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RAS technology state-of-the-art and further development

University of Rostock

Aquaculture & Sea-Ranching

Faculty of Agricultural and Environmental Sciences

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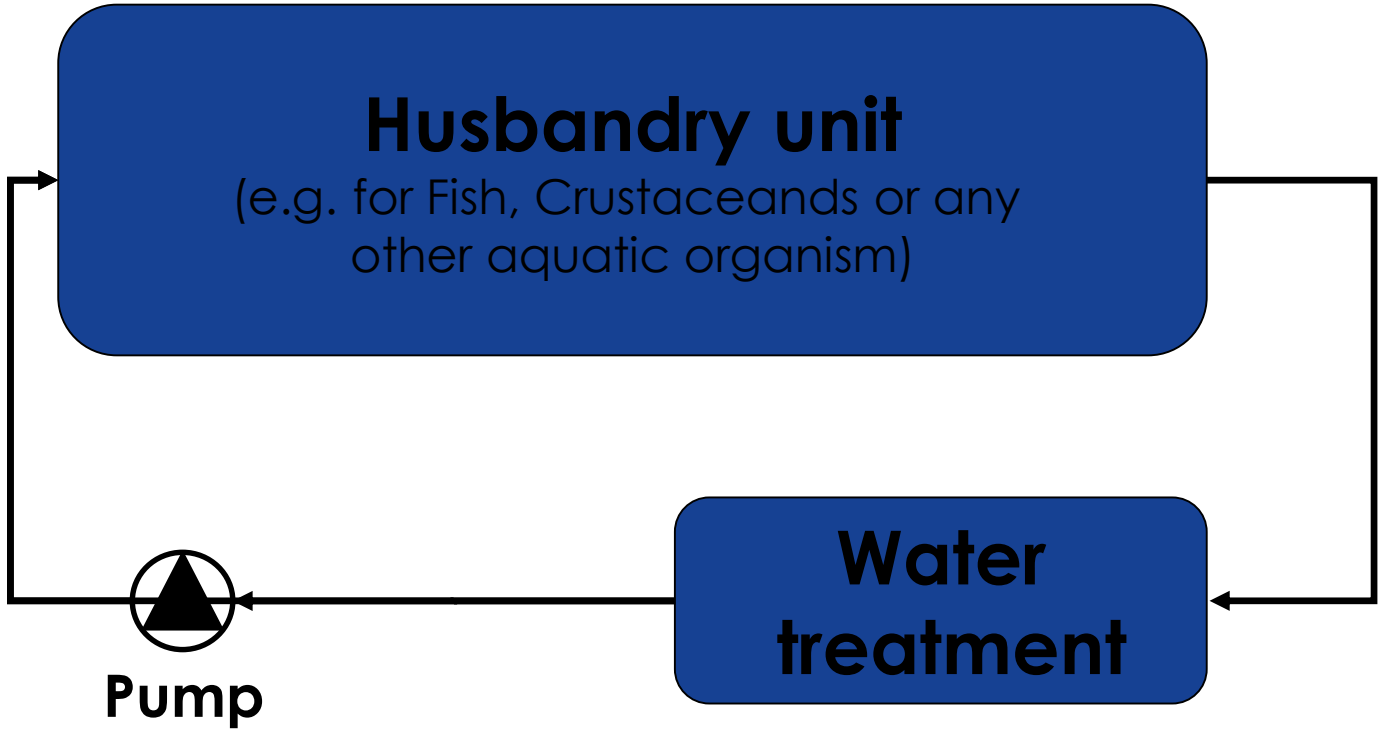
RAS technology state-of-the-art and further development

- Questions to be answered:
  - What is a Recirculating Aquaculture System (RAS)?
  - What components are applied?
  - What are RAS used for?
  - What are the advantages of a RAS?
  - What are the disadvantages of a RAS?
  - How do state-of-the-art RAS look like?

What is a Recirculating Aquaculture System (RAS)?



