

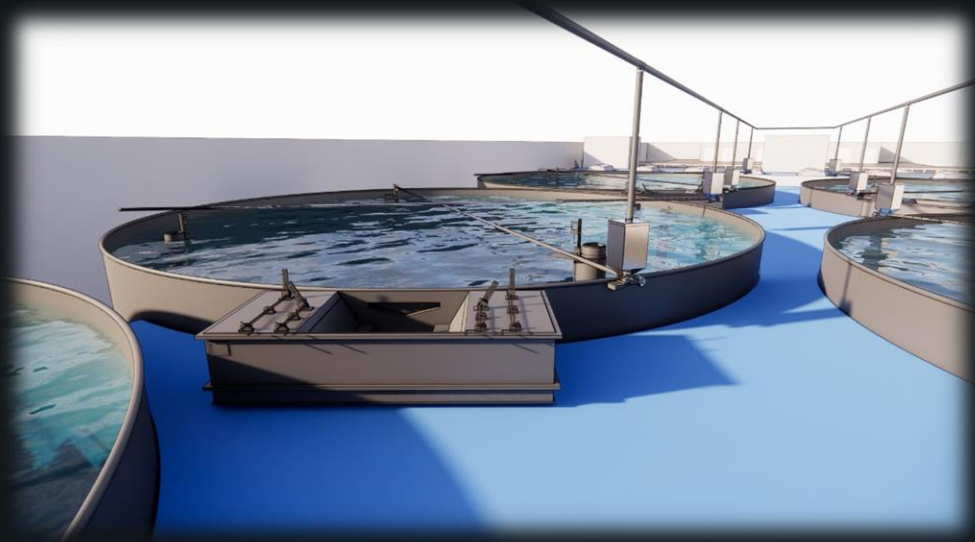
Pre Qualification –Adamselv

Grieg Seafood

Process Description

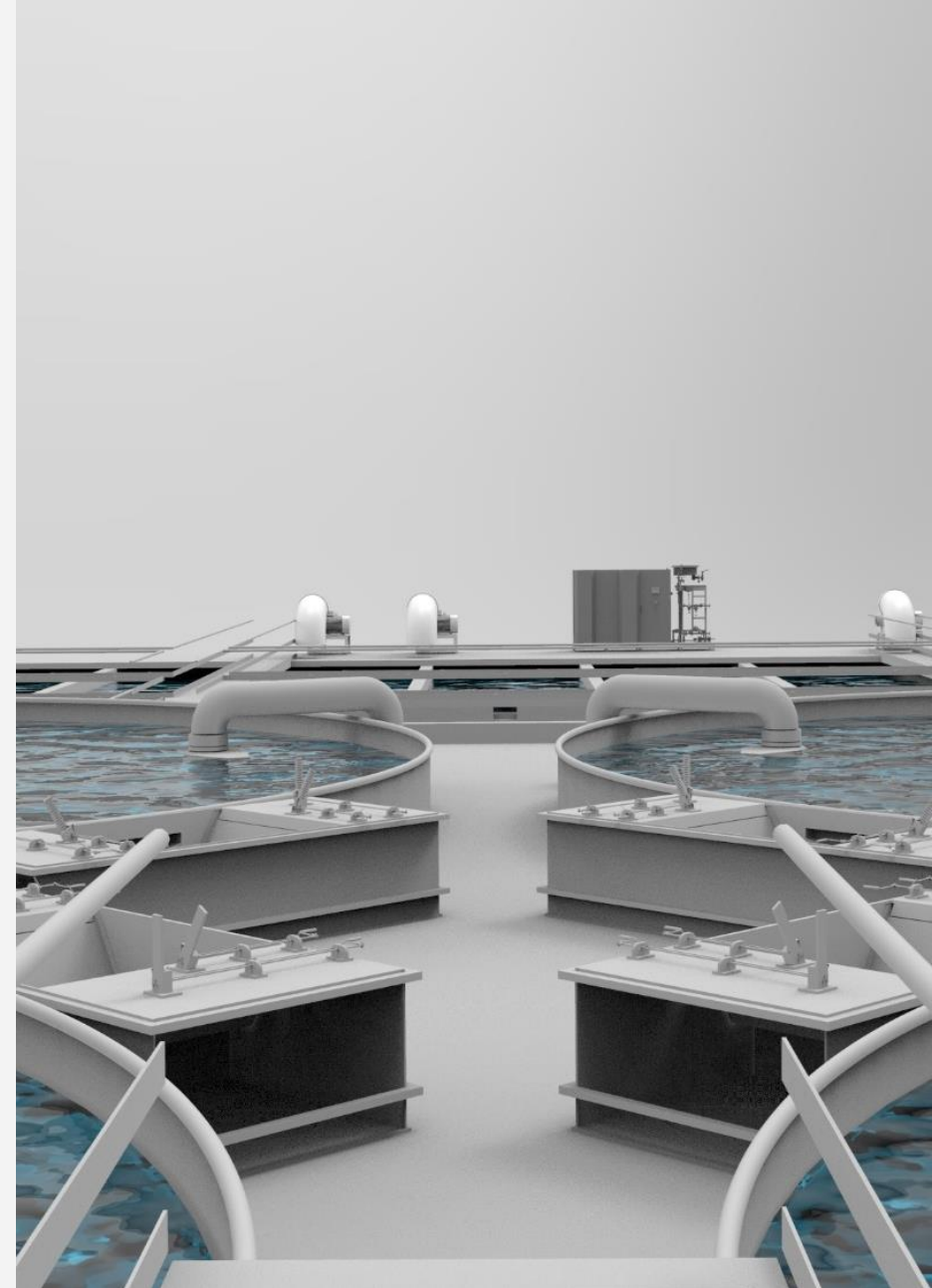
Post Smolt Module - RAS

July, 2021



AKVA's documented solution for RAS provides high performance at a sustainable cost

AKVA's solution for RAS is verified in commercial scale system, showing that the solution provides a stable environment for the fish that ensures high performance, high feed utilization and fish health



Seamless tank and pipe system reduces risk and improve fish health

