Aquaculture Innovation Workshop
Oct 14-15 2015
Shephardstown

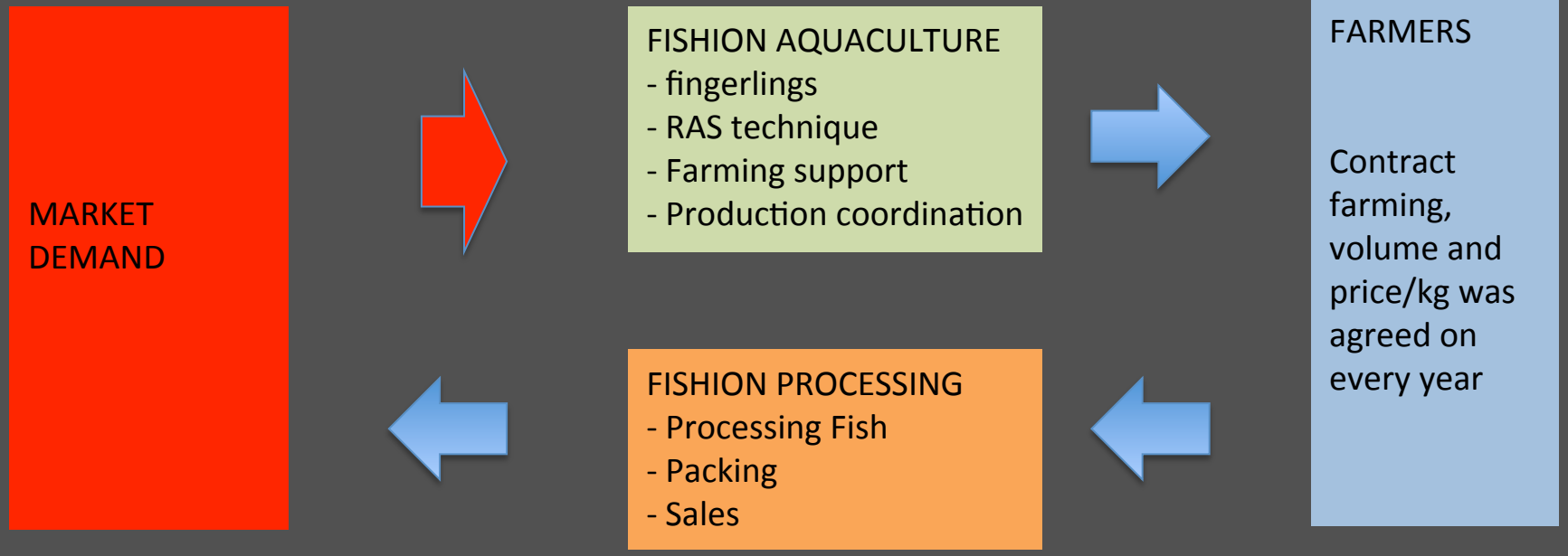
Commercial application of denitrification in RAS

Ir. Victor Bierbooms
Viqon Water Solutions
The Netherlands

VIQON
WATERSOLUTIONS

Project:	ZON Aquafarming, Realization of market driven sustainable aquaculture production chain
Company:	FISHION, job function RAS, R&D, design and realization
Period:	1996-2010
Location:	southern part of the Netherlands, rural area
Fish:	Tilapia
Farm size:	700 ton annual production
Production goal:	10.000 ton annual production

