IMPROVING PLANT AERATION USING GAS INFUSION TECHNOLOGY
AERATION IN WASTEWATER

- Municipal sewer collection systems-Odor Mgmt.
  - Lift and transfer stations
- Lagoons / Retention Ponds
  - BOD / COD treatment
  - Enhanced bio-activity – Sludge reductions
- Facilities & Plants
  - Head works
  - Aeration augmentation / replacement
  - Post aeration / disinfection
Common Types of Aeration

- Mechanical
  - Rotors or Brush
  - Slow & High Speed Splash
  - Induced Aspiration
- Combination
  - Submerged Turbine with compressor
  - Jet (pumps with compressor)
- Diffused
  - Coarse bubble
  - Fine Pore
  - Flexible membrane
- Gas Infusion Technology
  - Supersaturation of soluble gases
Aeration

• Aeration is the process of placing air into water as part of the treatment process.
  – Air contains slightly less than 21 % oxygen
  – Air “bubbles” high buoyancy causes off-gassing
  – Air bubbles “strip” and carry odors to the surface.
  – Aeration best suited for deep lagoons or tanks
  – Aeration systems are designed to run 24/7
  – Aeration systems average under 35 % efficiency

Oxygen Transfer Ratio
Oxygenation

- Oxygenation is the process of entraining dissolved oxygen into water
  - Utilizes oxygen gas to saturate carrier water
  - Dissolved oxygen does not form bubbles; eliminates off-gassing
  - DO remains in suspension until sheared or consumed
  - Effective even in shallow trenches or streams
  - Designed to run based on DO demand or set point
  - High efficiency Oxygen Transfer Efficiency (99+%)
Wastewater Energy Usage

Energy usage in WWTP

National Association of Clean Water Agencies (NACWA)
Survey of Energy Use
47 Respondents used 2.1 billion kWh of electricity

- In-plant pumping: 38%
- Effluent reuse pumping: 25%
- Aeration: 26%
- Other: 11%
Why Bubble knowledge is Important.

• Bubble size can impact effectiveness of mass transfer
  – Impacting rate of rise
  – Amount of interface area
  – Transfer efficiency

• Varying fluid conditions impact behavior of bubbles.
  – Surfactants
  – Viscosity
  – Density

• Determining bubble size for best “aeration” objective for wastewater influent
Basic Bubble Dynamics

- Typical shapes are spherical for smaller and ellipsoidal for larger bubbles
- Bubbles oscillate their shape and trajectory as they move through fluids
- The movement of a bubble results in a continuous change of the interface with the liquid.
- Bubbles reach terminal velocity rapidly based on buoyancy rise and drag force during ascent
- Bubbles grow as they rise in fluid column, until they disintegrate into smaller bubbles near surface, and gas off.
Bubble Movement

• Bubbles in turbulent flow vary their trajectory, behavior and evolution.
  – Example: stream of bubbles in a rising plume will accelerate faster than a lone bubble.

• Shearing of fluids creates lift perpendicular to velocity shear

• Drag factor affected by viscosity and density of liquid, which are affected by temperature
Fluid Flow Around Bubble

Clean Water – Faster rising

Surfactant Present - Slower Rising
# Mechanical Energy Efficiency Average of Mfgs.

<table>
<thead>
<tr>
<th>Type of equipment</th>
<th>kgO2/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brush Aerators</td>
<td>1.91</td>
</tr>
<tr>
<td>Surface Aerators Low Speed</td>
<td>1.86</td>
</tr>
<tr>
<td>Surface Aerators High Speed</td>
<td>2.43</td>
</tr>
<tr>
<td>Induced Surface</td>
<td>1.86</td>
</tr>
<tr>
<td>Submerged Turbine</td>
<td>2.07</td>
</tr>
<tr>
<td>Coarse Bubble Static Tube</td>
<td>1.49</td>
</tr>
<tr>
<td>Coarse Bubble Wide Band Grid</td>
<td>2.60</td>
</tr>
<tr>
<td>Fine Pore Ceramic Disc</td>
<td>2.34</td>
</tr>
<tr>
<td>Infusion Process Nano Infusion</td>
<td>5.44</td>
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</tbody>
</table>
Gas Infusion Technology
Efficiency Example

<table>
<thead>
<tr>
<th>Wastewater Flow Rate (gpd)</th>
<th>500.00 gal/min</th>
<th>30,000 gal/hr</th>
<th>720,000.00 gal/day</th>
<th>0.72 MGD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave BOD Concentration</td>
<td>200 mg/l</td>
<td>0.83 #/min</td>
<td>50 #/hr</td>
<td>1,201.59 #/day</td>
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<tr>
<td>Ave TKN Concentration</td>
<td>10 mg/l</td>
<td>0.04 #/min</td>
<td>3 #/hr</td>
<td>60.08 #/day</td>
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<tr>
<td>O2 Requirement</td>
<td>1.23 #/min</td>
<td>74 #/hr</td>
<td>1,769.94 #/day</td>
<td></td>
</tr>
</tbody>
</table>

129.38 GPM of Supersaturated carrier water required.

<table>
<thead>
<tr>
<th>Flow rate</th>
<th>130.00 gal/min</th>
<th>7,800 gal/hr</th>
<th>187,200.00 gal/day</th>
<th>0.1872 MGD</th>
</tr>
</thead>
<tbody>
<tr>
<td>O2 Delivered</td>
<td>880 mg/l</td>
<td>1.24 #/min</td>
<td>74 #/hr</td>
<td>1,787.00 #/day</td>
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<tr>
<td>Oxygen Excess or (Deficit)</td>
<td></td>
<td></td>
<td></td>
<td>17.06 #/day</td>
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</tbody>
</table>

Electrical costs based on 90% operating time

<table>
<thead>
<tr>
<th>Elect Estimate</th>
<th>117 gallons</th>
<th>220 volts *</th>
<th>79.56 amps</th>
<th>17503.2 watts or</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17.5032 kw/hr</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>420.0768 kw/day</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12707.32 kw/mo</td>
</tr>
</tbody>
</table>
Gas Infusion Technology

• Two gasification processes
  – Fixed bubble size – “Nano” Sub-micron
  – Variable size – By application requirement
    • 0.25 and larger for DAF, IAF processes
    • Mixing requirements
• High Density Oxygenation Processes
• Alternate Gas Rich Solutions CO2, N, etc.
• Delivery methodologies
  – Green Start Designs
  – Engineered to meet application requirements
Gas Infusion Technology

• Dissolved Gas levels in carrier fluid exceeding 800 PPM
• Infusion Technology bubble size - nano
  – Low buoyancy factor reduces off gassing
  – Modifiable bubble size for optimum performance
  – Moderate mixing action range
• Low energy to lbs/O2/day operation
• Operates utilizing wastewater side-stream or external fluid source.
Gas Infusion Technology

- Use wastewater as carrier; side stream of flow.
- Infuse carrier with supersaturated dissolved oxygen
- Return or direct oxygen rich carrier to basin or tank
- Offers O2 as preferred electron receptor to clock formation of H2S
- Treat at wet well, manhole or interceptors along collection system
Infusion Technology Advantages

• Delivers more dissolved oxygen than any other form of aeration.
• Can be injected into shallow stream or partially full pipe.
• Dissolved oxygen “emulsion” is stable resulting in minimal losses to natural off gassing.
• Utilizes a fraction of the energy required by other technologies.
• Competitive capital costs and low operating costs
• Compact footprint and minimal installation requirements
Infusion Technology
IT-15
IT 50

New Model in Production
IT-50 System

Green Start LLC
LeClaire, IA