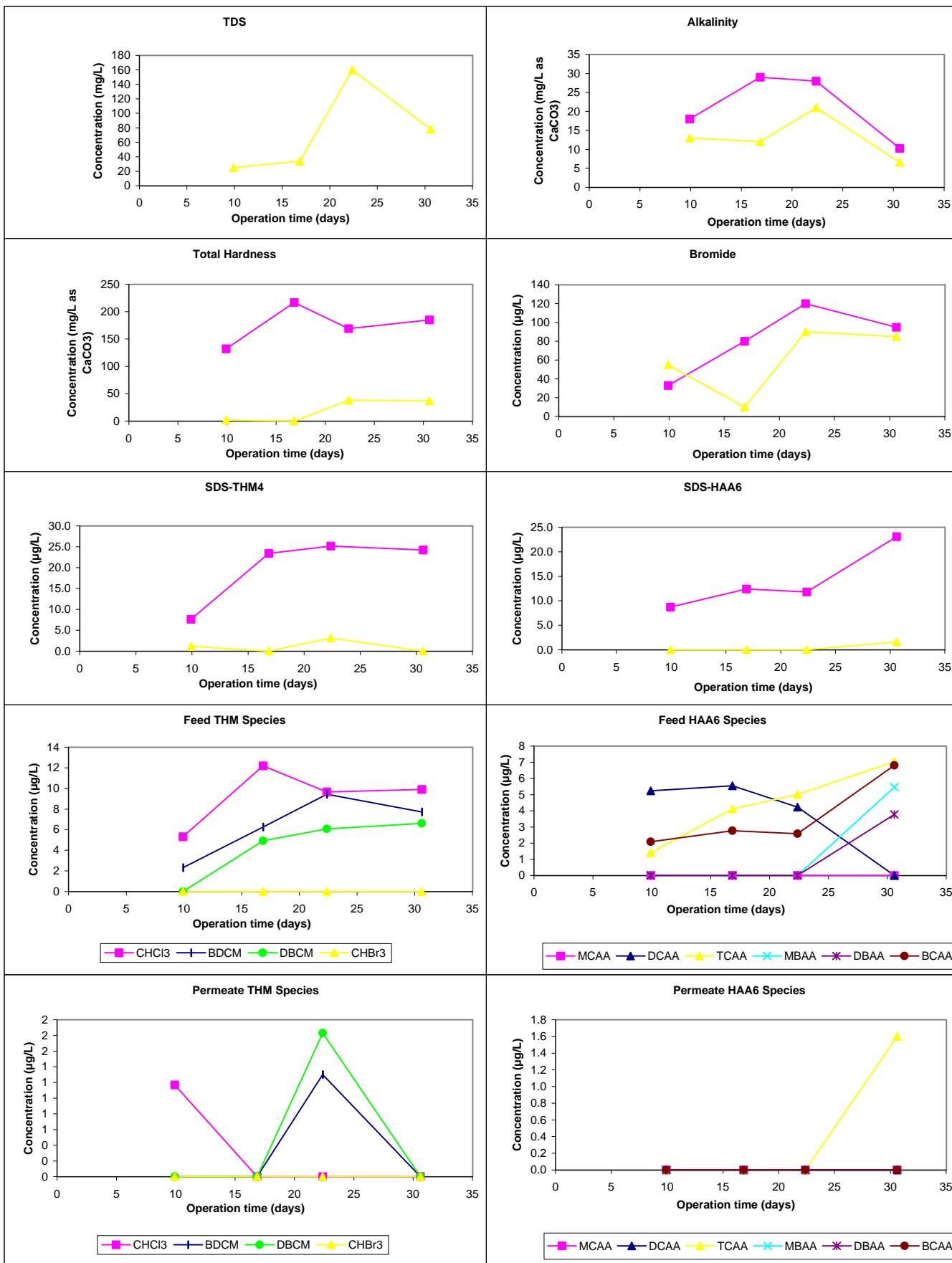
## Chart Legend:



## Water Quality Parameter Graphs

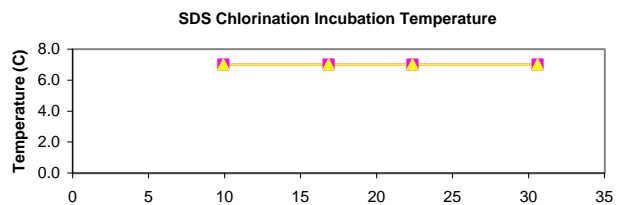
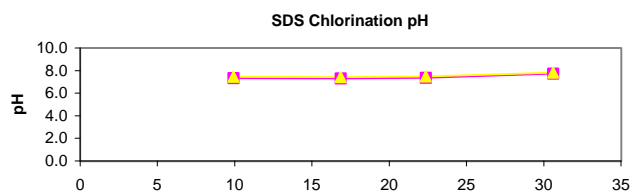
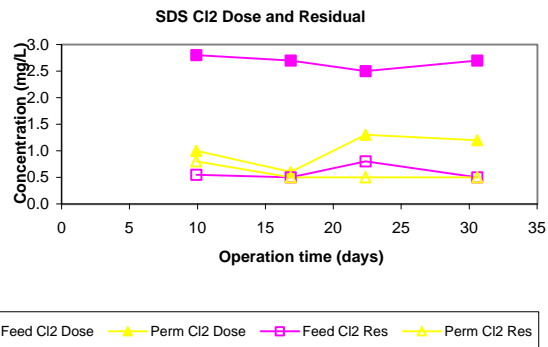


## Water Quality Parameter Graphs (Continued)

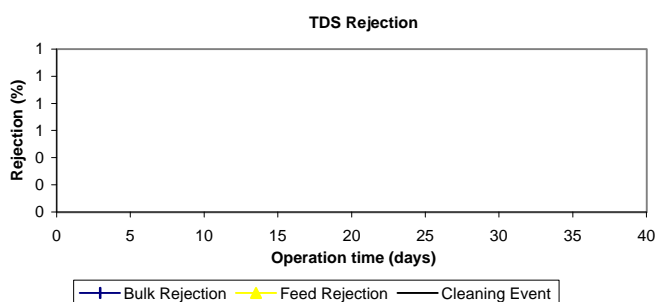
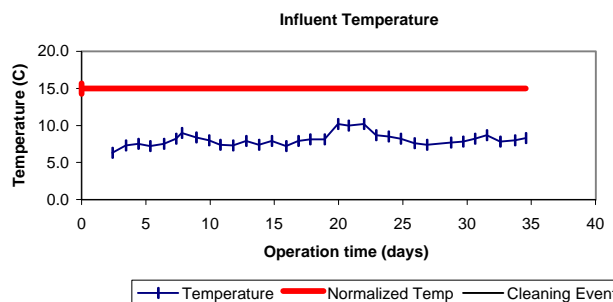
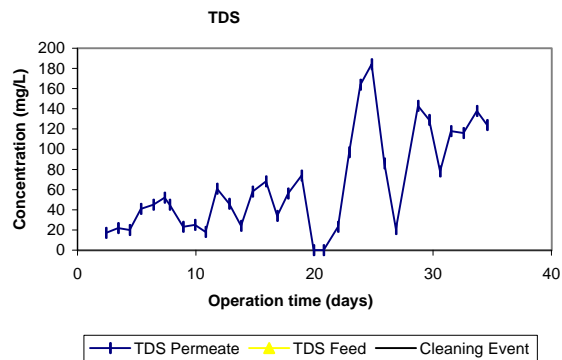
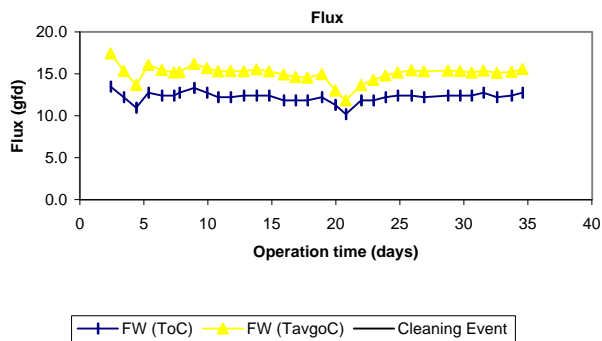
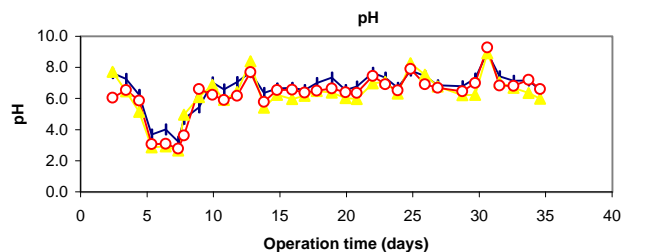
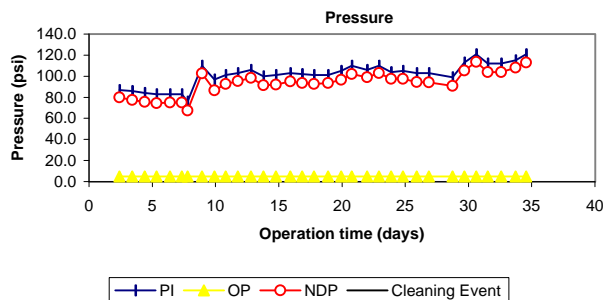
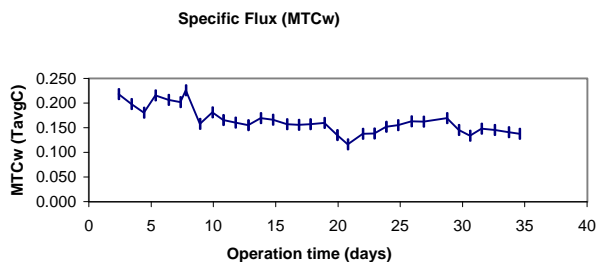
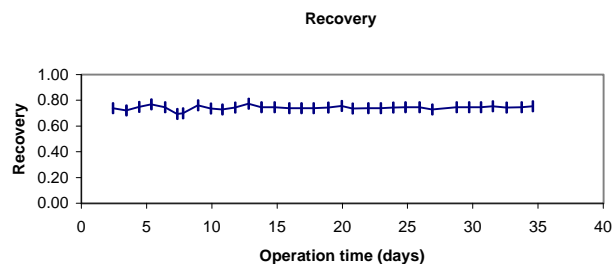