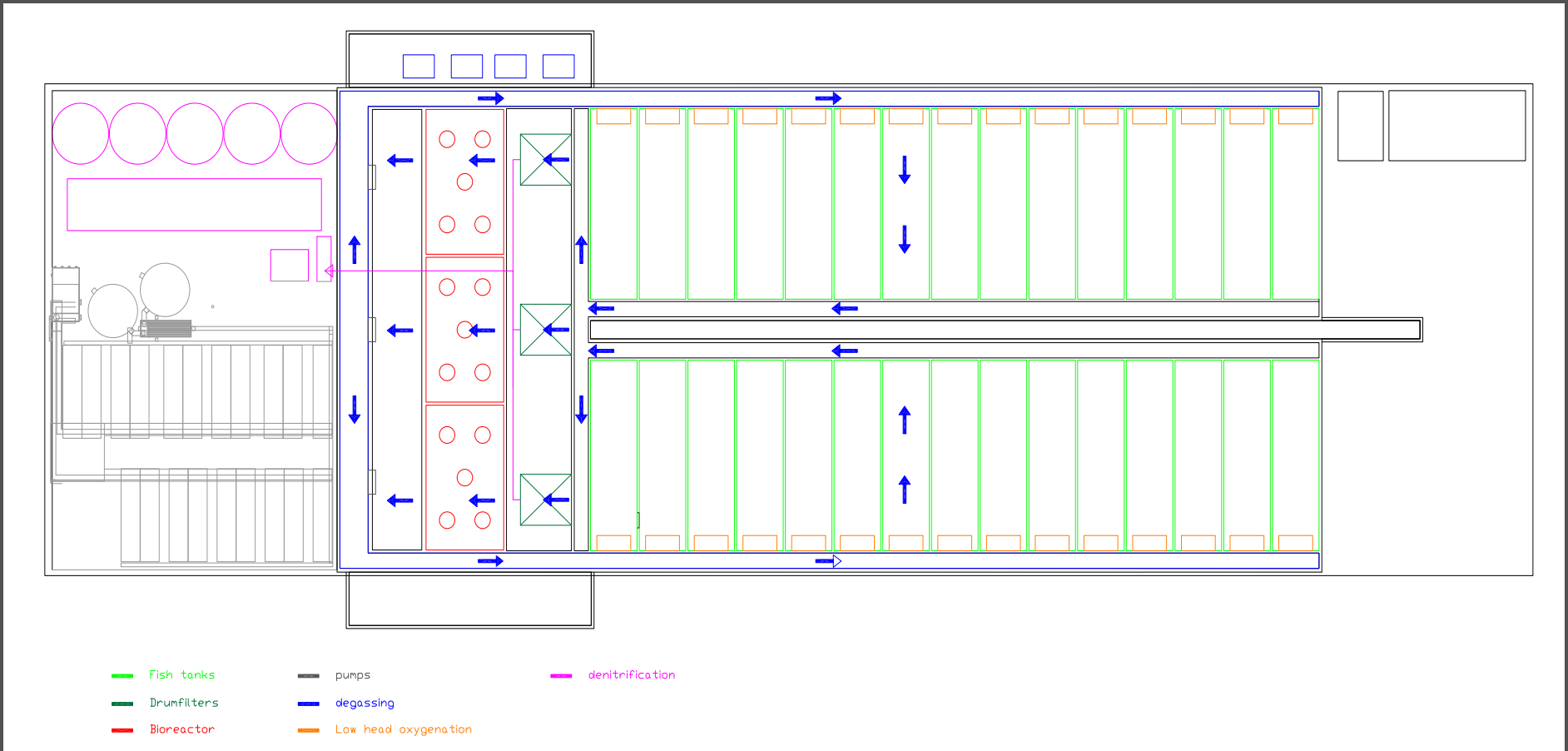
PROJECT STRUCTURE ZON



VIQON WATERSOLUTIONS

General RAS design

- low head design (total head loss 90 cm)
- energy 150 kW
- output 700 ton Tilapia 750 g



