An Efficient Aeration Strategy Sits on a Three-Legged Stool

A Case Study of Brookfield, WI

by Wendy Raisbeck
Outline

- Aeration Efficiency Stool
- Existing Conditions and Project Goals
- Aeration System Efficiency Evaluations
  - Diffuser Performance and Technology
  - In-Basin Aeration Piping
  - Post-Aeration Air Requirements
  - Airflow Requirements
  - Blower Performance and Technology
- Post-Construction Operation Data
Aeration Efficiency Stool

Efficient Aeration System

- Diffusers
- Blowers
- Process Control
Existing Conditions

- Original Construction in 1974
- Major Upgrades in 1985 and 2000
  - 12.5 mgd average flow
  - 31.2 mgd peak flow full treatment
  - 50.1 mgd peak flow wet weather (blended)
- Liquid Train
  - Screening, Grit Removal, Primary Clarification, BNR Activated Sludge, Sand Filtration, Disinfection
Existing Conditions – Aeration System

- Four Activated Sludge Basins
  - Fouled Ceramic Diffusers (2000)
  - Large Aeration Piping (1985)
  - Dormant Basins
- Activated Sludge Effluent Channels
- Post-Aeration
  - DO Measurement
- Primary Effluent Splitter Box
- Four Blowers (1985)
  - Centrifugal, 600 HP
Existing Aeration System Performance

![Graph showing airflow and percent of airflow equal or less than ceramic diffuser airflow and existing blower operating range.](image-url)
Project Goals

- Identify and Evaluate Solutions for Excess Energy Usage within Aeration System
- Implement Recommendations

INCREASED ENERGY EFFICIENCY
Aeration System Efficiency Evaluations

- Diffuser Performance and Technology
- Post-Aeration Air Requirements
- Air Control Piping and DO Control
- Blower Performance and Technology
Aeration System Efficiency Evaluations

- Diffuser Performance and Technology
- Post-Aeration Air Requirements
- Air Control Piping and DO Control
- Blower Performance and Technology
### Diffuser Performance and Technology

#### Diffuser Type

<table>
<thead>
<tr>
<th>Diffuser Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceramic Discs</td>
<td>• High new efficiency (1.2-2.2% per ft)</td>
<td>• Loss of efficiency over time</td>
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<tr>
<td></td>
<td>• 20 year life</td>
<td>• Requires constant airflow to diffuser</td>
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<tr>
<td></td>
<td>• 9” disc: Industry standard</td>
<td>• Prone to plugging</td>
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<td></td>
<td>• Many manufacturers</td>
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<tr>
<td></td>
<td>• Resistant to corrosive compounds</td>
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<td>EPDM Discs</td>
<td>• High efficiency (1.2-2.2% per ft)</td>
<td>• Loss of efficiency over time</td>
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<tr>
<td></td>
<td>• 7-12 year life</td>
<td>• ~1% per year over time</td>
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<td></td>
<td>• 9” disc: Industry standard</td>
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<td>• Many manufacturers</td>
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<tr>
<td></td>
<td>• Can use in-basin piping</td>
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</tr>
<tr>
<td>EPDM Discs + Teflon Coating</td>
<td>• High efficiency (1.2-2.2% per ft)</td>
<td>• Increased cost over EPDM</td>
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<td></td>
<td>• 7-12 year life</td>
<td>• Limited manufacturers</td>
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<tr>
<td></td>
<td>• 9” disc: Industry standard</td>
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</tr>
<tr>
<td></td>
<td>• No efficiency loss over time</td>
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<td>• Resistant to corrosive compounds</td>
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<td>• Can use in-basin piping</td>
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</tr>
<tr>
<td>High Efficiency</td>
<td>• Highest efficiency (2.2-3.8% per ft)</td>
<td>• High capital</td>
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<td></td>
<td>• 7-12 year life</td>
<td>• Limited manufacturers</td>
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<tr>
<td></td>
<td>• Single diffuser vs. multiple discs</td>
<td>• Cannot use in-basin piping</td>
</tr>
</tbody>
</table>
Diffuser Performance and Technology

Cumulative Cost, $

Years in Operation

Ceramic (1.7%/ft)  EPDM (2%/ft)  EPDM+Teflon (2%/ft)  HE EPDM (3%/ft)
Diffuser Performance and Technology

- **Recommendation**
  - Reuse In-Basin Piping
  - Bid EPDM Discs and EPDM Discs with Teflon Coating

- **Implementation**
  - EPDM Discs with Teflon Coating
Aeration System Efficiency Evaluations

- Diffuser Performance and Technology
- Post-Aeration Air Requirements
- Air Control Piping and DO Control
- Blower Performance and Technology
Post-Aeration Air Requirements

- Blowers
  - Aeration Blowers
  - Dedicated Post-Aeration Blower

- Effluent DO Measurement Location
Post-Aeration Air Requirements

Location of Existing DO Probe

Parshall Flume

Location of New DO Probe

Step Aeration

Fine Bubble Aeration Tank No. 1

Coarse Bubble Aeration Tank No. 1

Fine Bubble Aeration Tank No. 2

Coarse Bubble Aeration Tank No. 2
Post-Aeration Air Requirements

DO (mg/l)

January  February  March  April  May  June  July  August  September  October  November  December

- Assumed Influent DO
- DO from Cascade Aeration
- DO Limit
Post-Aeration Air Requirements

- Recommendation
  - Aeration Blowers to Provide Air
  - Relocate DO Probe
Aeration System Efficiency Evaluations

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Air Control Piping and DO Control
Existing Layout

From Aeration Blowers

Zone 1 - Anoxic

Zone 2 - Aerobic

Zone 4 - Aerobic

Zone 3 - Aerobic

ML

DO

FM

20” FCV

ML

DO

ML
Air Control Piping and DO Control
New Layout

Zone 1 - Anoxic
ML
4" FCV
FM
DO

Zone 2 - Aerobic
FM
6" FCV
ML

Zone 3 - Aerobic
ML
DO

Zone 4 - Aerobic
ML
DO
NH4

From Aeration Blowers
Air Control Piping and DO Control
New Layout
Aeration System Efficiency Evaluations

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Sulzer-ABS 400-hp Blower Selection

![Graph showing airflow and percent comparison](image-url)
Aerzen 400-hp Blower Selection
Blower Performance and Technology
Post-Construction Operation Data

Post-Aeration Operational Data

- Old DO Probe Location
- New DO Probe Location

Graph showing airflow and DO levels from January 2014 to June 2016.

- Effluent DO
- DO Limit
- Airflow

X-axis: Months (Jan-14 to Jun-16)
Y-axis: DO (mg/l) and Airflow (cfm)
Post-Construction Operation Data

Blower Operational Data

Airflow (scfm)

Jan-16 Feb-16 Mar-16 Apr-16 May-16 Jun-16 Jul-16 Aug-16
Blower Operational Data (2/26/16-8/28/16)
- Decreased Power Usage
  - 411,600 kwh (2,225 kwh/day)

Energy Savings to Date*
- $33,750 ($182/day)

Estimated Annual Energy Savings*
- $75,000

* Does not include demand charges
Post-Construction, A Level Stool

Efficient Aeration System

- Diffusers
- Blowers
- Process Control
Questions