What is a Recirculating Aquaculture System (RAS)?

- A RAS is a collection of different components between which water is circulated with a "pump"

- Units for the culture of the organisms and the water treatment are usually (spatially) separated from each other

What is the purpose of the different components?

- **Husbandry units:**

  Enclosure of the cultured organisms in which the organisms are supplied with feed, can grow and in which the organisms excrete nutrients

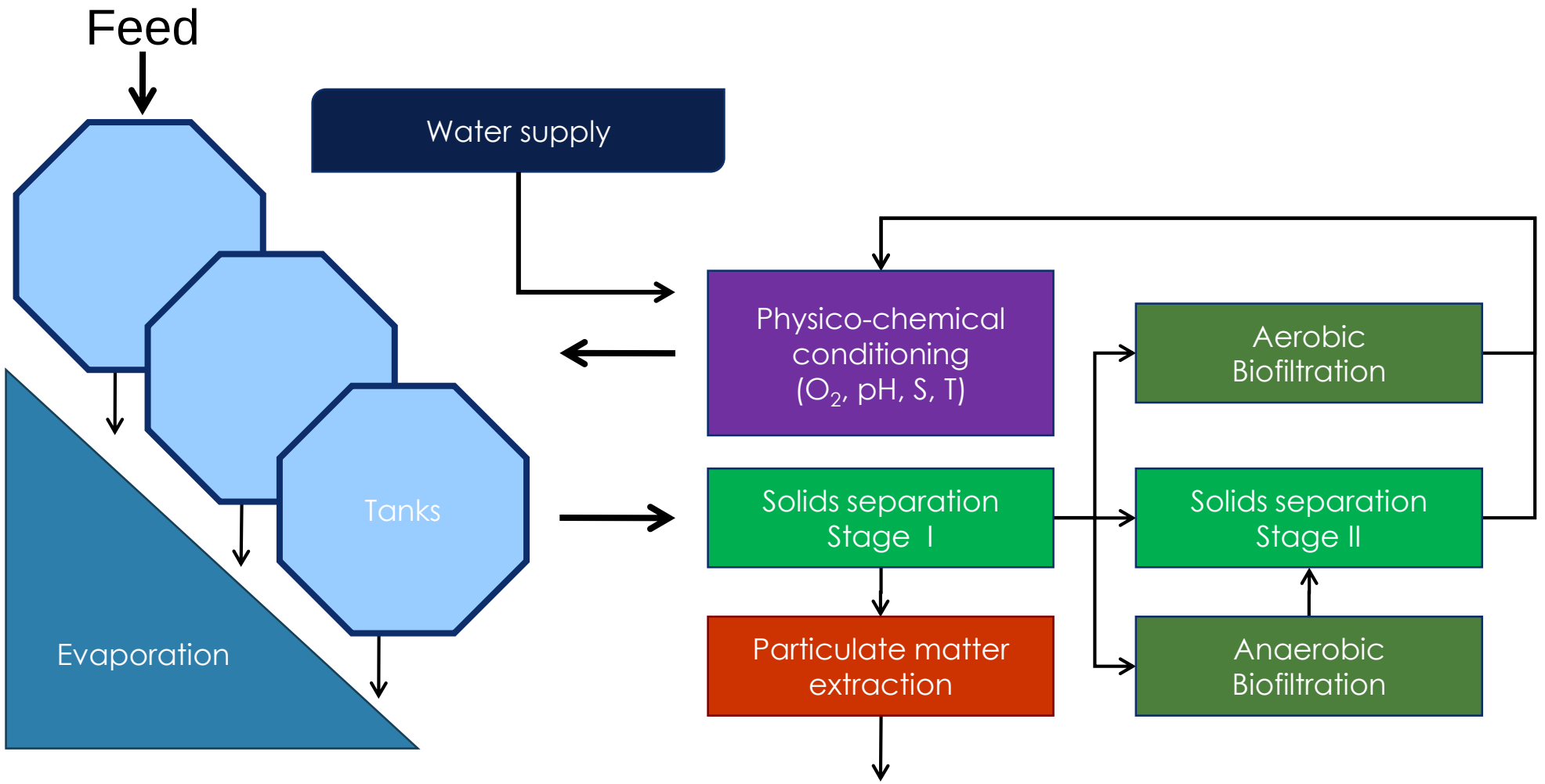
- **Water treatment:**

  Area for maintaining water quality in which solids excretions are removed and dissolved nutrients are absorbed or transformed

- **Pumps:**

  Movement of water between production (site of nutrient emission) and water treatment (site of nutrient transformation / nutrient extraction)

Schematic layout of a RAS



Components

- **Basins and tanks**

→ Should be adapted to
  - the culture species
  - the life stage of the culture species
  - the environmental conditions present
  - the intended product

Components

- **Mechanical filtration**

→ For the removal of particulate nutrient loads

→ Should be
  - efficient
  - water-saving
  - not too expensive

Components

- **Biological filtration**

→ To convert fish-toxic nitrogen compounds into less harmful compounds

  - Aerobic biofiltration: **Nitrification**
  - Anaerobic biofiltration: **Denitrification**

Components

- **Feed supply**

→To supply the cultured organisms with species- and age-appropriate feed mixtures and quantities, such as

  - handfeeding
  - beltfeeders
  - Pendulum type demand feeders
  - pneumatic type automatic feeder

Components

- **Physico-chemical conditioning**

→ To maintain and adapt the culture water to the species-specific requirements of the culture organisms, e.g.
  - Temperature
  - pH
  - Oxygen content
  - Alkalinity

Components

- **Pipes and channels**

→ For controlled circulation of the water between all components of the recirculation system

