Pompano Culture in Recirculating Aquaculture Systems

Funding Thanks to Paul S. Wills
Inland Recirculating Aquaculture Systems

Production
Reproduction and Larviculture
Nutrition
Engineering
Recirculating Aquaculture Systems (RAS)

- Year round growing season
- Reduced water consumption
- Reduced effluent discharge
- Intensive production
- Enhanced biosecurity
- Increased food safety
- Containment of escapees
- Environmental Sustainability

Ocean Science for a Better World
Basic RAS Design

Waste Water & Evaporation

Feed

Solid and Dissolved wastes

Solids Filtration

Ammonia (Highly Toxic)

Concentrated Waste Sludge

Biofiltration

Makeup Water

Oxygen

Nitrate (very low toxicity)
Advanced RAS design and Operation

HBOI-FAU ACTED Workshop:

“Recirculating Aquaculture Systems: Design, Engineering and Operation”

Instructors: Michael Timmons and Jim Ebeling

Dates: October 17-19, 2013

Cost: $450

Information: See Jill Sunderland
or, www.aquaculture-online.org
or, www.fau.edu/hboi
or, call 772-242-2506
Basis of the Commercial System Design

• Scaled up version of tested design developed jointly for USDA-ARS project and FL-FWCC marine hatchery program FMFEI

• System Tested with:
  – Red Drum up to ~90 Kg/m³
  – Florida Pompano ~40 Kg/m³
1. Long flow pathway moving bed reactor with cross flow oxygenator, float valves, and propeller pump; 2. Incoming salt and freshwater lines with float valves and water meters; 3. UV sterilizer; 4. Torrus filters with 13ft³ of MB3 floating plastic media; 5. Ten-foot diameter tanks w/ center sump and sidebox drain; 6. Diverter box; and 7. 60 micron drum filter.
Commercial System Design

Culture Tank
20,230 gallons
25 ft diameter 6 ft deep
6 inches free board

Pump Basin
100 gpm each
200 gpm

UV Filter

Foam Fractionator
Solar Panel

Static Bed Filters*

Moving Bed Biofilter
250 ft³ of MB³ biomedia

Drum Screen Filter 40 µm

Drum Filter Washdown Water Filters

Frictional Head Loss 15 inches

Overflow Bypass

* Static Bed filters each contain 8 ft³ of MB³ biomedia
Panorama of Filtration System

- Return Water
- Foam Fractionator
- Main Pumps
- Biofilter Drum Screen Filter
- Static Bed Filters
- Ultraviolet filters
- Pumping Basin
- Main Pumps
- Biofilter Drum Screen Filter
- Static Bed Filters
- Ultraviolet filters
- Pumping Basin
Drum Screen Filter
Microscreen Cleaning Process
Waste Water Recapture

- We used a Static Bed Filter to separate solids from Drum Screen Filter Waste stream
  - Concentrates solids prior to discharge
  - Recaptures significant component of water used for wash down of drum screen
  - Each contains 8 Ft³ MB³ Media
Solids removal efficiency
(< 50 microns)

Removal Efficiency (%)

Swirl separator
Static bed
Moving bed

RE = (TSS\textsubscript{IN} - TSS\textsubscript{OUT}) / TSS\textsubscript{IN}
Moving Bed Biofilter
(250 ft$^3$ MB$^3$ Biomedia)

Aeration Keeps Bed Fluidized
Minimum Dose Desired

30,000 uW sec/cm²

The two units delivering

~150,000 uW sec/cm²
Tank Cover
Aeration and Oxygenation
Aeration and Oxygenation

Oxygenation Zone 1

Oxygenation Zone 2

Aeration Zone

25 ft Diameter

O_2 Sensors
Backup Systems

• Systems designed to combat “Murphys Law”
  – “If anything can go wrong it will”

• Therefore managers must:
  – Anticipate
  – Plan
  – Train
  – Respond

• (an automatic system that “cries wolf” can derail this necessary task)
Backup Systems

• Generators
• Automatic oxygen system
Generators

- Must have disconnect switch and meet other local requirements
Automatic Oxygen System

- Opens oxygen flow to tanks regardless of monitoring systems or other backup systems if the power turns off.
- Must use Normally Open Solenoid Valves for failsafe system.
  - Normally open → closed when power applied.
Broodstock Conditioning and Spawning System
USDA-ARS/HBOI-FAU Design
Broodstock Profile

**Florida Pompano**

Weight: 0.7 – 2.3 kg  
Mature age: 1 – 3 yrs  
Temp: 18 – 30 °C  
Salinity: 5 – 36 ppt
## Water Quality Management Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Target Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>16 – 30 C</td>
</tr>
<tr>
<td>pH</td>
<td>7.6 – 8.2</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>≥ 5 mg/L</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>≥ 200 mg/L</td>
</tr>
<tr>
<td>Ammonia</td>
<td>≤ 1 mg/L</td>
</tr>
<tr>
<td>Nitrite</td>
<td>≤ 2 mg/L</td>
</tr>
<tr>
<td>Total dissolved solids</td>
<td>≤ 5 mg/L</td>
</tr>
</tbody>
</table>
Broodstock Conditioning System

Culture Unit (5.7 m³)

Egg Collectors (0.3 m³)

Sump (2.3 m³)

Pump to chiller

Cartridge filters

UV

Beadfilter (0.1 m³)

Return from chiller

Waste
Nursery System
Limitations of RAS Technology

• Waste products from the fish must be treated before discharge
  – This is much easier than in other aquaculture systems such as open ocean net-pens

• No one has ever achieved 100% recirculation due to water needed for removing waste products and lost to evaporation

WASTES !!!!!
What are they?
- Uneaten feed and other Solids
- Liquid Excretions

One Characteristic of these “Wastes” is that they contain quite a bit of nutrient
- (esp., Nitrogen, Phosphorus)

So, why not USE nutrients instead of discharging them?
The Answer: Integrated Multi-Trophic Aquaculture (IMTA)

Turn Wastes into Resources

The Next Generation in Recirculating System Design

IMTA = Integrated Multi-trophic Aquaculture Systems
Prototype Land Based HBOI-IMTA Funded Through Aquaculture SLP

Prepared Feed

Fed Culture

Fed Culture

Prepared Feed