Post treatment of effluents from a fish cannery by combined partial nitrification and Anammox processes

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CLONIC Final Workshop 07, Barcelona: 19-20th April 2007

Layout

- Introduction
- Objectives
- Materials and methods
- Results
  - Synthetic wastewater
  - Fish cannery wastewater
- Conclusions

Introduction

Introduction

Fish canning wastewater

Influent characterization

TKN: 0.60-0.65 g/L

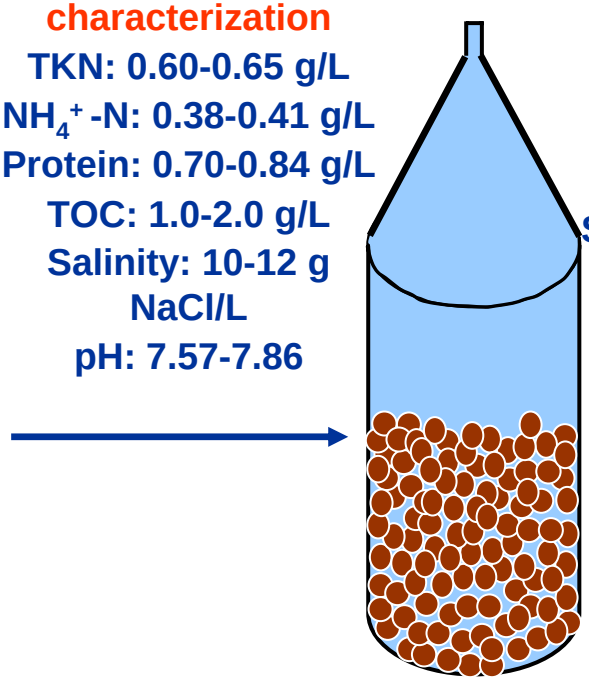
NH_4^+-N: 0.38-0.41 g/L

Protein: 0.70-0.84 g/L

TOC: 1.0-2.0 g/L

Salinity: 10-12 g NaCl/L

pH: 7.57-7.86



Effluent of anaerobic digester

NH_4^+-N: 0.7-1.0 g/L

TOC: 0-0.25 g/L

Salinity: 10-12 g NaCl/L

pH: 8.2-8.3

Environment

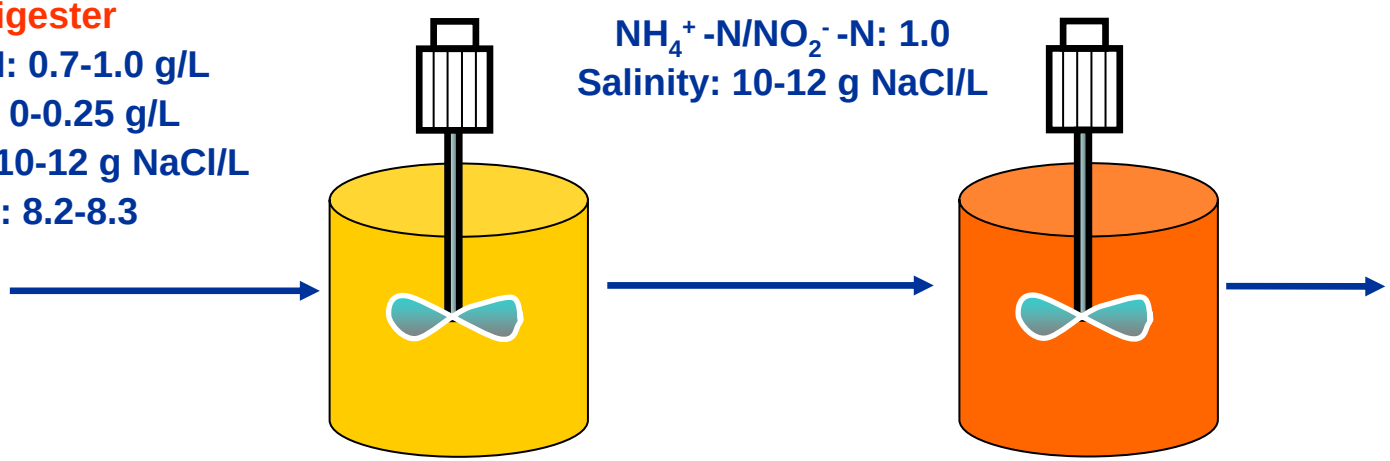
- High ammonia concentration
- Very low C/N ratio
- High salinity

Anaerobic digester

Fish canning wastewater

Effluent of anaerobic digester
NH_4^+-N: 0.7-1.0 g/L
TOC: 0-0.25 g/L
Salinity: 10-12 g NaCl/L
pH: 8.2-8.3

Effluent of SHARON
NH_4^+-N/NO_2^--N: 1.0
Salinity: 10-12 g NaCl/L



SHARON

Anammox

Introduction

Effects of salinity on Anammox and nitrifying biomasses

- Campos *et al.* (2002):
  - Nitrifying activated sludge reactor
  - Operation at 100% efficiency with up to 13 g/L NaCl

- Windey *et al.* (2005):
  - OLAND process → Operation with 30 g/L

- Kartal *et al.* (2006):
  - Adaptation of non-marine Anammox bacteria to salinity in concentrations up to 30 g/L

Objectives

Objectives

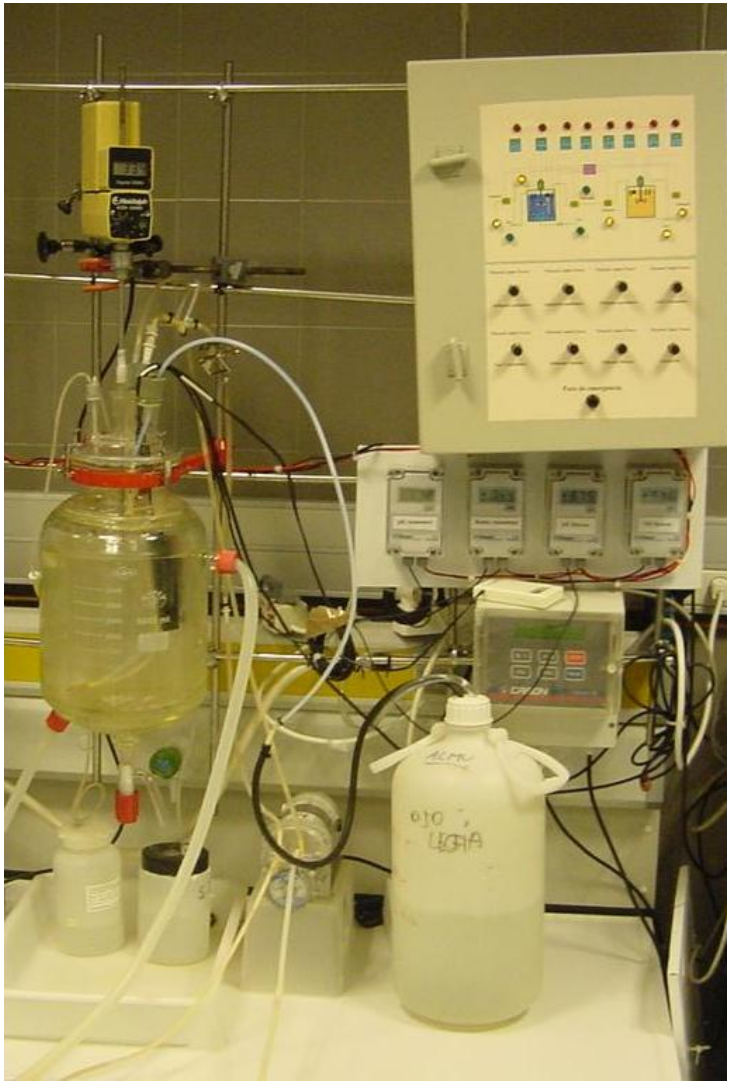
- **Effects of high salt concentrations on Sharon and Anammox processes treating synthetic wastewaters**