VIQON WATERSOLUTIONS

Set-up RAS

VIQON WATERSOLUTIONS

WATER BALANCE RESTRICTIONS

Expected water usage 700 ton tilapia farm 25 m3/hour

↓

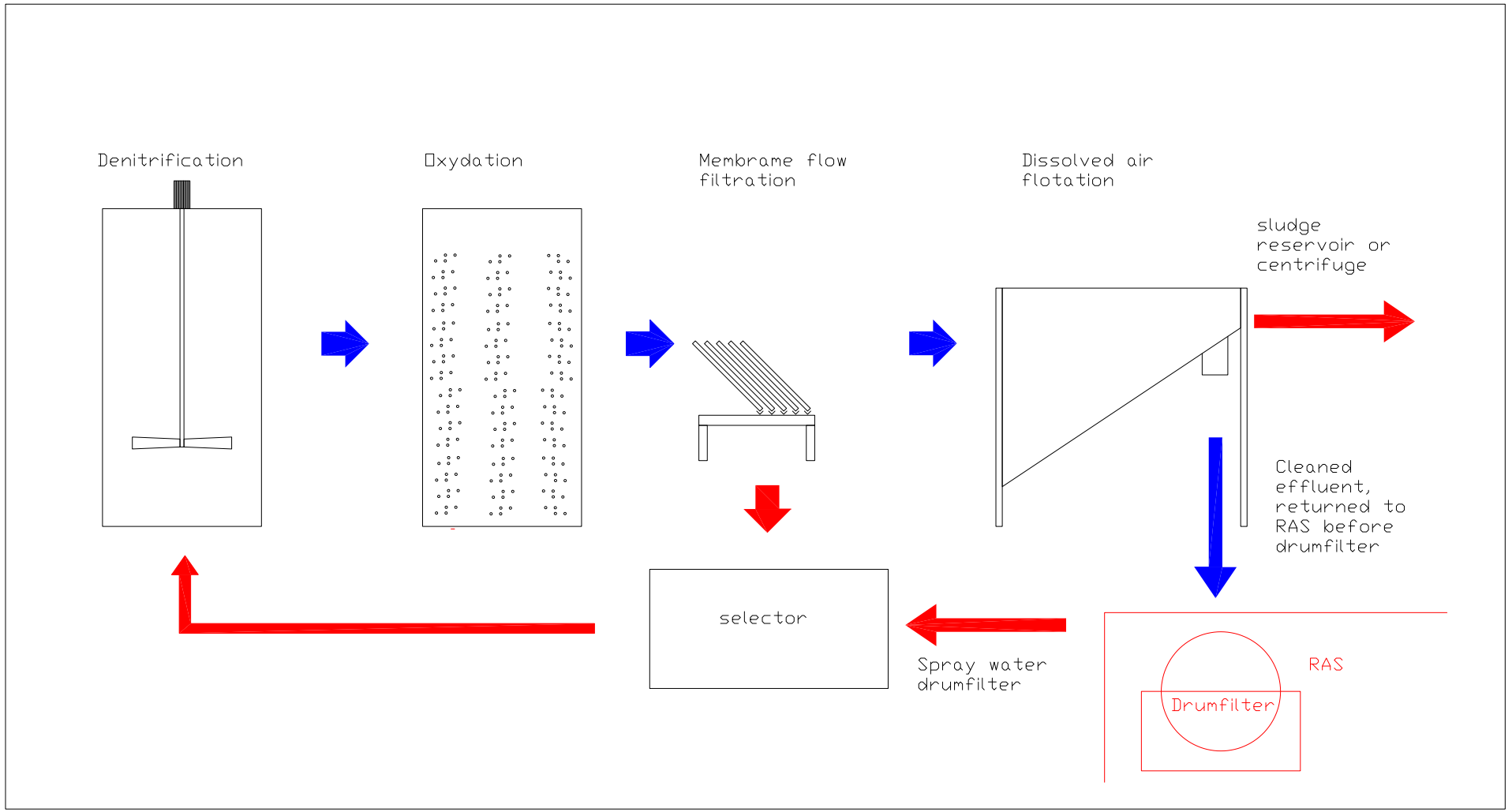
Well/discharge regulation, max. 10-15 m3/hour

↓

Denitrification (manure as C-source)

VIQON WATERSOLUTIONS

Set-up DENOX system



VIQON WATERSOLUTIONS

Denitrification

VIQON WATERSOLUTIONS

SPECS SYSTEM RAS 700 ton Tilapia

RAS	
Recirculating flow (m3/hour)	6400
Average feeding level (kg/day)	2400
make up water (m3/day)	120
COD level (mg/l)	250
ortho-P	60
NO3 level (mg/l)	830

DENOX	
capacity (m3/hour)	20
Denitrification volume (m3)	135
Oxidation volume (m3)	90
Dry matter content active sludge (g/l)	6
NO3-N removal (g NO3-N/kg dm/hour)	**2,3**
NO3-N removal (mg NO3-N/l/hour)	**14**

