Nitrogen removal from freshwater aquaculture effluents: sequencing versus continuous granular sludge reactors

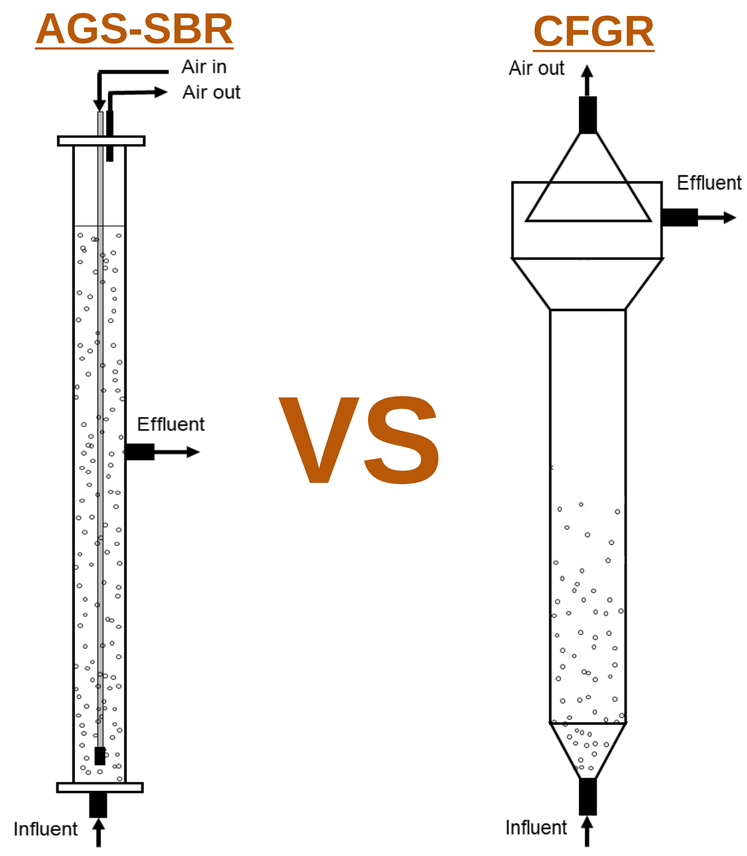
Ana T. Couto [1] *, Sergio Santorio Aldariz [2], Catarina L. Amorim [1], Angeles Val del Rio [2], Luz Arregui [3], Anuska Mosquera-Corral [2], Paula M. L. Castro [1]

[1] Universidade Católica Portuguesa, CBQF - Centro de Biotecnologia e Química Fina – Laboratório Associado, Escola Superior de Biotecnologia, Rua Diogo Botelho 1327, 4169-005 Porto, Portugal
[2] Biology CRETUS Institute, Department of Chemical Engineering, Universidade de Santiago de Compostela, Rúa Lope Gómez de Marzoa s/n, E-15705 Santiago de Compostela, Spain
[3] Grupo Tres Mares, S.L. Lires s/n, E-15270 Cee, A Coruña, Spain
* atcouto@ucp.pt

Introduction

Aquaculture is a growing sector and intensive production activities demand high water volumes from natural streams. Recirculating aquaculture systems (RAS) reduce water usage but increase nutrients concentrations in the resulting effluents. As nitrogen compounds such as ammonium are toxic to fish over 2.3 mg NH_4^+-N/L, RAS should ensure their appropriate removal to assure fish health and a successful production. Aerobic granular sludge (AGS) technologies could be promising systems to apply in RAS due to their lower footprint, but their potential is quite unexplored.
Thereby, this study aimed to compare the nitrogen removal capacity of two AGS-based technologies one operating in sequencing batch mode and the other in continuous, for the treatment of extremely low-strength wastewater (WW), mimicking freshwater aquaculture station's recirculating water.