- **Suitability of the treatment of fish cannery wastewaters with the Sharon-Anammox system**

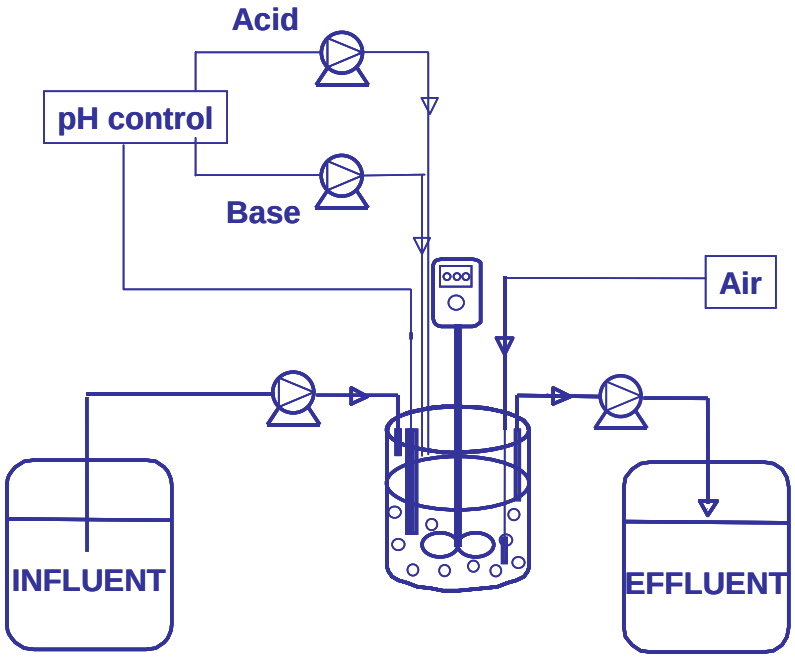
Materials and methods

Materials and methods

Sharon reactor



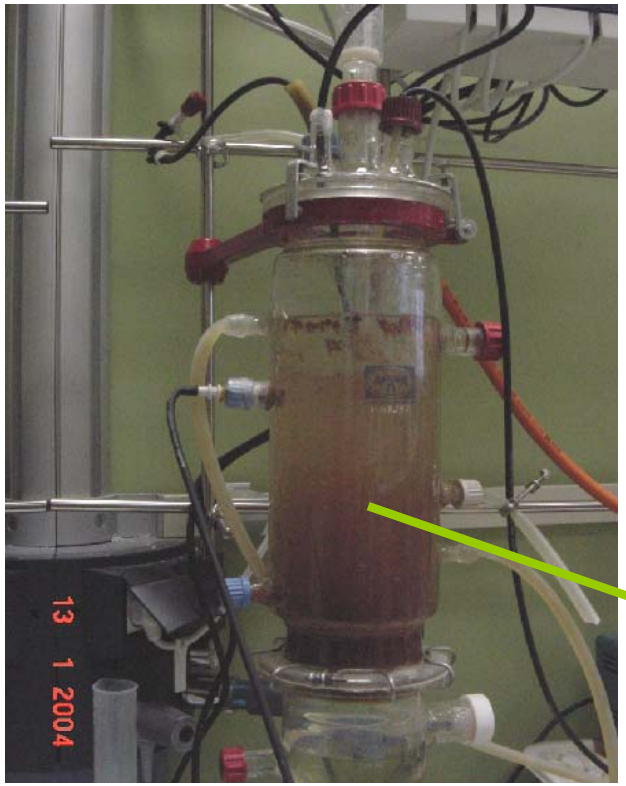
V: 3.2 L
Temperature: 35ºC
HRT=SRT= 1 d
DO > 2 mg/L
pH: 7.0-7.5
Stirring: 300 rpm