Components

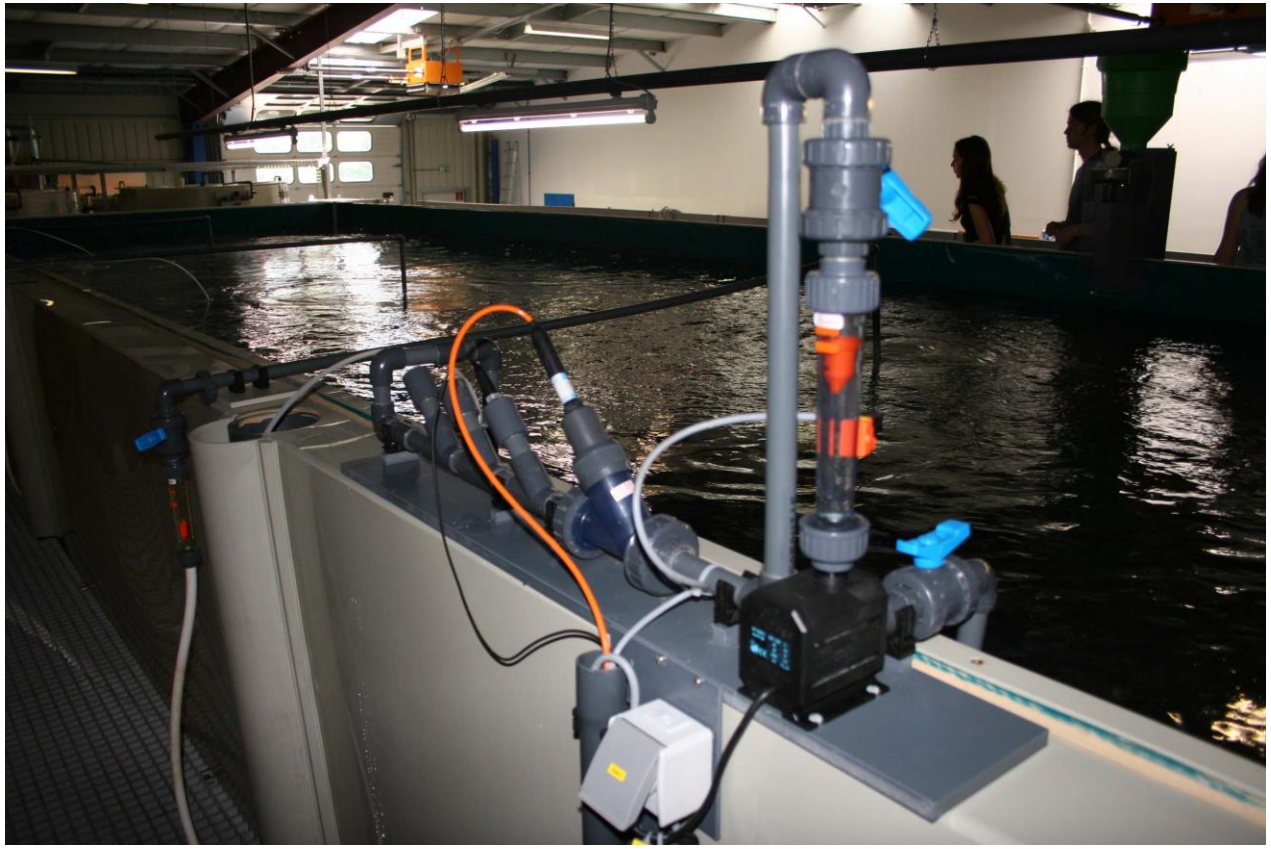
- **Pumps**

→ To maintain pressure on the piping system to deliver sufficient medium (water or air) to the components of the circulation system

Components

- **Measurement and control systems**

→ For control, regulation and documentation of water parameters, such as
  - Temperature
  - pH
  - Oxygen
  - Redox
  - Water level



Components

- **Disinfection units**

→ For the reduction of microorganisms to the species-specific requirements of the culture organisms, such as
  - UV light
  - Ozone treatment

What are RAS used for?

- Research & investigation of aquatic organisms under controlled conditions
- Rearing of particularly sensitive life stages
- Culture of non-native species
- Construction of alternative combinations of organisms
- Ongrowing and grow out of aquaculture organisms

What are the advantages of a RAS?

- Control of all parameters
  - biotic and abiotic parameters
  - feed (type, quantity & timing)
  - harvest
- Compatibility of different organisms
- Independence of location

What are the disadvantages of a RAS?

