Wastewater Treatment Plant Energy Reduction With High Efficiency Aerators

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OBJECTIVE

TO PRESENT HIGH EFFICIENCY AERATORS THAT WILL REDUCE ENERGY CONSUMPTION IN WASTEWATER TREATMENT PLANTS, BASED ON EXPERIENCE AT THE DHAHRAN NORTH SEWAGE TREATMENT PLANT (NSTP)
OUTLINE

• BACKGROUND
• EVALUATION
• HIGHER MECHANICAL AERATOR EFFICIENCY
• DHAHRAN NSTP PROJECT
• CONCLUSION
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Dhahran NSTP Overview

**Dhahran North Sewage Treatment Plant**

**Dhahran Advanced Wastewater Treatment Plant**

Secondary Biological Treatment

Tertiary-Filtration Treatment
EXISTING AERATORS LOW EFFICIENCY
OUTLINE

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Energy Efficient Aeration Alternatives

Fine Bubble Diffusers

High Efficiency Mechanical Aerators
## Energy Efficient Aeration Alternatives

<table>
<thead>
<tr>
<th>SYSTEM TYPE</th>
<th>FINE BUBBLE DIFFUSERS</th>
<th>HIGH EFFICIENCY MECHANICAL AERATORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOFOULING</td>
<td>Biofouling sometimes reduces efficiency. Acid Cleaning Sometimes Required.</td>
<td>None.</td>
</tr>
<tr>
<td>ENERGY EFFICIENCY</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>ESTIMATED CAPITAL COST</td>
<td>More Expensive</td>
<td>Less Expensive</td>
</tr>
</tbody>
</table>
## ESTIMATED ELECTRIC POWER COSTS

<table>
<thead>
<tr>
<th>AERATOR</th>
<th>$O_2$ TRANSFER LB $O_2$/HP·HR</th>
<th>POWER USD/YEAR</th>
<th>SAVINGS USD/YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPICAL MECHANICAL AERATORS</td>
<td>2.5</td>
<td>$146,000</td>
<td>0</td>
</tr>
<tr>
<td>HIGH EFFICIENCY MECHANICAL AERATORS</td>
<td>3.5</td>
<td>$88,000</td>
<td>$58,000</td>
</tr>
</tbody>
</table>
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Fundamentals of Surface Aeration

- Surface Aeration is a distinct two-step process consisting of the “Spray Zone” and the “Re-Aeration Zone.”

- Approximately 66% of the mass transfer occurs in the “Re-Aeration Zone.”

- The “Re-Aeration Zone” is enhanced by fluid volume and higher pumping rates through the surface aerator.

- Novel system configurations can optimize the performance of both the “Spray” and “Re-Aeration” zones.
Surface Aeration System
Oxygen Transfer Characteristics

Surface Re-aeration Mass Transfer Zone

Spray Mass Transfer Zone
HI-FLO Surface Aeration System Impeller
Computational Fluid Dynamics (CFD)

Rigorous fluid dynamics simulation provides fundamental mixing insight
- Detailed impeller geometry used
  - Sliding-mesh model for impellers
- No experimental velocity data used as input
- Solve turbulent Navier-Stokes equations to obtain flow field
Technology Development Facilities
State College, PA., USA
m²t technologies Full Scale Aeration Test Facility
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Dhahran NSTP Plant Overview

- Converting Cell A to anoxic
- New Trains 6&7 constructed here
- Existing Trains 1-5
Construction of New Aeration Basins
Aeration Platform Elevation Check
HI-FLO Aerator Impeller Installation
# Dhahran Aeration System Process Requirements

<table>
<thead>
<tr>
<th>Stage</th>
<th>SOTR, lbs. O$_2$/hour</th>
<th>Minimum Bottom Velocity, ft./sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>157</td>
<td>0.5</td>
</tr>
<tr>
<td>2</td>
<td>84</td>
<td>0.5</td>
</tr>
<tr>
<td>3</td>
<td>61</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Required Train Average Standard Aeration Efficiency ("SAE") of 3.5 lbs. O$_2$/BHP-hr
HI-FLO Surface Aeration Design Configuration

<table>
<thead>
<tr>
<th>Stage</th>
<th>Nameplate HP</th>
<th>Speed, rpm</th>
<th>Impeller Diameter, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>45</td>
<td>87</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>45</td>
<td>74.5</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>45</td>
<td>74.5</td>
</tr>
</tbody>
</table>

Note: All parts in contact with the liquid were made from 316 SS
# Dhahran HI-FLO Performance Test Results

<table>
<thead>
<tr>
<th>Stage</th>
<th>Measured SOTR, lbs.O₂/hour</th>
<th>Actual BHP</th>
<th>Measured Bottom Velocity, ft./sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>165.9</td>
<td>44.6</td>
<td>0.69</td>
</tr>
<tr>
<td>2</td>
<td>86.2</td>
<td>24.9</td>
<td>0.73</td>
</tr>
<tr>
<td>3</td>
<td>61.5</td>
<td>18.7</td>
<td>0.64</td>
</tr>
</tbody>
</table>

Measured Train Average Standard Aeration Efficiency ("SAE") of 3.56 lbs. O₂/BHP-hr
HI-FLO Surface Aerator in Operation
OLD AERATORS
OUTLINE

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CONCLUSIONS

• HIGH EFFICIENCY MECHANICAL AERATORS ARE LOW MAINTENANCE COMPARED TO OTHER AERATION SYSTEMS

• HIGH EFFICIENCY MECHANICAL AERATORS REDUCE ENERGY CONSUMPTION
Thank you