AKVA's tank and pipesystem are designed for optimal tank hydraulics to improve swimming patterns, efficient solids removal and to avoid any unwanted sedimentation.

Efficient self cleaning and reduced risk

All fish tanks are fitted with lining of polyethylene. This creates a smooth and hydrofob surface which reduces the ability for microbiota, biofilm and particles to stick to the surface. This reduces the the need for cleaning the tanks.

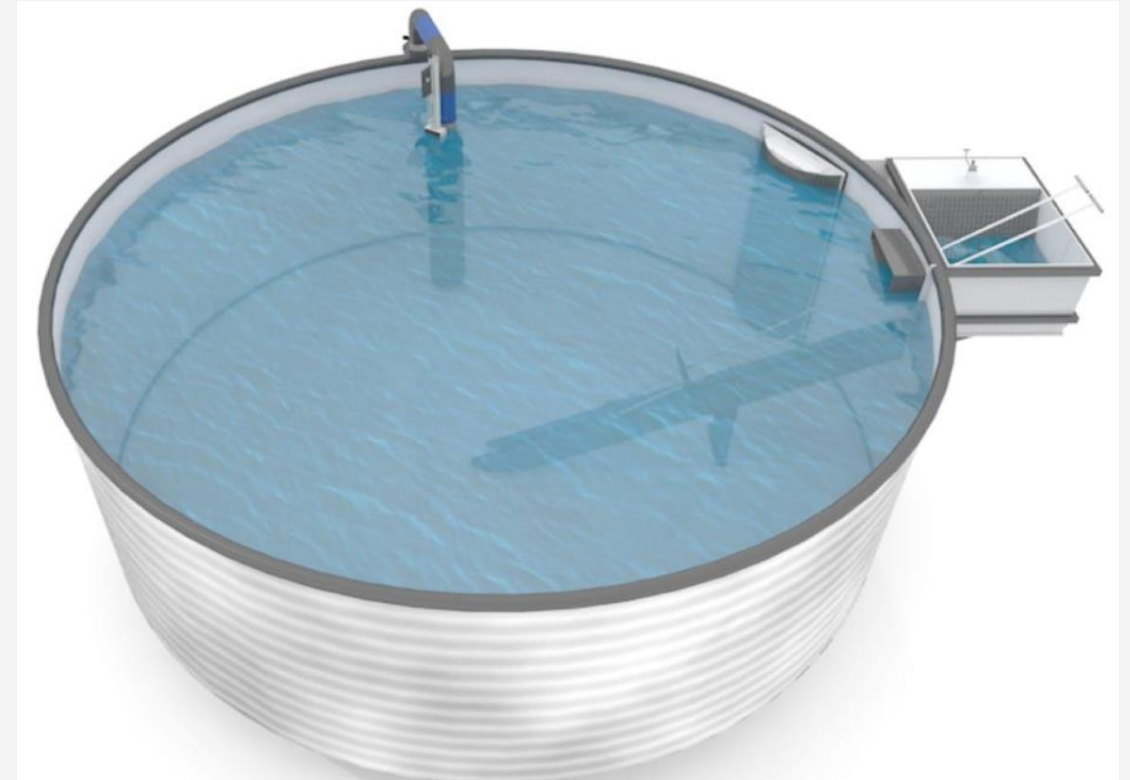
In addition, our inlet/outlet system provides hydraulic that ensures efficient removal of particles in the tank and prevents accumulation of organic matter.