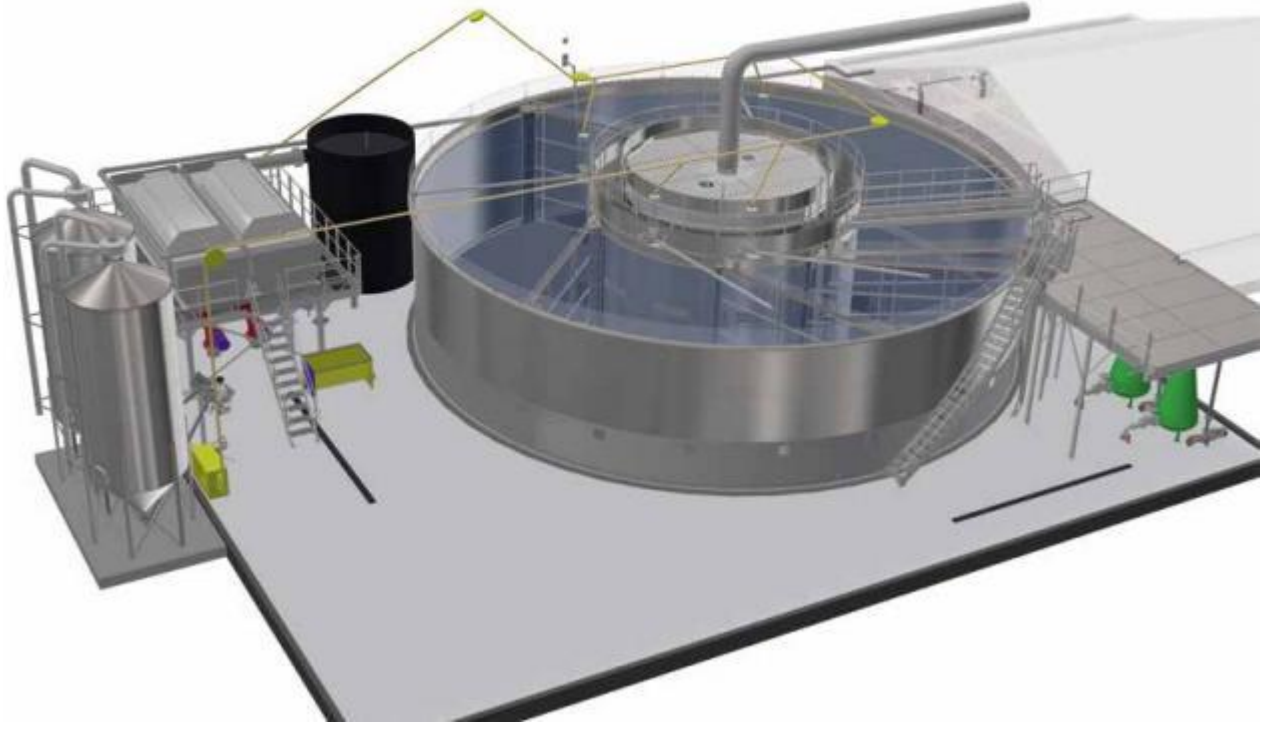
- High expectations towards the staff
  - Competences: biological, chemical & technical knowledge
  - Flexibility & commitment
- Cost intensive (investment and running costs)
- Competition on the market
- No organic certification according to EU standards possible (according to current status)

How do state-of-the-art RAS look like?