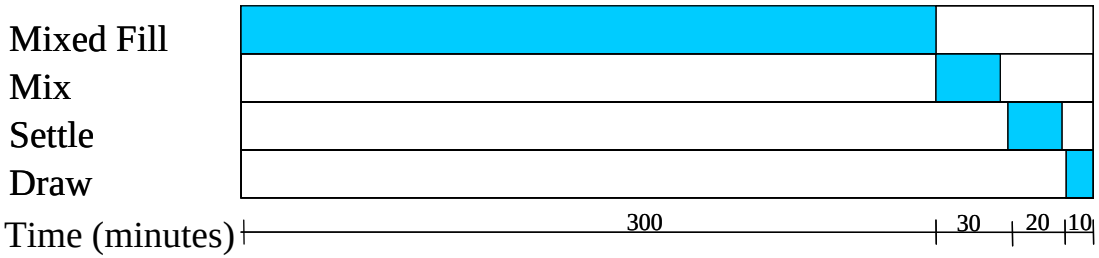


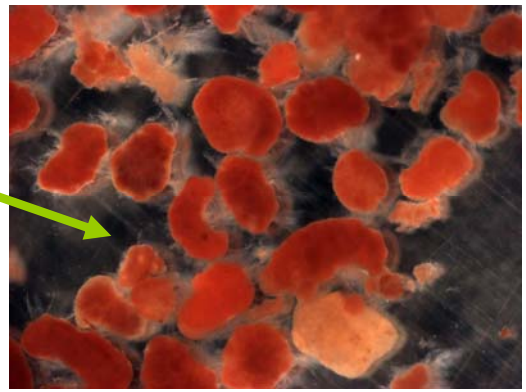
Materials and methods

Anammox reactor

SBR
V: 3 L
Temperature: 35ºC
HRT: 1.8 d
pH: 7.5-8.2
Stirring: 100 rpm





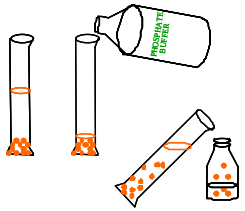


Materials and methods

Activity determinations

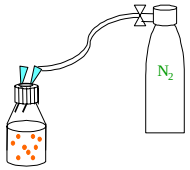
-Anammox and denitrifying activity

1. Wash with phosphate buffer

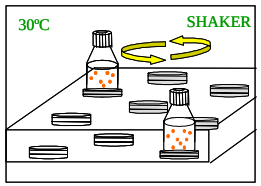


X = 1.5 gVSS/L

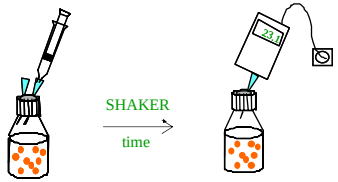
2. Purge with Nitrogen



3. Take to constant T

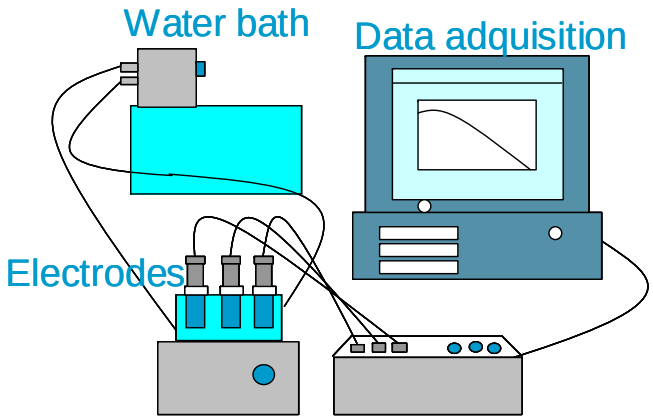


4. Add reagents
Meassure ΔP (t)



V_L=40 ml V_G=27ml P_0 = 1 atm
5mM $(NH_4)_2SO_4$ 5mM $NaNO_2$

-Ammonium- and nitrite-oxidizing activity
-Heterotrophic activity



Biological Oxygen Monitor

Materials and methods: Strategy

- First Stage: Testing of long-term effects of salinity
  - Synthetic influent of the Sharon reactor:
    - 1.0 g NH_4^+-N/L
    - 0→5→10→15→20→25→30 g NaCl/L
  - Synthetic influent of the Anammox reactor:

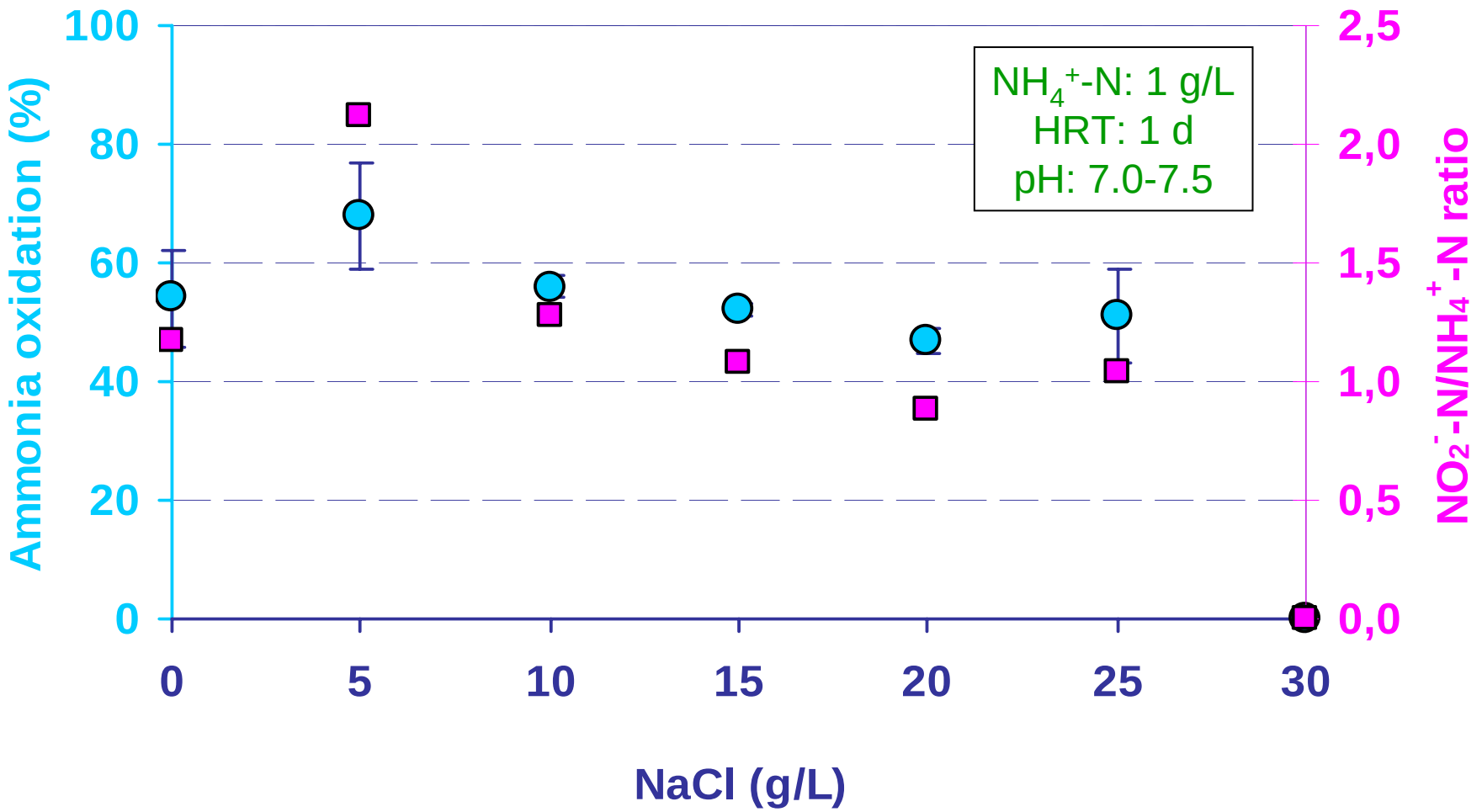
	Nitrite Loading Rate (g N/(L·d))	NaCl (g/L)
Salinity increasing	0.15	0→20
Stabilization	0.07→0.20	10→15
NLR increasing	0.20→0.35	15

