Waterkwaliteit in recirculatie systemen

Ep Eding

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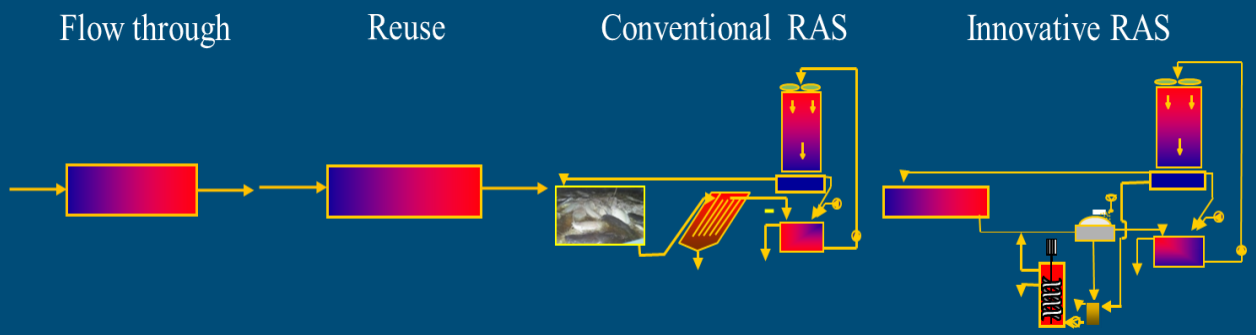
Vermindering water verbruik

Nile Tilapia
(Oreochromis niloticus)



	Doorstroom	Reuse	Conventionele Recirculatie systemen	Recirculatie systemen met denitrificatie
System water exchange (m^3/kg voer)	204	59	0.187	0.029

Vermindering water gebruik

Toenemende ccumulatie van stoffen in kweekwater

Source: http://www.sustainaqua.org/images/handbook/EN.pdf p84.

Waterkwaliteit

Tilapiakwekerij

100 MT Tilapia productiecapaciteit

(Courtesy Fishion Aquaculture BV, The Netherlands)

Waterkwaliteit

Tilapia

Tilapia (*Oreochromis niloticus*)

(*Courtesy Fishion Aquaculture BV, The Netherlands*).

Handhaven waterkwaliteit 100 MT kwekerij

1. Productie plan (maximum draagkracht systeem)
2. Berekening vuilproductie (in g/kg voer)
3. Dagelijkse variatie in vuil productie
4. Water kwaliteitsgrenswaarden vis ($C_{Toegestaan}$)
5. Verwijdering vaste stoffen
6. Biofiltratie
7. Begassing en ontgasssing
8. Denitrificatie
9. Ontwerp concept voor waterkwaleitscontrole in RAS

Waterkwaliteit

1. Productieplan

1.	**Vissoort:**	Tilapia		
2.	**Groeitraject tilapia (g)**		70 - 845	gram
	2a.	Voerinname (% G)	$26.4\ G^{-0.47}$	% G[1)]
	2b.	Voederconversie	$0.57\ G^{0.14}$	(kg voer/kg groei)
	2c.	Sterfte	$1.75\ G^{-0.8}$	%week
	2d.	Max. dichtheid	$35\ Ln(G)^{-80}$	kg/m^3
	2e.	Max. dichtheid	140	kg/m^3
	2e.	Kweek periode	24	weken
3.	**Productie plan tilapia.**			
	3a.	Production doel	100	MT/jaar *(100 MT - 8.3MT = 91.7MT)*
	3b.	Oogstinterval	3	weken
	3c.	Bezettingsinterval	3	weken
	3d.	Groeifasen	2	
		- Fase 1.	1 - 12	weken
		- Fase 2.	12 - 24	weken
	3e.	Max. voerbelasting	349	kg/dag
	3f.	Totale tank water volume	246	m^3

[1)] *Gewicht (G) in g*

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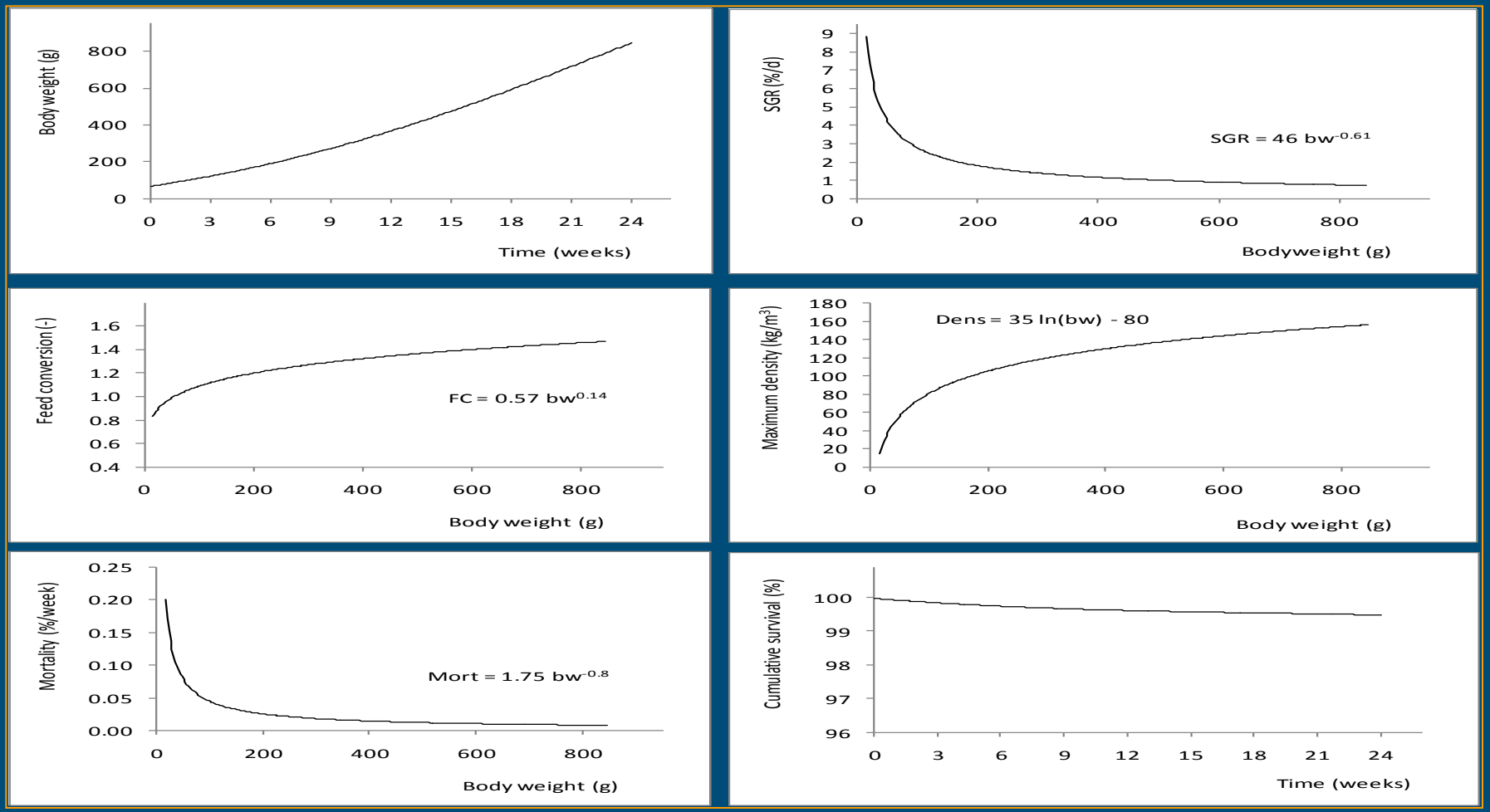
Waterkwaliteit