http://www.assentoftaqua.dk/

- **Stakroge Fish Farm (Denmark)**

ModulRAS



- All size classes are lcoated in one tank but separated by screens

- Water quality is regulated by a number of treatment steps

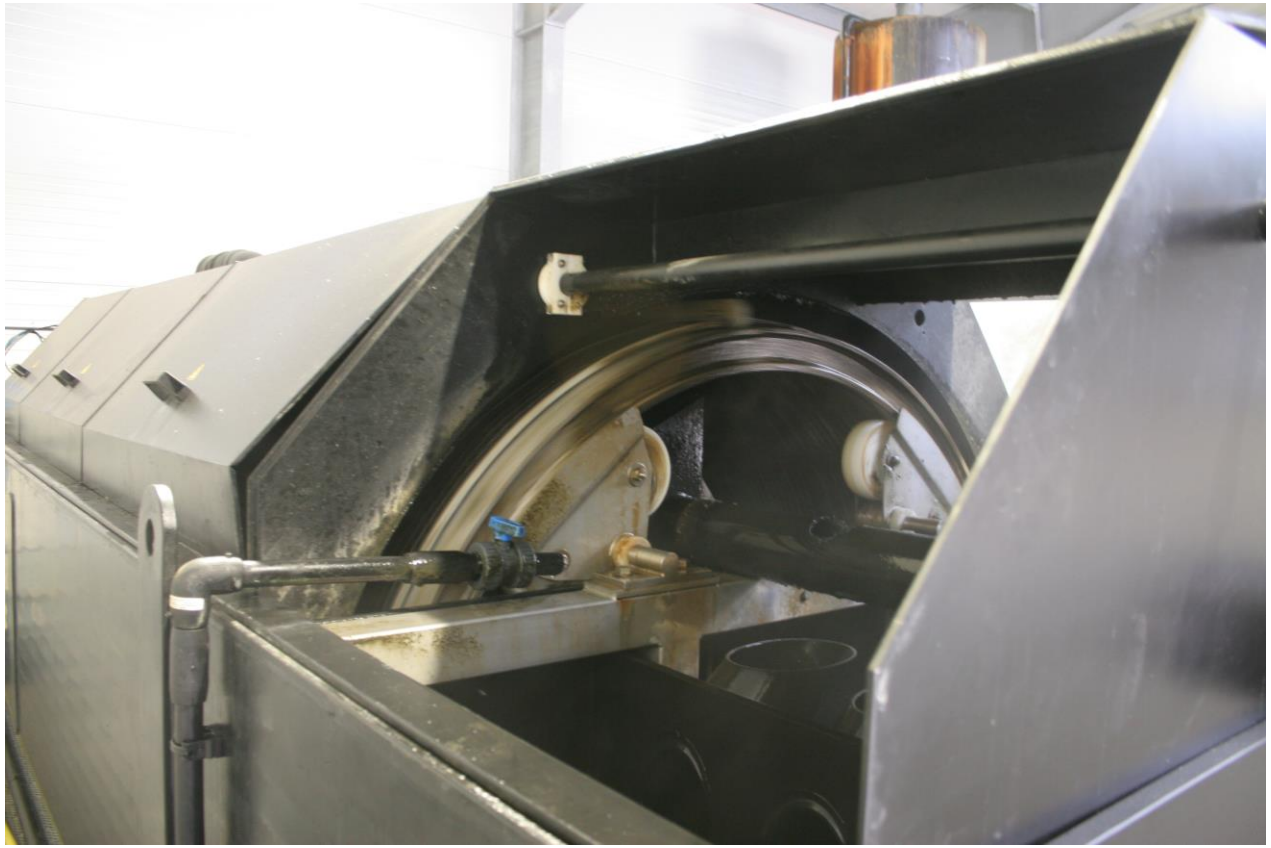
Stakroge Fish Farm

- The piping was installed in the ground and thus the foundation of the hall before the construction of the pool and the water treatment

- All common steps of water treatment were taken into account

Stakroge Fish Farm

- Mechanical filtration
  - Two separate drum filters, which are operated synchronously, for the removal of particulate nutrients



Stakroge Fish Farm

- Biological filtration
  - The biofilter is operated as a Moving Bed Biological Reactor (MBBR) in the centre of the fish tank and the water cleaned there goes directly back into the fish units

Stakroge Fish Farm

- Water conditioning
  - Oxygen supply through the oxygen cones, pH regulation through the lye as well as UV application for germ reduction are installed