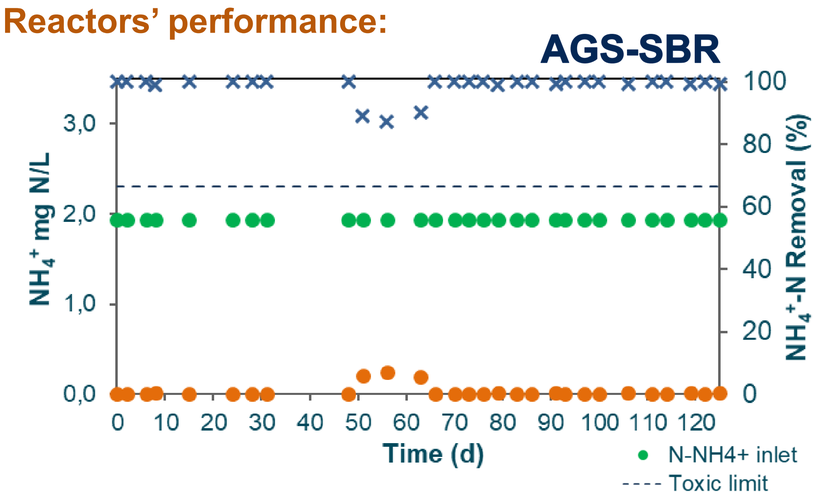
Methods

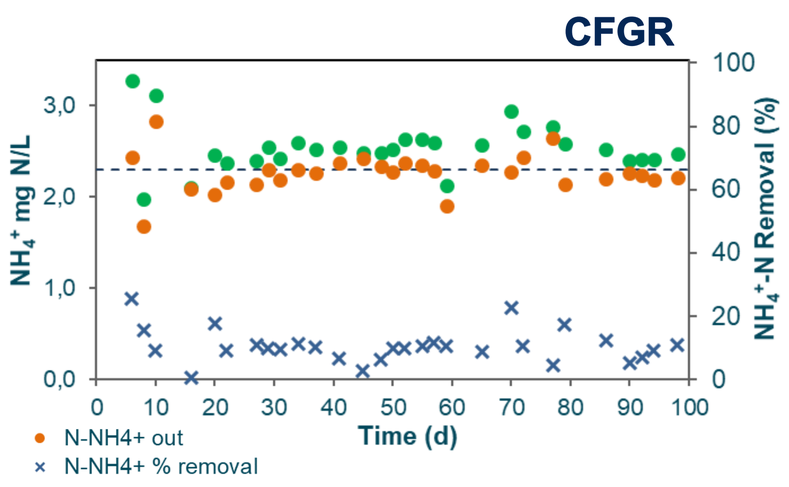


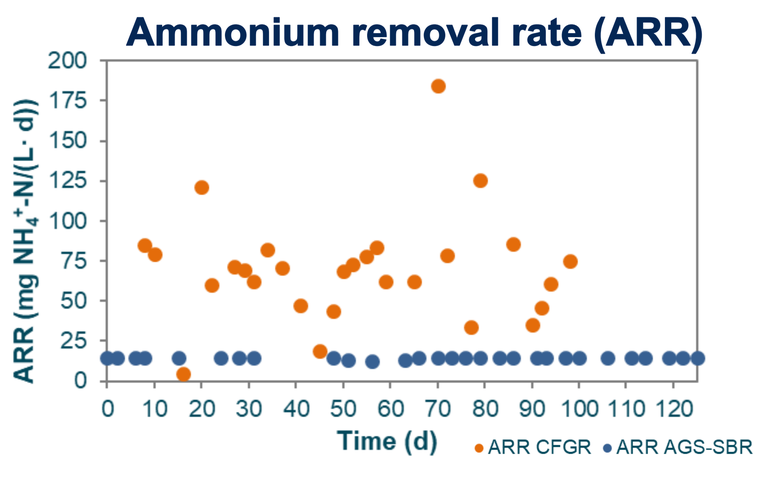
	AGS-SBR Sequencing Batch Reactor	CFGR Continuous Flow Reactor
Feeding regime	Batch:16 feeding cycles/day (90 min)	Continuous feeding and effluent withdrawal
Working volume (L)	2.5	2.0
Hydraulic retention time (HRT) (min)	237	5.2 – 8.1
Ammonium loading rate (ALR) (mg NH_4^+-N/(L·d))	31.0	690 – 800
[NH_4^+] in wastewater (mg/L)	1.94	2.5 – 2.9
Inflow (L/d)	15.2	355.9 – 554.4
Inoculum	AGS – full-scale urban WW Nereda® system	Activated sludge – secondary treatment of an urban WWTP
Feeding media	Synthetic media mimicking recirculating aquaculture water	

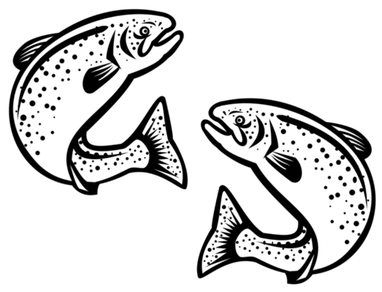
Results & Conclusions

Reactors' performance:









AGS-SBR

100% NH4+ removal
15 mg NH4+-N/(L·d)

- Effluent of **high chemical quality**
- Treated **high** flows

CFGR

10 - 20% NH4+ removal
90 mg NH4+-N/(L·d)

- Treated **extremely high** flows
- Effluent of **moderate** chemical quality

- ***Nitrogen removal efficiencies in both granular reactors were dependent on the HRT and ALR applied***
- ***The sequential and continuous system produced effluents with nitrogen concentrations below the toxic levels for fish, suitable for recirculation in aquaculture facilities***
- ***The AGS-SBR produced an effluent with high chemical quality, whilst the CFGR was able to treat larger flows.***

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