ENGINEERING DEPARTMENT

UTILIZING BIOREACTORS TO REMOVE DISSOLVED NUTRIENTS IN WASTEWATER

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INTRODUCTION
DESIGN REQUIREMENTS

• Find mean value where nitrogen is sitting during summer, and say we are trying to reduce it at least by half (will at least decrease the cleaning time by a factor of two)

• Average Concentrations:
  – 0.8761 mg/L Nitrogen - N
  – 0.0049 mg/L Ammonia – NH₃
  – 0.0057 mg/L Nitrite – NO₂⁻
  – 0.8655 mg/L Nitrate - NO₃⁻
  – 1.1119 mg/L Phosphate – PO₄³⁻
ATTACHED GROWTH FILTERS

- Designed to filter out nutrients with the use of microorganisms
- Microorganisms consume nutrients (dissolved solids) and form biomass that can be physically removed (suspended solids)
- Utilizes packing materials or medias to support and facilitate the growth of microbes
ATTACHED GROWTH WITH PLASTIC MEDIA
TESTING

Experiment Goal: Optimize algae growth within closed system

• Variables:
  – Media
    • Type and quantity
  – Lighting
    • Color and duration
  – Aeration
  – HRT (Hydraulic Residence Time)
    • Flowrate
    • Volumes
MEDIA

• Surface area of media
  - Pool surface area: 10,000 ft²
• Type of media
  - Ceramic: 45 ft²
  - Plastic: 2 ft²
The blue and purple bucket visually showed the most growth along with faster nitrification.

Red algae grew brown algae, but the goal is to grow primarily green algae.
NITRATE LEVELS WITH NITRIFICATION

- Total Nitrogen will be reduced with attached growth filters
- Nitrification will cause nitrate (NO₃⁻) to increase while nitrite (NO₂⁻) and ammonia (NH₃) decrease

Figure 4.11. Time-course behavior of measured forms of N in attached-growth batch experiments at 20 °C.

ATTACHED-GROWTH SYSTEM FOR NITRIFICATION AT LOW TEMPERATURE Zhe Sun Purdue University
AERATION

• Oxygen demand is a limiting factor in growth
HRT (HYDRAULIC RESIDENCE TIME)

- Desired HRT of 2 days
- Prototype Methods:
  - Pump voltage
  - Pipe diameters (1.5" to ¾")
  - Head loss calculations (17 GPM to 2.0 GPM)
  - HRT 6 minutes

<table>
<thead>
<tr>
<th>Discharge Height Above Pumping Level</th>
<th>5 ft (1.5 meters) 1,800 gallons/hr (6,814 liters)</th>
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<tbody>
<tr>
<td>10 ft (3.0 meters) 1,320 gallons/hr (4,997 liters)</td>
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<tr>
<td>15 ft (4.5 meters) 720 gallons/hr (2,725 liters)</td>
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<tr>
<td>20 ft (6.0 meters) 120 gallons/hr (454 liters)</td>
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CURRENT PROTOTYPE
RECOMMENDED OF ACTION

- Install 500-gallon tank with blue LED
- 422 units of ceramic media (double surface area)
- Year-long duration
- HRT of 2 days
RISK MANAGEMENT

- Algae growth
- Light
- Media spillage
COST ANALYSIS

Over 8 months of cleaning from 32 to 16 water changes

• Labor: $3,072
  – $32/6 hours to drain and refill

• Water: $8,432
  – $0.0062/gallon

• Total: $11,504
REFERENCES

• Zhe Sun. ATTACHED-GROWTH SYSTEM FOR NITRIFICATION AT LOW TEMPERATURE Zhe .Sun Purdue University. 2014.  
  https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1293&context=open_access_theses