Improved tank environment and fish health

Smoother surface reduces the risk of mechanical damage on the fish and the efficient self cleaning ensures good water quality which leads to higher biosecurity and good fish health

Seamless solution reduces risk

PE lining and PE pipes creates the oportunity to weld together the different components. This reduces the risk of leakage and risk of accumultaton of organic matter in «pockets» created by clamping rings and gaskets.



Mechanical filtration improves the performance of all components of the facility

100 % of the flow is filtered through the mechanical filter to ensure efficient removal of organic matter from feed and fecal matter

The mechanical filter provides a gentle filtration that avoids breaking down particles to smaller substances

The efficient filters produce a low amount of sludgewater for each cubic of water filtered

The main supplier of mechanical filters is Hydrotech



Hybrid biofilter with continuous removal of particles

AKVA's hybrid biofilter utilizes the advantages of fixed and moving bed for stable performance with low maintenance efforts

AKVA's hybrid biofilter provides high efficiency

The design of the filter contributes to high water quality conditions with an active surface area of 800m²/m³

Continuous removal of organic matter maintains a thin biofilm and reduce risk

The biofilter is designed with a automatic cleaning system (previous called SAC-system) that provides continuous cleaning of the biomedium and removal of organic matter

Automated cleaning system reduce risk of dead zones and anaerobic conditions, and reduce the amount of TSS and BOD in the water stream.

Low maintenance

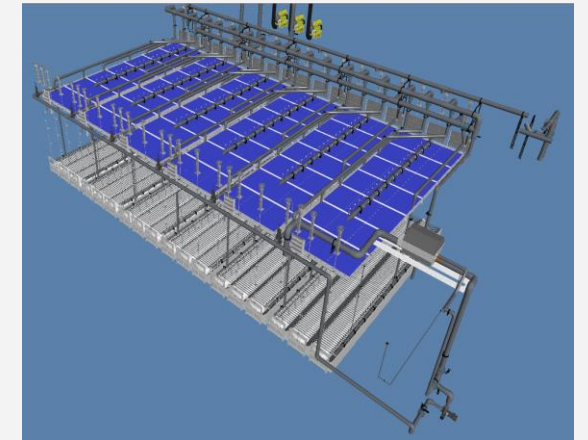
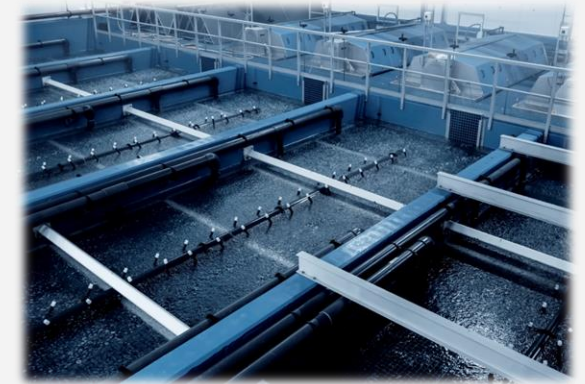
Automated cleaning system reduces the backwashing intervals, and the backwashing process is automated which simplify maintenance.

