MMC FIRST PROCESS

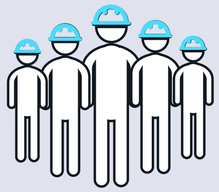
2023-11-06 “RISIKO I LANDBASERT OPPDRETT”
EIVIND VINJE – VP R&D

ELECTROCHEMICAL WATER TREATMENT

A GLOBAL LEADER IN MISSION-CRITICAL FISH HANDLING TECHNOLOGY

Company overview

Headquartered on the west coast of Norway



~215 employees

Market leading position within fish handling

35 years experience

Long track record and know-how

Locations

Digerneset, Ålesund

2,100 m2 *office space*

2,200 m2 *assembly & storage*

76 *employees*

HQ: Mjølstadneset, Fosnavåg

1,930 m2 *office space*[1]

2,940 m2 *production & storage*[1]

110 *employees*

Haugesund

230 m2 *office space*

760 m2 *production & storage*

11 *employees*

SEGMENTS

AQUACULTURE

Wellboat
Aquaculture processing
Stun and bleed vessel
Land based farming
Closed cage farming
Holding tank

WILD CATCH

Pelagic fishing vessel
Pelagic processing
White fish vessel

AFTERMARKET & SERVICE

Spare parts
Service 24/7
Upgrade and rebuild

GLOBAL FOCUS

Norway and North Sea area
Iceland
Chile, Peru and Ecuador
Japan, Korea
West Africa
USA, Canada