## Water Quality Parameter Graphs (Continued)



## Productivity Graphs



## ICR Information

ID / ICR#: KS 2009110 / 380  
 ICR Contact: Mr. Thomas F. Schrempp  
 Phone No.: (913) 895-5820  
 Period: 2/27/98 - 4/9/98 (41 days)

## Membrane Information

Manufacturer: Osmonics-Desal-PPC  
 Trade Name: PPC B22-1  
 Membrane Model: NR  
 MWCO: 200 Daltons  
 Element Size: 4" x 40"  
 Element Area: 64.0 ft<sup>2</sup>  
 Design Flux: NR gfd  
 Mfr. NDP: NR psi

Mfr. MTC<sub>w</sub>: NR (gfd/psi)  
 Mfr. Temp: NR °C  
 Max Flow: NR gpm  
 Min Flow: NR gpm  
 Total Width: 11.3 ft  
 Feed Sp Thickness: 0.0027 ft  
 840 Element Area This membra ft<sup>2</sup>  
 840 Purchase Price: This membrane has be

## Design Parameters

Norm Temp: 15.0 °C  
 Temp Norm MTC-w: ##### TavGC  
 Design Recovery: 0.75  
 Design Flux: 10.0 gfd

Recycle Ratio: 6.59  
 Manuf rep Rej<sub>TDS</sub>: NA  
 TDS<sub>F</sub>: NA mg/L

## Water Quality Summary

|         | Mean  | SD   | Feed Count | Min/Max       | Mean  | SD   | Permeate Count | Min/Max       | Mean               | SD    | Concentrate Count | Min/Max       |
|---------|-------|------|------------|---------------|-------|------|----------------|---------------|--------------------|-------|-------------------|---------------|
| pH      | 6.9   | 0.7  | 4          | 5.9 - 7.3     | 6.5   | 0.4  | 4              | 6.0 - 6.8     | 6.5                | 0.2   | 4                 | 6.2 - 6.7     |
| Temp    | 13.1  | 2.4  | 4          | 10.3 - 15.7   | 13.1  | 2.4  | 4              | 10.3 - 15.7   | 13.1               | 2.4   | 4                 | 10.3 - 15.7   |
| Alk     | 26    | 12   | 2          | 18 - 35       | 10    | 1    | 2              | 10 - 11       | 75                 | 57    | 2                 | 34 - 115      |
| TDS     | NA    | NA   | 0          | 0 - 0         | 102   | 32   | 4              | 70 - 147      | 446                | 96    | 4                 | 314 - 518     |
| TotHard | 208   | 61   | 4          | 150 - 293     | 14    | 15   | 4              | 0 - 33        | 351                | 130   | 4                 | 191 - 507     |
| CaHard  | 162   | 54   | 4          | 104 - 230     | 11    | 13   | 4              | 0 - 28        | 254                | 80    | 4                 | 142 - 325     |
| Turb    | 1.50  | 0.45 | 4          | 0.90 - 1.90   | 0.06  | 0.03 | 4              | 0.05 - 0.10   | NA                 | NA    | 0                 | 0.00 - 0.00   |
| Amm     | 0.1   | 0.0  | 3          | 0.1 - 0.1     | 0.1   | 0.0  | 3              | 0.0 - 0.1     | 0.2                | 0.1   | 3                 | 0.1 - 0.2     |
| TOC     | 2.4   | 0.4  | 4          | 2.1 - 2.9     | 0.4   | 0.2  | 3              | 0.3 - 0.6     | 4.5                | 0.9   | 3                 | 3.6 - 5.3     |
| UV254   | 0.057 | 0.0  | 4          | 0.050 - 0.070 | 0.022 | 0.0  | 4              | 0.017 - 0.027 | 0.089              | 0.0   | 4                 | 0.067 - 0.109 |
| SUVA    | 2.34  | 0.14 | 4          | 2.14 - 2.44   | NA    | NA   | 3              | NA            | NA                 | NA    | 3                 | NA            |
| Bromide | 60    | 39   | 4          | 10 - 100      | 48    | 45   | 4              | 10 - 100      |                    |       |                   |               |
| TOX     | 89    | 32   | 4          | 50 - 126      | 17    | 10   | 4              | 13 - 32       |                    |       |                   |               |
| CHCl3   | 9.6   | 1.4  | 2          | 8.6 - 10.6    | 0.6   | 0.9  | 2              | 0.0 - 1.2     | Mass Balance       |       |                   |               |
| BDCM    | 7.2   | 0.1  | 2          | 7.2 - 7.2     | 0.8   | 1.1  | 2              | 0.0 - 1.6     | Closure Errors (%) |       |                   |               |
| DBCM    | 4.8   | 0.5  | 2          | 4.5 - 5.2     | 1.3   | 1.8  | 2              | 0.0 - 2.6     | WQP                | Count | Avg               | SD/RD         |
| CHBr3   | 0.0   | 0.0  | 2          | 0.0 - 0.0     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | Alk                | 2     | 25                | 21            |
| THM4    | 21.6  | 1.0  | 2          | 20.9 - 22.3   | 2.7   | 3.8  | 2              | 0.0 - 5.3     | TDS                | 0     | n/a               | n/a           |
| MCAA    | 1.5   | 2.1  | 2          | 0.0 - 3.0     | 4.2   | 1.8  | 2              | 3.0 - 5.5     | TotHard            | 3     | -50               | 54            |
| DCAA    | 8.5   | 1.7  | 2          | 7.3 - 9.7     | 2.4   | 0.9  | 2              | 1.7 - 3.0     | CaHard             | 3     | -49               | 50            |
| TCAA    | 5.7   | 0.7  | 2          | 5.2 - 6.2     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | Turb               | 0     | n/a               | n/a           |
| MBAA    | 0.0   | 0.0  | 2          | 0.0 - 0.0     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | Amm                | 3     | -21               | 50            |
| DBAA    | 0.0   | 0.0  | 2          | 0.0 - 0.0     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | TOC                | 3     | -12               | 48            |
| BCAA    | 3.0   | 0.3  | 2          | 2.8 - 3.2     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | UV254              | 4     | -18               | 38            |
| TBAA    | 0.0   | 0.0  | 2          | 0.0 - 0.0     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | TDS <sub>t</sub>   | 0     | #####             | #DIV/0!       |
| CDBAA   | 0.0   | 0.0  | 2          | 0.0 - 0.0     | 0.0   | 0.0  | 2              | 0.0 - 0.0     | Comments:          |       |                   |               |
| DCBAA   | 4.6   | 0.5  | 2          | 4.3 - 4.9     | 0.0   | 0.0  | 2              | 0.0 - 0.0     |                    |       |                   |               |
| HAA5    | 15.8  | 4.5  | 2          | 12.6 - 19.0   | 6.6   | 2.7  | 2              | 4.7 - 8.5     |                    |       |                   |               |
| HAA6    | 18.7  | 4.8  | 2          | 15.3 - 22.2   | 6.6   | 2.7  | 2              | 4.7 - 8.5     |                    |       |                   |               |
| HAA9    | 23.3  | 5.3  | 2          | 19.6 - 27.1   | 6.6   | 2.7  | 2              | 4.7 - 8.5     |                    |       |                   |               |