1. Productieplan



(SustainAqua, 2009

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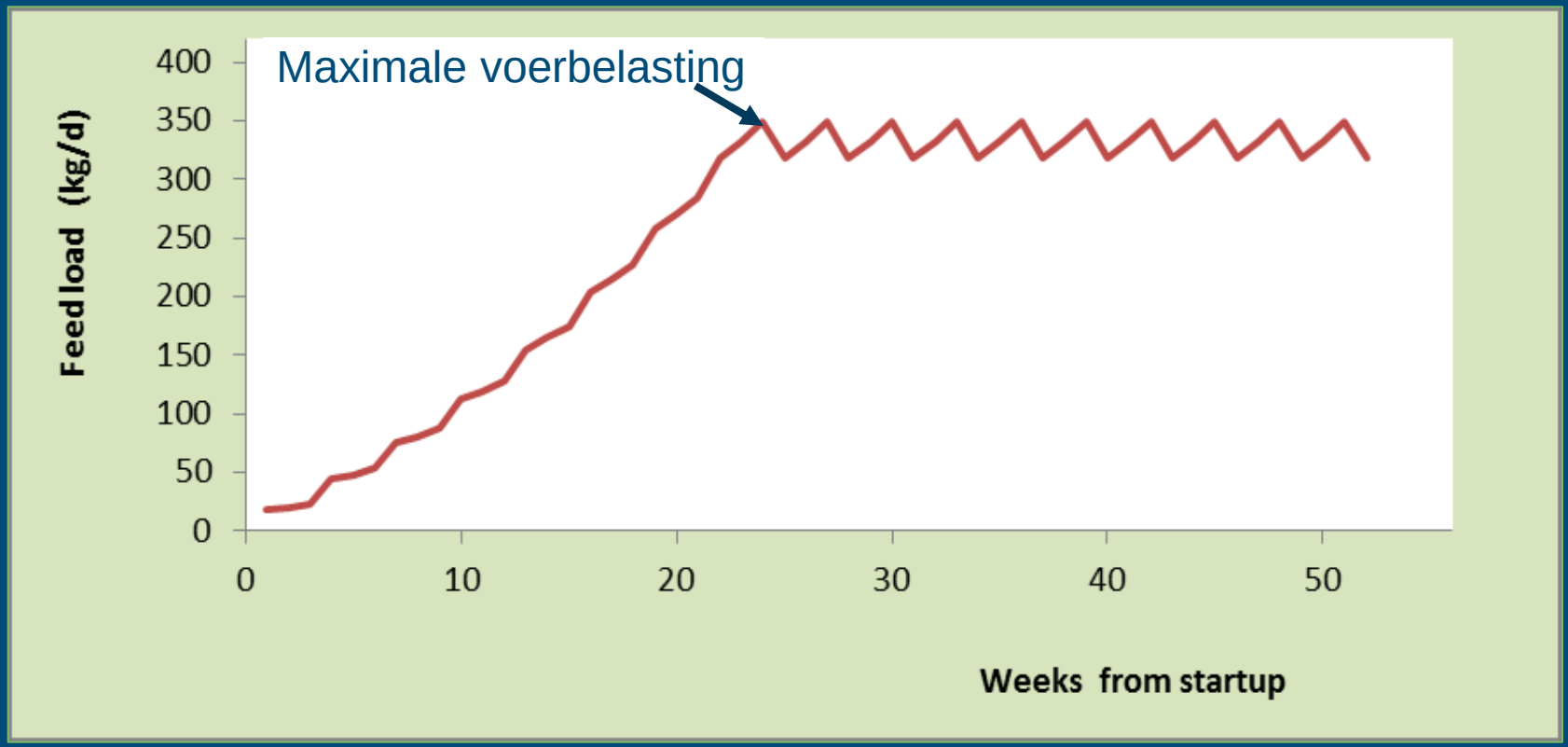
Productieplan → Maximale voerbelasting

Week 24, 12 vistanks in gebruik (totaal 246 m^3).



Waterkwaliteit

1. Productieplan

Productie situatie eind week 24.
Aantal tanks in gebruik: 12 tanks.

Week	Cohort	Gewicht (g)	Aantal vissen (N)	Biomassa (kg)	Voer (kg)
24	1	845	6827	5769	64
21	2	716	6829	4890	57
18	3	592	6831	4044	53
15	4	476	6834	3253	46
12	5	368	6836	2516	40
9	6	273	6840	1867	35
6	7	193	6845	1321	30
3	8	126	6852	863	24
			54694	24523	349

http://www.haki.hu/tartalom/SUSTAIN0906/SustainAqua%20handbook_EN.pdf

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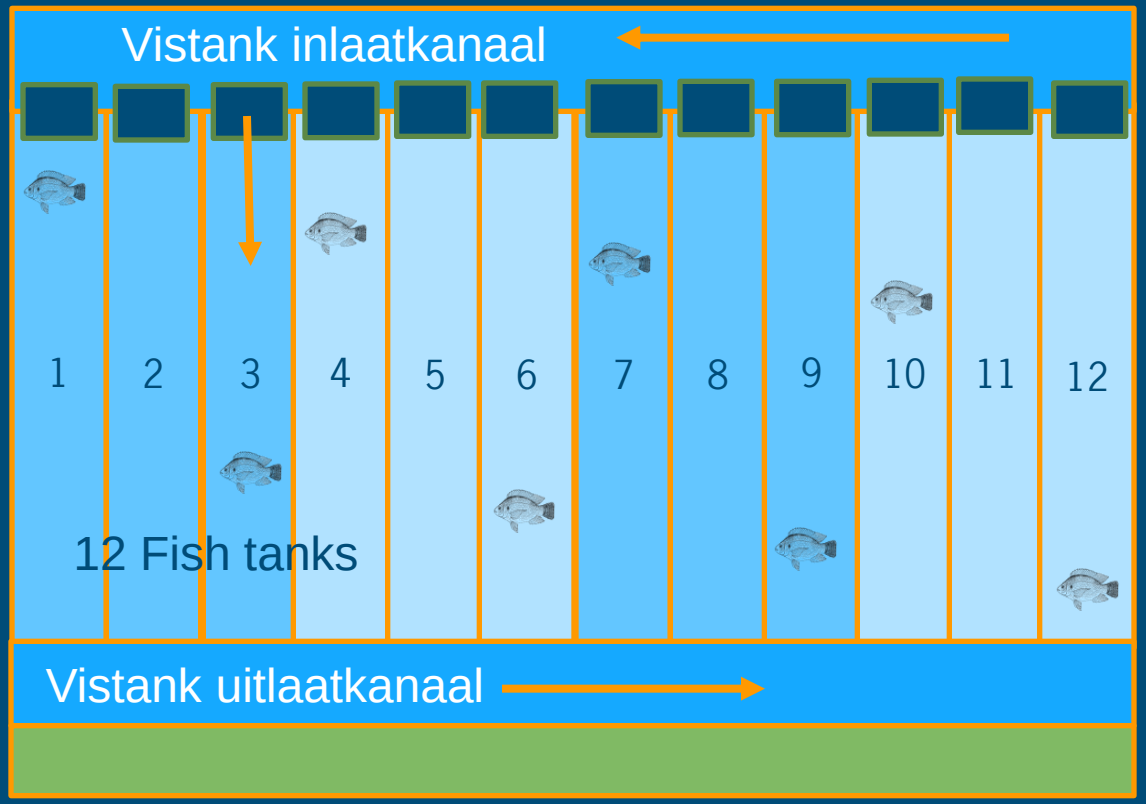
Waterkwaliteit

1. Productieplan

Schema bovenaanzicht vistanks



Waterzuivering

Waterkwaliteitsgrenzen vis?
Waterdoorstroming?
Waterbehandeling?

http://www.haki.hu/tartalom/SUSTAIN0906/SustainAqua%20handbook_EN.pdf

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2. Berekening vuilproductie

Voersamenstelling en verteerbaarheid

Voersamenstelling	Eenheid	Waarde	Verteerbaarheid (fraction)
Eiwit	(g/kg)	380 [1)]	0.9
Vet	(g/kg)	110	
As	(g/kg)	111	
Fosfaat	(g/kg)	12	0.6
Energie	(kJ/g)	18.4	
COD	(g/kg)	1192	0.85

[1)] 16% van het eiwit is stikstof (N) (60.8 g/kg feed)

(SustainAqua, 2009)

Waterkwaliteit

2. Berekening vuilproductie

Vuilproductie per kg voer
Maximum voer belasting: 349 kg voer/dag

Massabalans	Eenheid	Stikstof	Fosfaat	COD
Voer	(g/kg voer)	60.8	12	1192
➡ Feces	(g/kg voer)	6.1	5	179
➡ Excretion	(g/kg voer)	35.3	2	124
➡ Respiratie	(g/kg voer)			512
Groei (aanzet)	(g/kg voer)	19.4	5	377