Stakroge Fish Farm

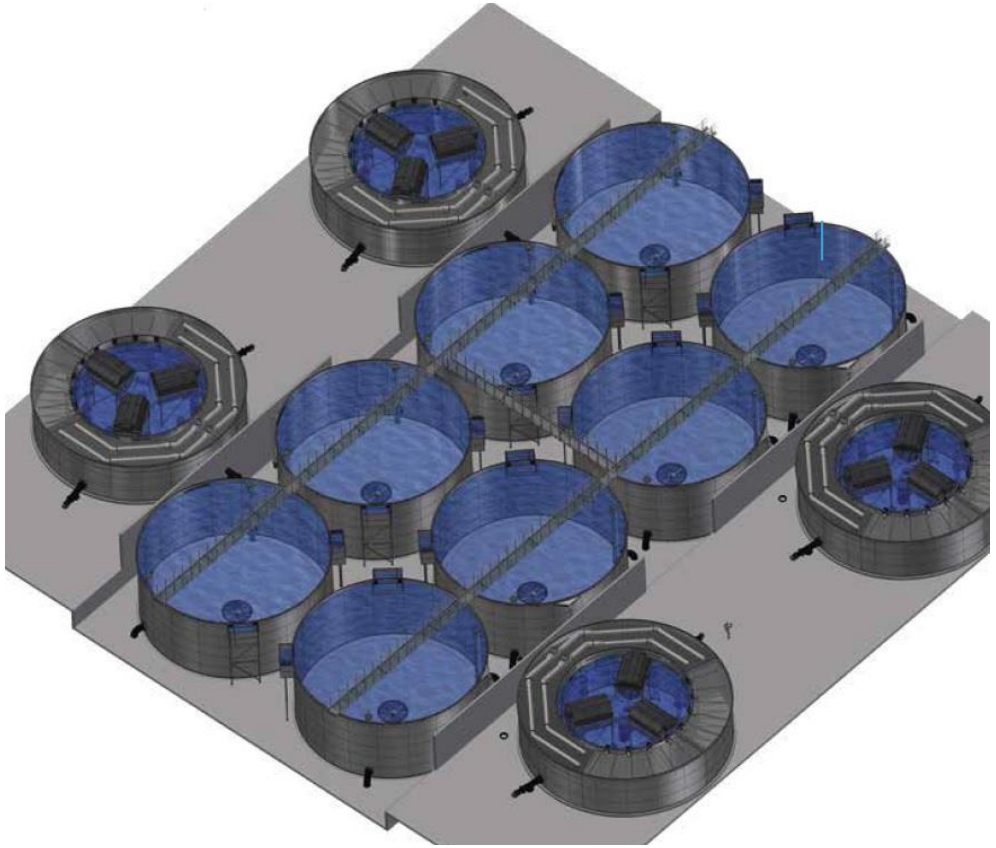
- ***Production figures (Rainbow trout)***
  - Stocking size: **35 – 50** g (monthly stockings)
  - Harvest size: **180 – 550** g (average 330 g)
  - Production period: **88 – 112** days
  - Stocking density at fish out: **100 kg*m^{-3}**
  - Maximum standing stock: **70 tons = 90 kg*m^{-3}**
  - Mortality rate: **< 1%**
  - Production harvest: **420 tons*year^{-1}**
  - Feed consumption: **400 tons*year^{-1} → FCR = 0.95**