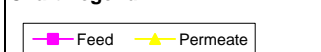
## SDS Conditions

| WQP       | Avg  | SD   | Count | Min - Max   |
|-----------|------|------|-------|-------------|
| Res (0)   | 0.63 | 0.18 | 8     | 0.50 - 1.00 |
| Temp (°C) | 7.0  | 0.0  | 8     | 7.0 - 7.0   |
| pH (unit) | 7.1  | 0.1  | 8     | 7.0 - 7.4   |
| Time (hr) | 48.0 | 0.0  | 8     | 48.0 - 48.0 |

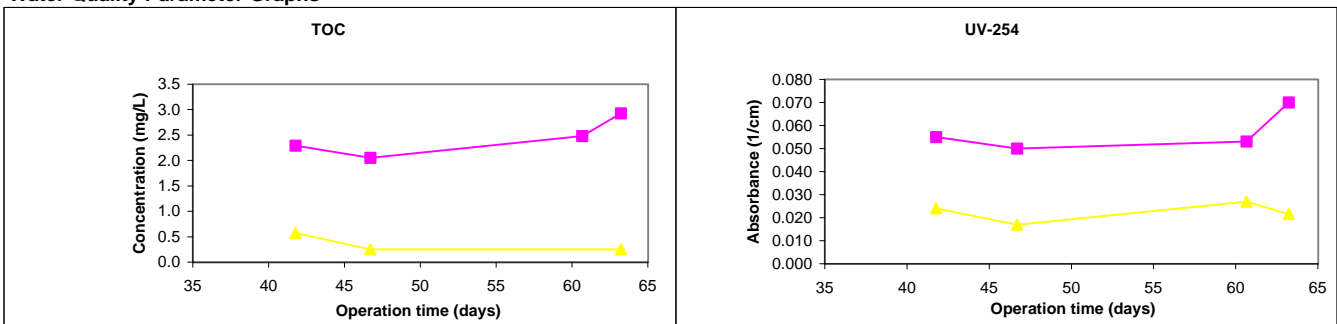
## Pretreatment Information

| Process   | Description                                    | Scale       |
|---|--|-------------|
| Ferric Sulfate (Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ) | 107.8 pounds per M.G. net filtered as Fe       | Full-Scale  |
| Potassium Perm. (KMnO <sub>4</sub> )                              | 1.9 pounds per M.G. net filtered               | Full-Scale  |
| Polymer   | 5.5 pounds per M.G. net filtered               | Full-Scale  |
| Carbon  | 14.6 pounds per M.G. net filtered              | Full-Scale  |
| Sand filtration   |  | Pilot-Scale |
| Pre-filter  | 5 mm inline cartridge filter                   | Pilot-Scale |
| Acid addition   | 93% H <sub>2</sub> SO <sub>4</sub> ; 0.33 ml/L | Pilot-Scale |
| Antiscalant addition  | mg/L Sodium Hexametaphosphate; 1.3 r           | Pilot-Scale |

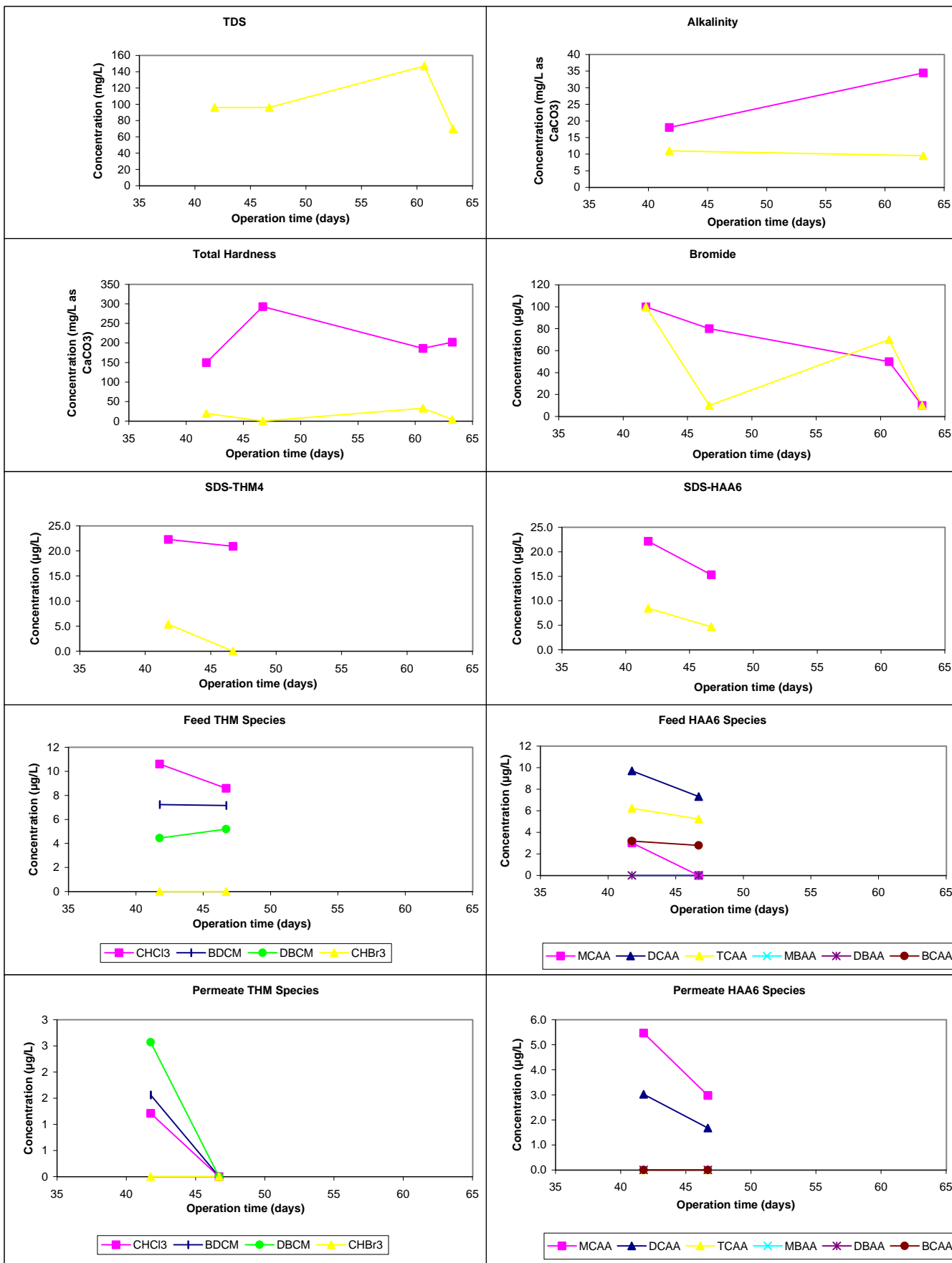
## Chart Legend:



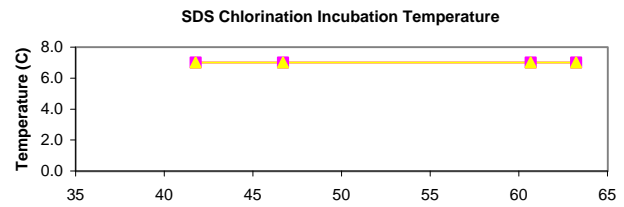
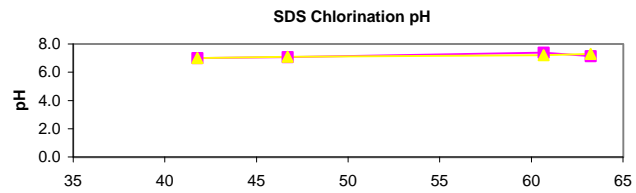
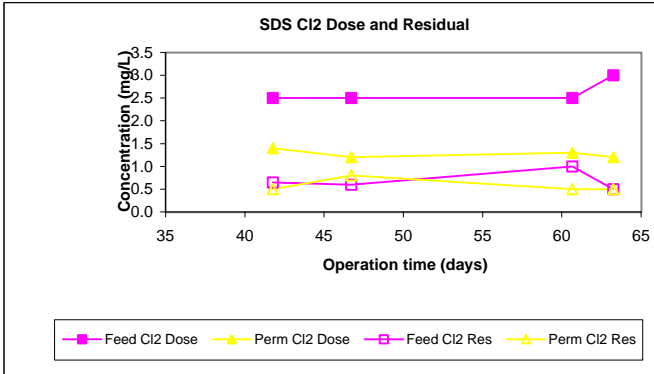
## Water Quality Parameter Graphs