http://www.haki.hu/tartalom/SUSTAIN0906/SustainAqua%20handbook_EN.pdf

Waterkwaliteit

4. Grenswaarden

Waterkwaliteitgrenswaarden en k-warden om voor dagelijkse variatie te corrigeren

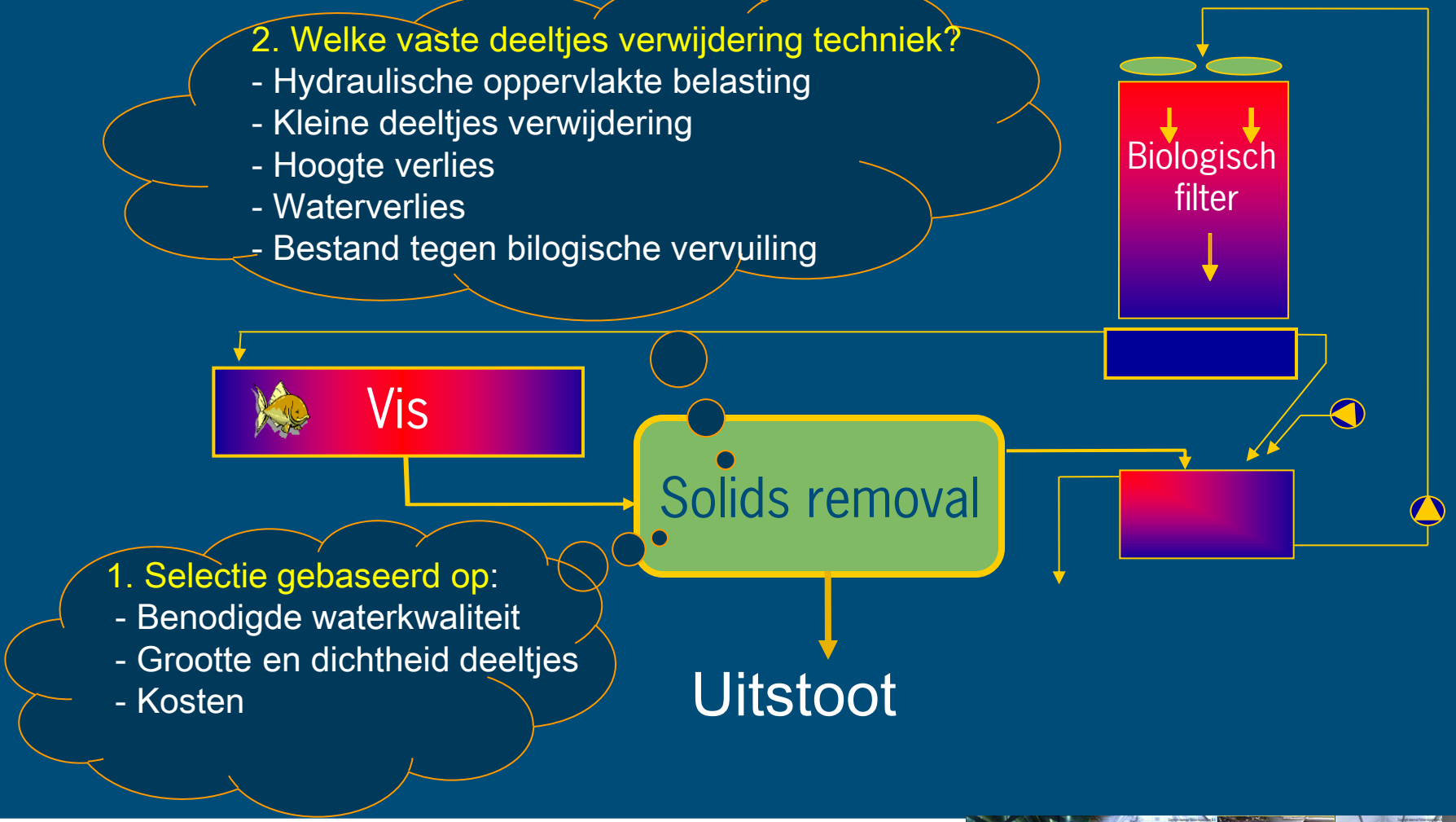
Waterkwaliteit parameters	Vis		k - waarde	
	Range	Keuze	Range	keuze
Temperatuur	24-28	27		
pH	5.5-7.5	7		
NH_3-N	0.01-0.1	0.01		
TAN		1.5	1-2	1.4
NO_2-N	0.05-1	1		
NO_3-N	100-200	165	1-2	1
O_2	4-6	4.5	1-1.2	1.2
CO_2	15-20	15	1-1.2	1.2
COD dissolved	100-300	200	1-2	1
Suspended solids		25		

http://www.haki.hu/tartalom/SUSTAIN0906/SustainAqua%20handbook_EN.pdf

Water kwaliteit

5. Vaste stoffen verwijdering

2. Welke vaste deeltjes verwijdering techniek?
- Hydraulische oppervlakte belasting
- Kleine deeltjes verwijdering
- Hoogte verlies
- Waterverlies
- Bestand tegen bilogische vervuiling



1. Selectie gebaseerd op:
- Benodigde waterkwaliteit
- Grootte en dichtheid deeltjes
- Kosten

Vaste stoffen verwijdering

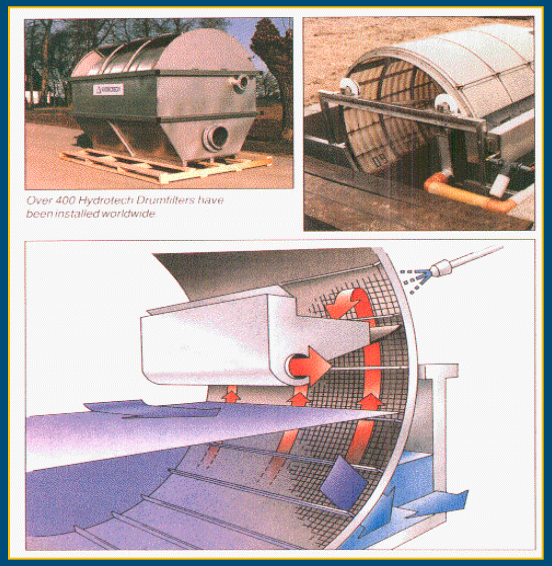
Platen bezinker

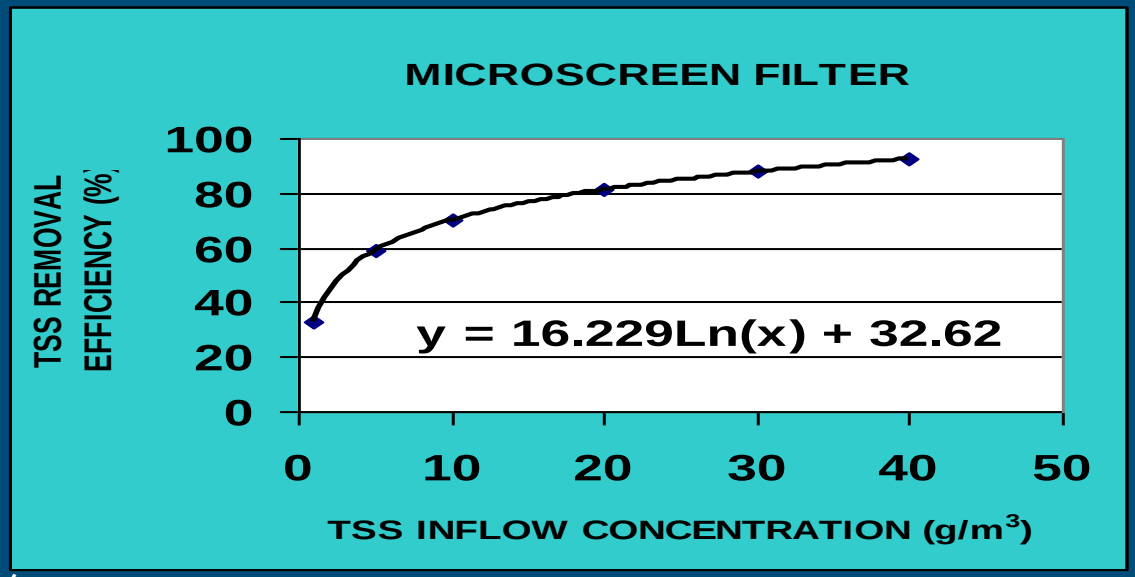
Techniek	Deeltjes grootte (µm)	Hoogte verlies	Hydraulische oppervlakte belasting	TSS verwijdering
Bezinking	>100		30-90 ($m^3/m^2/d$)	40-60%

(Timmons and Ebeling, 2010, Recirculating Aquaculture 2nd edition)

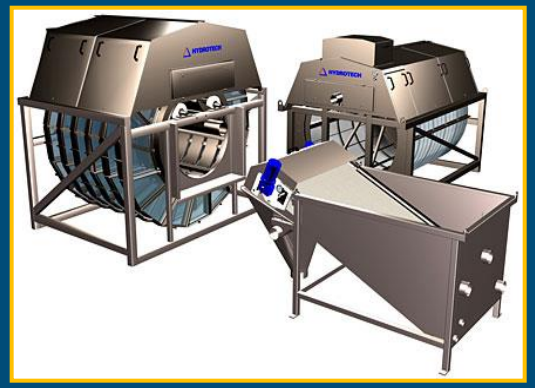
Vaste stoffen verwijdering

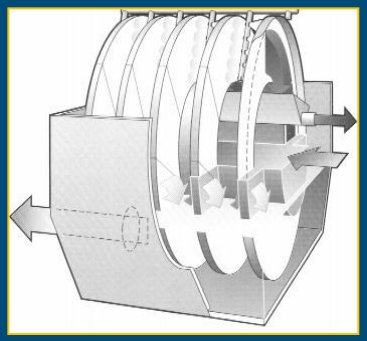
Zeef filtratie





(*After Summerfelt et al., 2001. In: Fish hatchery management 2nd edition*)