- Second Stage: Coupling of the reactors, feeding of Sharon reactor with the effluent of a fish cannery
  - 0.7-1.0 g NH_4^+-N/L
  - 0.1-0.25 g TOC/L
  - 10-12 g NaCl/L

Results: Sharon with syntetic wastewater

Results: Sharon

Sharon reactor: Synthetic wastewater



Sharon reactor: Organic matter effect

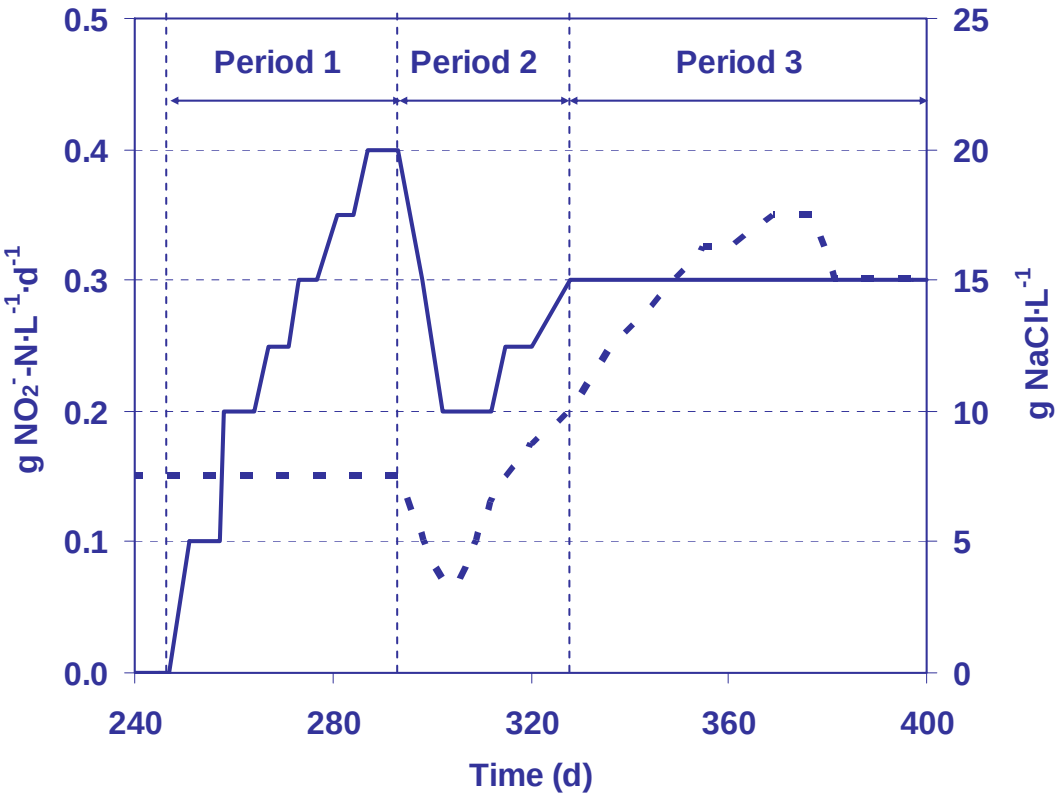
Specific Activity during acetate addition

C/N ratio		0	0.2	0.3
Ammonium oxidizing	(g N /g VSS· d)	3.6	2.4	ND
Nitrite oxidizing	(g N /g VSS· d)	ND	ND	ND
Heterotrophic	(g O_2 /g VSS· d)	ND	0.4	2.0