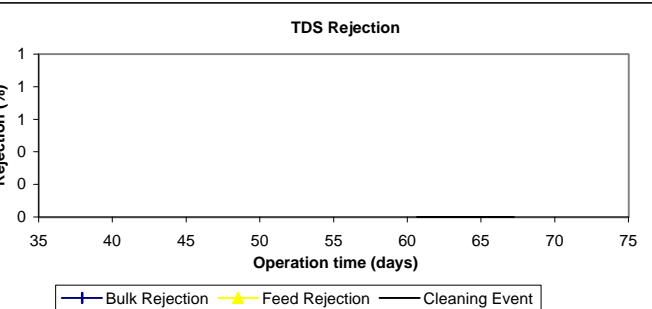
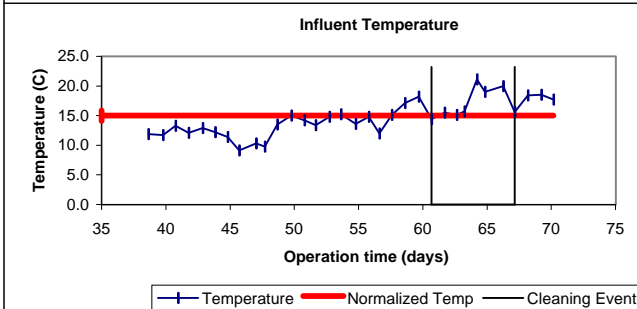
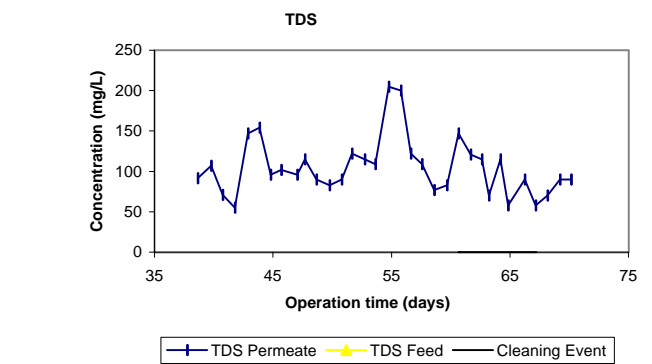
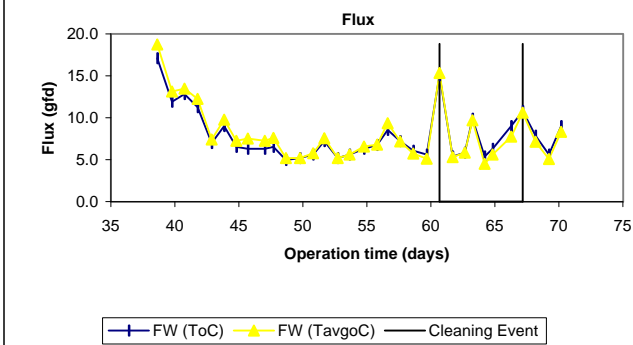
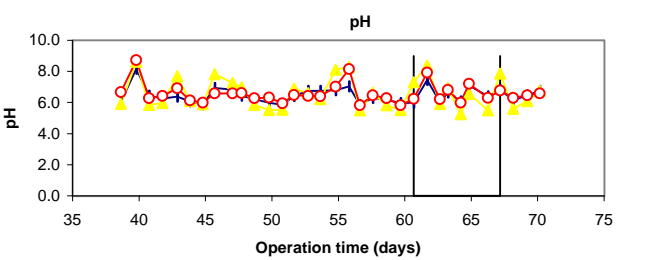
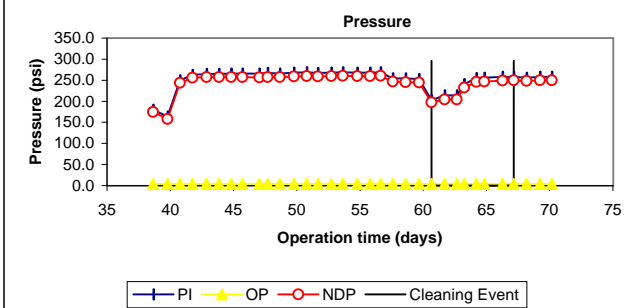
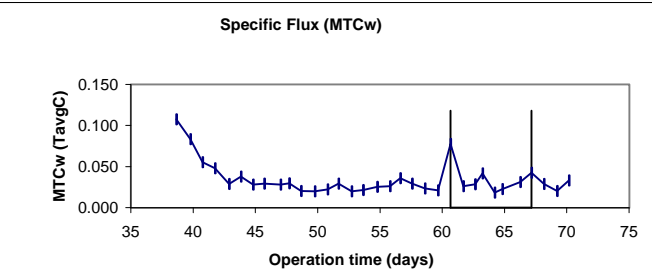
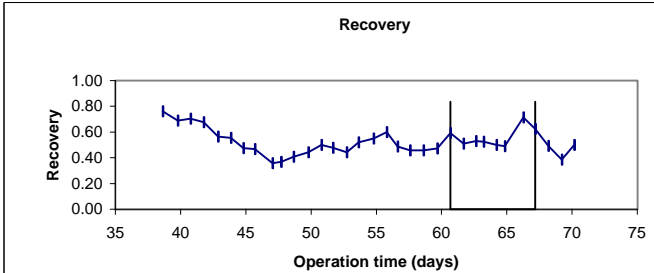
## Water Quality Parameter Graphs (Continued)



## Water Quality Parameter Graphs (Continued)



## Productivity Graphs



## ICR Information

ID / ICR#: KS 2009110 / 380  
 ICR Contact: Mr. Thomas F. Schrempp  
 Phone No.: (913) 895-5820  
 Period: 4/11/98 - 5/15/98 (34 days)

## Membrane Information

Manufacturer: Dow FilmTec  
 Trade Name: NF200B  
 Membrane Model: NF200B-4040  
 MWCO: 400 Daltons  
 Element Size: 4" x 40"  
 Element Area: 79.0 ft<sup>2</sup>  
 Design Flux: 16.5 gfd  
 Mfr. NDP: 70.0 psi

Mfr. MTC<sub>w</sub>: 0.235 (gfd/psi)  
 Mfr. Temp: 25.0 °C  
 Max Flow: 16.0 gpm  
 Min Flow: 4.0 gpm  
 Total Width: 16.0 ft  
 Feed Sp Thickness: 0.0023 ft  
 840 Element Area: 400.0 ft<sup>2</sup>  
 840 Purchase Price: \$700

## Design Parameters

Norm Temp: 15.0 °C  
 Temp Norm MTC-w: 0.175 TavGC  
 Design Recovery: 0.75  
 Design Flux: 12.0 gfd

Recycle Ratio: 4.13  
 Manuf rep Rej<sub>TDS</sub>: 85%  
 TDS<sub>F</sub>: 1000.0 mg/L