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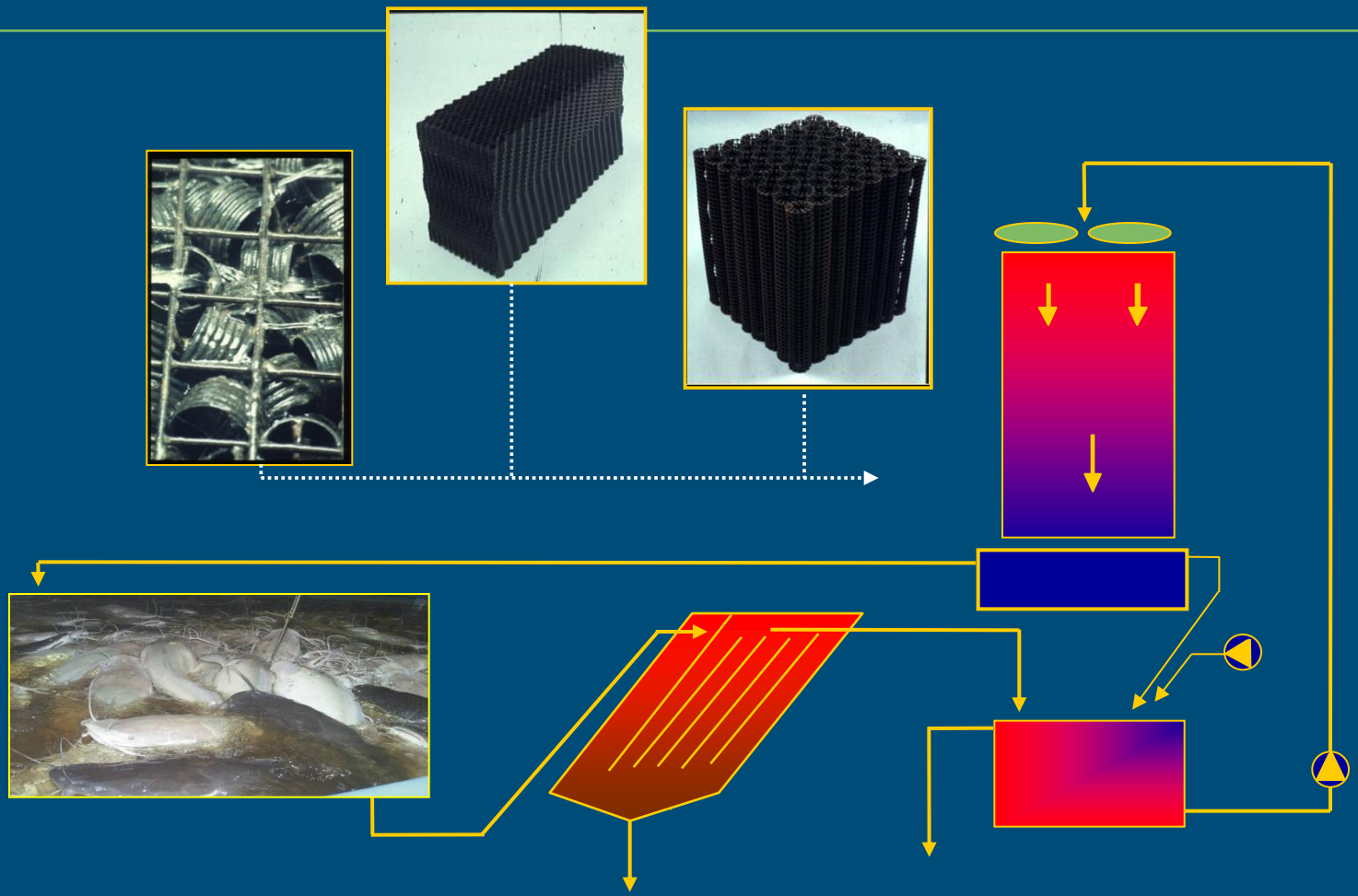
Waterkwaliteit

5. Biofiltratie



(Eding et al., 2006. Aqaucultural Engineering 34, 234-260)

Biofiltratie

Nitrificatie

Reaction by nitrification

1. *Ammonia Oxy. Bacteria*

$$NH_4^+ + \frac{3}{2}O_2 \rightarrow NO_2^- + H_2O + 2H^+$$

2. *Nitrite Oxy. Bacteria*

$$NO_2^- + \frac{1}{2}O_2 \rightarrow NO_3^-$$

$$NH_4^+ + 2O_2 \rightarrow NO_3^- + H_2O + 2H^+$$

⇒ 4.57 kg O_2/kg NO_3^--N

(After Henze, 1997. In Waste water treatment: Biological and Chemical processes, Springer Verlag)

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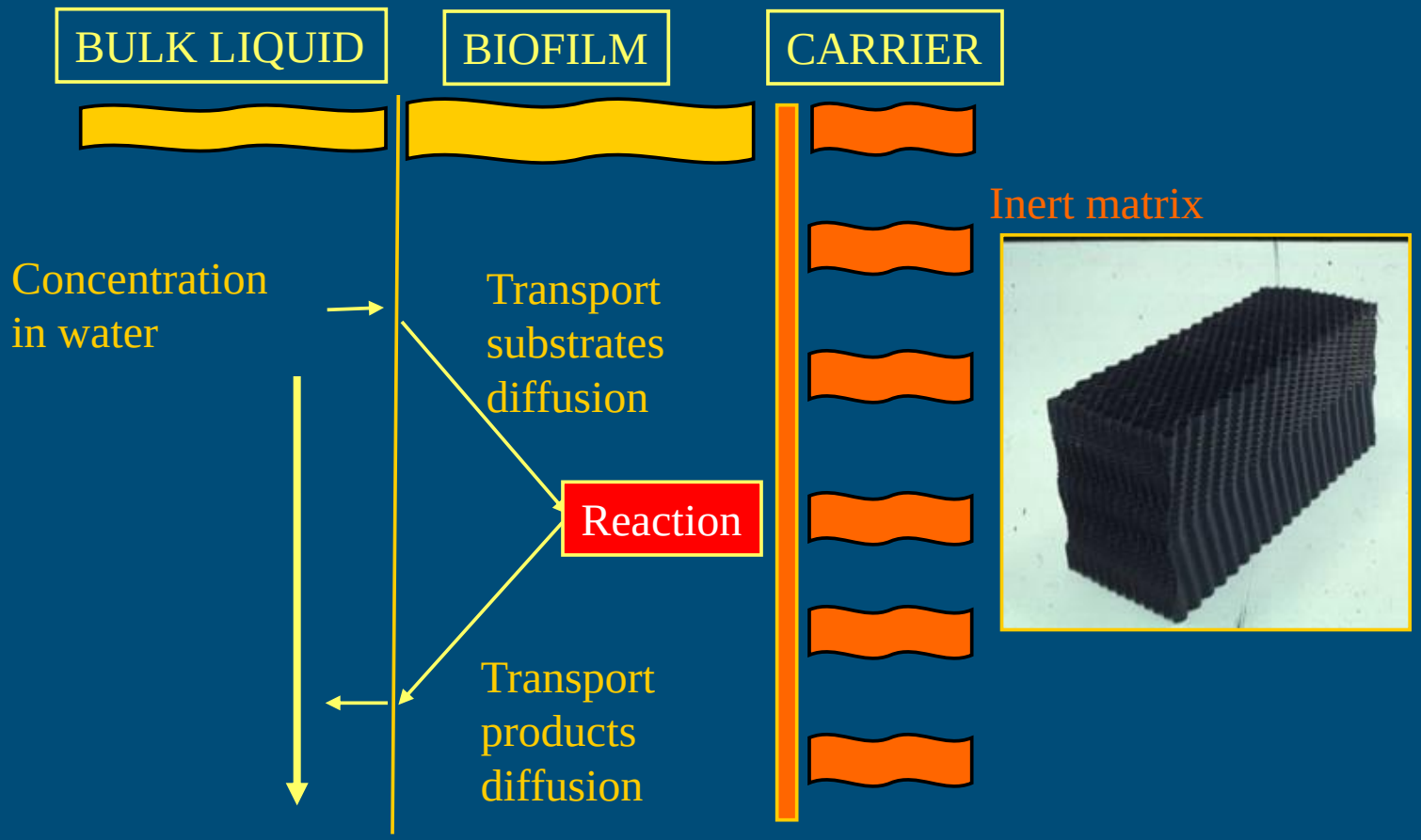
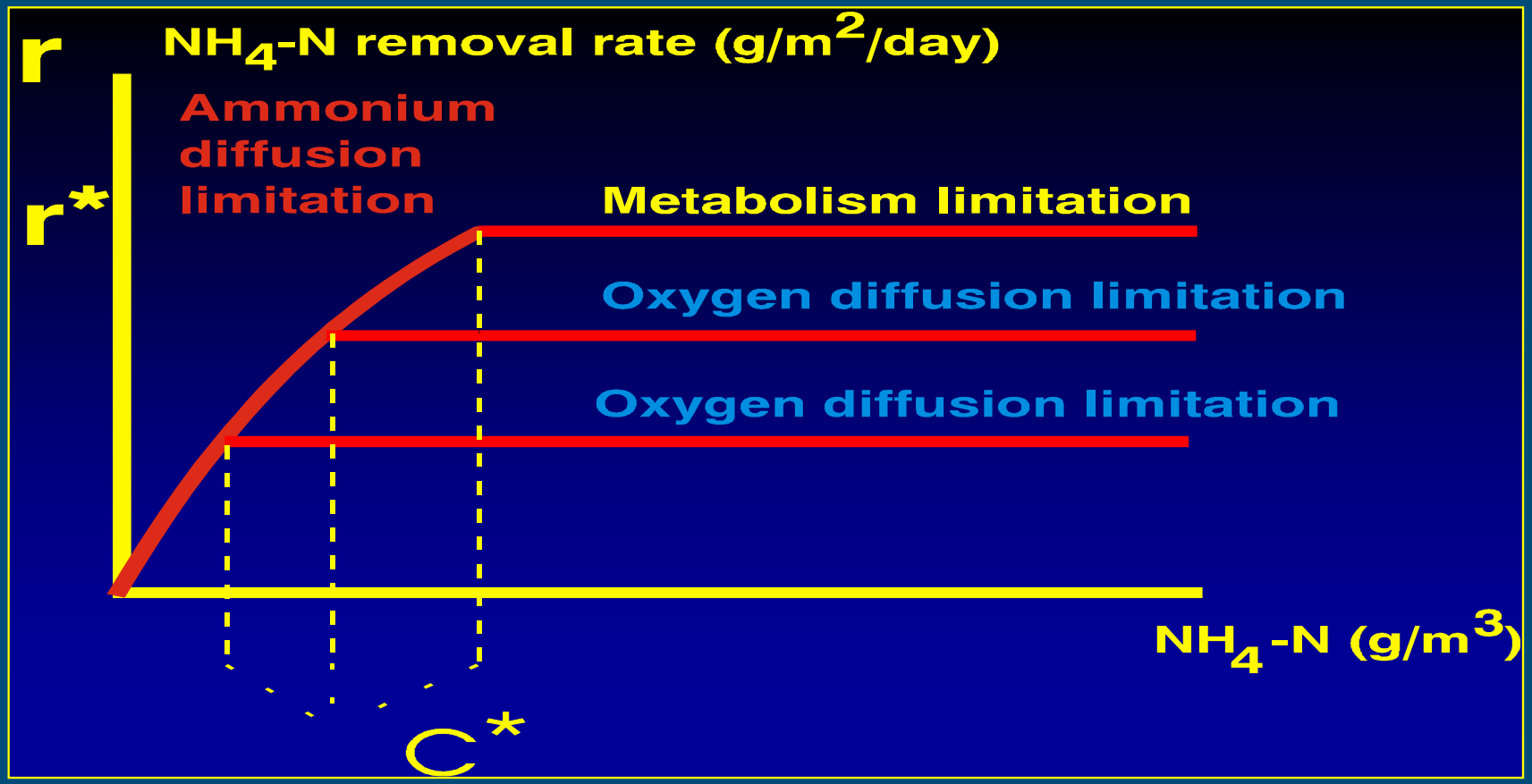
5. Biofiltratie



