Photoelectrocatalytic Oxidation (PECO)
Advanced Water Treatment Technology

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Overview

1. Aquaculture

2. Problems
   a) Ammonia
   b) Chemicals that cause “off-flavors” in fish

3. Photoelectrocatalytic oxidation (PECO)
   a) What is PECO?
   b) Solving the ammonia problem
   c) Solving the off-flavor problem

4. Other applications
Aquaculture

Human Population Growth

World Fish Production

Resource Efficient Production

<table>
<thead>
<tr>
<th>Feed conversion ratio</th>
<th>Energy retention</th>
<th>Protein retention</th>
<th>Edible yield</th>
<th>Edible meat per 100 kg fed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27%</td>
<td>10%</td>
<td>14%</td>
<td>27%</td>
</tr>
<tr>
<td></td>
<td>24%</td>
<td>21%</td>
<td>18%</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>68%</td>
<td>46%</td>
<td>52%</td>
<td>41%</td>
</tr>
<tr>
<td></td>
<td>11 kg</td>
<td>21 kg</td>
<td>17 kg</td>
<td>4-10 kg</td>
</tr>
</tbody>
</table>

Note: FCR of cattle varies between 4.2 and 9.8 depending on feed (finished on cereal or grass)

Sources:
Climate Friendly Production

Production Methods

Ponds

Net Pens

RAS
Problem of Ammonia

Nitrogen Cycle

Ammonia ➔ Nitrite ➔ Nitrate

The point at which this filter system is mature.
Biofiltration has Problems

- 4-8 week lag time
- Nitrate accumulation
- Vulnerable to environmental change
- Antibiotics
- Space issues
- Cleaning

Solution

PECO device that converts ammonia into nitrogen gas
Mechanisms of Action

1. UV photolysis
2. Direct oxidation
3. Production of oxidants
   a. hydroxyl radicals
   b. chlorine
Problem of “Off-Flavors”

- Geosmin and 2-methylisoborneol (MIB) - highly odorous, earthy-musty metabolites of aquatic microorganisms.
- Very low concentrations are a problem (~15 ng/L)
- Rapidly absorbed by fish and stored in lipid
- Management of off-flavors is difficult and expensive
Current Solutions

1. Manage microorganisms that produce these chemicals
   a) Antibiotics
   b) Ozone

2. Purging off-flavored fish with clean water before marketing

![Geosmin](image1)

![MIB](image2)

PECO is Potential Solution

![Graph](image3)
Other Applications for PECO

1. Recreational water (pools, spas, etc.)
2. Drinking water
3. Environmental remediation
4. Industrial remediation
5. Food and beverage
6. Oil and gas applications
   a) Sterilize fracking flow-back water
   b) Destroy polymers used during enhanced oil recovery
7. Ballast water disinfection

Advantages of PECO

* Multiple modes of action
* On-site oxidant production
* No hazardous transportation
* Easy installation and start-up
* Low maintenance
* High reliability
* Scalable
* Easily integrated into systems
* Compact footprint
* Minimal byproducts
* Relatively inexpensive
* Superior treatment
* Low energy