## Water Quality Summary

|         | Mean  | SD   | Feed Count | Min/Max       | Mean  | SD   | Permeate Count | Min/Max       | Mean               | SD    | Concentrate Count | Min/Max       |
|---------|-------|------|------------|---------------|-------|------|----------------|---------------|--------------------|-------|-------------------|---------------|
| pH      | 6.6   | 1.5  | 4          | 5.7 - 8.9     | 6.1   | 0.7  | 4              | 5.3 - 6.8     | 6.0                | 0.4   | 4                 | 5.5 - 6.3     |
| Temp    | 16.0  | 1.6  | 4          | 14.8 - 18.1   | 16.0  | 1.6  | 4              | 14.8 - 18.1   | 16.0               | 1.6   | 4                 | 14.8 - 18.1   |
| Alk     | 35    | 15   | 4          | 25 - 58       | 30    | 15   | 4              | 20 - 51       | 50                 | 22    | 4                 | 30 - 80       |
| TDS     | NA    | NA   | 0          | 0 - 0         | 191   | 32   | 4              | 160 - 218     | 744                | 83    | 4                 | 659 - 838     |
| TotHard | 196   | 14   | 4          | 176 - 205     | 52    | 22   | 4              | 33 - 84       | 421                | 27    | 4                 | 381 - 440     |
| CaHard  | 175   | 16   | 4          | 158 - 196     | 47    | 23   | 4              | 29 - 81       | 376                | 45    | 4                 | 315 - 422     |
| Turb    | 0.56  | 0.22 | 4          | 0.35 - 0.75   | 0.06  | 0.03 | 4              | 0.05 - 0.10   | 0.35               | 0.03  | 3                 | 0.32 - 0.37   |
| Amm     | 0.1   | 0.0  | 4          | 0.0 - 0.1     | 0.1   | 0.0  | 4              | 0.0 - 0.1     | 0.1                | 0.0   | 4                 | 0.1 - 0.1     |
| TOC     | 2.6   | 0.4  | 4          | 2.3 - 3.2     | 0.8   | 0.1  | 4              | 0.6 - 0.9     | 5.7                | 0.4   | 4                 | 5.4 - 6.2     |
| UV254   | 0.059 | 0.0  | 4          | 0.056 - 0.061 | 0.025 | 0.0  | 4              | 0.022 - 0.027 | 0.118              | 0.0   | 4                 | 0.107 - 0.135 |
| SUVA    | 2.25  | 0.29 | 4          | 1.82 - 2.42   | 3.32  | 0.34 | 4              | 3.04 - 3.75   | 2.07               | 0.12  | 4                 | 1.94 - 2.19   |
| Bromide | 69    | 40   | 4          | 10 - 95       | 85    | 13   | 4              | 70 - 100      |                    |       |                   |               |
| TOX     | 127   | 14   | 4          | 107 - 141     | 13    | 0    | 4              | 13 - 13       |                    |       |                   |               |
| CHCl3   | 22.9  | 4.1  | 4          | 19.3 - 28.4   | 1.5   | 1.1  | 4              | 0.0 - 2.6     | Mass Balance       |       |                   |               |
| BDCM    | 12.9  | 0.8  | 4          | 12.0 - 13.9   | 3.2   | 1.7  | 4              | 1.5 - 5.4     | Closure Errors (%) |       |                   |               |
| DBCM    | 5.0   | 0.8  | 4          | 3.9 - 5.6     | 5.0   | 2.7  | 4              | 2.4 - 8.4     | WQP                | Count | Avg               | SD/RD         |
| CHBr3   | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 4.2   | 2.3  | 4              | 2.1 - 6.7     | Alk                | 4     | -2                | 47            |
| THM4    | 40.8  | 4.0  | 4          | 37.5 - 45.6   | 13.9  | 7.8  | 4              | 5.9 - 23.1    | TDS                | 0     | n/a               | n/a           |
| MCAA    | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | TotHard            | 4     | -31               | 21            |
| DCAA    | 10.3  | 2.7  | 4          | 7.8 - 14.2    | 2.2   | 0.6  | 4              | 1.6 - 2.8     | CaHard             | 4     | -32               | 22            |
| TCAA    | 9.8   | 3.6  | 4          | 6.5 - 14.8    | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Turb               | 3     | -469              | 227           |
| MBAA    | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Amm                | 4     | -5                | 71            |
| DBAA    | 0.6   | 0.7  | 4          | 0.0 - 1.2     | 1.9   | 0.9  | 4              | 1.1 - 3.1     | TOC                | 4     | -29               | 18            |
| BCAA    | 5.1   | 1.0  | 4          | 4.3 - 6.5     | 2.0   | 0.6  | 4              | 1.4 - 2.8     | UV254              | 4     | -20               | 13            |
| TBAA    | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     |                    |       |                   |               |
| CDBAA   | 0.6   | 1.2  | 4          | 0.0 - 2.4     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | TDS <sub>t</sub>   | 0     | #####             | #DIV/0!       |
| DCBAA   | 7.8   | 2.4  | 4          | 5.8 - 11.1    | 0.3   | 0.5  | 4              | 0.0 - 1.1     | Comments:          |       |                   |               |
| HAA5    | 20.7  | 5.8  | 4          | 15.5 - 29.0   | 4.1   | 1.4  | 4              | 3.0 - 6.0     |                    |       |                   |               |
| HAA6    | 25.7  | 6.8  | 4          | 19.8 - 35.5   | 6.1   | 2.0  | 4              | 4.5 - 8.8     |                    |       |                   |               |
| HAA9    | 34.1  | 10.3 | 4          | 25.6 - 49.0   | 6.4   | 2.2  | 4              | 4.5 - 8.8     |                    |       |                   |               |

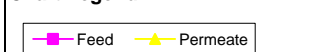
## SDS Conditions

| WQP       | Avg  | SD   | Count | Min - Max   |
|-----------|------|------|-------|-------------|
| Res (0)   | 0.64 | 0.16 | 8     | 0.50 - 0.90 |
| Temp (°C) | 13.0 | 0.0  | 8     | 13.0 - 13.0 |
| pH (unit) | 7.3  | 0.0  | 8     | 7.2 - 7.4   |
| Time (hr) | 48.0 | 0.0  | 8     | 48.0 - 48.0 |

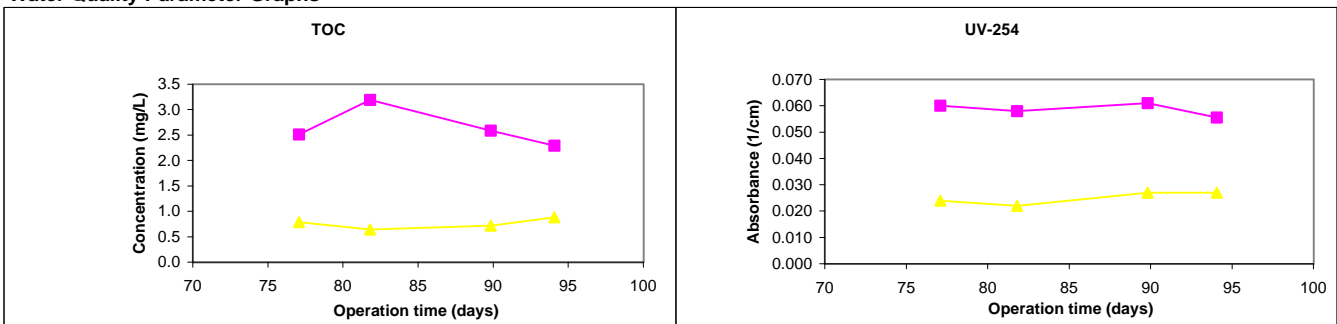
## Pretreatment Information

| Process   | Description                                    | Scale       |
|---|--|-------------|
| Ferric Sulfate (Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ) | 107.8 pounds per M.G. net filtered as Fe       | Full-Scale  |
| Potassium Perm. (KMnO <sub>4</sub> )                              | 1.9 pounds per M.G. net filtered               | Full-Scale  |
| Polymer   | 5.5 pounds per M.G. net filtered               | Full-Scale  |
| Carbon  | 14.6 pounds per M.G. net filtered              | Full-Scale  |
| Sand filtration   |  | Pilot-Scale |
| Pre-filter  | 5 mm inline cartridge filter                   | Pilot-Scale |
| Acid addition   | 93% H <sub>2</sub> SO <sub>4</sub> ; 0.33 ml/L | Pilot-Scale |
| Antiscalant addition  | mg/L Sodium Hexametaphosphate; 1.3 r           | Pilot-Scale |