WATER TREATMENT

Wellboat
Land based

ENERGY EFFICIENCY SYSTEMS

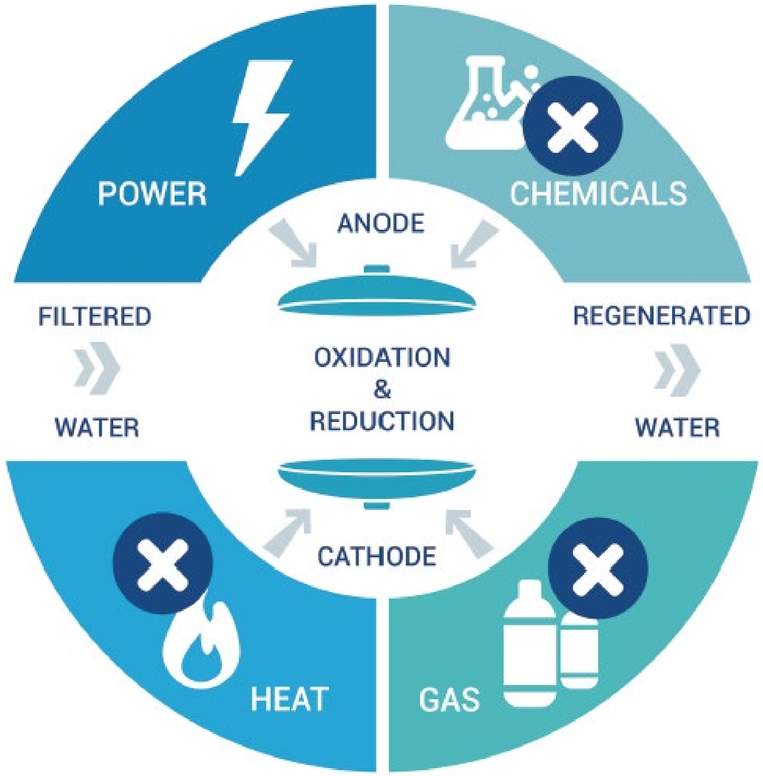
Cooling
Energy

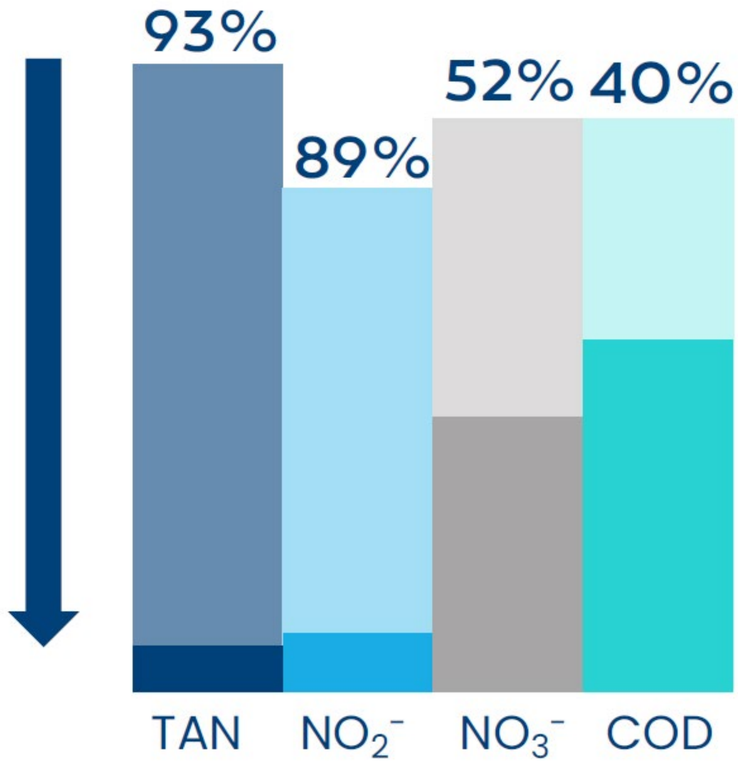
SUMMARY

- Goal: Achieve higher recirculation rate on holding tanks
  - Reduce new water intake
- Solution: Electrochemical oxidation technology
  - Electricity to promote a chemical reaction to remove TAN from water
- Result: Predictable and efficient water treatment process
  - Simplicity
  - Higher culture density
  - Easy scalability
  - On-off technology
  - In-site disinfection
  - Reduce new water requirement

ELOXIRAS – EL OXI RAS – **EL**ECTROCHECMICAL **OXI**DATION FOR **RAS**

THE REACTOR UNIT





Stages of the treatment

Post- treatment
Adsorption & degassing

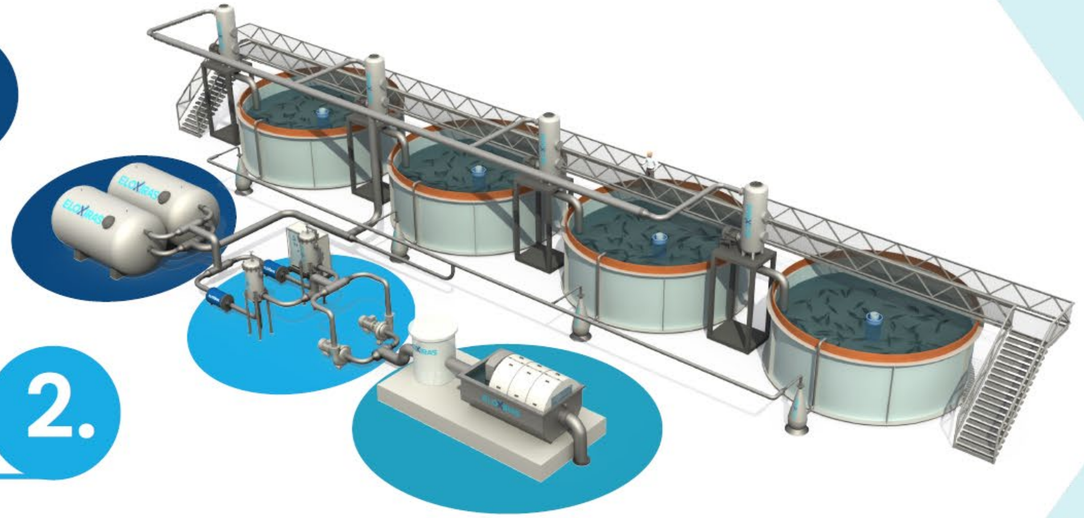
3.

By products removal and gas balance

Main treatment:
electrochemical oxidation

2.