(After Henze, 1997. In Waste water treatment: Biological and Chemical processes, Springer Verlag)

Biofiltratie

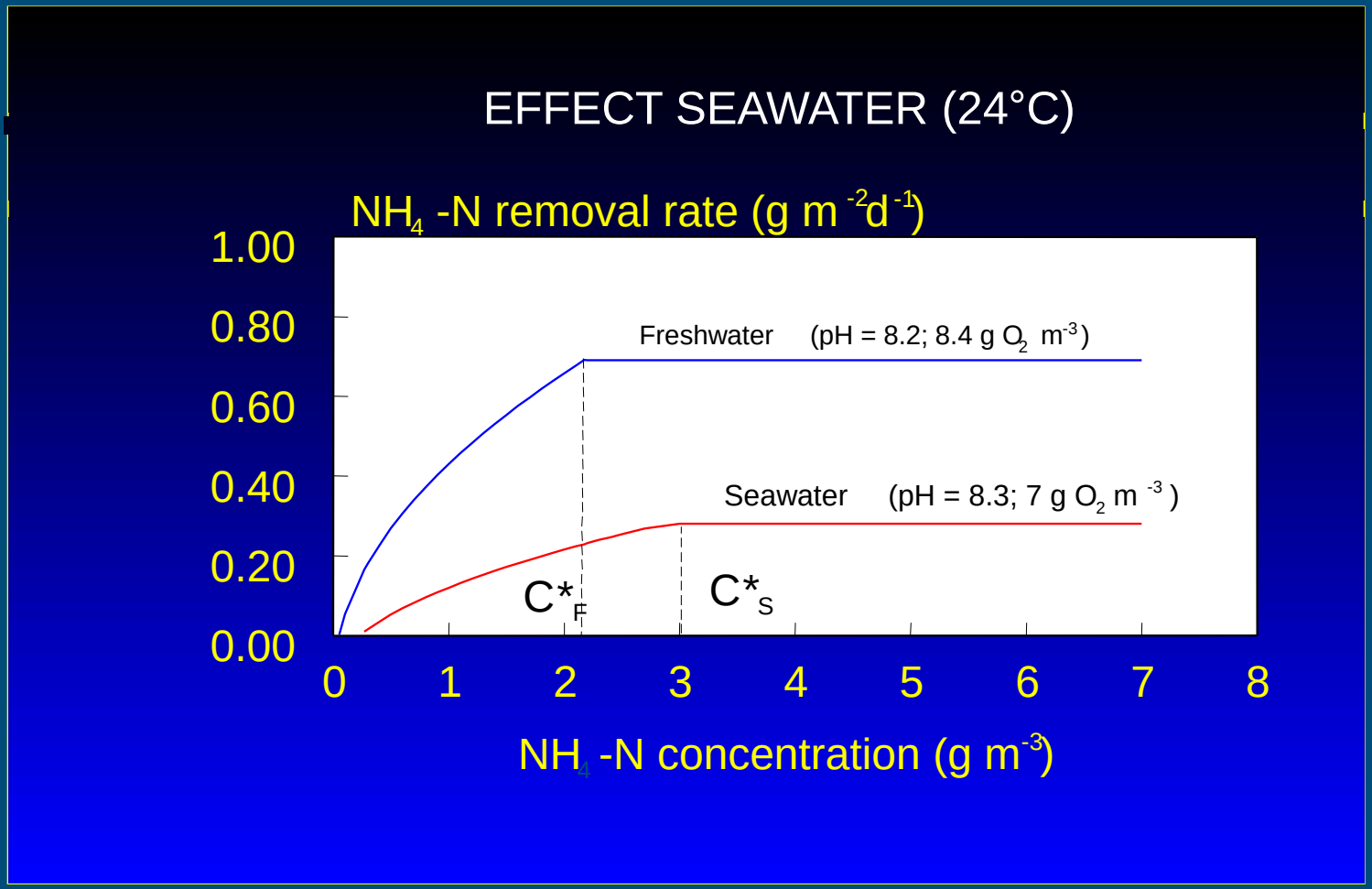
Effect van zuurstof en ammonium concentratie



(After Harremoës, 1978. Water pollution microbiology, Wiley, New York)