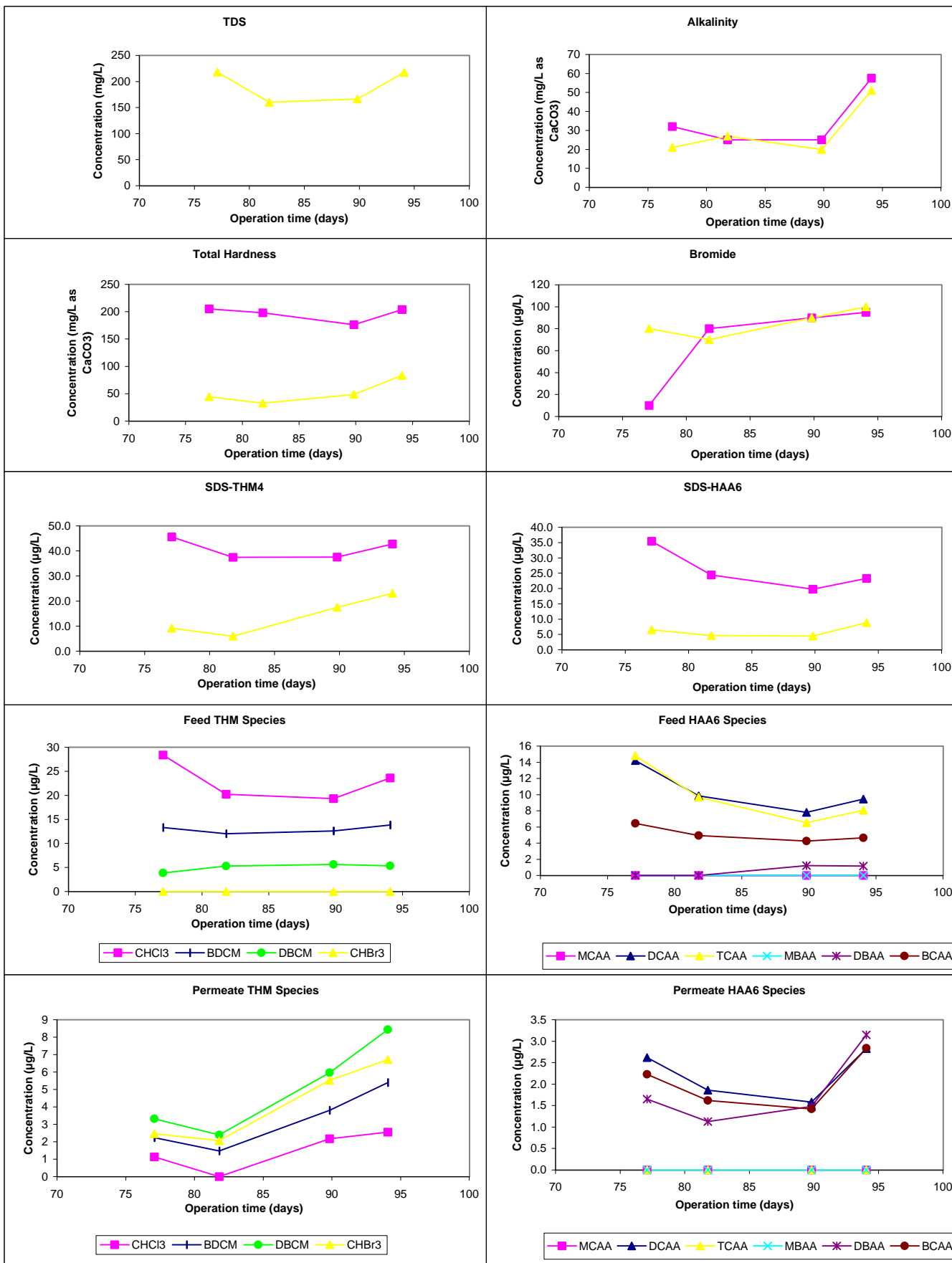
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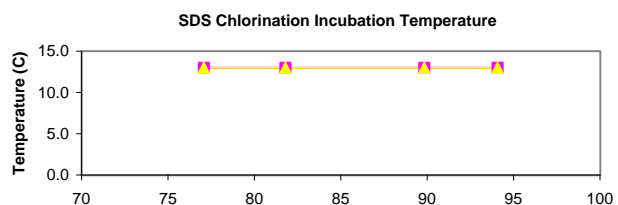
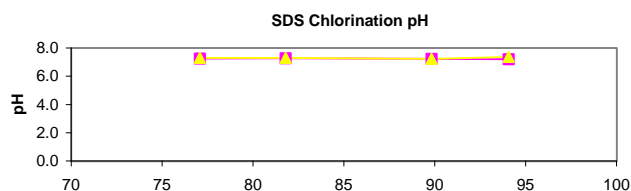
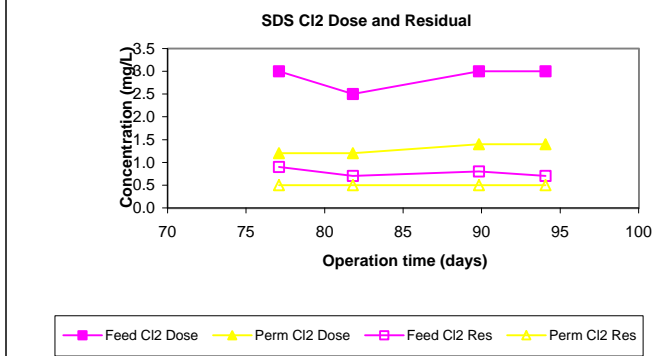
## Water Quality Parameter Graphs



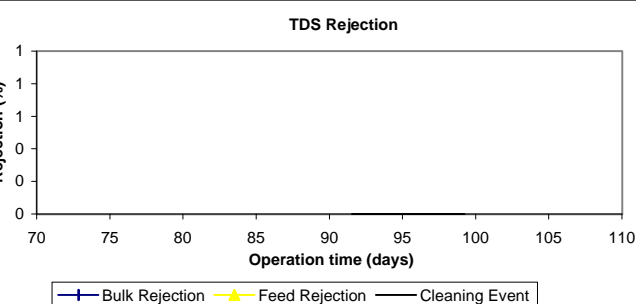
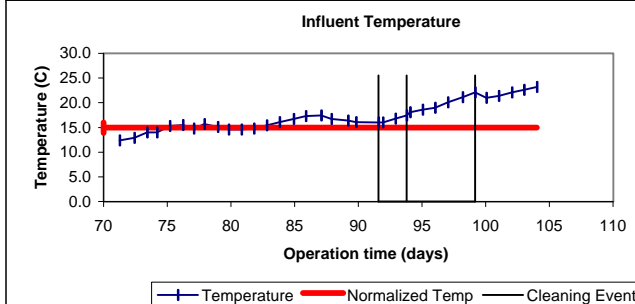
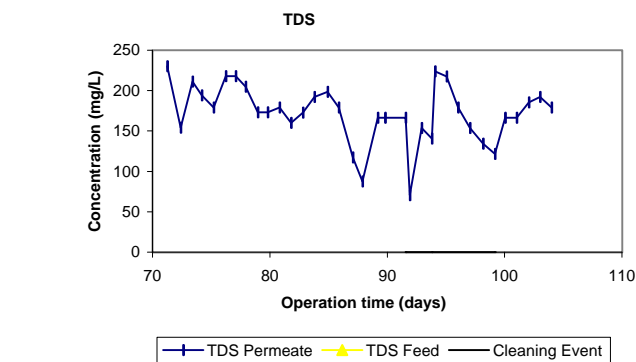
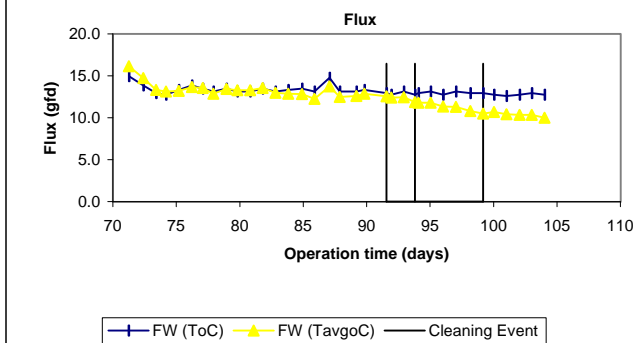
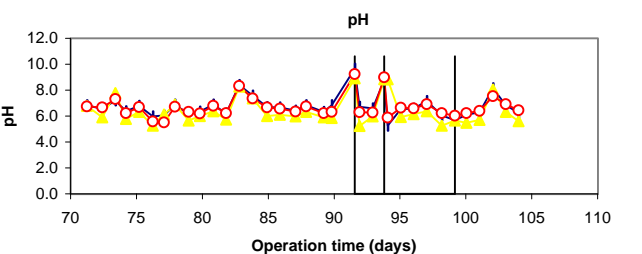
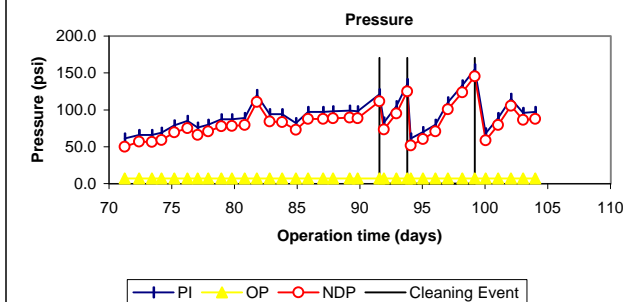
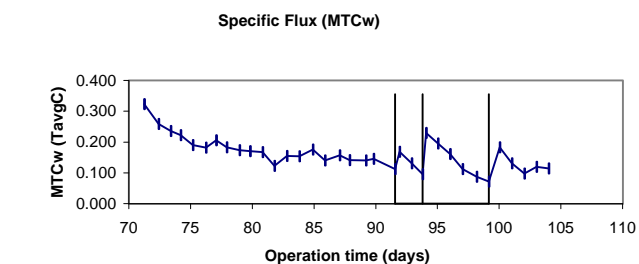
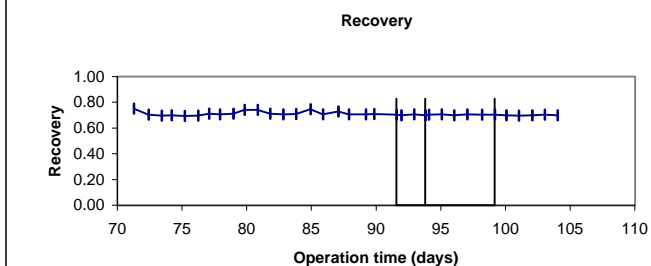
## Water Quality Parameter Graphs (Continued)