Ammonia, nitrate, organic material, and pathogens removal

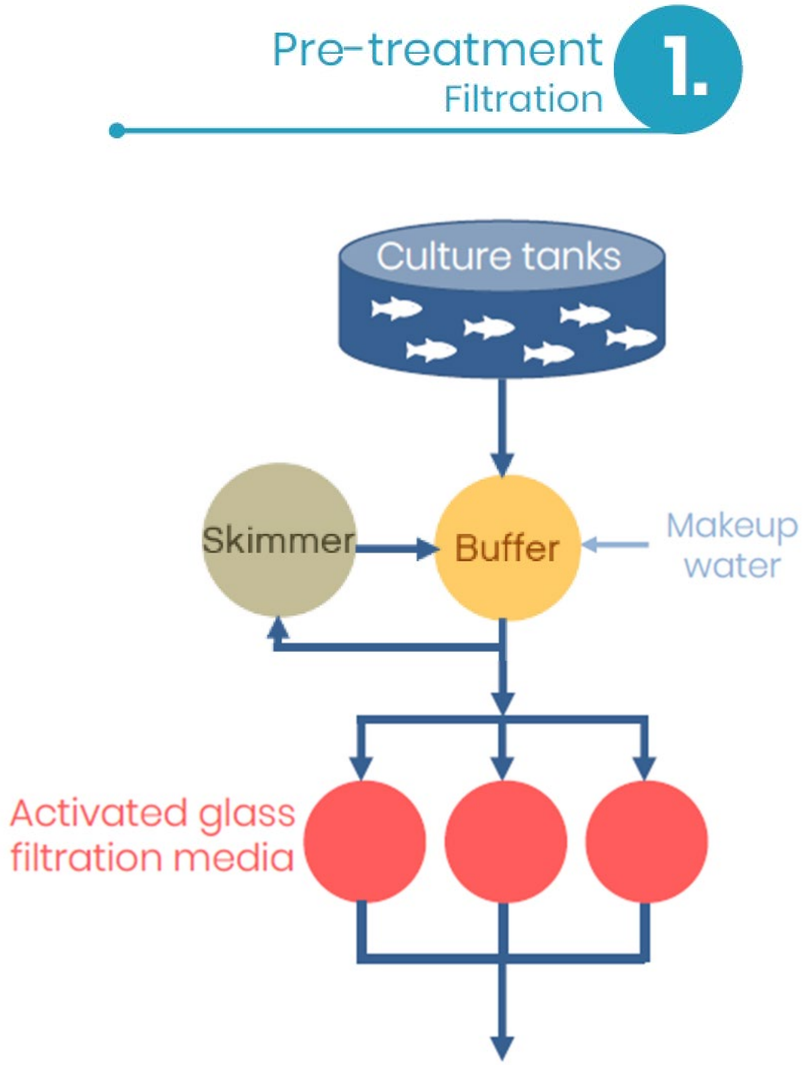


Pre-treatment
Filtration

1.

Solids and fats removal

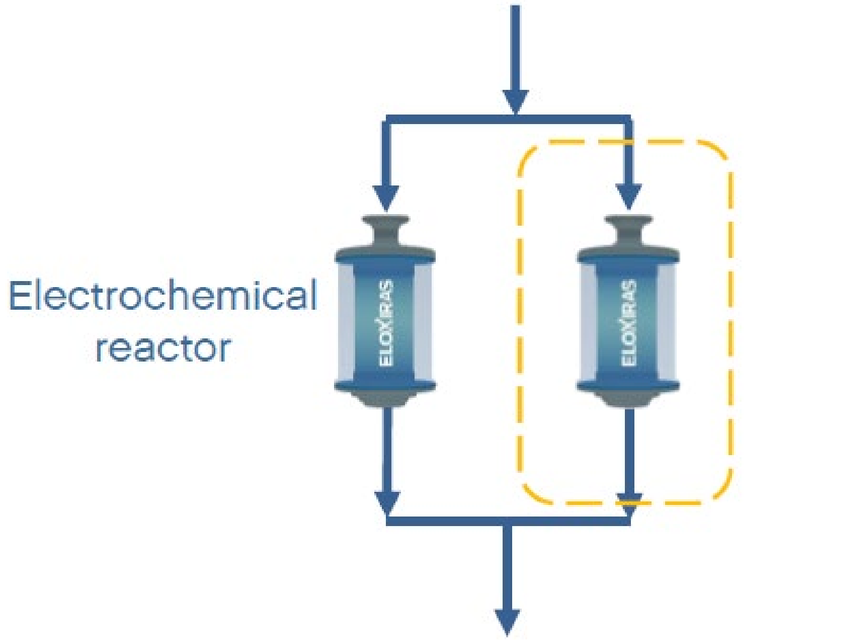
INTRODUCTION TO ELOXIRAS – PRE-TREATMENT



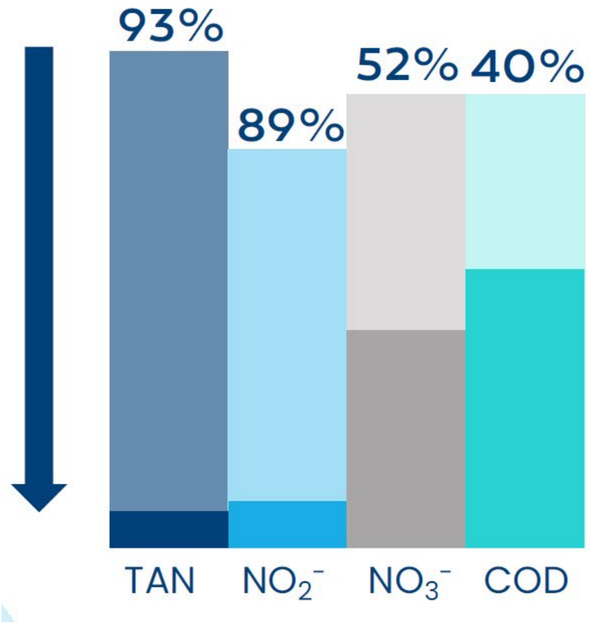
INTRODUCTION TO ELOXIRAS – MAIN TREATMENT

Main treatment:
electrochemical oxidation

2.