Reduced risk of oversaturation

The movement in the filter is caused by water and not air alone, this reduces the total gas pressure and the risk of over saturation. Using water instead of air also reduce the energy requirement.

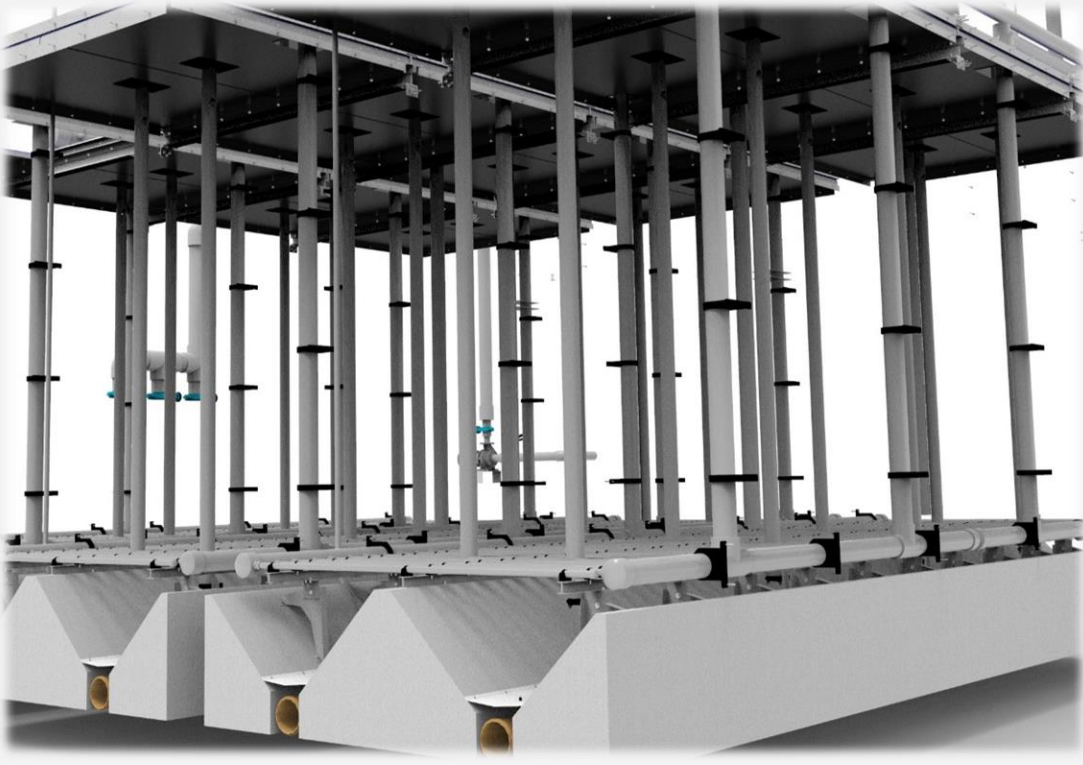
Top water suction reduce water use during backwashing

The filters are designed with a top suction function that reduces the amount of water used during backwashing. After the first phase of the backwashing process is done and the dirtiest water is removed, the top layer of the next phases is pumped out and trough a small mesh size mechanical filter. With this solution you take out the particles from the top layer in the biofilter, but you can reuse the water. The water that is filtered is returned to the loop in front of the mechanical filters in the RAS-loop.



Sludge removal from the bottom of the biofilter is part of overall particle removal and ensure good water quality

The biofilter is designed for precipitation of sludge particles during operation. With automatized sludge valves it is possible to continuously remove this sludge. Same valves will be used for removing dirty water after backwashing



Ozonation that ensures biosecurity and water quality

AKVA's standard RAS is design with the option of running 100 % of the flow trough ozone ensuring good water quality and high biosecurity