Results: Anammox with syntetic wastewater

Results: Anammox

Adaptation at high salinity



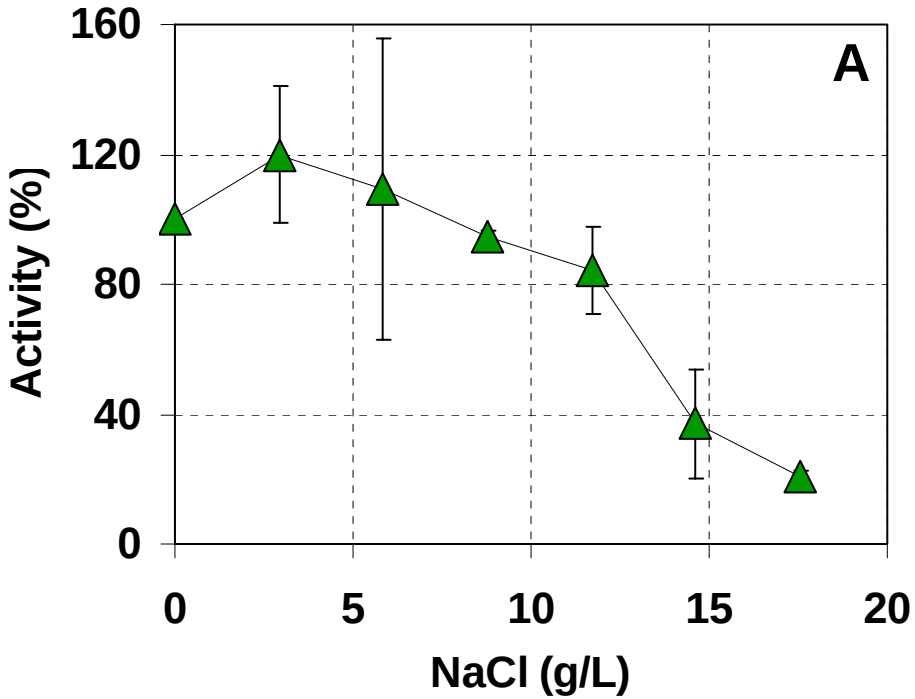
Operational strategy

--- NLR

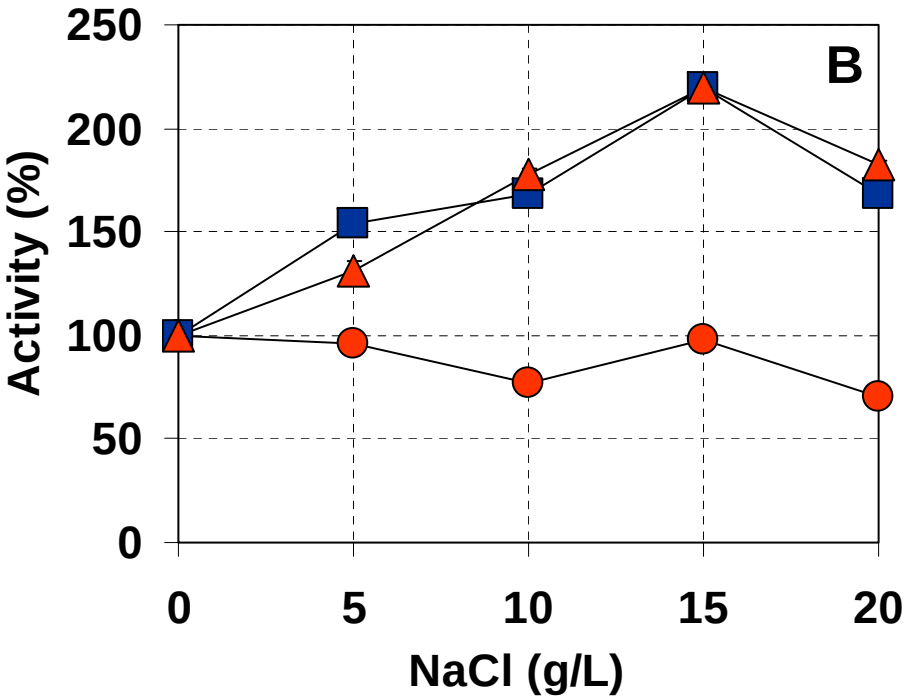
— NaCl concentration

Results: Anammox

Anammox reactor: Activity



Non-adapted Anammox biomass

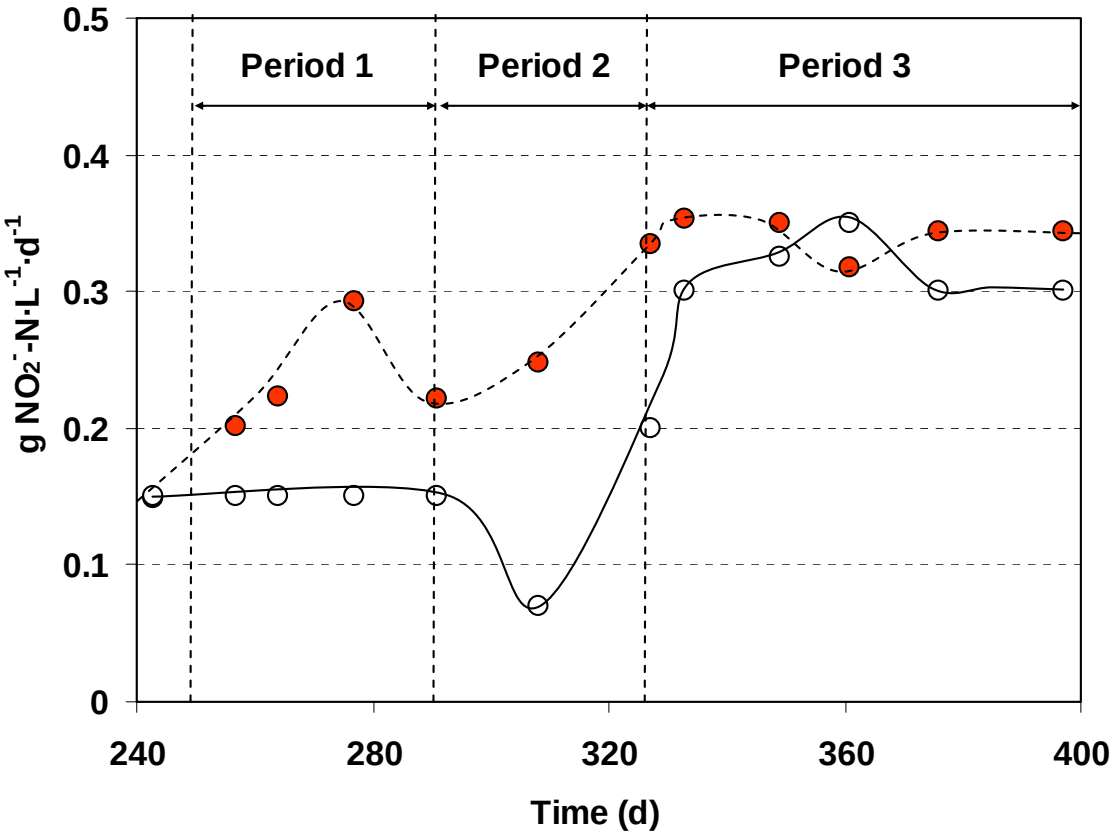


Adapted Anammox biomass

