How Can So Little Do So Much?
Doubling Membrane Flux with 5 mg/L of Precoagulant

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Overview

- Plant Description
- History of Membrane Plant
- Troubleshooting of Flux Problems
- Solution to Flux Problems
- Plant Update
BCWID

- District established in 1925
- Located in the heart of Texas
- Water Source: 29,712 Ac. Ft. Authorized Diversions in Lake Brownwood
- Good water quality
Rated for 7.5 MGD

Improvements needed for 2013
Rated for 9 MGD at 20° C
Early History of Microfiltration Plant

Pilot Testing
- Nov. ‘03 – Mar. ’04
- Approved flux of 80 gfd
- No pretreatment needed even during turbidity challenge phase

Online
- Flux rate of 43 gfd
- Only 4-5 MGD of production

2002
- Feasibility Study

2004
- • Nov. ‘03 – Mar. ’04
  • Approved flux of 80 gfd
  • No pretreatment needed even during turbidity challenge phase

2006
- • Flux rate of 43 gfd

2008
- • Only 4-5 MGD of production

2010
- • 40 new modules added
  • Flux rate adjusted to 75 gfd

Add’l Modules Added

Bid
Why Can’t We Get More Water?

http://www.smh.com.au
Why We Need More Water from the MF Plant

Operating Costs:
- MF Plant = $107 / MG
- Conventional Plant = $138 / MG

Conventional Plant Improvements:
- MF Plant produces 4-6 MGD
- West Plant needs to undergo improvements ASAP
- TWDB funded project
- MF Plant cannot reliably meet the water demand

New Customers
How Can We Get More Water?

- Identify bottlenecks
- Assess solutions to remove bottleneck
Concern #1

Recirculation of Backwash Water

Backwash water sent to sludge storage lagoon for settling

Decant from sludge lagoon recirculated to Terminal Storage

Critical water quality parameters were accumulating:

- Iron
- Mangenese
- Turbidity

Solution: Enhance solids settling in sludge lagoons with ACH dosing
Concern #2

Lake Water Quality

TOC during pilot study (Oct ‘03-Mar ’04):

- 3.86 – 4.08 mg/L
- Average = 3.9 mg/L

TOC following full-scale start-up (‘09 – present):

- 4.1 – 6.34 mg/L
- Average = 4.75 mg/L

Average Difference ≈ 1 mg/L (20% increase)

Is this really a problem?
Concern #2 (cont…)

Lake Water Quality

Membrane Performance Index (MPI) performed by U. of New Hampshire

Assessed the impact of Pre-Coagulation on Filterability

With 5 mg/L ACH

- DOC removal of 15%
- MPI improved by 45%

Promising results… let’s test it

<table>
<thead>
<tr>
<th>ACH Dose, mg/L</th>
<th>DOC, mg/L</th>
<th>Turbidity, NTU</th>
<th>MPI</th>
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<tbody>
<tr>
<td>0</td>
<td>5.44</td>
<td>0.05</td>
<td>2.82</td>
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<tr>
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<td>4.61</td>
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<td>1.39</td>
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<tr>
<td>20</td>
<td>4.48</td>
<td>0.04</td>
<td>1.05</td>
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</table>
Performance Testing Protocol

- Test each rack individually
  - Water Demand < MF Design
  - Test rack will operate independently of the remaining 6 racks
- 5 mg/L ACH dosed upstream of the filters
- Set flux to 75.0 gfd (20° C)
  - 937 gpm at test conditions (~14.5° C)
- Data recorded 3-times per FM event (FM occurs every 14,000 gal)
- Test duration for each rack will span from one EFM to the next (800,000 gal)
Two initial rounds of tests were conducted:

- Each round tested all seven racks
- The first round was conducted following a CIP
- The second round was conducted immediately prior to the next required CIP

Based upon success of the testing each rack independently, a full-scale performance test would be conducted on all 6 racks simultaneously.

<table>
<thead>
<tr>
<th>Round</th>
<th>Days After CIP</th>
<th>Maximum Pressure Setting, psi</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>35</td>
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<tr>
<td>2</td>
<td>28</td>
<td>42</td>
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</table>
Results

First Round of Independent Rack Tests

Gross Flux w/ 1 Module Out (@20), gfd

Target Flux Rate

<table>
<thead>
<tr>
<th>Rack Number</th>
<th>After FM</th>
<th>Middle FM</th>
<th>Before FM</th>
<th>All Data</th>
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<tbody>
<tr>
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</tbody>
</table>
Results

First Round of Independent Rack Tests
Results

First Round of Independent Rack Tests

- Rack 2
- Rack 4
- Rack 7

16% (128,000 gal)
49% (392,000 gal)
Results

First Round of Independent Rack Tests

- 5 of 7 racks maintained target flux
- Rack 2 and Rack 4 were close to targeted value

- PLC will open rack’s valve position to 100% if the pressure header reaches the max pressure set point
  - Increase max pressure set point from 35 psi to 42 psi
Results

Second Round of Independent Rack Tests

Target Flux Rate
Results

Second Round of Independent Rack Tests

Percent Valve Opening, %

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Percent of Total EFM Duration, %

- Rack 1
- Rack 2
- Rack 3
- Rack 4
- Rack 5
- Rack 6
- Rack 7
Results
Second Round of Independent Rack Tests

- All 7 racks exceeded target flux
  - … at the end of the CIP cycle
  - … without exceeding 80% valve opening
  - … with only 5 mg/L ACH
Full-Scale Testing

Preparation for full-scale testing

- Drought conditions → Water Restrictions → BUT… we need to use more water
- Coordination with City of Brownwood (lowered all tanks)
- Fire Department conducted yearly testing fire plugs

Full-scale Test

- Header pressure set at 42 psi
- Full capacity for 48 hrs
- Paused for 8 hr to lower tanks
- Continued at full capacity for another 24 hrs

SUCCESSFUL TEST!
Performance Since ACH Addition

- Conventional plant has not operated since April
- Percent valve opening does not approach 85% until the last week of the CIP cycle
- BCWID exploring to converting operating mode to flow-based rather than pressure-based
- Conventional plant expected online in early 2014
- New customers expected to be online in Summer 2014
  - ~2 MGD demand
Acknowledgments

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Questions