Ensure biosecurity

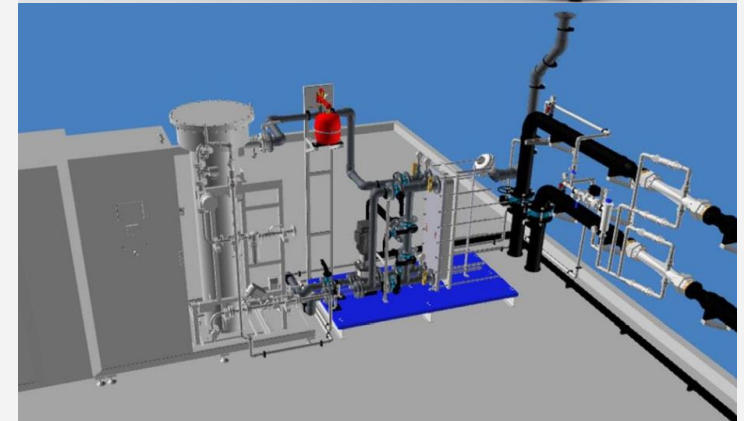
- Ozone brakes down the cell wall of bacteria and virus
- It is place after the biofilter to reduce the amount of bacterias coming form the biofilter, this reduces the BOD, CO2-production in the RAS loop and risk of disease.

Flocculating of smaller particles

80-90 % of particles in the RAS system is smaller than 30 micron. Ozone leads to flocculation of these particles, creating larger particles that can be filtered out trough the mechanical filter.

This leads to:

- Cleaner water for optimal growth and fish welfare
- Reduced colour for good visual inspection
- Reduced TSS and BOD



Efficient degassing in order to sustain fish growth and welfare

Efficient degassing is obtained by a two-step solution

1. Pre- degasser: The pre-degasser is placed between the drumfilter and the biofilter
2. Degasser: The main degasser is placed between biofilter and pump sump

Both steps are based on air-to-water ratio of 4:1 which gives an efficient removal of CO₂ and nitrogen gas. The reduction in total gas pressure contribute to that the oxygen diffuses more easily, reducing both energy and oxygen consumption.

Low energy requirement for pumping

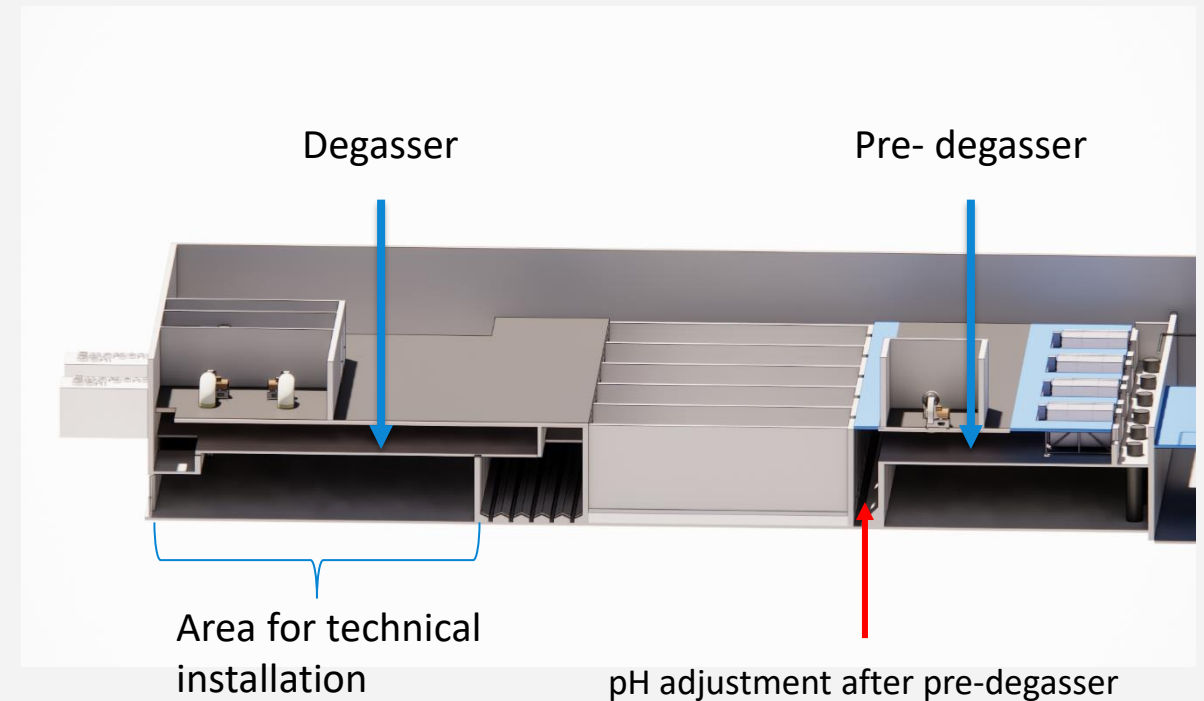
The degasser is placed above ground level in order to reduce lifting height to the fish tank, and by that reducing pumping energy.