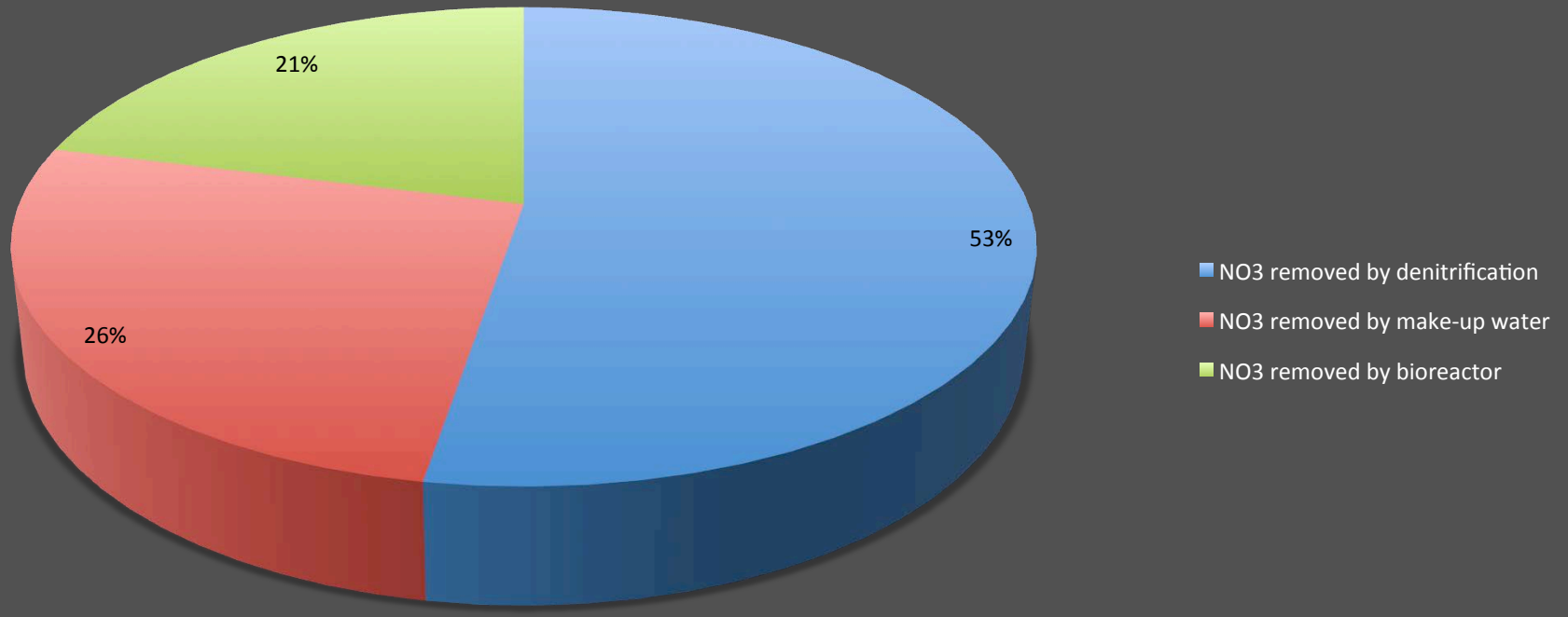
WATER QUALITY

Influent denitrification	
volume spray water drumfilter (m3/day)	480
Dry matter content (g/l)	2
COD level (mg/l)	1700
Ortho-P (mg/l)	60
NO3 (mg/l)	830

Effluent denitrification	
Dry matter content (g/l)	0
COD level (mg/l)	250
Ortho-P (mg/l)	40
NO3 (mg/l)	380