Biofiltratie

Effect of zoutgehalte

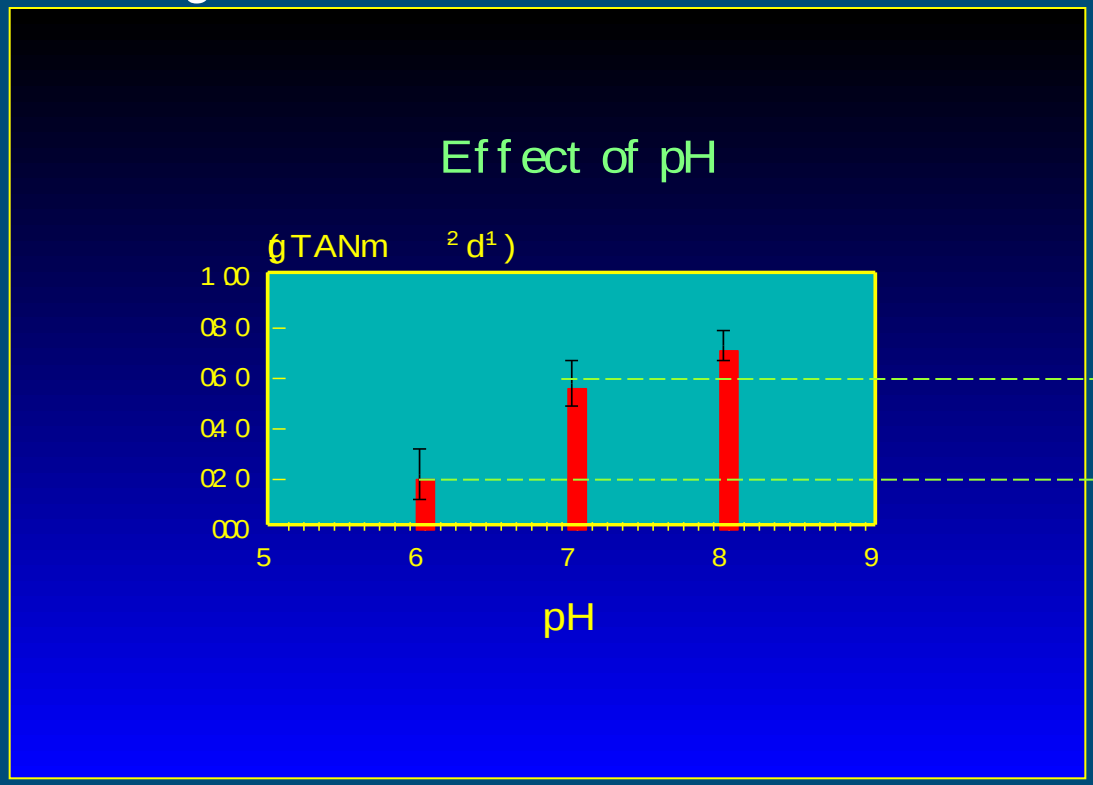


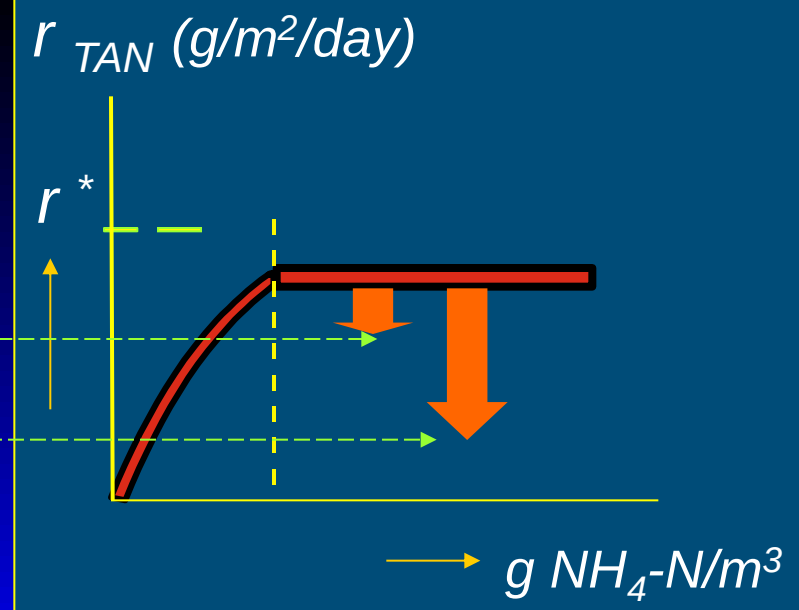
(After Nijhof and Bovendeur, 1989. Aquaculture 87, 133-143)

Biofiltratie

Effect of pH

Trickling filter





(After Bovendeur, 1989 in Eding et al., 2006 Aquacult. Eng. 34, 234-260)

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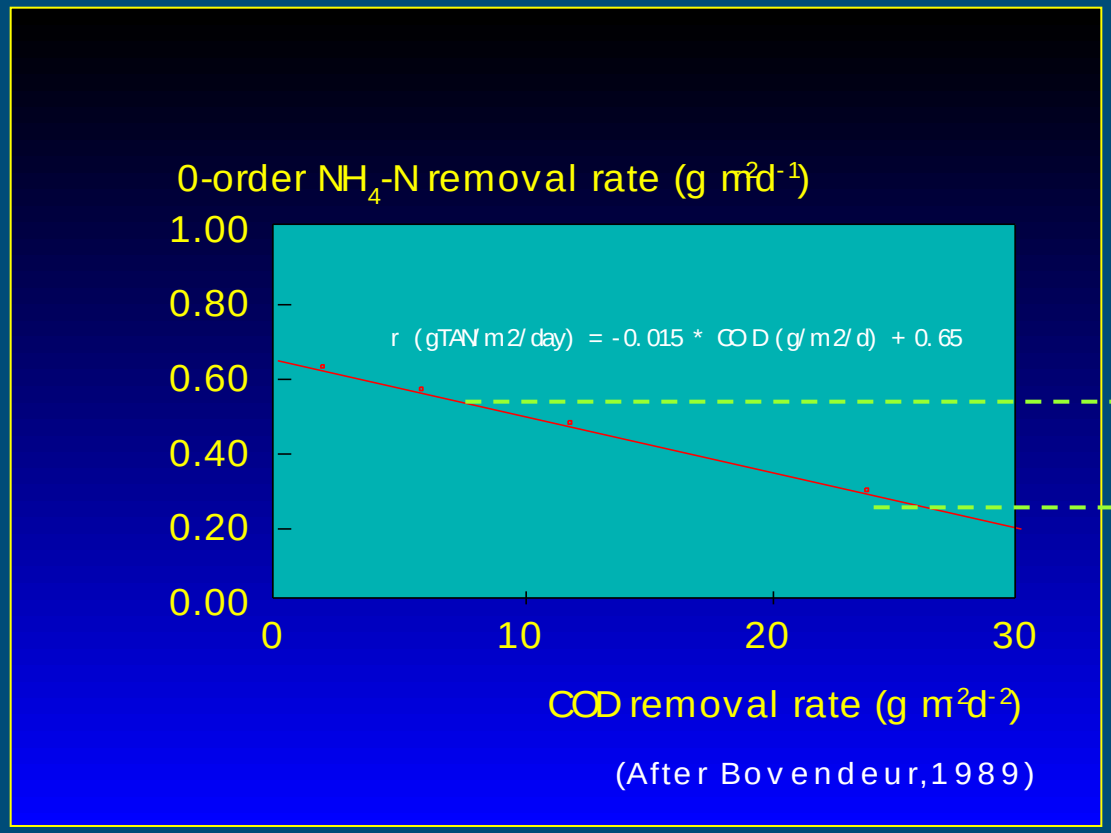
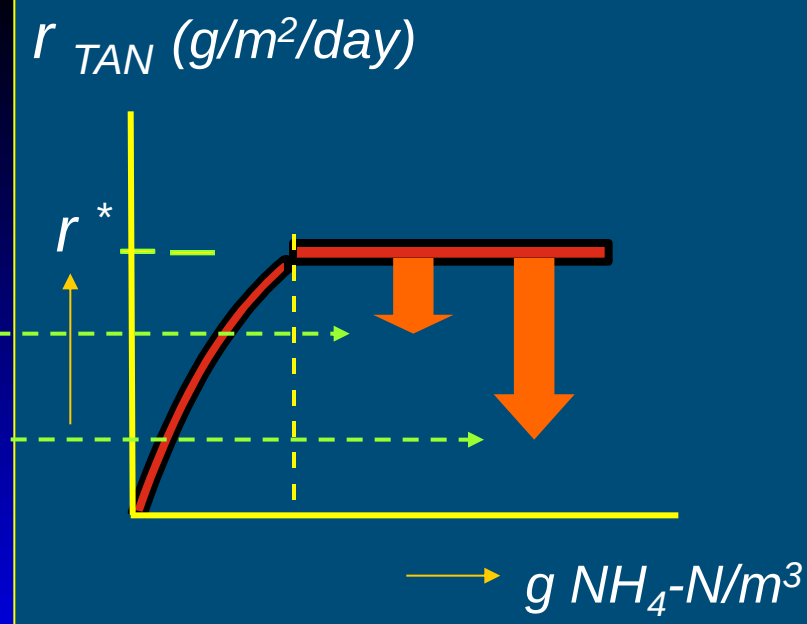
BIOFILM MODEL

Effect organische stof belasting (3-4 hr)





(After Bovendeur, 1989. Dissertation Wageningen University , The Netherlands).

