RECIRCULATION AQUACULTURE SYSTEM (RAS) - A BIOSECURITY SOLUTION FOR PRAWN FARMING

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RAS explained
How it works?
Bio filtration
The future of RAS
Why RAS fails?
RAS in prawn farming - where is the value?
Q/A
Recirculating aquaculture system (RAS) is a technology for farming of aquatic animals in which the process water is continuously reconditioned and reused.

What justifies a RAS?

1. **Limited availability of water in:**
   - Quantity
   - Quality

2. **Limited discharge**
   Current legislation in QLD impose discharge limits to:
   - Chemicals and Drugs
   - Physico-chemical indicators
Recirculating aquaculture system (RAS) is a technology for farming of aquatic animals in which the process **water is continuously reconditioned and reused.**

1. RAS can decreases the water demand up to 99% of the original requirements in flow through (FAO)
2. Independence from external condition
3. Control all the parameters in the production
Flow Through – Limited control.

- Water Exchange
- O2
- Stock Density
- Feeding Rate
- Feed Quality
### MAIN ADVANTAGES

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<th>Light</th>
<th>Temperature</th>
<th>Salinity</th>
<th>Alkalinity</th>
<th>pH</th>
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- **Nitrogen nutrients**
- **CO2**
- **Water Exchange**
- **O2**
- **Feed Quality**
- **Organics**
- **Stock Density**
- **Feeding Rate**

**Control** = **Monitoring**
1. Risk reduced
   - Better filtration
   - Probiotic

- Light
- Temperature
- Salinity
- pH
- Organics
- Feeding Rate
- Stock Density
- CO2
- Nitrogen
- nutrients
- O2
- Water Exchange
- Alkalinity
- Feed Quality
- Organics
- Diseases
HOW IT WORKS?

- **Aeration and Oxygenation**
  - Diffusers, P. wheels, O2 cones, U tubes

- **CO2 Removal**
  - Diffusers, Degassing Column

- **Biological Filtration**
  - Fluidised media, Micro filters, etc.

- **Disinfection**
  - Ozone contact

- **Fines & Dissolved Solids**
  - Foam Fractionation

- **Solids Removal**
  - Sedimentation, Scree filters, Bead Filters, Sand Filters, Drum filters, Bag filters

- **Temperature**
  - Inline and submersible heaters, heat ex

- **Disinfection**
  - UV

- **Reservoir**

- **Water Source**
  - Fresh
  - Marine

- **Culture Tanks**

- **Sump & Pumps**

- **Culture Tanks**

- **pH**
Toxicity of Ammonia and Nitrite to Penaeus monodon Juveniles

Jiann-Chu Chen, Shun-Chiang Lei

First published: December 1990  Full publication history
Cited by (CrossRef): 65 articles  Check for updates  Citation tools
Important facts about bio-filters and nitrifying bacterial:
1. It consumes O2 and alkalinity, and produces CO2
2. It needs substrate for to grow, but it do NOT consumed organic solids
3. Produces little bacterial biomass and growth slow
4. Easily flushed out
5. Grow better in warm water >3ppm of dissolved nitrogen
6. NOT made to operate with light, otherwise…
7. Sensitive to environment changes
8. When matured, it becomes a source of natural probiotic

Nitrogen removal mechanism:
1. Photoautotrophic algae
2. Heterotrophic bacteria
3. Autotrophic bacterial
“nothing is created, nothing is lost, everything is transformed.”

**Energy efficiency:**
Single lifting stages

**Sludge and waste treatment:**
Dewatering technologies
Biological use of waste – BFT and integrated systems

**Nitrogen waste removal:**
Deammonification reactors – Anammox
Production of Micro- and Macro-algae biomass
Why there is so many failure in RAS operations?

1 - System design
2 - Business plan
3 - Marketing
4 - Lack of resources

SOURCE: Jeffery K., Stinton N. & Ellis T (Cefas) (2010)
RAS IN PRAWN FARMING

Where RAS delivers value in prawn farming?

- **Decrease viral load and prevent it from entering the farm**
  - **BIOSECURITY**
  - **WSSV**

- **Decrease Stress**
  - **SPR animals**
  - **Geomembrane**
  - **Water filtration**
  - **Water disinfection**

- **Increasing Resistance**
  - **SPR animals**
  - **Water**

- **Control of water parameters, Temp, pH, salinity**
  - **Organic matter treatment**

- **Good Practices**
  - **Probiotics**

- **Sanitary dry-outs**
  - **Sanitary barriers: domes, green-houses**

- **SPF animals**

- **People and equipment disinfection**

- **Decrease Stress**

- **Immune-stimulants**

- **RAS**
RAS IN PRAWN FARMING

Biosecurity and Performance

- **WSSV**
- **BIOSECURITY**
- **Decay and Stress**
- **Decrease viral load and prevent it from entering the farm**
- **Control of water parameters, Temp, pH, salinity**
- **SPF animals**
- **Probiotics**
- **Immune-stimulants**
- **Increasing Resistance**
- **Decrease Stress**
- **Sanitary dry-outs**
- **Geomembrane**
- **Water filtration**
- **Water disinfection**
- **RAS**
- **Organic matter treatment**
- **Aeration and O2**
- **Nutrition**
- **Sanitary barriers: domes, green-houses**
- **People and equipment disinfection**
- **Good Practices**

**Good Practices**

- **Decrease viral load and prevent it from entering the farm**
- **Control of water parameters, Temp, pH, salinity**
- **SPF animals**
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**Immune-stimulants**

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- **Water disinfection**
- **RAS**

**Sanitary dry-outs**

- **Geomembrane**
- **Water filtration**
- **Water disinfection**
- **RAS**

**Geomembrane**

- **Water filtration**
- **Water disinfection**
- **RAS**

**Water filtration**

- **Water disinfection**
- **RAS**

**Water disinfection**

- **RAS**
Biosecurity and Performance

1. Mainly in fish farming globally
   1. Quarantine
   2. Broodstock
   3. Hatchery – Nursery
   4. Grow out

2. Prawn farming
   1. Quarantine
   2. Maturation
   3. Breeding programs
   4. Larval hearing up top PL

But commercial production has been done more in BFT
THANK YOU!

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CARBON DIOXIDE, ALKALINITY AND PH RELATIONSHIP

• Respiration releases (CO$_2$) in the water. It hydrates and form carbonic acid(H$_2$CO$_3$), which equilibrates in the water carbonate buffer forming bicarbonate(HCO$_3^-$) and carbonate(CO$_3^{2-}$) with the release of the H$^+$. 
(This represents the increase of alkalinity and decrease of pH)

• Degassing water removes (CO$_2$), than the carbonate system in the water re-equilibrates to form additional (CO$_2$) and (H$_2$CO$_3$) using bicarbonate(HCO$_3^-$) and carbonate(CO$_3^{2-}$) with the removal of (H$^+$).
(This represents the decrease in Alkalinity and increase in pH).

• Nitrification releases H$^+$ ions to the water, decreasing the pH, making the carbonate system re-equilibrate to form additional CO$_2$ and H$_2$CO$_3$ using bicarbonate(HCO$_3^-$) and carbonate(CO$_3^{2-}$)
(This represents the decrease in Alkalinity with decrease in pH).