INTRODUCTION TO ELOXIRAS – MAIN TREATMENT



$2NH_4^+ + 3HOCl \rightarrow N_2 + 5H^+ + 3Cl^- + 3H_2O$

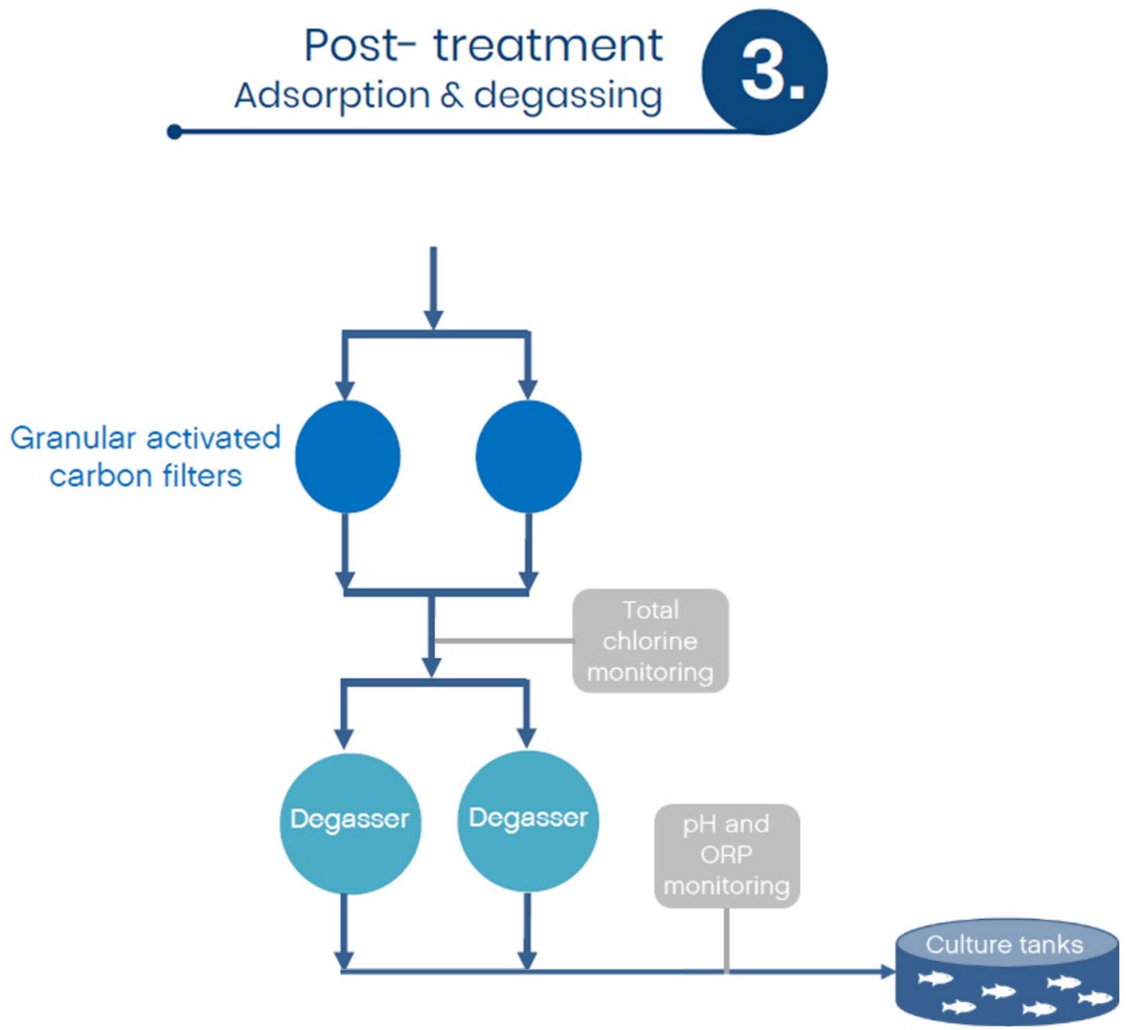
$NO_2^- + HOCl \rightarrow NO_3^- + Cl^- + H^+$

Avoiding the generation of nitrite and nitrate

Organic matter → $CO_2 + H_2O$

Pathogens → disinfection

INTRODUCTION TO ELOXIRAS – POST-TREATMENT



INTRODUCTION TO ELOXIRAS – POST-TREATMENT

Parameter	Units	Max. value obtained	Quality criteria
Bromate (BrO_3^-)	mg/L	n.d.*	0.07 mg BrO_3^-/L (IMO, 2008)
Chlorate (ClO_3^-)	mg/L	0.57	0.7 mg ClO_3^-/L (WHO, 2011)
Perchlorate (ClO_4^-)	mg/L	n.d.*	-
Total chlorine	mg Cl_2/L	0.1	-
Total trihalomethanes (TTHMs)	µg/L	< LOQ** (3.01)	100 µg/L (Directive 98/83/EC)

*** n.d.: not detected —below the limit of detection (LOD) of the method (LOD of bromate: 0.05 mg/L; LOD of perchlorate: 1 mg/L)—.**
**** < LOQ: below the limit of quantification of the method (5 µg/L).**