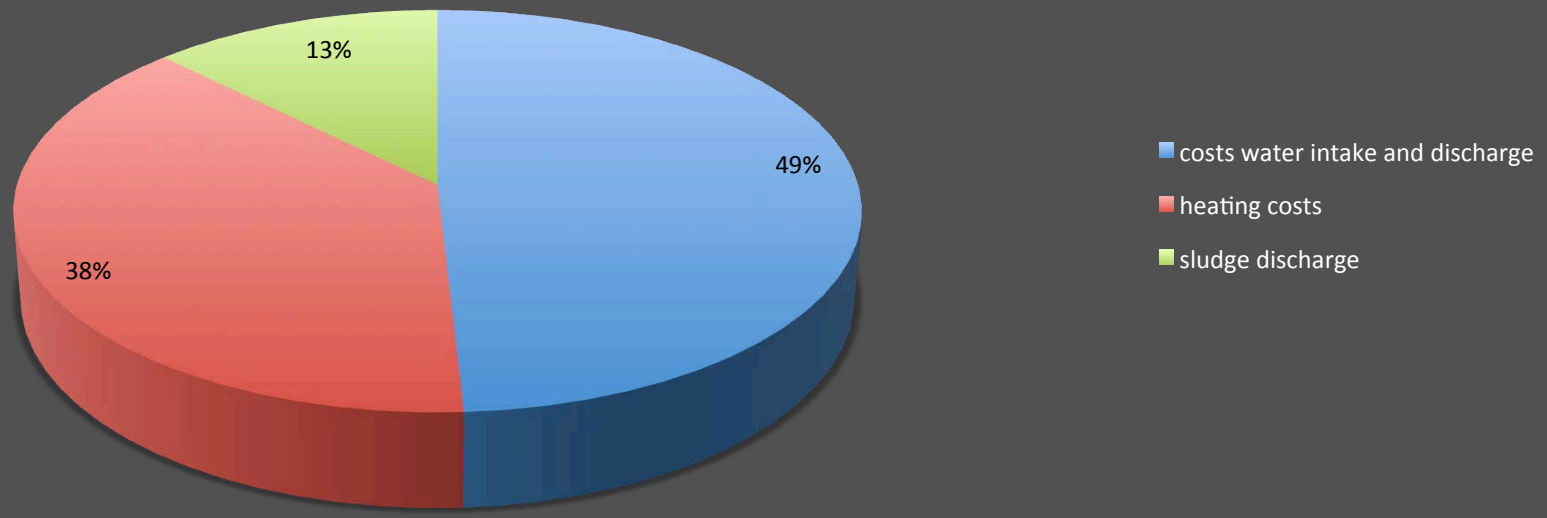
VIQON WATERSOLUTIONS

NO3 balance 700 Ton Tilapia farm with integrated DENOX system



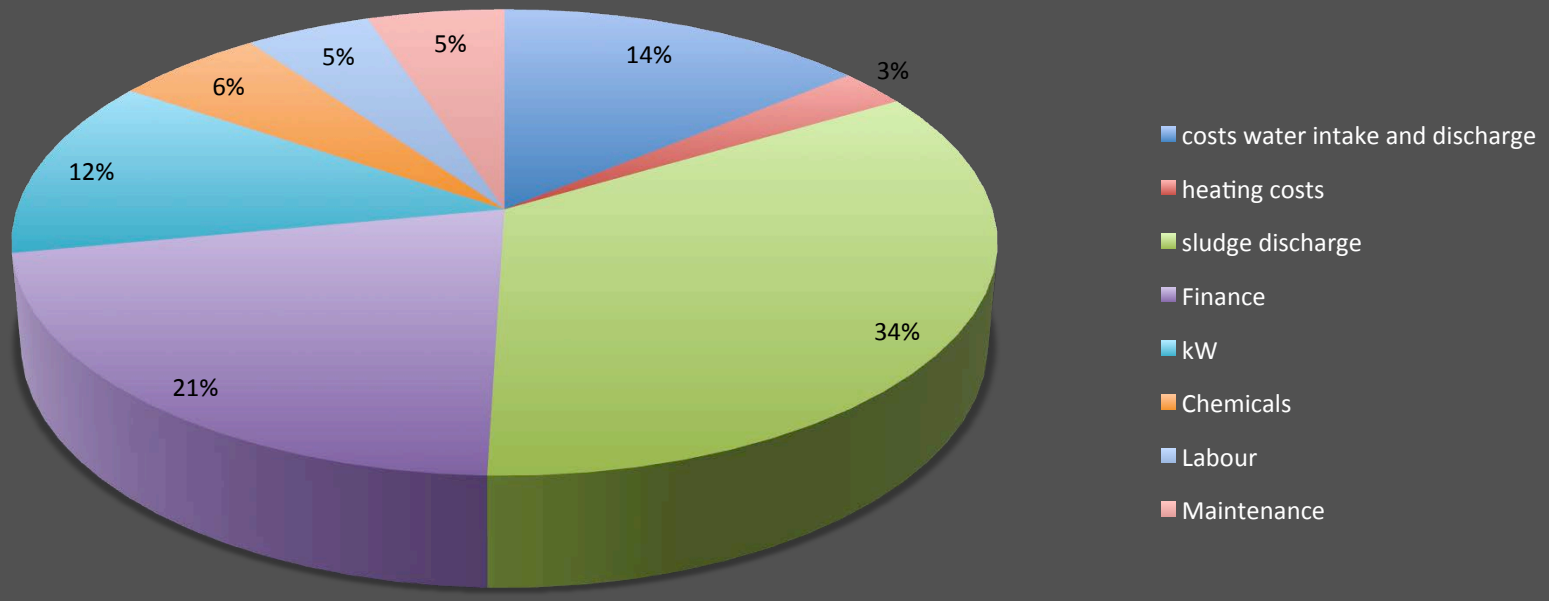
VIQON WATERSOLUTIONS

NO DENOX, water balance costs Euro 0,23 Euro/kg production (maritime climate)



