Overcoming UV Interference in Leachate Discharges

NEW YORK STATE ASSOCIATION FOR SOLID WASTE MANAGEMENT

BOLTON LANDING, NY

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Site Landfill

- History
- Treatment Investigation and Plan
- UV Interference
- Design Considerations
- Treatment Plant Construction
- Startup
- Operation Maintenance Staffing
- Acceptance
- Effluent Pipeline
Landfill History

- 214 Acre site in limestone quarry 240 ft deep
- LF closed 2004
- Reaction in South Quarry
- Reaction:
  - Elevated temperatures
  - Odors
  - Subsidence
  - High strength leachate
  - Discharge to POTW cut off
  - Hauling -> $4 mil/mo
Tasks in 14 Months

► Testing
► Plans
► Permitting
► Interim Plan
► Final Plan – Permit from MSD
► UV Transmissivity
  ▪ Reroute Effluent Bissel Point Summer/Missouri River Plant – New 6 mile Force Main
  ▪ Coordination with MSD and State for Forcemain
► O&M Plan and Staffing Planning
Leachate Design Considerations

- Variability – Flow/Strength
- BOD/COD/TSS
- Ammonia
- TDS
- Color Refractory COD
- Metals – ex. Arsenic / Zinc
- Total Dissolved Solids/ Chlorides
- Heat (exothermic reaction)
- Cooling Towers / Heat Exchangers
  - Mesophilic vs. Thermophilic
- Corrosion/scaling
- Aeration Control
- Foam Control
- MBR Fouling
- Odors
- Aeration Control
- UV transmittance (POTW)
Leachate Pilot Scale Test at Site

- Clarification
- MBR
- Sludge Dewatering
- Electrocoagulation
- Reverse Osmosis
- Thermal Oxidizer
- Scrubber
- UV Investigation
Focus on UV Interference

► Discharge to POTW
► Many POTW installing UV disinfection
► 253.7 nm effective for bacterial kill, virus inactivation
  ▪ causes adjacent thymine molecules on DNA to dimerize.
  ▪ thymine dimer defects accumulate on a microorganism's DNA
  ▪ replication is inhibited,
  ▪ UV disinfection by rendering the microorganisms harmless.
► Leachate interferes with UV
  ▪ Turbidity/Iron
  ▪ Humic substances/Fulvic substances
► As UV absorbance increases, UV transmittance decreases:
  \[ \%\text{UVT} = 100 \times 10^{-A} \]

Source: UVComparison.com
Pilot Test Units
## UV-T Removal Technologies

### Advanced Oxidation Processes
- Ozonation
- TiO2 Photo-Catalytic Oxidation
- H2O2-O3 Treatment
- Ferrate
- Sulfate Radical Oxidation

### Physical Treatment Processes
- Powdered Activated Carbon
- Chemical Precipitation
- Nano-Filtration
- Reverse Osmosis
- Electrocoagulation

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Dilution</th>
<th>in DI H2O</th>
<th>in Tap H2O</th>
<th>in POTW Final Effluent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Blank</td>
<td>100.00</td>
<td>100.00</td>
<td>62.86</td>
</tr>
<tr>
<td>0.040</td>
<td>1 to 25</td>
<td>2.86</td>
<td>2.57</td>
<td>1.83</td>
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<tr>
<td>0.020</td>
<td>1 to 50</td>
<td>17.45</td>
<td>15.28</td>
<td>10.60</td>
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<tr>
<td>0.010</td>
<td>1 to 100</td>
<td>41.95</td>
<td>36.56</td>
<td>25.60</td>
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<tr>
<td>0.007</td>
<td>1 to 150</td>
<td>56.00</td>
<td>48.98</td>
<td>34.71</td>
</tr>
<tr>
<td>0.005</td>
<td>1 to 200</td>
<td>64.67</td>
<td>56.67</td>
<td>40.19</td>
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<tr>
<td>0.004</td>
<td>1 to 250</td>
<td>70.66</td>
<td>61.92</td>
<td>43.58</td>
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<tr>
<td>0.003</td>
<td>1 to 300</td>
<td>75.12</td>
<td>65.94</td>
<td>46.66</td>
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</tbody>
</table>
UV Transmittance with MBR Pilot Test Effluent

- 65% required at POTW
- Biologically treated waste had 0% transmittance
- Activated sludge showed sub-65% UV-T
- Testing program to raise leachate to 65% UV-T

<table>
<thead>
<tr>
<th>Sample Date</th>
<th>No dilution</th>
<th>1:100 dilution</th>
<th>1:200 dilution</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/29/2013</td>
<td>0.00%</td>
<td>49.20%</td>
<td>70.20%</td>
</tr>
<tr>
<td>9/25/2013</td>
<td>0.00%</td>
<td>40.80%</td>
<td>64.80%</td>
</tr>
<tr>
<td>9/30/2013</td>
<td>0.00%</td>
<td>40.60%</td>
<td>64.50%</td>
</tr>
</tbody>
</table>
Testing Program

- Bench scale
- Pilot scale treatment tests
  - at CEC,
  - other treatability labs,
  - at landfills
- Leachate contained recalcitrant organics
  - leachate effluents are resistant to further biological treatment (BOD/COD < 0.1)
- Test: ozone, ozone and hydrogen peroxide, Fenton’s Reagent oxidation, Sulfate radical, Titanium catalyst AOP, and membrane nanofiltration
- Discarded carbon adsorption, reverse osmosis, and electrocoagulation
UV-T after ozone and ozone/H$_2$O$_2$ treatment