FLEXIBILITY IN LAYOUTS

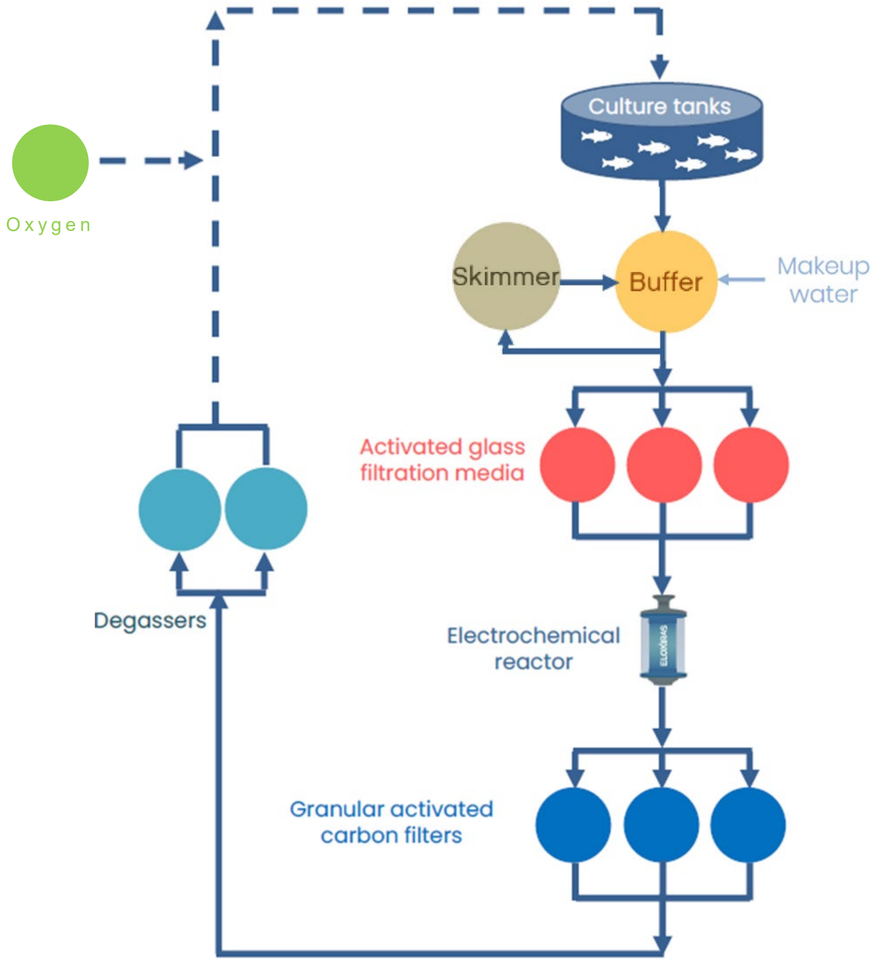


Figure 1 - Water treatment in a single loop

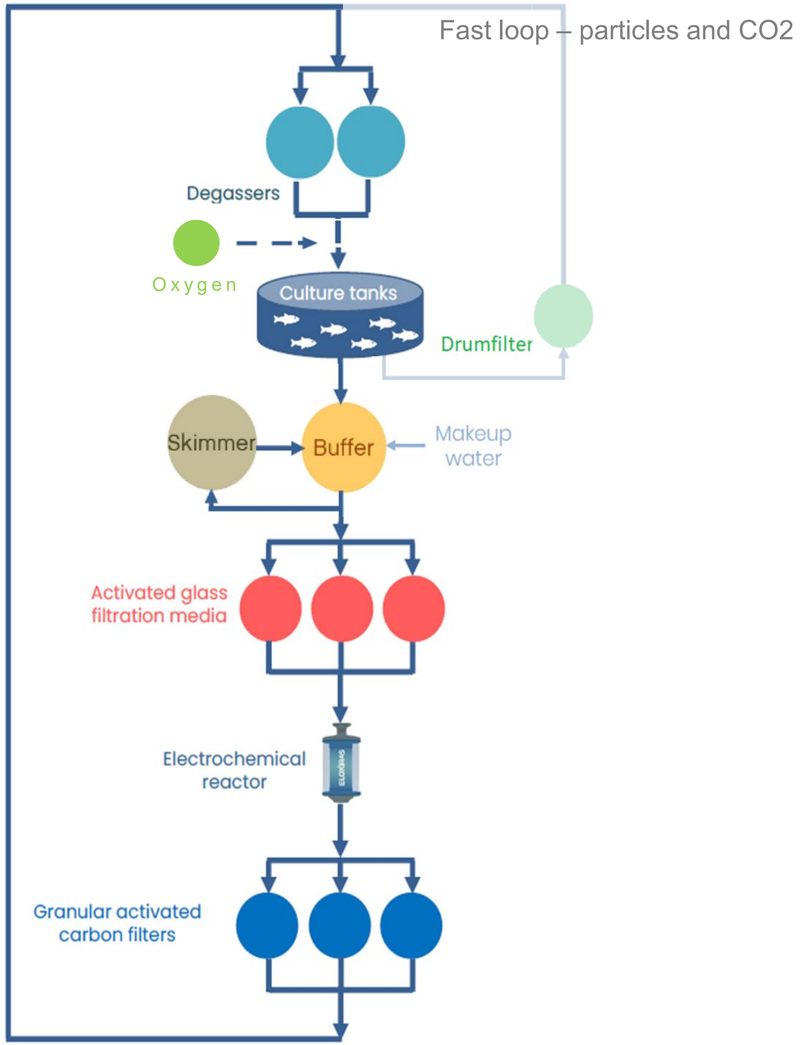


Figure 2 - Water treatment with additional fast loop

ELOXIRAS – REFERENCES

ELOXIRAS® MINI-600-4.0,

IRTA, Spain

Parameter	Units	Average value (± Std deviation)	Quality criteria*
Oxygen	mg O_2/L	8.70 ± 0.57	> 5
Temperature	ºC	20.4 ± 2.1	22
pH	-	7.18 ± 0.20	6.5 - 8.5
ORP	mV	170.7 ± 88.5	-
TSS	mg/L	20 ± 12	10 - 80
TAN	mg N-NH_3/L	0.55 ± 0.42	< 3
Nitrite	mg NO_2^-/L	0.08 ± 0.11	< 1
Nitrate	mg N-NO_3^-/L	2.5 ± 3.1	0 - 90
Chemical oxygen demand (COD)	mg O_2/L	< 30	-
Total bacteria	CFU/mL	1.10^2 - 2.10^3	-
Vibrio spp	CFU/mL	3.10^1 - 7.10^2	-

*Quality criteria according to Timmons et al., 2009

Cultivated species: sea bream and sea bass

Culture tanks: two units (V_{total} = 20 m^3)

Maximum biomass density: 45 kg/m^3

CYCLE		Hydrogen sulfide generation*
1st	23 days of operation	0 mg/L
2nd	17 days of operation	0 mg/L

*Measured with Test Kit HS-WR (223801)

"Practical absence of significant anomalies or injuries in all the examined organs. No signs of small alterations in gills, skin or kidney, which are very common in aquaculture fish, were found."

ELOXIRAS – REFERENCES

Rodecan, Spain

Cultivated specie: turbot

Culture tanks: two units (V_{total} = 8 m^3)

Density: 45 kg/m^3

IEO, Spain

Cultivated specie: sole

Culture tanks: one unit (V_{total} = 0.8 m^3)

Density: 25.7 kg/m^3

