Application of Ultrasound Radiation for Agricultural Product Improvement and Environmental Renovation

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Contents of Presentation

1. Introduction
2. Environmental Renovation
3. Quality Improvement of Agricultural Product
4. Summary
Application of Ultrasound Technology

1. Utilization of reflection echo from target substances
   echo diagnosis, fish finder, vehicle sonar etc.

2. Utilization of kinetic power of ultrasound radiation
   washing devices, atomizer, cosmetic devices etc.
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Percentage of water bodies which meets Water Environmental Standard

Necessary measures have to be taken for Internal load.

Sediment improvement
Lake Kasumigaura

- Basin area: 220km²
- Total dike length: 249.8km
- Ave. depth: 4m
- Max depth: 7m
- Ave. rainfall: 1,282mm
- Annual water flow: Appx. 1.3 Bil m³
- Volume: Appx. 0.8 Bil m³
- Ave. water retention time: Appx. 200 day
- Water quality (COD): 7.5mg/L
- Population around: 0.96M
Enclosed water body in summer

Formation of Density gradient

higher Temp.
lower

Algal blooming

Anaerobic condition

Acceleration of nutrients release
Enclosed water body in winter

- Lower temp.
- Higher temp.
- $O_2$

Aerobic condition
Rapid monitoring of the lake sediment and its location

Stimulation of mineralization (minimize organic substance content as source of nutrients)
Inhibition of reduction in sediment surface

**Biological treatment**
- Development of microbial pellets
  - Indigenous bacteria
  - High degradation ability of organic matter
  - Psychrophilic bacteria

**Physico-chemical treatment**
- Supply of oxygen to bottom layer
- Countermeasure for algal blooms

**Monitoring technique**
- Rapid monitoring of the lake sediment and its location

**Seasons**
- Winter
- Summer

**Screening**
Depress growth of microalgae

Degradation by bacteria or zooplankton which can predate microalgae
Prototype of device for algae treatment with ultrasound radiation
<table>
<thead>
<tr>
<th>Treatment time</th>
<th>bottom</th>
<th>Surface (side view)</th>
<th>Surface (top view)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 min</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
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<tr>
<td>10 min</td>
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<td>40 min</td>
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</table>
Target Area
a. Map of Sydney Olympic Park (O)
b. Overview of the target pond
c. Constructed mesocosm (6-meter in diameter, 8-meter in depth)
a. Before operation  
*Front:* treatment mesocosm,  *Back:* Control mesocosm

b. Treatment mesocosm after 1 day operation.  
c. Control mesocosm after 1 day operation  
d. Treatment mesocosm after 2 day operation  
e. Control mesocosm after 2 day operation
Fish finder

- Reflection echo
- Transmission of ultrasound

School of fish A

School of fish B
Geological profiles of a polluted lake sediment
Transducer for sediment monitoring
Outline of the sediment monitoring device

- Satellite
- Sensor GPS
- GPS signal receiver
- Notebook computer
- Signal amplifier
- Analogue/digital transformer
- Location data on map
- Bottom of lake
- Transducer: transmit and receive
- Sediment
Scanning of lake sediments

- Sediment layer (turbid)
- Bottom of lake (soft mud)
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Percent removal of ethion standard solution using ultrasonic irradiation with various frequencies
Ethion residue in tangerine after washing in the combination of ultrasonication and ozonation. Error bars denote standard deviations. Different letters indicate significant differences by Duncan's multiple range test ($p \leq 0.05$).
Percent degradation of chlorpyrifos by ultrasonication
Percent degradation of chlorpyrifos by ozonation
Percent degradation of chlorpyrifos after using ultrasonic and ozone treatments
Ultrasound chamber for treatment of agricultural crops
Summary

Ultrasound radiation was found to be effective to deflate phytoplankton which causes water quality deterioration in enclosed water bodies.

Ultrasound radiation was successfully applied to monitor rough morphological profile of lake sediment.

Ultrasound radiation was able to apply to degrade chemical substances causing quality problems of agricultural and aquaculture crops with assist of ozonation or photocatalytic materials.
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Thank you very much for your kind attention!
ขอบคุณมากครับ
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