Low maintenance and stable high efficiency

The design ensures low maintenance efforts during operation and requires no backwashing. The low level of biofouling also secures a stable high efficiency.

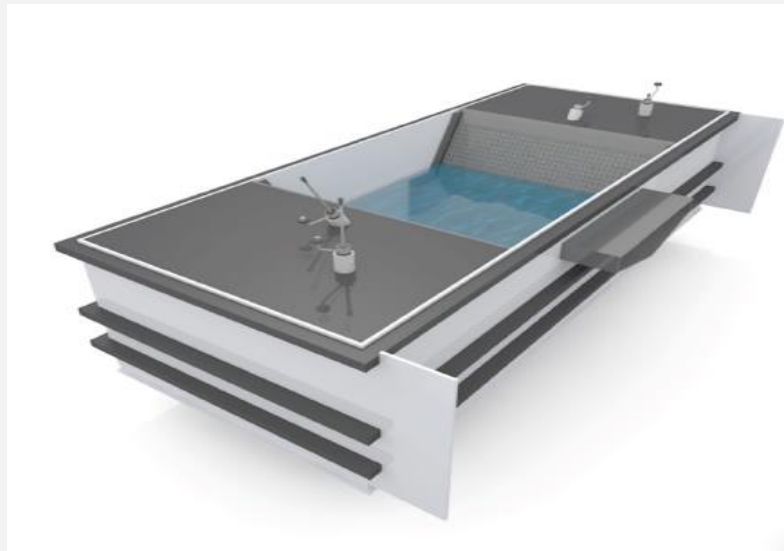
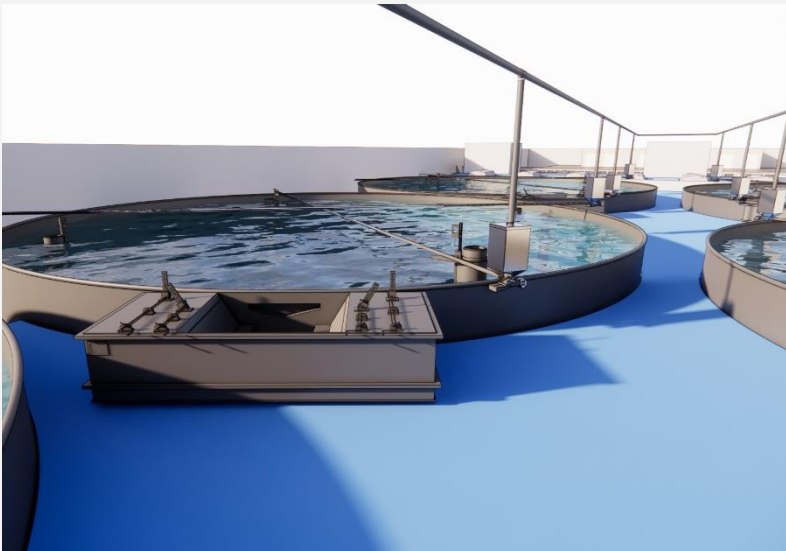
pH dosing and degasser efficiency

To secure degasser efficiency the design allows addition of Alkalinity/ pH-dosing (lye, lime, bicarbonate etc.) both after the drumfilter and after the final degassing step. This flexibility allows for adjusting pH according to biofilter performance, degassing efficiency and system load e.g. during start up and peak load. pH-adjustment is regulated based on real time sensor feedback.