MacDuff Shellfish, UK

Cultivated specie: edible crab, lobster

Culture tanks: one unit (V_{total} = 0.5 m^3)

Density: 500 kg/m^3

Aqua Production Sys, Canada

Cultivated specie: lobster

Density: 220 kg/m^3

Low salinity technical trail

Rainbow trout **90g**

Stocking density **40 kg/m3**

Salinity **2,5 ppt**

Low water renewal, and pollutants within quality limits.

Histopathological study

– gills, bowels, skin and muscles, liver, kidney

– excellent condition and no histologic alternations compared to flow-through

Quality criteria for rainbow trout farming

Pollutant	Recommendation[2]	Mean value observed
TAN (mg TAN/L)	< 9.4[a]	1.08
Nitrites (mg N-NO_2^-/L)	< 0.06	0.04
Nitrates (mg N-NO_3^-/L)	< 50	1.8 (max. 3.4)

[a]Calculated from ammonia recommendation, based on pH and temperature values during the test.

Installation in Norway Q1 2024

Atlantic Salmon	**50g - 1000g**
Stocking density	**80 kg/m3**
Feed	**2% of body weight/day (80 kg feed over 16 hours)**
Salinity	**10 ppt**
Configuration	Convert flow through with freshwater source to RAS

Possibility to visit the site from Q2 2024 ☺

ELOXIRAS – OPERATIONAL COST

- Pre-treatment
  - Long lifetime of filter and media
  - Electricity
  - New water to replace backflush
- Main treatment
  - New coating every 2-4 years
  - Power consumption 1-1,2 kWh / kg feed
- Post-treatment
  - Add activated carbon 10-20% per year
  - Electricity
  - New water to replace backflush