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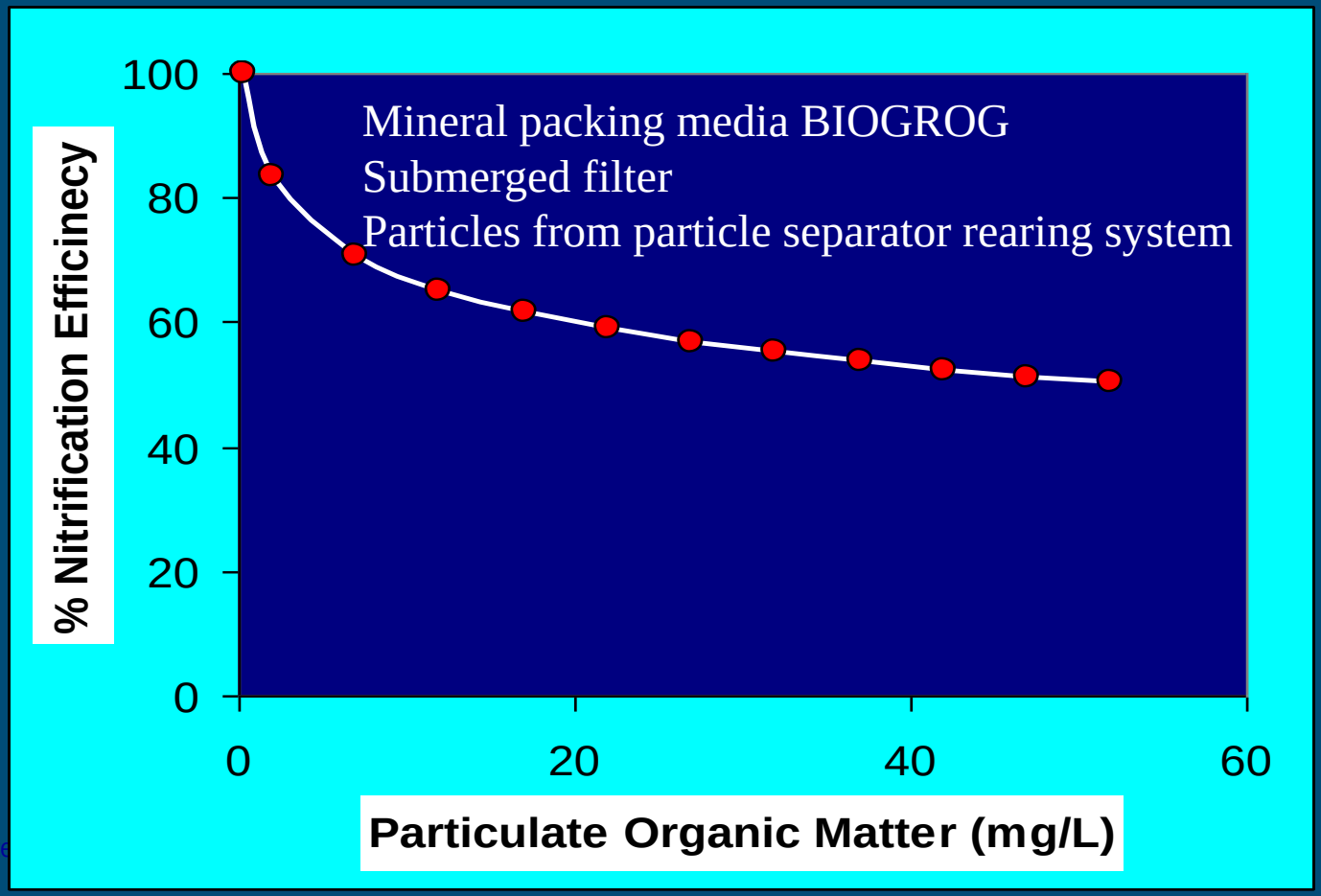
BIOFILM MODEL

Effect organische stof deeltjes

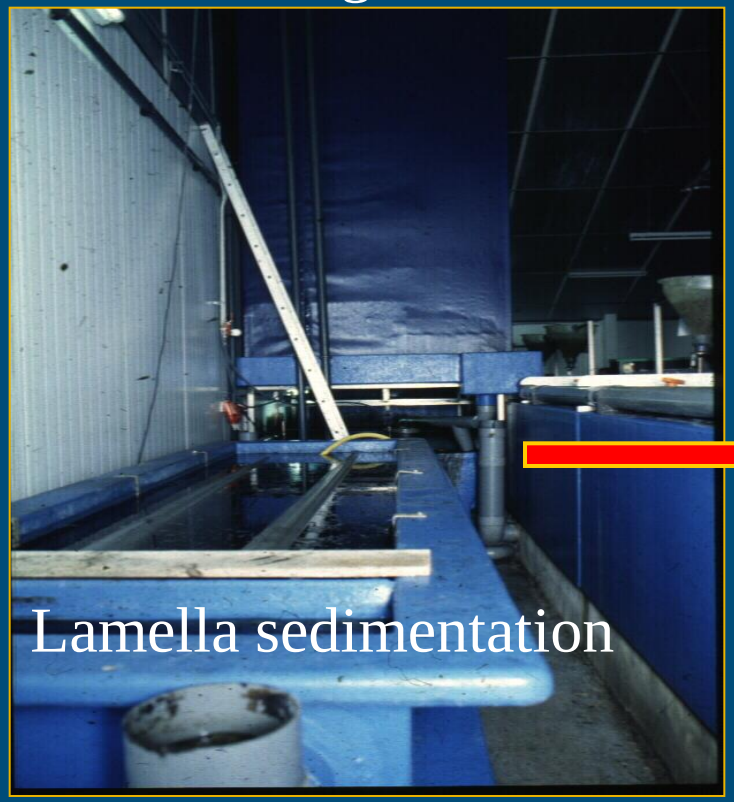


(After Chen et al., 2006. Aquacult. Eng.34, 179-197)

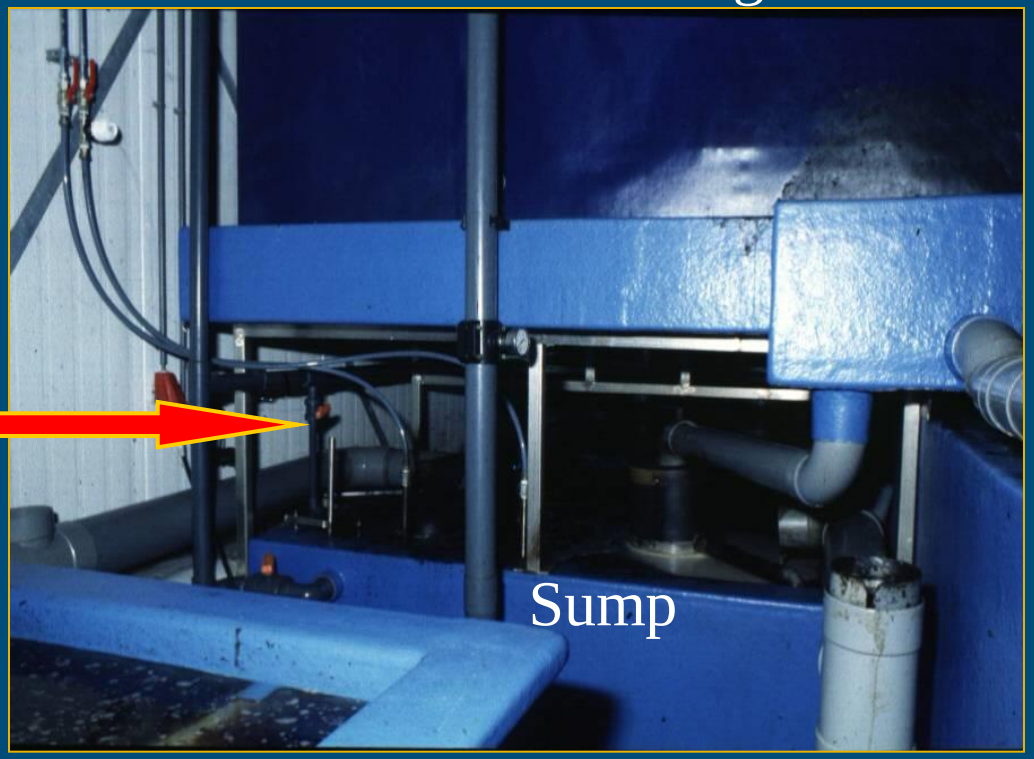
Trickling filter

African catfish RAS

Trickling filter



Trickling filter



(Courtesy Fleuren & Nooijen BV, Someren The Netherlands, (http://www.fleuren-nooijen.nl/Home.html)

(Bovendeur et al.,1987. Aquaculture 63,329-353; Heinsbroek and Kamstra, 1990. Aquacult. Eng 9, 187-207)

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Trickling filter

African catfish RAS

Courtesy Fleuren & Nooijen BV, Someren, The Netherlands (http://www.fleuren-nooijen.nl/Home.html)

(From Eding and Schneider, 2005. RAS-Short course, Trondheim)