- Washed with saline buffer
- Not washed
- Washed with non-saline buffer

Results: Anammox

Anammox reactor capacity



Reactor performance

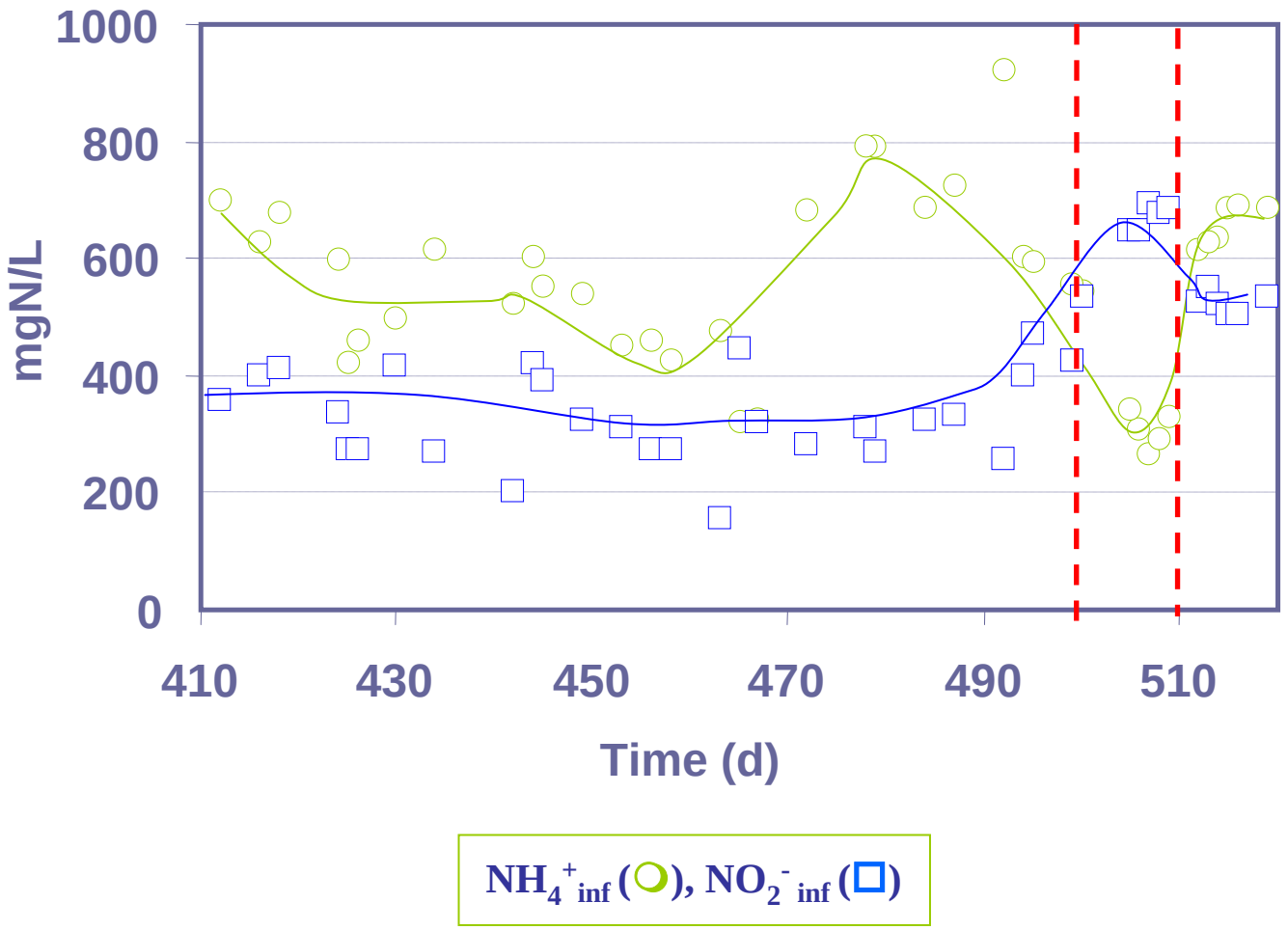
○ **NLR**

● **Capacity**

Results: Fish cannery effluent treatment

Results: Fish cannery effluent

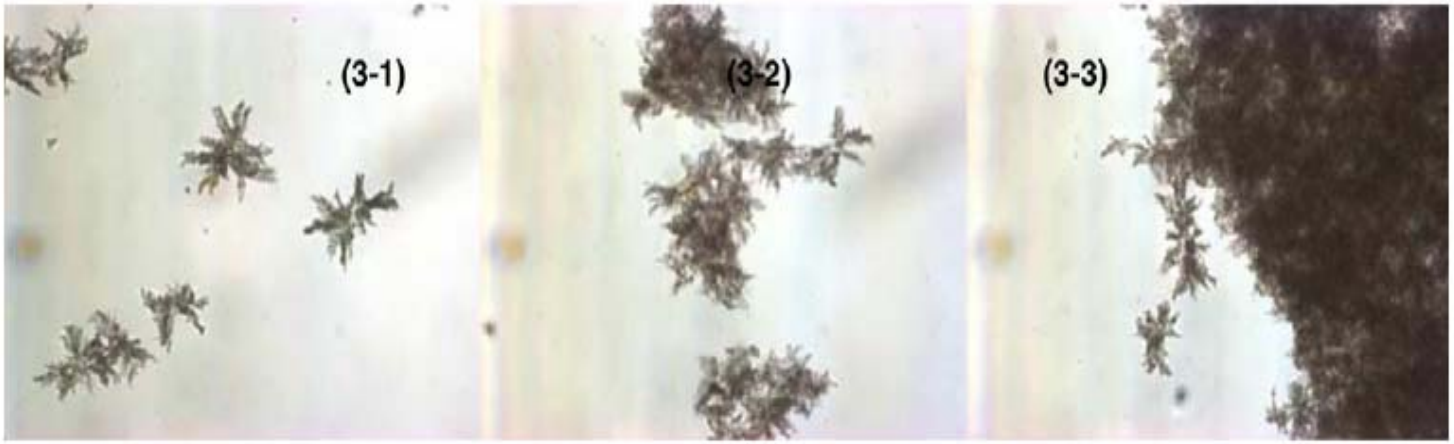
Sharon reactor: Fish cannery effluent treatment