~3 kWh/kg feed

Consumes no oxygen

Reduced water circulation

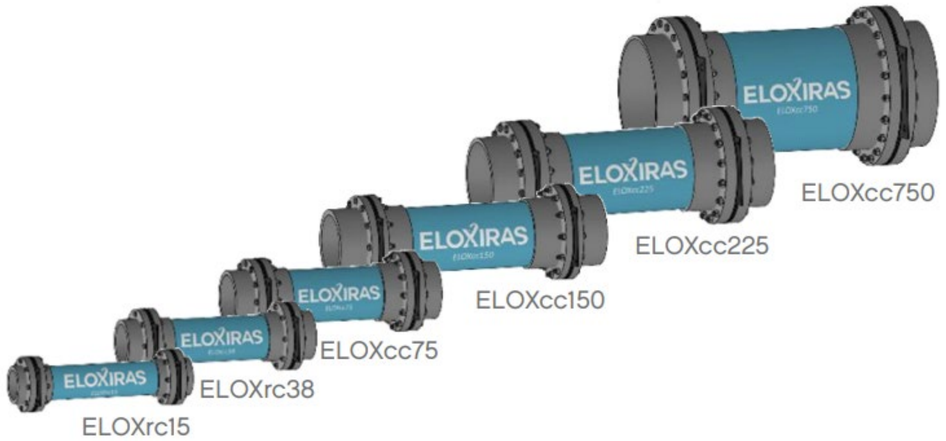
Reduced new water intake

Good water quality all the time

ELOXIRAS – SUMMARY

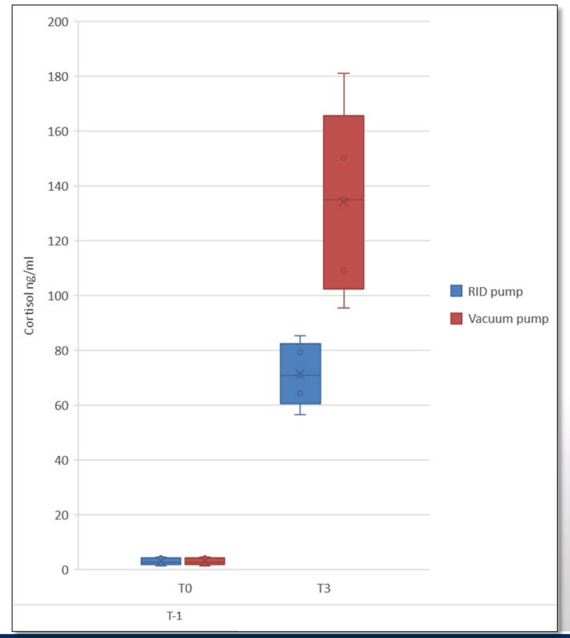
- Utilization
  - Standalone
    - Intensive RAS
    - Reduced new water intake in FTS
  - Parallel with biofilter
    - Offload peaks
    - Treat nitrogen
  - Purge tanks and holding tanks
  - Wellboats and trucks

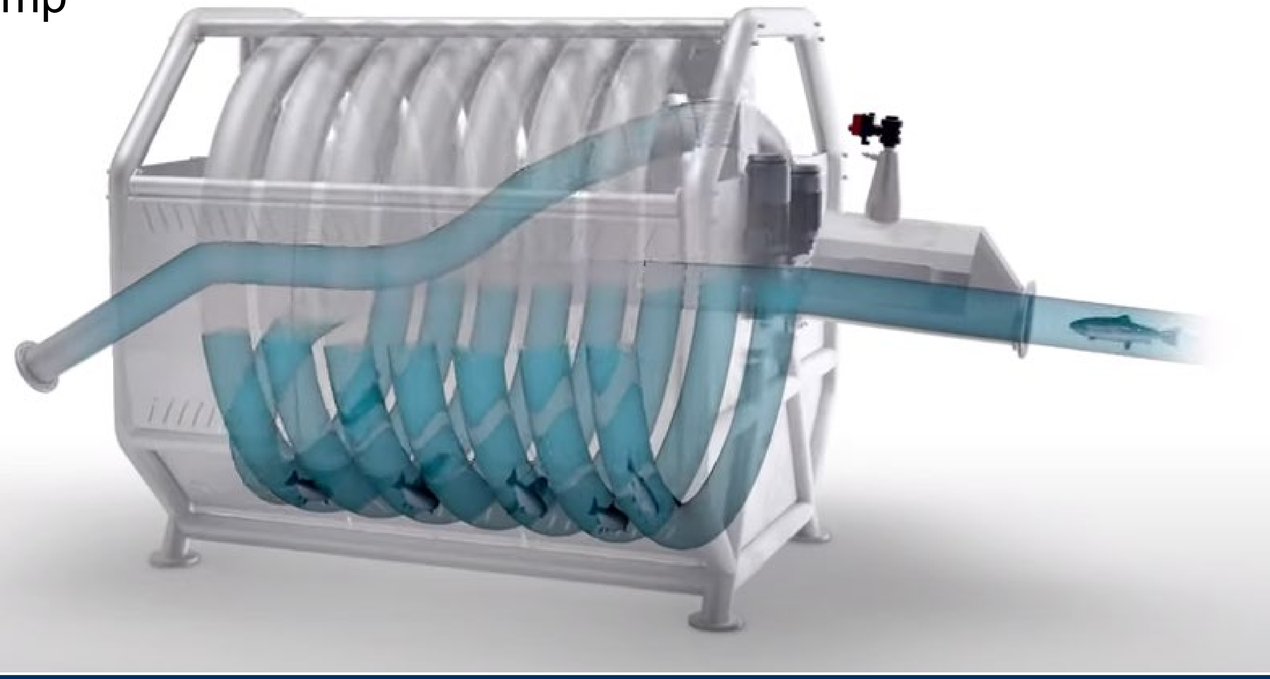
- Market trends (?)
  - Post-smolt
    - Reduce need for lice treatment
    - Optimize biomass in sea
  - Heart health – temperature/growth
  - Industry reputation
  - Regulations i.e. BAT-AEL
  - Environmental footprint