## Water Quality Parameter Graphs (Continued)



## Productivity Graphs



## ICR Information

ID / ICR#: KS 2009110 / 380  
 ICR Contact: Mr. Thomas F. Schrempp  
 Phone No.: (913) 895-5820  
 Period: 5/15/98 - 7/1/98 (47 days)

## Membrane Information

Manufacturer: Osmonics-Desal-PPC  
 Trade Name: PPC B22-1  
 Membrane Model: NR  
 MWCO: 200 Daltons  
 Element Size: 4" x 40"  
 Element Area: 64.0 ft<sup>2</sup>  
 Design Flux: NR gfd  
 Mfr. NDP: NR psi

Mfr. MTC<sub>w</sub>: NR (gfd/psi)  
 Mfr. Temp: NR °C  
 Max Flow: NR gpm  
 Min Flow: NR gpm  
 Total Width: 11.3 ft  
 Feed Sp Thickness: 0.0027 ft  
 840 Element Area This membra ft<sup>2</sup>  
 840 Purchase Price: This membrane has be

## Design Parameters

Norm Temp: 15.0 °C  
 Temp Norm MTC-w: ##### TavGC  
 Design Recovery: 0.75  
 Design Flux: 10.0 gfd

Recycle Ratio: 6.43  
 Manuf rep Rej<sub>TDS</sub>: NA  
 TDS<sub>F</sub>: NA mg/L

## Water Quality Summary

|         | Mean  | SD   | Feed Count | Min/Max       | Mean  | SD   | Permeate Count | Min/Max       | Mean               | SD    | Concentrate Count | Min/Max       |
|---------|-------|------|------------|---------------|-------|------|----------------|---------------|--------------------|-------|-------------------|---------------|
| pH      | 6.6   | 0.3  | 4          | 6.2 - 6.9     | 6.7   | 0.7  | 4              | 6.2 - 7.8     | 7.1                | 0.4   | 4                 | 6.7 - 7.6     |
| Temp    | 24.0  | 1.7  | 4          | 22.3 - 26.0   | 24.0  | 1.7  | 4              | 22.3 - 26.0   | 24.0               | 1.7   | 4                 | 22.3 - 26.0   |
| Alk     | 17    | 4    | 4          | 12 - 22       | 7     | 5    | 4              | 0 - 13        | 42                 | 16    | 4                 | 27 - 63       |
| TDS     | 236   | 32   | 2          | 213 - 258     | 50    | 17   | 4              | 32 - 70       | 690                | 152   | 4                 | 472 - 826     |
| TotHard | 152   | 20   | 4          | 138 - 180     | 6     | 6    | 4              | 0 - 13        | 355                | 41    | 4                 | 304 - 394     |
| CaHard  | 139   | 23   | 4          | 119 - 171     | 6     | 6    | 4              | 0 - 11        | 321                | 35    | 4                 | 282 - 352     |
| Turb    | 1.16  | 0.98 | 4          | 0.50 - 2.60   | 0.06  | 0.03 | 4              | 0.05 - 0.10   | 0.46               | 0.27  | 4                 | 0.15 - 0.75   |
| Amm     | 0.0   | 0.0  | 4          | 0.0 - 0.1     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | 0.1                | 0.0   | 4                 | 0.0 - 0.1     |
| TOC     | 2.2   | 0.5  | 4          | 1.7 - 2.9     | 0.3   | 0.2  | 4              | 0.3 - 0.6     | 5.6                | 1.4   | 4                 | 4.1 - 7.0     |
| UV254   | 0.053 | 0.0  | 4          | 0.048 - 0.059 | 0.021 | 0.0  | 4              | 0.018 - 0.024 | 0.101              | 0.0   | 4                 | 0.050 - 0.128 |
| SUVA    | 2.53  | 0.48 | 4          | 2.06 - 3.18   | 7.26  | 2.47 | 4              | 3.86 - 9.60   | 1.84               | 0.65  | 4                 | 1.06 - 2.63   |
| Bromide | 68    | 13   | 4          | 50 - 80       | 20    | 20   | 4              | 10 - 50       |                    |       |                   |               |
| TOX     | 117   | 17   | 4          | 103 - 138     | 16    | 6    | 4              | 13 - 25       |                    |       |                   |               |
| CHCl3   | 27.9  | 1.8  | 4          | 25.7 - 29.5   | 2.3   | 0.2  | 4              | 2.0 - 2.6     | Mass Balance       |       |                   |               |
| BDCM    | 12.3  | 2.5  | 4          | 8.7 - 14.6    | 1.6   | 1.2  | 4              | 0.0 - 2.8     | Closure Errors (%) |       |                   |               |
| DBCM    | 3.8   | 1.7  | 4          | 1.7 - 5.4     | 0.3   | 0.7  | 4              | 0.0 - 1.3     | WQP                | Count | Avg               | SD/RD         |
| CHBr3   | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Alk                | 3     | 0                 | 30            |
| THM4    | 44.0  | 3.6  | 4          | 39.9 - 48.6   | 4.3   | 1.9  | 4              | 2.3 - 6.7     | TDS                | 2     | -27               | 12            |
| MCAA    | 1.4   | 1.7  | 4          | 0.0 - 3.3     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | TotHard            | 3     | -54               | 26            |
| DCAA    | 15.4  | 4.3  | 4          | 11.1 - 21.3   | 2.2   | 0.4  | 4              | 1.7 - 2.6     | CaHard             | 3     | -55               | 30            |
| TCAA    | 14.0  | 5.1  | 4          | 7.9 - 20.5    | 1.1   | 0.8  | 4              | 0.0 - 2.0     | Turb               | 4     | -790              | 429           |
| MBAA    | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Amm                | 3     | -37               | 66            |
| DBAA    | 0.6   | 0.7  | 4          | 0.0 - 1.3     | 0.3   | 0.6  | 4              | 0.0 - 1.2     | TOC                | 4     | -23               | 23            |
| BCAA    | 6.4   | 1.2  | 4          | 5.0 - 7.5     | 0.8   | 0.9  | 4              | 0.0 - 1.6     | UV254              | 4     | -45               | 36            |
| TBAA    | 0.0   | 0.0  | 4          | 0.0 - 0.0     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | TDS <sub>t</sub>   | 20    | -35               | 16            |
| CDBAA   | 1.2   | 1.5  | 4          | 0.0 - 2.8     | 0.0   | 0.0  | 4              | 0.0 - 0.0     | Comments:          |       |                   |               |
| DCBAA   | 9.6   | 2.7  | 4          | 7.3 - 12.9    | 0.0   | 0.0  | 4              | 0.0 - 0.0     |                    |       |                   |               |
| HAA5    | 31.5  | 10.3 | 4          | 20.3 - 45.1   | 3.6   | 0.6  | 4              | 2.9 - 4.4     |                    |       |                   |               |
| HAA6    | 37.9  | 11.1 | 4          | 26.2 - 52.6   | 4.4   | 1.5  | 4              | 2.9 - 5.9     |                    |       |                   |               |
| HAA9    | 48.8  | 13.1 | 4          | 35.9 - 65.5   | 4.4   | 1.5  | 4              | 2.9 - 5.9     |                    |       |                   |               |