![Graph showing improvement in UV-T over time for ozone only and ozone and hydrogen peroxide treatments.](image-url)
COD after ozone and ozone/H₂O₂ treatment

- Ozone only
- Ozone and hydrogen peroxide
Ozone and Ozone/Hydrogen Peroxide Color Change

Color change of biologically treated leachate with various oxidants (left to right: before oxidation, with ozone only, and with ozone and hydrogen peroxide)
Fenton’s Reagent

- No treatment
- 30 min
- 120 min

Transmittance, %

Wavelength, nm
Fenton’s Reagent Color Change

Leachate before Fenton’s (left) and post-Fenton’s leachate (120 min reaction time) after 30 minutes of settling (right).
Nanofiltration

Comparison of leachate color before and after nanofiltration

- Leachate color before and after nanofiltration and resin (absorber) steps
Membrane Alternatives

Leachate dilution ratio in effluent with 65% UV-T

- Ahlstrom Disruptor
- Ozone, 7 hrs
- Hydronautics
- Hydronautics + Disruptor
- Trisep
- Trisep + Disruptor
- RO membrane
<table>
<thead>
<tr>
<th>Heading</th>
<th>Multiplier</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effluent treatment</td>
<td>100</td>
<td>Meets Effluent requirements</td>
</tr>
<tr>
<td>Commercially Availability</td>
<td>10</td>
<td>Fundamental.</td>
</tr>
<tr>
<td>Construction</td>
<td>10</td>
<td>Equipment Delivery and Construction</td>
</tr>
<tr>
<td>Operability (ease of)</td>
<td>8</td>
<td>Ease of Operation</td>
</tr>
<tr>
<td>Hydraulic Variability (ability to manage)</td>
<td>5</td>
<td>Feed tank should buffer this.</td>
</tr>
<tr>
<td>Waste Loading Variability (ability to manage)</td>
<td>5</td>
<td>Feed tank should buffer this.</td>
</tr>
<tr>
<td>Chemical Storage &amp; Delivery (extent, hazard, DG compliance</td>
<td>7</td>
<td>Impacts footprint and distances to premises</td>
</tr>
<tr>
<td>requirements, complexity)</td>
<td></td>
<td>boundaries; System security.</td>
</tr>
<tr>
<td>Secondary Waste</td>
<td>6</td>
<td>Was secondary waste created? If so, what is the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>difficulty and cost to manage?</td>
</tr>
<tr>
<td>Footprint (small)</td>
<td>4</td>
<td>Critical for this site.</td>
</tr>
<tr>
<td>Power Requirement (low)</td>
<td>7</td>
<td>Small flows - all relatively low.</td>
</tr>
<tr>
<td>Capital Cost (low)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>O&amp;M Cost (low)</td>
<td>9</td>
<td>Can override capital over a long period of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>operation.</td>
</tr>
<tr>
<td>Start-up Period (low)</td>
<td>3</td>
<td>This is intended to be &quot;initial commissioning&quot;.</td>
</tr>
</tbody>
</table>
Comparative Ranking of Alternatives (higher better)

Relative Rank

- Pump and Haul Pretreatment; Ozone; Absorber
- Pretreatment; Nanofiltration; Absorber
- Pretreatment; Fenton's Reagent Plus Absorber
- Pretreatment; Absorber
- Forcemain
Construction Progress - May 2013
Construction Progress – June - July 2013
Construction Progress – Fall 2013
Construction Progress December 2013
Construction Progress January 2014
Construction Progress – March 2014 Treatment Bldg
Construction Progress March 2014 – Aeration Tanks
Construction Progress – April 2014
Construction Progress - May 2014
Construction Progress – May 2014
Startup – May 2014
Construction Status – June 2014
Startup - July 2014 – Process Flow
Progress – July 2014 – Solids Processing
Startup – August 2014
-We Make Sludge!
Startup Challenges

- Operator Transition & Philosophy
- Foam
- Temperature
- Pump Issues
- UV – Pipeline to Mississippi River WWTP
Weather and Power Outage Protection
Clarifier Removes 75% solids
Effluent Acceptance by MSD

- **BOD:**
  - 30,000 mg/l $\rightarrow$ 34 mg/l $= 99.932\%$ removal

- **COD**
  - 55,000 mg/l $\rightarrow$ 2,200 mg/l $= 96\%$ removal

- **Metals – All under limits**

- **Metals** | Permit, mg/l | Acceptance Test, mg/l
  - Arsenic | 0.4 | 0.0529
  - Chromium | 5.0 | 0.0298
  - Copper | 2.7 | 0.247
  - Iron | 150 | 2.7
  - Lead | 0.4 | 0.0082
  - Nickel | 2.3 | 0.0359
  - Zinc | 3.0 | 0.0595
Conclusion

► Be aware of non-traditional leachate concerns
► High strength leachate 65% UV-T is challenging
► Numerous technologies available
► NF - 1,000 Dalton cutoff may not work in every location – may need “loose” RO
► Multiple serial technologies may be required
► UV lamp replacement with newer technology lamps at POTW may be an alternative
► Bench and pilot tests recommended
  ▪ Each leachate is different!
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