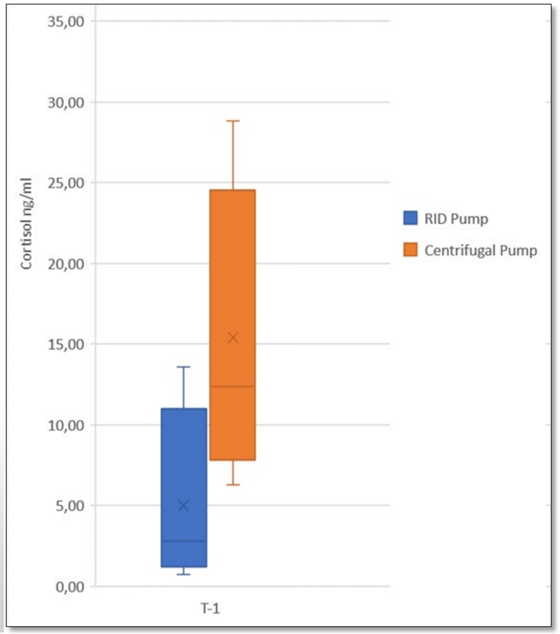
THE RID FISH WELFARE PUMP

- RID-500 – SALMON ~4kg
- ~600m3/h (55% of capacity)
- Crowding: decrease water level
- Small pipe diameter, many sharp bends
- 2x less stress with RID-pump

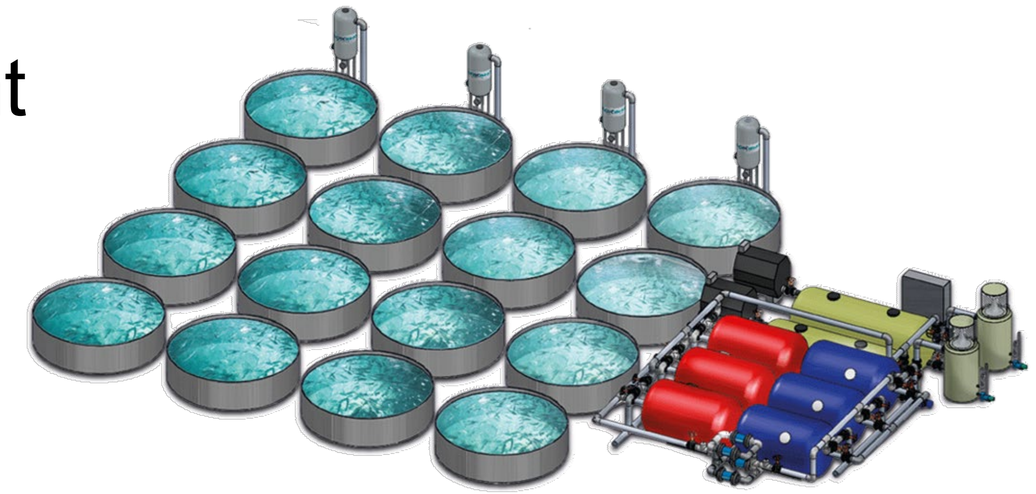




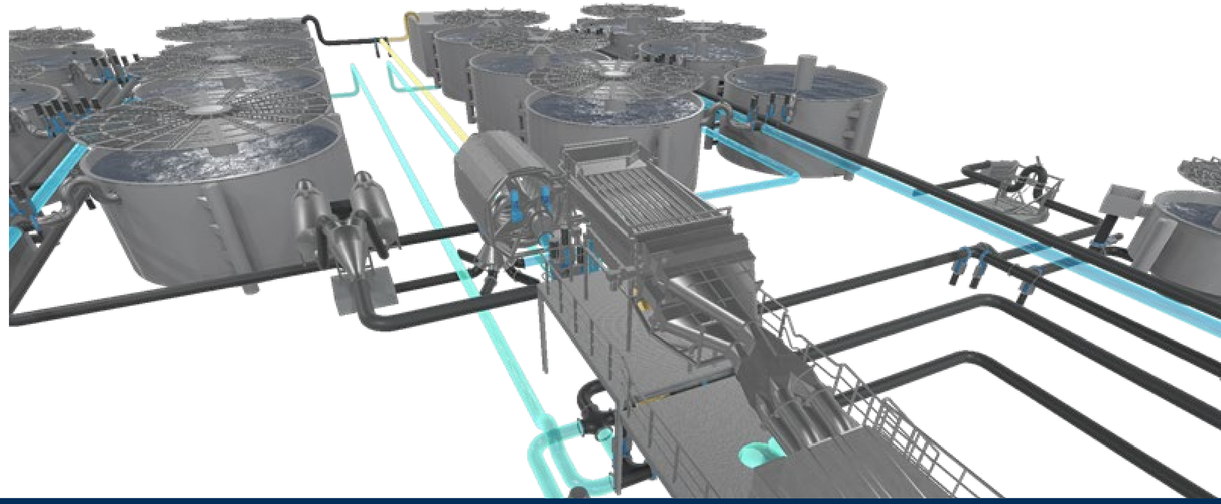
- RID-150 – RAINBOW TROUT ~100g
- ~60m3/h (95% of capacity)
- Crowding: decrease water level
- 3x less stress with RID-pump



Talk to MMC First Process if you want



- Predictable and stable water quality
- World’s best fish logistics system



A COMPLETE GAME CHANGER