Organic Matter !!!
250 mg TOC/L

Results: Fish cannery effluent

Sharon reactor: Biomass properties

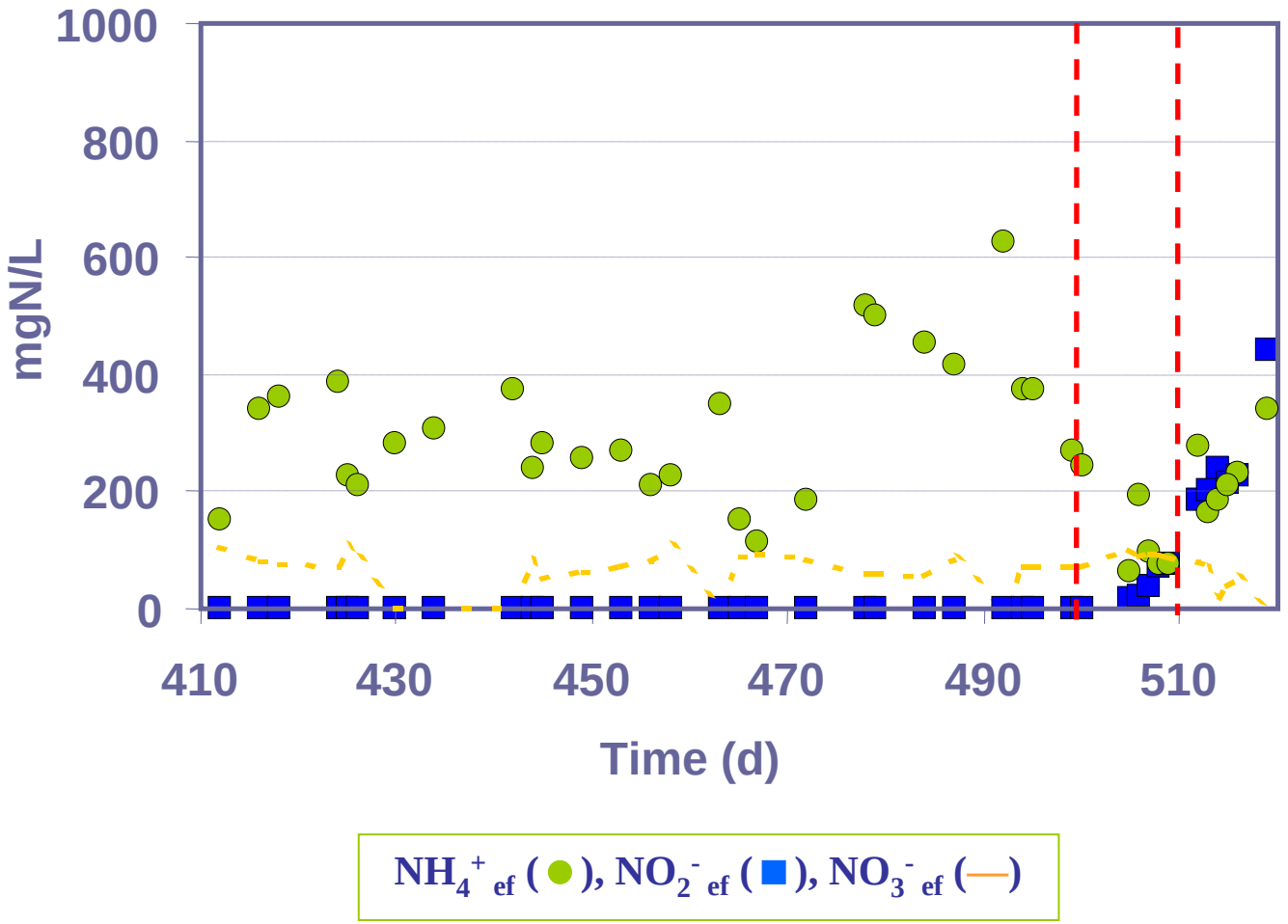


Flocculation and aggregation of flocs by NaCl addition

NaCl (mM)	Biomass (mg VSS/L)	Ashes content (%)
0	108	18
85	98	23
171	73	28
256	78	27
342	57	35
427	51	38
513	31	34