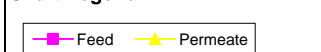
## SDS Conditions

| WQP       | Avg  | SD   | Count | Min - Max   |
|-----------|------|------|-------|-------------|
| Res (0)   | 0.69 | 0.14 | 8     | 0.50 - 0.90 |
| Temp (°C) | 15.0 | 0.0  | 8     | 15.0 - 15.0 |
| pH (unit) | 7.6  | 0.2  | 8     | 7.3 - 7.8   |
| Time (hr) | 48.0 | 0.0  | 8     | 48.0 - 48.0 |

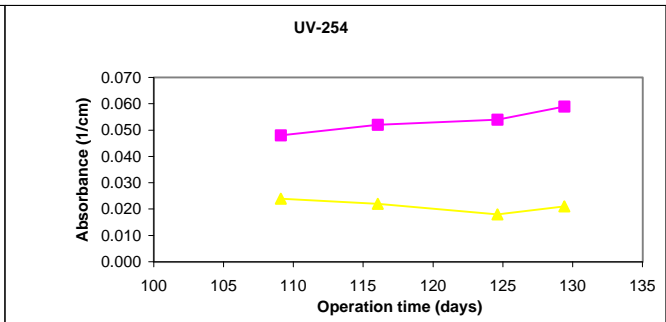
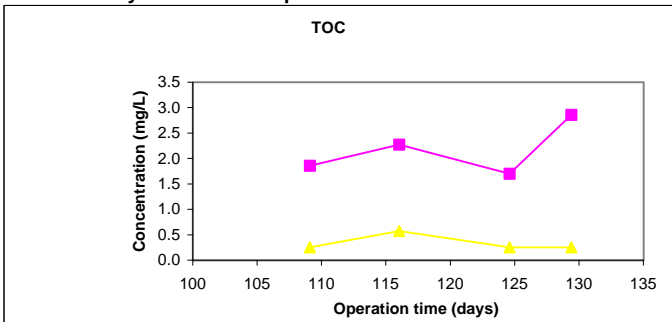
## Pretreatment Information

| Process   | Description                                    | Scale       |
|---|--|-------------|
| Ferric Sulfate (Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ) | 107.8 pounds per M.G. net filtered as Fe       | Full-Scale  |
| Potassium Perm. (KMnO <sub>4</sub> )                              | 1.9 pounds per M.G. net filtered               | Full-Scale  |
| Polymer   | 5.5 pounds per M.G. net filtered               | Full-Scale  |
| Carbon  | 14.6 pounds per M.G. net filtered              | Full-Scale  |
| Sand filtration   |  | Pilot-Scale |
| Pre-filter  | 5 mm inline cartridge filter                   | Pilot-Scale |
| Acid addition   | 93% H <sub>2</sub> SO <sub>4</sub> ; 0.33 ml/L | Pilot-Scale |
| Antiscalant addition  | mg/L Sodium Hexametaphosphate; 1.3 r           | Pilot-Scale |

## Chart Legend:

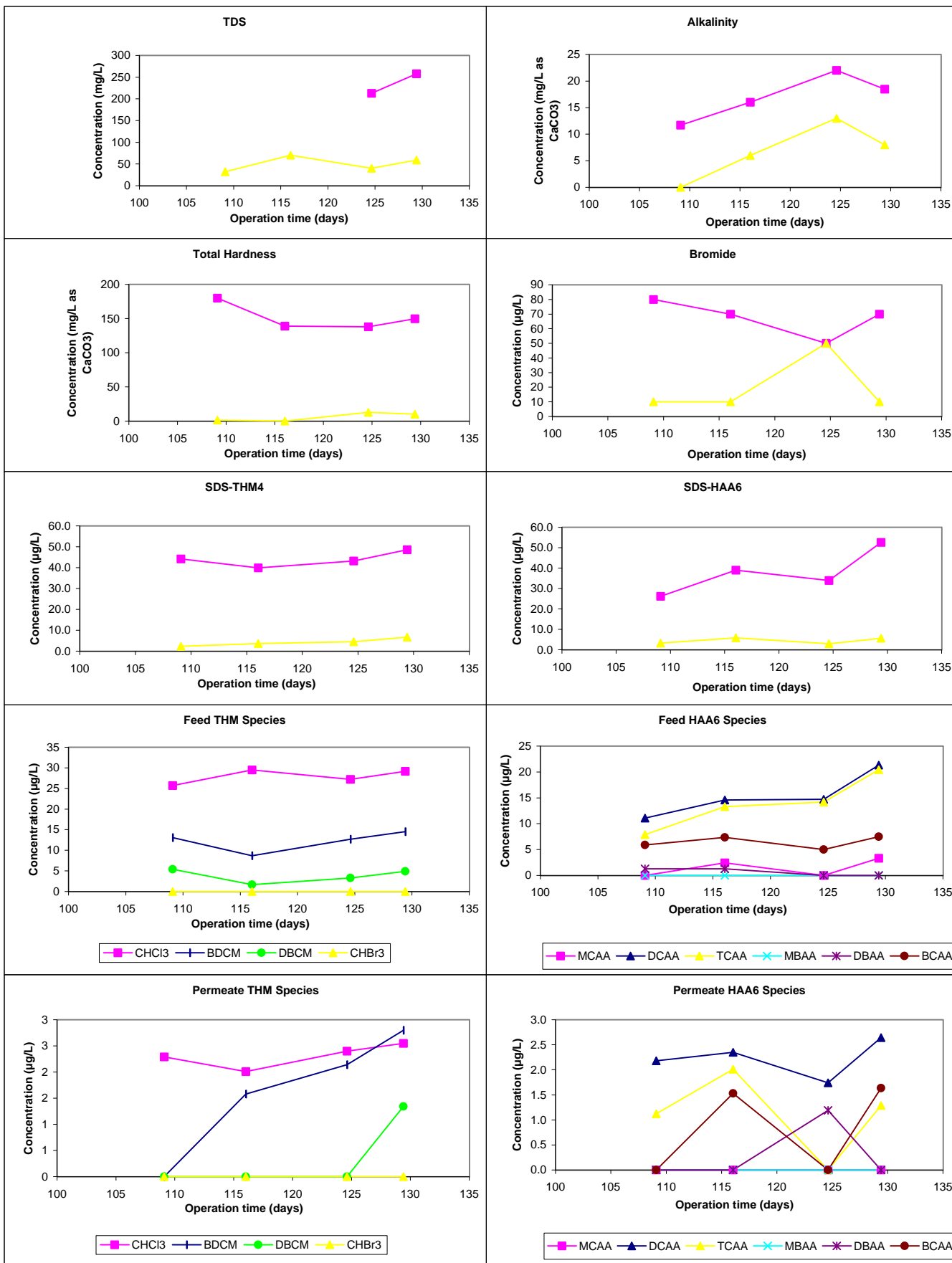


## Water Quality Parameter Graphs

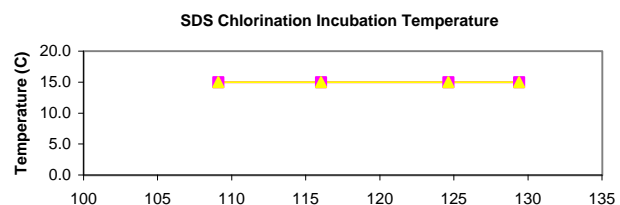
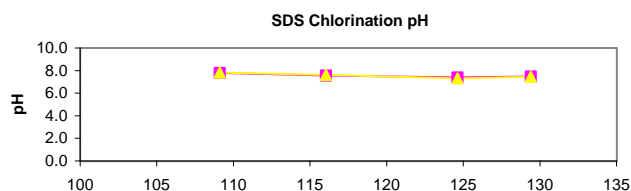
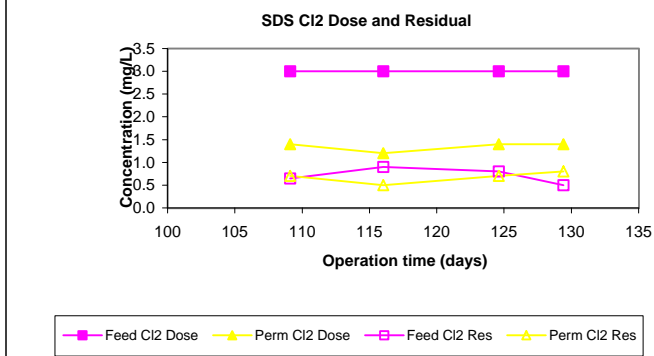




## Water Quality Parameter Graphs (Continued)



## Water Quality Parameter Graphs (Continued)



## Productivity Graphs