VIQON WATERSOLUTIONS

DENOX, water balance costs 0,17 Euro/kg production (maritime climate)



VIQON WATERSOLUTIONS

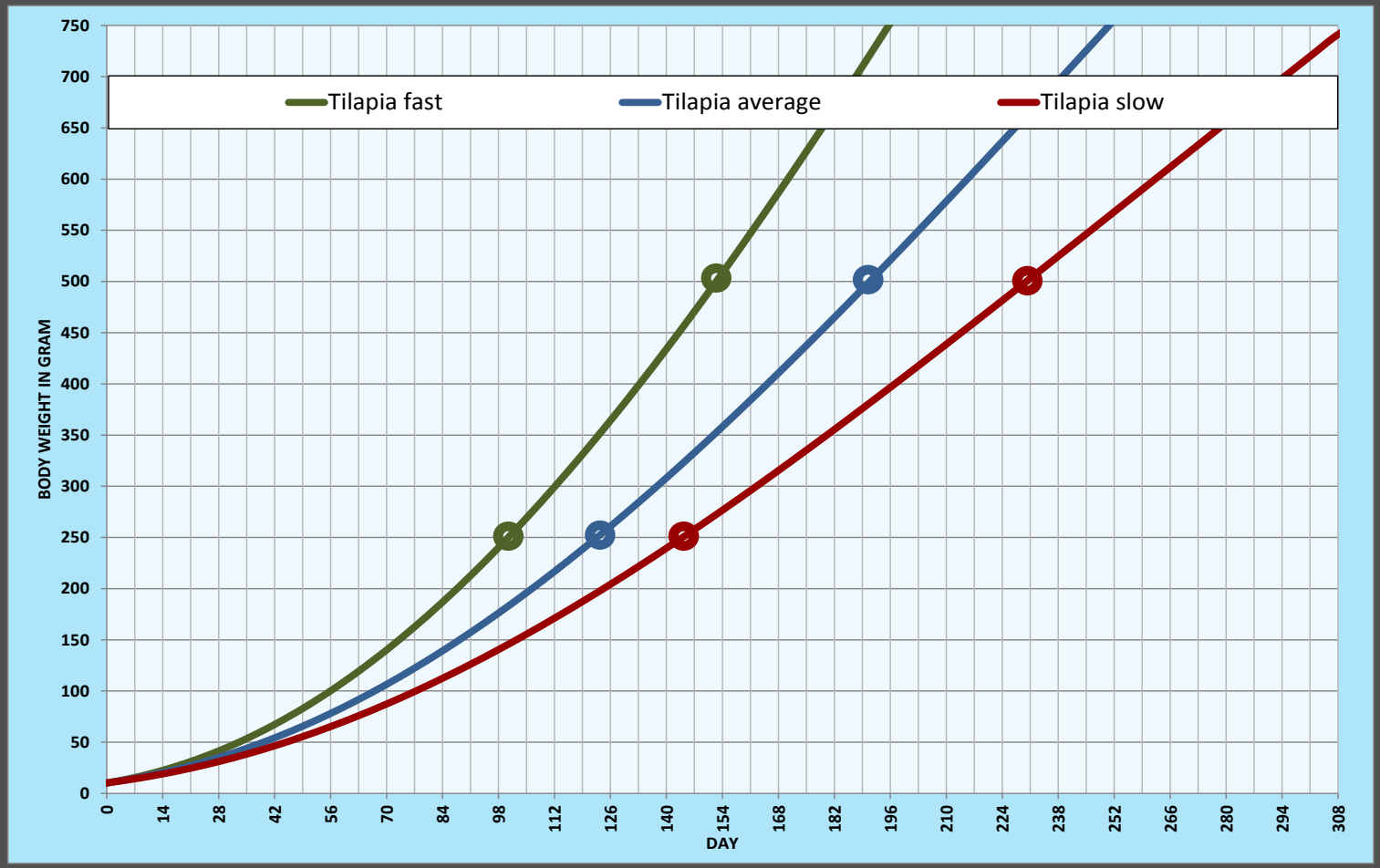
Water quality balance 700 Ton Tilapia farm after 2 years of production using denox system