  - Power consumption: **720.000 kWh*year^{-1}**, approx. **2 kWh*kg^{-1}** net fish production
  - Oxygen consumption: **378 tons*year^{-1}**, → **0.9 kg*kg^{-1} fish**
  - Direct production costs: **1.55 €*kg^{-1} fish**
  - Work power: **1 production manager** + **50% assistant** for harvesting and back-up

https://www.fischlexikon.eu

Stakroge Fish Farm

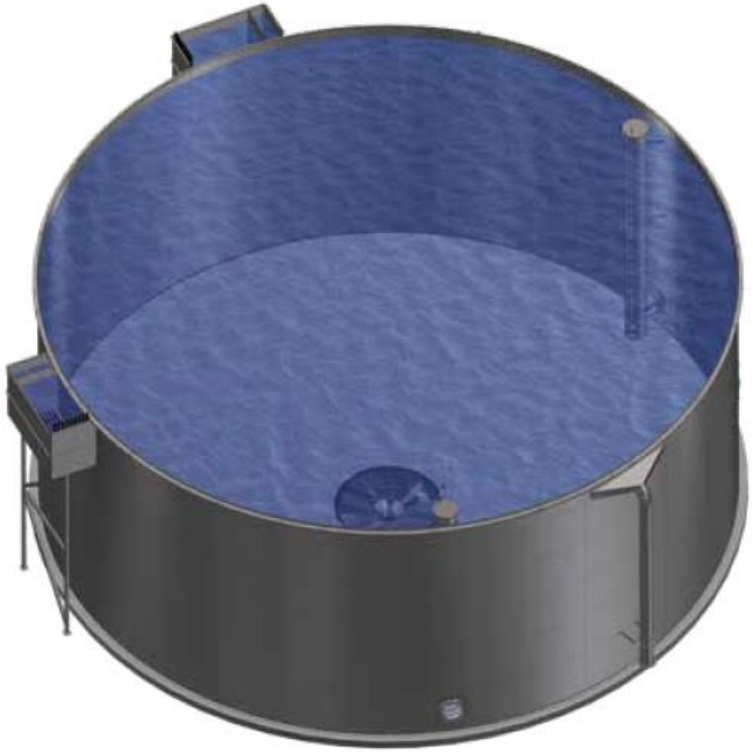
- Aussentoft Aqua (Vision):
  - Compact recirculating aquaculture systems, each consisting of two production tanks and a water treatment unit