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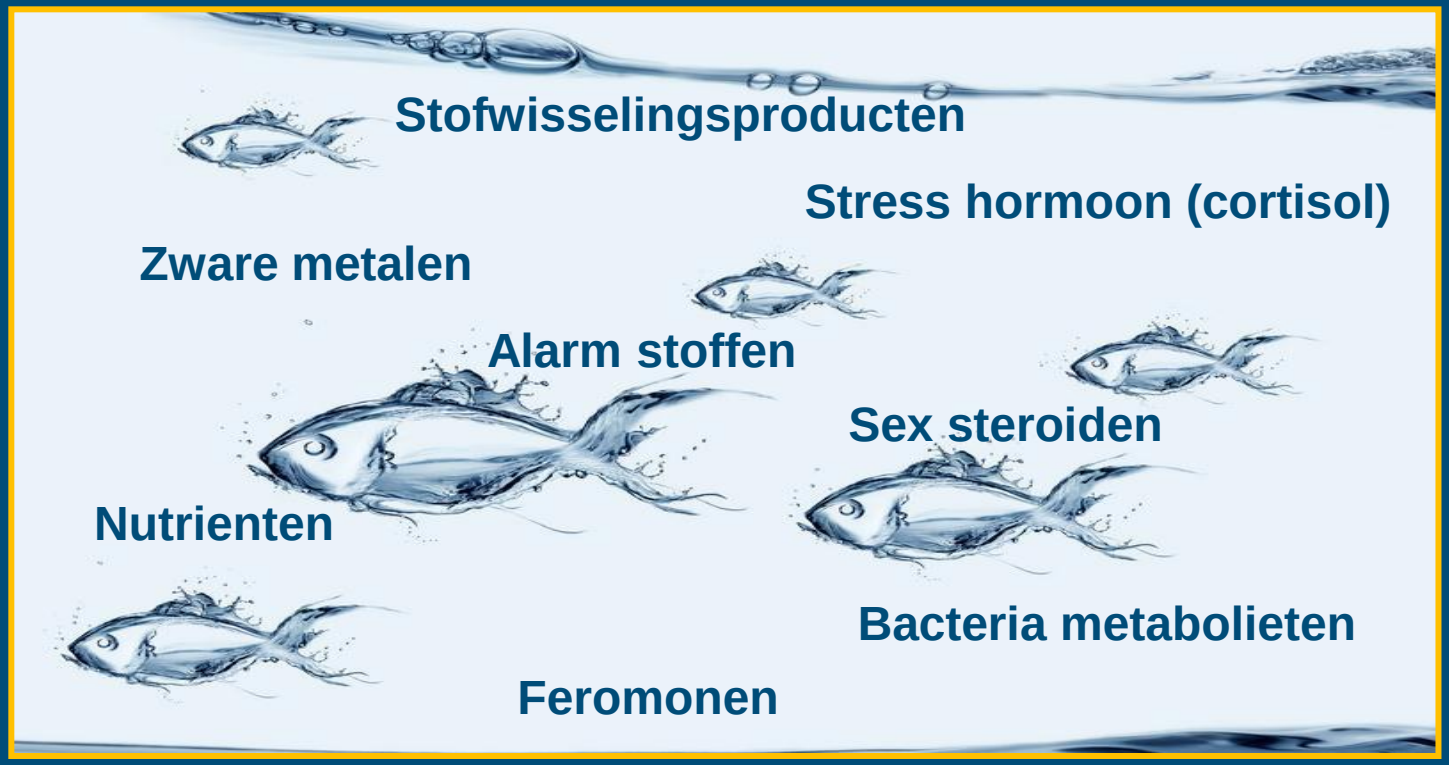
Water kwaliteit in RAS

Vermindering watergebruik

- “ophoping chemische, fysiologische en biologische stoffen ” (Colt ,2006)



Water kwaliteit in RAS

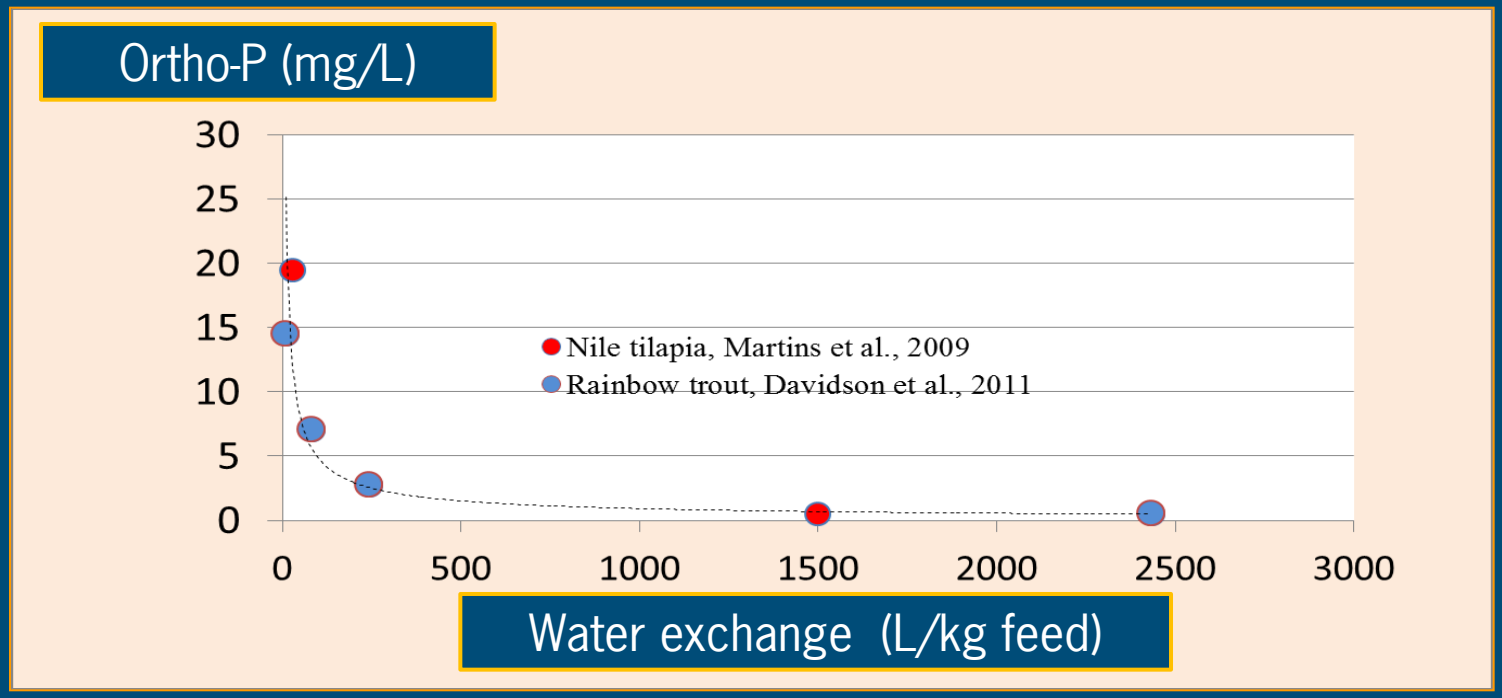
Vermindering watergebruik

Welke stoffen accumuleren?

Water kwaliteit in RAS

Vermindering watergebruik

- Accumulatie van fosfaat (Ortho-P) in zoetwater RAS



Water kwaliteit in RAS

Vermindering watergebruik

Water quality parameter	High accumulation (30L/kg feed/day)	Low accumulation (1500L/kg feed/day)	P-value
Temperature (°C)	24,0 ± 0,0	24,0 ± 0,0	>0.05
pH	7,2 - 7,3	8,5 - 8,6	0,00
Conductivity (µS/cm)	1342 ± 10,1	586,9 ± 9,6	0,00
Dissolved oxygen (mg/L)	8,5 ± 0,00	8,5 ± 0,0	>0,05
TAN (mg/L)	0,15 ± 0,04	0,02 ± 0,01	0,09
NH_3-N(mg/L)	0,001 ± 0,0	0,004 ± 0,002	>0,05
NO_2-N(mg/L)	0,1 ± 0,0	0,0 ± 0,0	0,01
NO_3-N(mg/L)	65,3 ± 1,0	14,8 ± 0,1	0,00
PO_4-P(mg/L)	19,5 ±1,0	0,51 ± 0,0	0,00
Total bicarbonate (mg/L)	18,5 ± 1,8	169,4 ± 1,5	0,00

Martins et al., 2009 . Aquaculture 291, 65-73.

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Water kwaliteit in RAS

Vermindering watergebruik

Water quality parameter (Metals)	High accumulation (30 l/kg feed/day) (µg/L)	Low accumulation (1500 l/kg feed/day) (µg/L)
As	17.3 - 22.0	6.0 - 9.3
Cd	0.0 - 0.6	0.0 - 0.3
Cu	11.0 - 18.3	5.2 - 15.3
Ni	6.9 - 11.7	0.8 - 2.5
Zn	29.6 - 206.9	3.3 - 13.0

- Copper and Zinc concentrations may become toxic

Martins et al., 2009. Aquaculture 291, 65-73.

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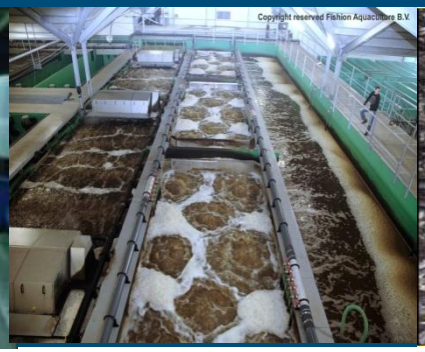
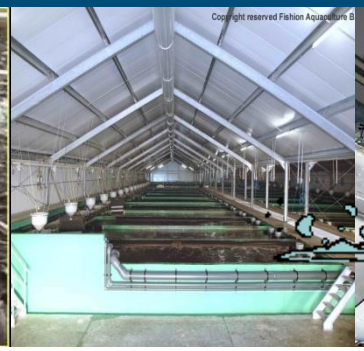
Vragen zijn welkom

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