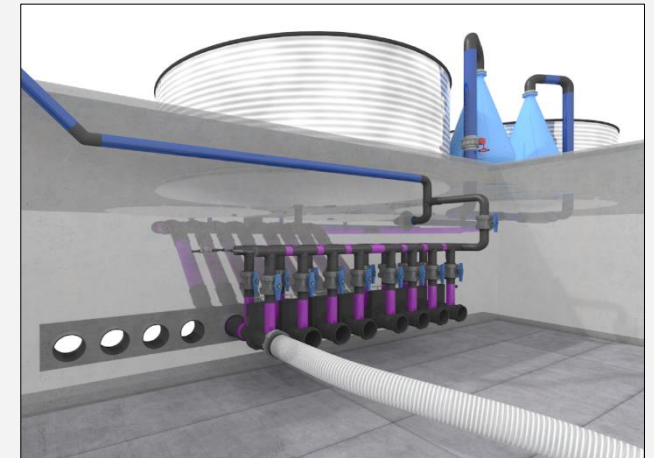
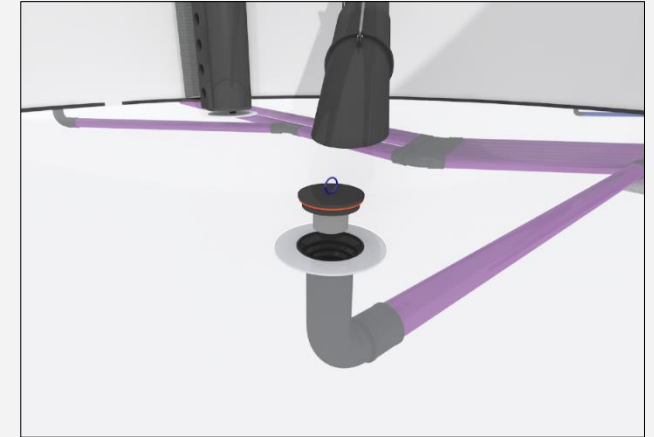
Outlet regulation box facilitate stress free dead fish handling

All water is passed through the outlet regulation box that has weirs that control outlet flow patterns. The box is placed outside the tank, which makes it possible to remove dead-fish without stressing the fish in the tank. The fish tank, tank hydraulic and fish handling system are all products customized by AKVA group.

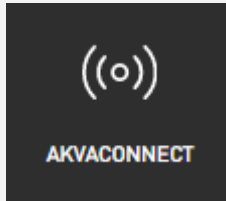


Fish handling and transportation – an integrated part of the total AKVA group system delivery

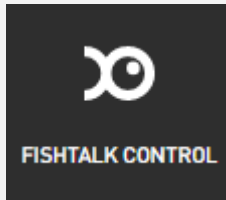
- The drain in the tank that facilitate gentle transport of fish directly to the fish transport module
- The fish transport module creates a flexible, efficient and gentle transport of fish between tanks, to vaccination, grading or transfer.
- Seamless and easy connection of pipes
- Rinsing of water through the system to make sure that the fish has enough oxygen and that there is no fish left in the pipes.



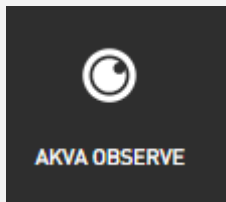
Continuous digital development with focus on RAS and land based farming – improving and leveraging our three digital product suites



Control system for local and remote control of the facility and feeding



Biological status, production planning, financials, reporting and much more



Fish monitoring and AI augmented feeding decisions



Production Advisory Services is a key offering to make sure customers achieve consistent output with the highest productivity

- A land based RAS production competence group with cross functional competence
 - Water treatment – Biology and fish health
 - Technical
 - Feeding
 - Farming operations and production protocols
- Advice customers on planning, production protocols, and technical perspectives to ensure a production of high quality smolt and post-smolt at the lowest possible cost
- Team involved in basic biological training if customer has opted for such in the project. Additional training and PAS-offerings available to client



Standardizing RAS-modules reduces overall capex for next facility, but main advantages are operational efficiency and max output across sites

The focus from AKVA group is to deliver low risk (e.g. mortality) well proven solutions with high production output of quality smolt, at competitive price

Compact solutions and standardization gives lower Capex, lower maintenance costs, less “error costs” and achieving (and benchmarking) max output across facilities