http://www.assentoftaqua.dk/

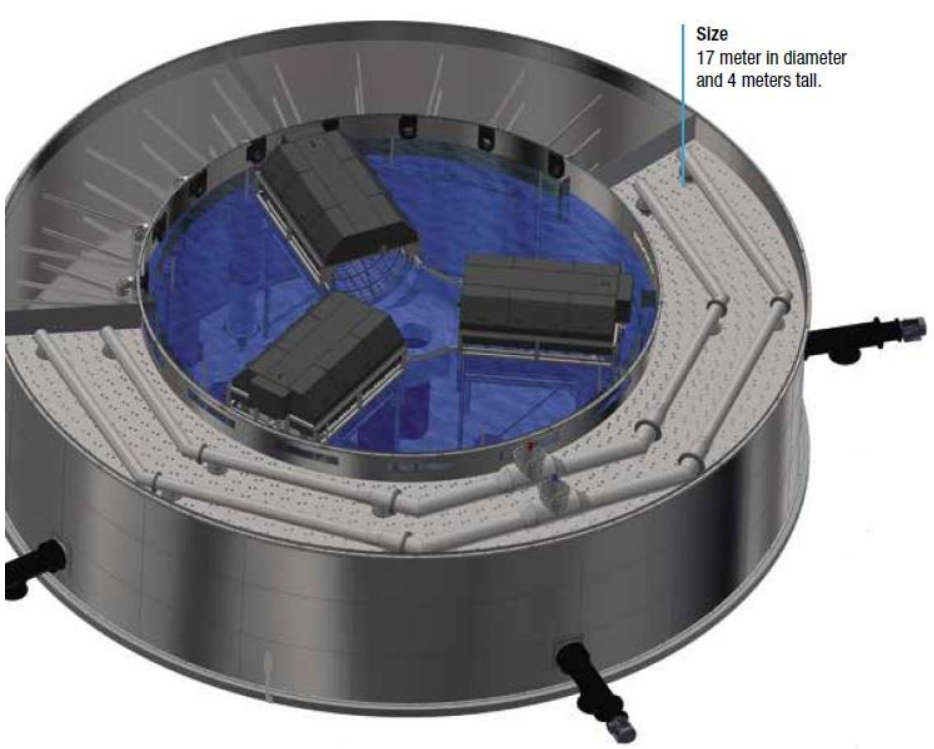


Stakroge Fish Farm

Production tank



Water treatment



http://www.assentoftaqua.dk/

Conclusion

- Recirculating Aquaculture Systems represent a special possibility for the culture of aquatic organisms
- For the operation of recirculation systems, high demands are expected of the personnel as well as the technology used
- Recirculation technology offers advantages over conventional aquaculture production systems, such as full system control and site independence, but this usually comes with higher investment costs

References

References:

- The copyright of all graphs and images belongs to the author of this presentation, Dr. Adrian Bischoff-Langor is openly accessible on the Internet and has been marked accordingly with the source.

Further readings:

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- Odd-Ivar Lekang (2007): Aquaculture Engineering. Blackwell Publishing Ltd, ISBN: 978-1-4051-2610-6
- M. B. Timmons and J. M. Ebeling (2010): Recirculating Aquaculture (2nd Edition), NRAC Publication No. 401-2010
- ModulRAS by Assentoft Aqua: http://www.assentoftaqua.dk/download/assentoft-aqua.pdf

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