Year	2007	2008	2009
Feeding level (kg/day)	1200	2400	2400
pH	8	5,8	5,9
NH4 (mg/l)	1,6	2	5
NO2 (mg/l)	0	0	1
NO3 (mg/l)	5	800	830
COD (mg/l)	24	160	250
ortho-PO4 (mg/l)	5	50	60
salinity (%)	0,05	0,08	0,19
alkalinity ^{0}d	6	0,3	0,5
Fe2+ (mg/l)	0,02	1,3	1,6

VIQON WATERSOLUTIONS

Growth curve Tilapia

-Farm producing on fastest growth curve



VIQON WATERSOLUTIONS

Cost price comparison of 700 ton Tilapia RAS production unit with/without denox

	NO DENOX	DENOX
Cost price Tilapia (Euro/kg)	**€ 2,34**	**€ 2,27**
juveniles	€ 0,05	€ 0,05
feed	€ 0,90	€ 0,90
water intake/discharge/sludge	€ 0,14	€ 0,08
heating	€ 0,09	€ 0,01
electricity	€ 0,19	€ 0,21
labour	€ 0,14	€ 0,15
other	€ 0,10	€ 0,11
insurance	€ 0,10	€ 0,10
finance	€ 0,63	€ 0,66

VIQON WATERSOLUTIONS

Findings ZON aquafarming project

1) application of manure based denitrification in large scale Tilapia farming is feasible

2) denitrification reduces sludge volume with 30-35%

2) water usage of 40-50 l/kg feed is possible for efficient Tilapia production

3) no effect of denitrification on fish quality/flavor and growth

4) Ortho Phosphate level > 150 mg/l gives soap like flavor to fish

5) dissolved air flotation unit removes COD and PO_4 efficiently and makes the quality of denitrification effluent more stable

6) achieved manure based denitrification rate 2,3 g NO_3-N/g DM/hour or 14 mg NO_3-N/l/hour

7) membrame flow filtration reduces flocculant use with 70-80% compared to traditional technique

8) denitrification can reduce water usage in RAS with 80-90%

9) feasibility denitrification depends a lot on local conditions

VIQON WATERSOLUTIONS

Latest developments

1) Application DENOX system in 300 ton eel farm as end of pipe solution

- increase NO_3-N removal rate by discontinuous mixing (induce hydrolysis)
- optimized polymer use on DAF in combination with $FeCl_3$
- 99% NO_3 removal, 95% COD removal, process more difficult to control

