Agenda

- **Energy independence**
  - Popular motto in industry
  - Decrease dependency on external energy sources

- **How do you get to independence?**
  - Where is energy consumed?
  - Stepwise process

- **Energy reduction**
  - Focus on aeration (at least for this presentation...)
Airflow Requirements

- **Variables of main concern**
  - Diffuser type
    - SOTE
    - $\alpha F$
  - Diffuser age
    - $\alpha F$
  - Process operation
    - DO setpoint
    - Process configuration
  - Mixing requirements
    - 0.06-0.10 scfm/ft²
Process and Mixing Airflow

- Thought experiment
  - 1 million gallon, four pass basin
  - 12 day SRT
  - 2 mg/L DO in all sections
  - Influent: 200 mg/L BOD, 30 mg/L TKN
  - How does loading rate impact airflow?
Process and Mixing Air

- **10 States design loading**
  - BOD: 15 lbs/1000 cu ft-day

- **Mixing conditions**
  - Minimum airflow: 0.12 scfm/square ft tank area

- **Operation**
  - Typically less than design loading
  - 50%? 75%?
Under loaded basins:
Mixing limited after 25% of basin volume
Process and Mixing Airflow

Influent Flow → A → B → C → D → Effluent

7.5 lbs/cu ft-day (50%)
11.2 lbs/cu ft-day (75%)
15 lbs/cu ft-day (100%)
18.6 lbs/cu ft-day (125%)
22.5 lbs/cu ft-day (150%)

Smaller value: more efficient

Airflow per mgd
Operational Flexibility

Closer unit process is operated to design capacity:
Higher efficiency

Source: WERF Energy Fact Sheet, 2011
Process and Mixing Airflow

- What does this mean??

- Efficient aeration:
  - process air > mixing air
  - In as much of aeration basin as possible

- Thought 1: Multi-pass basins to match load

- Thought 2: “Spread” load through basin
Spreading the Load

Influent Flow → A → B → C → D → Effluent

- **Airflow (scfm)**: 200, 400, 600, 800, 1,000, 1,200

- **Mixing**

- **Section**
  - A: 7.5 lbs/cu ft-day (50%)
  - B: 11.2 lbs/cu ft-day (75%)
  - C: 15 lbs/cu ft-day (100%)
  - D: 18.6 lbs/cu ft-day (125%)
  - Effluent: 22.5 lbs/cu ft-day (150%)

- **RAS**
Spreading the Load

- **Operational flexibility**
  - Operate closer to design loading conditions
  - Turn on/off aeration basins

- **Selector zones**
  - Still achieve BOD removal
  - “Push” ammonium down aeration basin

- **DO setpoints**
  - Decreased DO setpoints
  - Ammonium based DO control
Selector Zone Impact

Denitrification in selector zone

Load shifted through basin

Airflow (scfm)

Section

A B C D Total

Selector Zone

Influent Flow

Effluent

RAS
Selector Zone Impact

Influent Flow → A → B → C → D → Effluent

Load shifted through basin

Similar Effluent

- Full Aerobic
- Single Selector Zone

Ammonium (mg/L)

<table>
<thead>
<tr>
<th>Section</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<tr>
<td>Load</td>
<td>18</td>
<td>8</td>
<td>2</td>
<td>1</td>
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Influent Flow
DO Setpoint Impact

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<tbody>
<tr>
<td>Baseline</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
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<tr>
<td>Low DO</td>
<td>1.0</td>
<td>1.0</td>
<td>2.0</td>
<td>2.0</td>
<td>mg/L</td>
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</tbody>
</table>
DO Setpoint Impact

<table>
<thead>
<tr>
<th>Section</th>
<th>Airflow (scfm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>400</td>
</tr>
<tr>
<td>B</td>
<td>200</td>
</tr>
<tr>
<td>C</td>
<td>200</td>
</tr>
<tr>
<td>D</td>
<td>200</td>
</tr>
<tr>
<td>Total</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Reduced Airflow:
- Full Aerobic
- Full Aerobic - Low DO
DO Setpoint Impact

Influent Flow → A → B → C → D → Effluent

Ammonium (mg/L)

Similar Nitrification Rate

- Full Aerobic
- Full Aerobic - Low DO

Section

Ammonium (mg/L)

Section

A B C D
Accomplishing Efficient Aeration

- Operational flexibility in design
- Low DO operation
- DO control and level of control
- Currently under construction
- New aeration basins and blowers
Aeration Basin Flexibility
Impact on Airflow

Process flow diagram impacts airflow requirements

Operation based on treatment goals and energy targets

- Total Airflow (scfm)
- Modified University of Capetown (MUCT) Process
- Virginia Initiative Process (VIP)
- Johannesburg (JHB) Process

Bar chart showing airflow requirements for different processes.
Aeration Basins

- More to come at a future conference...
Trinity River Authority of Texas

- TRA CRWS Treatment Plant
  - North Texas
  - 189 mgd average day flow

- Single stage nitrification (SSN)

- Full scale impact of low DO and selector zones
Ammonia Based DO Control

- Nine Aeration Basins in Operation
  - AB 6: Selector zone for BNR = A/O Low DO
  - AB 12: SSN Low DO
  - AB 1-3, 4, 5, 10, 11: SSN Tapered Aeration
Full Scale Testing

- Low DO Operation
- Low DO Operation

Solid line: Instantaneous airflow
Points: 24-hour Average Values

- Total Airflow (scfm)
- No. Blowers Operating

Date Range:
9/1/2012 to 6/28/2013
Impact on Blowers

Historic operation:
- 4 blowers
- 1,200 horsepower each
- Guide vanes
- Total energy: 3,800 hp

Current operation:
- 3 blowers
- 1,200 horsepower each
- Total energy: 2,800 hp

30% Energy Reduction
Impact on Settling

- Low DO operation started mid-Sept. 2012

Graph showing SVI (mL/g) from 5/1/12 to 12/4/12, comparing Conventional DO Operation and Low DO Operation. SVI₅ = 90% SVI₃₀, Aerobic SRT: 7-9 days, MLSS: 4,500-5,500 mg/L.
New Lenox, IL

- STP No. 1: 2.5 mgd, nitrification facility
- Nutrient removal improvements currently under construction
- Aeration improvements included
  - Existing blowers: single speed, multi-stage centrifugal
  - No DO control
- How much DO control?
Option 1 - No Auto Control
Option 2 - Full Control
Option 3 - Control B+C
Option 4 - Control A
Option 5 - Control B
Option 6 - Control C
Impact on DO Concentrations

- DO Profile – Option 5 (Control B)

Model does not account for manual adjustments
Impact on Airflow Rates

Option 3 – Control B+C

No Control = constant airflow rate
Annual Savings

Increased Annual Savings

- Full Control: 25%
- Full Control 2ppm: 20%
- B+C Control: 20%
- A Control: 15%
- B Control: 30%
- C Control: 25%
- No Control: 0%

High savings, lowest capital (fewest control points)
Take Home Messages

- Operate close to design capacity

- **Selector zones:**
  - Reduced aerobic load
  - Utilize mixing air for process air

- **DO control**
  - Lower DO setpoints
  - Cost/benefit analysis on number of control points
Questions?

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