Results: Fish cannery effluent

Anammox reactor: Fish cannery effluent treatment



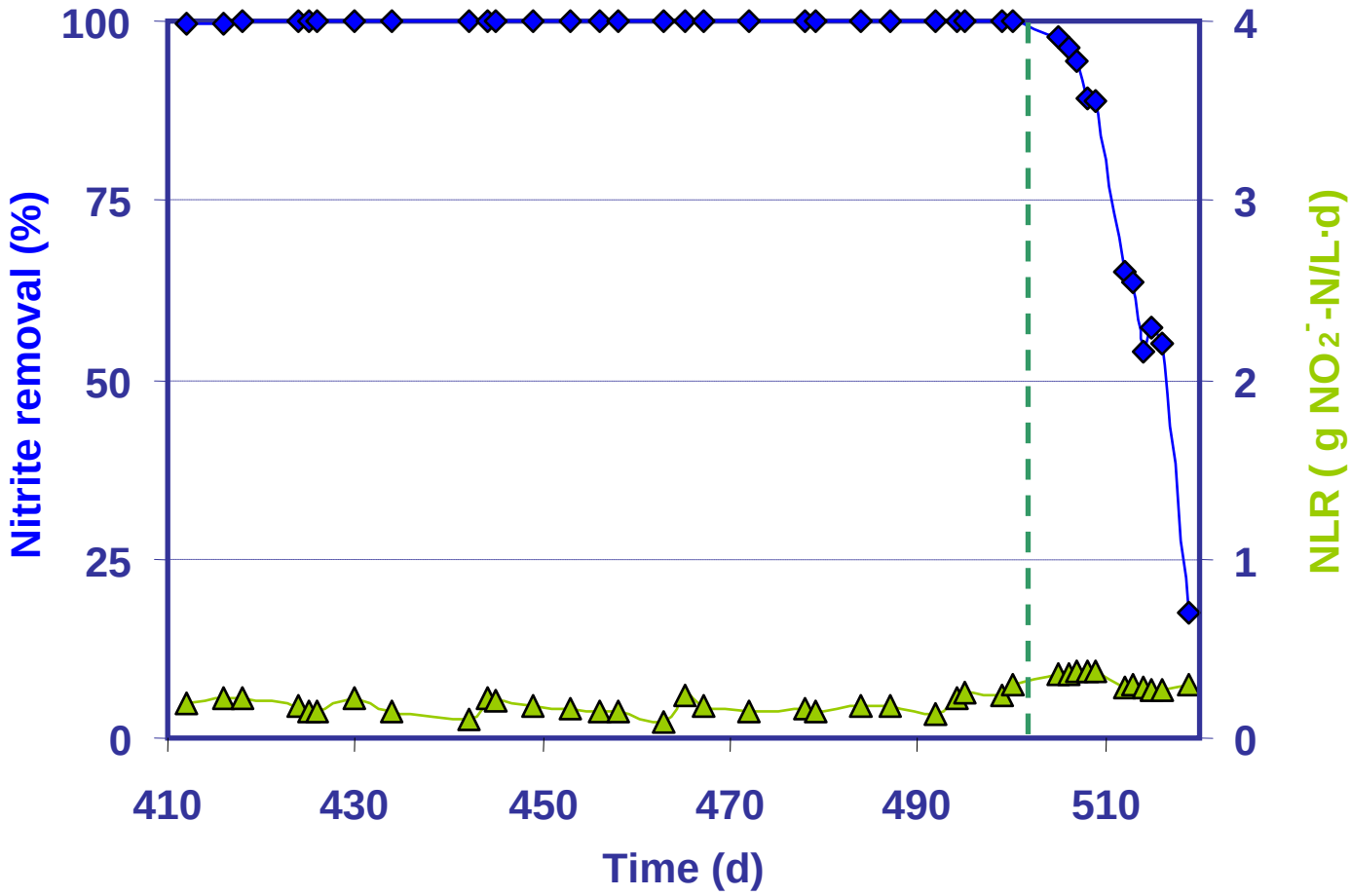
N removal

-67% of efficiency

-Up to 0.67 g N/L·d

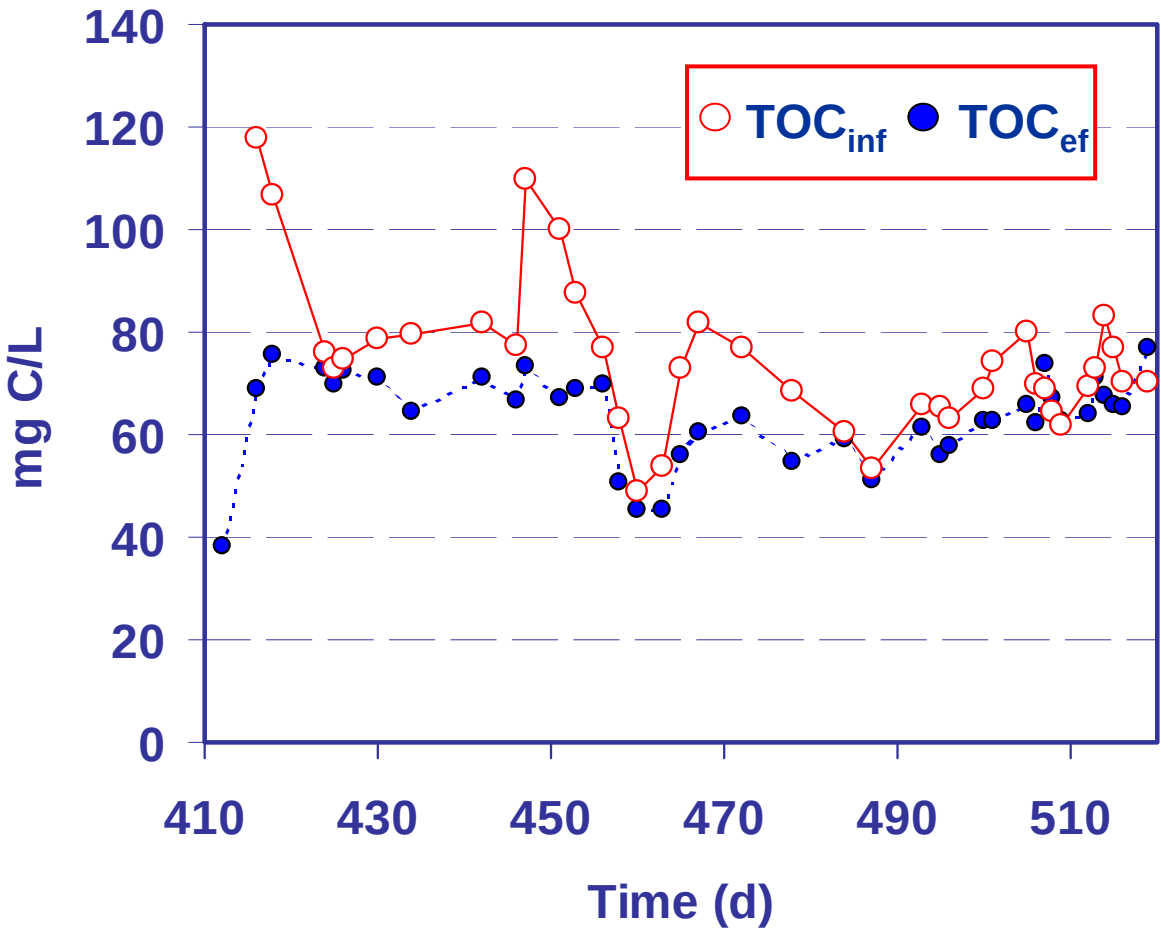
Results: Fish cannery effluent

Anammox reactor: Stability



Results: Fish cannery effluent

Anammox reactor: Organic compounds



Results: Fish cannery effluent

Anammox reactor: Biomass activity

Specific Activity		day 410	day 430	day 485
Anammox	(g N_2-N/ g VSS·d)	0.450	0.442	0.430
Denitrifying	(g N_2-N/g VSS·d)	0.041	0.052	0.068
Ammonium oxidizing	(g O_2/g VSS· d)	0.066	0.088	0.085
Nitrite oxidizing	(g O_2/g VSS· d)	ND	ND	ND
Heterotrophic	(g O_2/g VSS· d)	ND	ND	ND

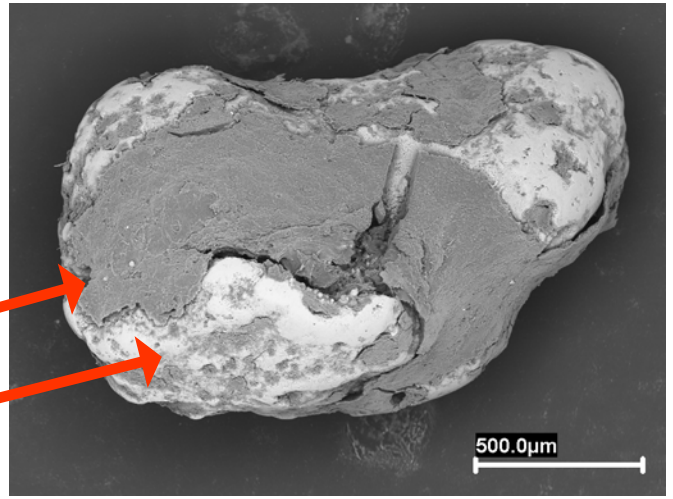
ND: Not detected

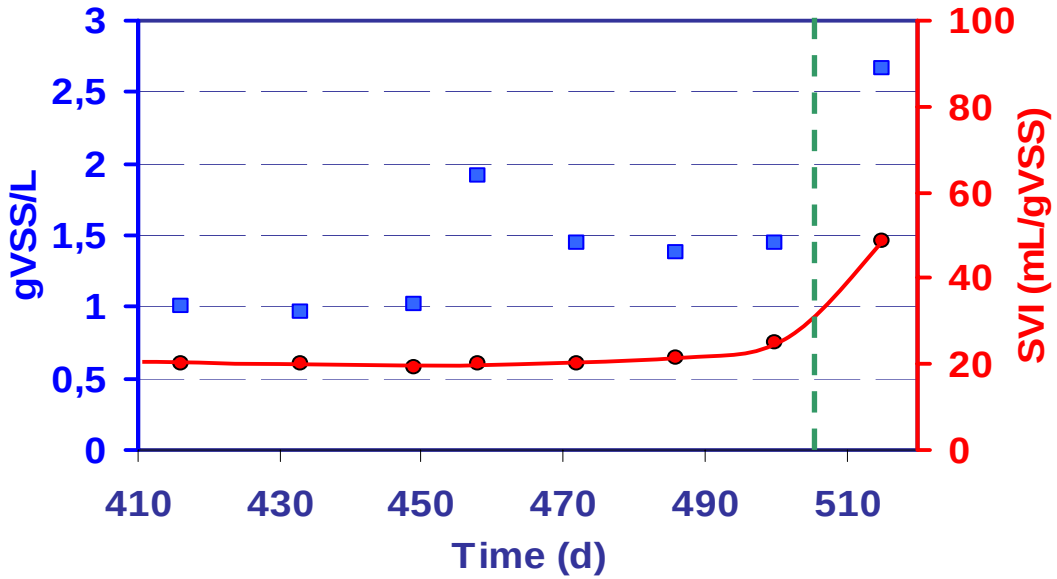
Results: Anammox biomass

Anammox reactor: Biomass characterization

NaCl initial addition:

- Granulation of Anammox biomass
- SVI decreased from 80 to 25 mL/g VSS
- VSS/TSS ratio decreased from 0.8 to 0.7





Conclusions

Conclusions

- **Salt concentrations up to 20 g NaCl/L did not have long-term negative effects on the operation of both reactors**

- **The partial nitrification-Anammox system can be applied for the treatment of fish canning wastewaters**

- **A control of the NO_2^--N/NH_4^+-N ratio of the effluent of the Sharon reactor is necessary in order to avoid the destabilization of the Anammox reactor**

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