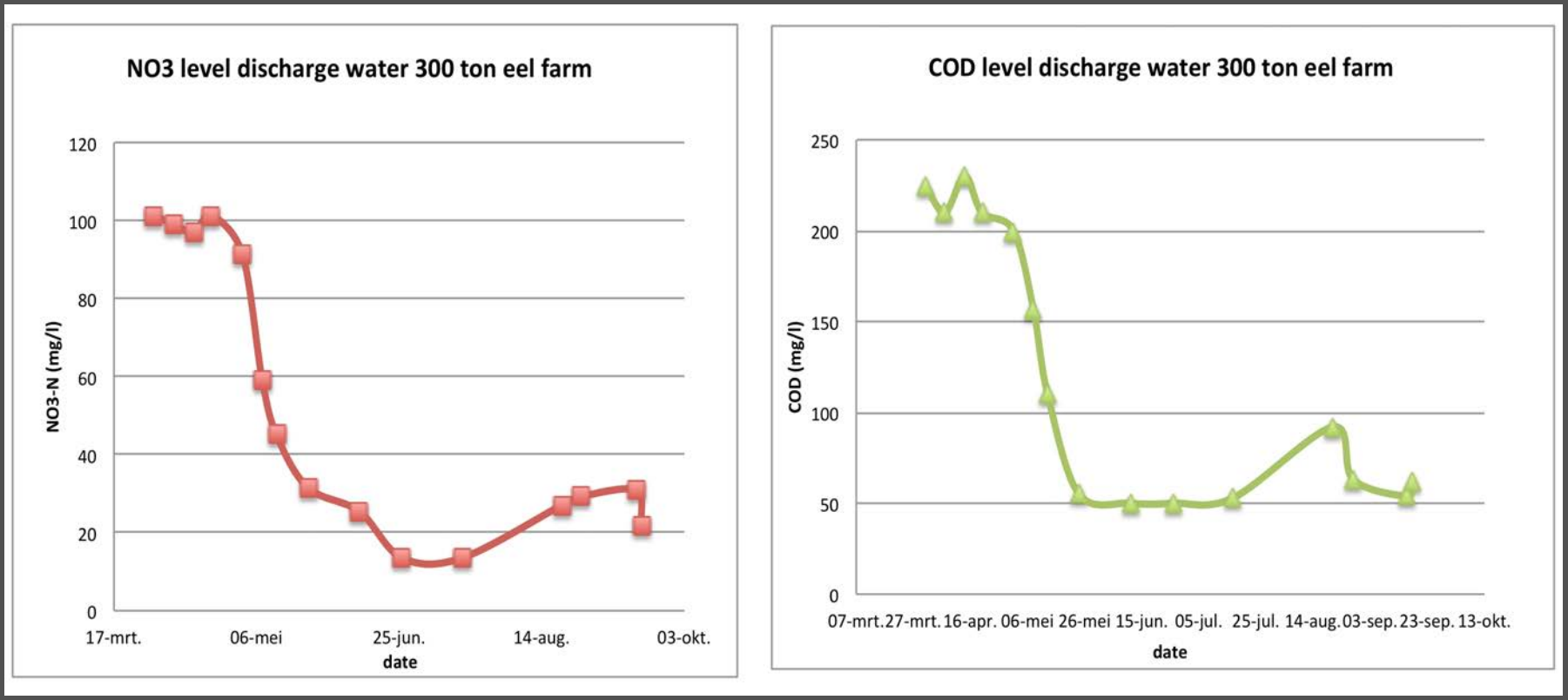




VIQON WATERSOLUTIONS

Result

Effect on water discharge quality



2) Application in RAS biofloc shrimp production units (replacement sequence batch reactor)

- better and easier biofloc control
- easier management compared to SBR technique (no influence by sedimentation characteristics)
- smaller footprint
- simple set-up, DAF unit not required because of biofloc technique in production

VIQON WATERSOLUTIONS

3) application in industrial water treatment

- replacement of discontinuous SBR
- membrame flow filter used as sludge/water separation, replacing settling tanks, belt filters and DAF units

VIQON WATERSOLUTIONS

Questions?

Viqon Water Solutions
The Netherlands
www.viqon.com