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Impact of cresols in the ammonium rich wastewater on anammox process

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- Occurrence of musty odor
- Blocking filtration
- Destruction of ecosystem

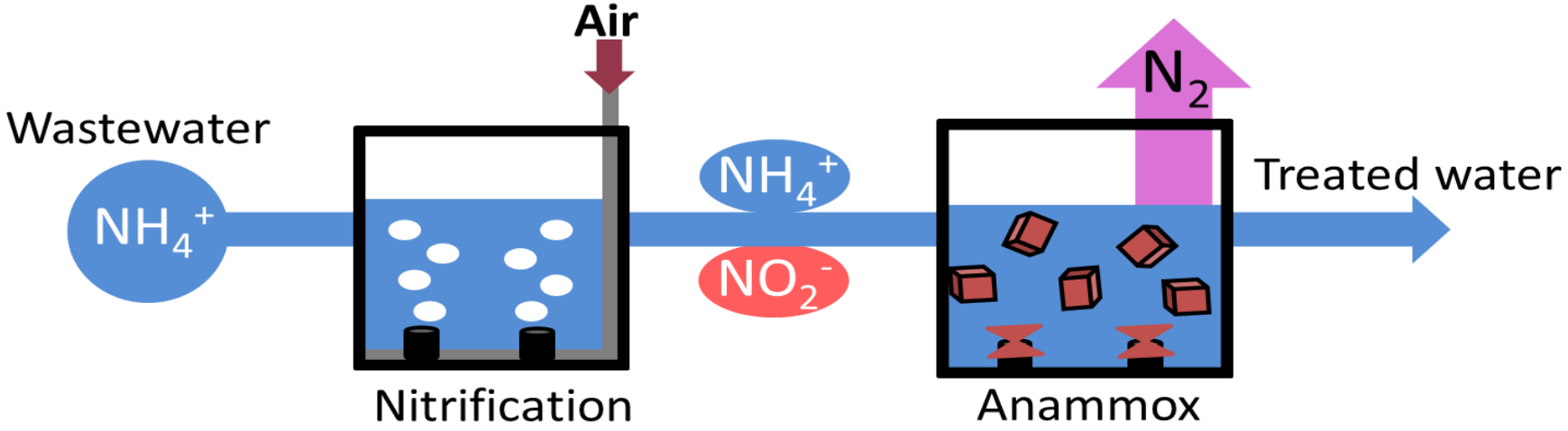
A traditional process demands a lot of energy

We need to build up high efficiency ammonia removal process

Motivation

Anaerobic **amm**onium **ox**idation (**Anammox**) process

$NH_4^+ + NO_2^- \rightarrow N_2 + 2H_2O$ eq･･･(1)



Nitrification

$1/2\ NH_4^+ + 3/4\ O_2 \rightarrow 1/2\ NO_2^-$

Anammox

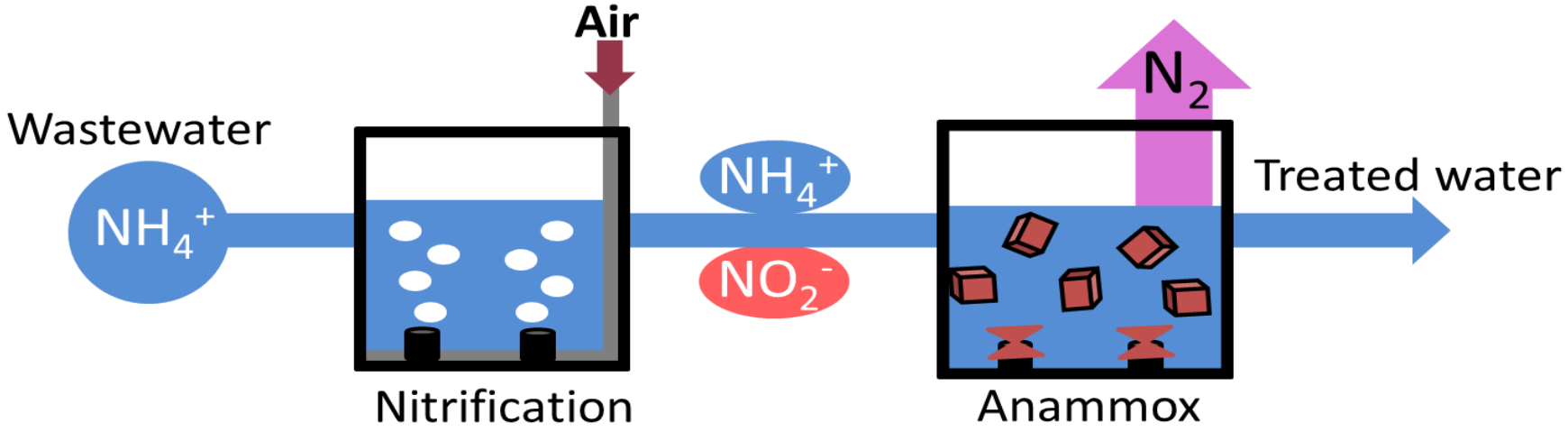
$NH_4^+ + NO_2^- \rightarrow N_2$

Advantages

1. Less energy
2. No organic matter
3. Less sludge production

Anaerobic **amm**onium **ox**idation (**Anammox**) process

$NH_4^+ + NO_2^- \rightarrow N_2 + 2H_2O$ eq･･･(1)



Nitrification

$1/2\ NH_4^+ + 3/4\ O_2 \rightarrow 1/2\ NO_2^-$

Anammox

$NH_4^+ + NO_2^- \rightarrow N_2$

Anammox process can remove ammonium quite efficiently and low cost to compare with the traditional process

Objective

- Anammox process is expected to apply ammonium rich wastewater such as semiconductor wastewater.
- It is known that cresols contain in ammonium rich wastewater and damage to biological treatment (Oller et al.2011).

Nitrification・denitrification

Many studies already have done

Anammox process

Few studies reported

To evaluate the impact of cresols on anammox process

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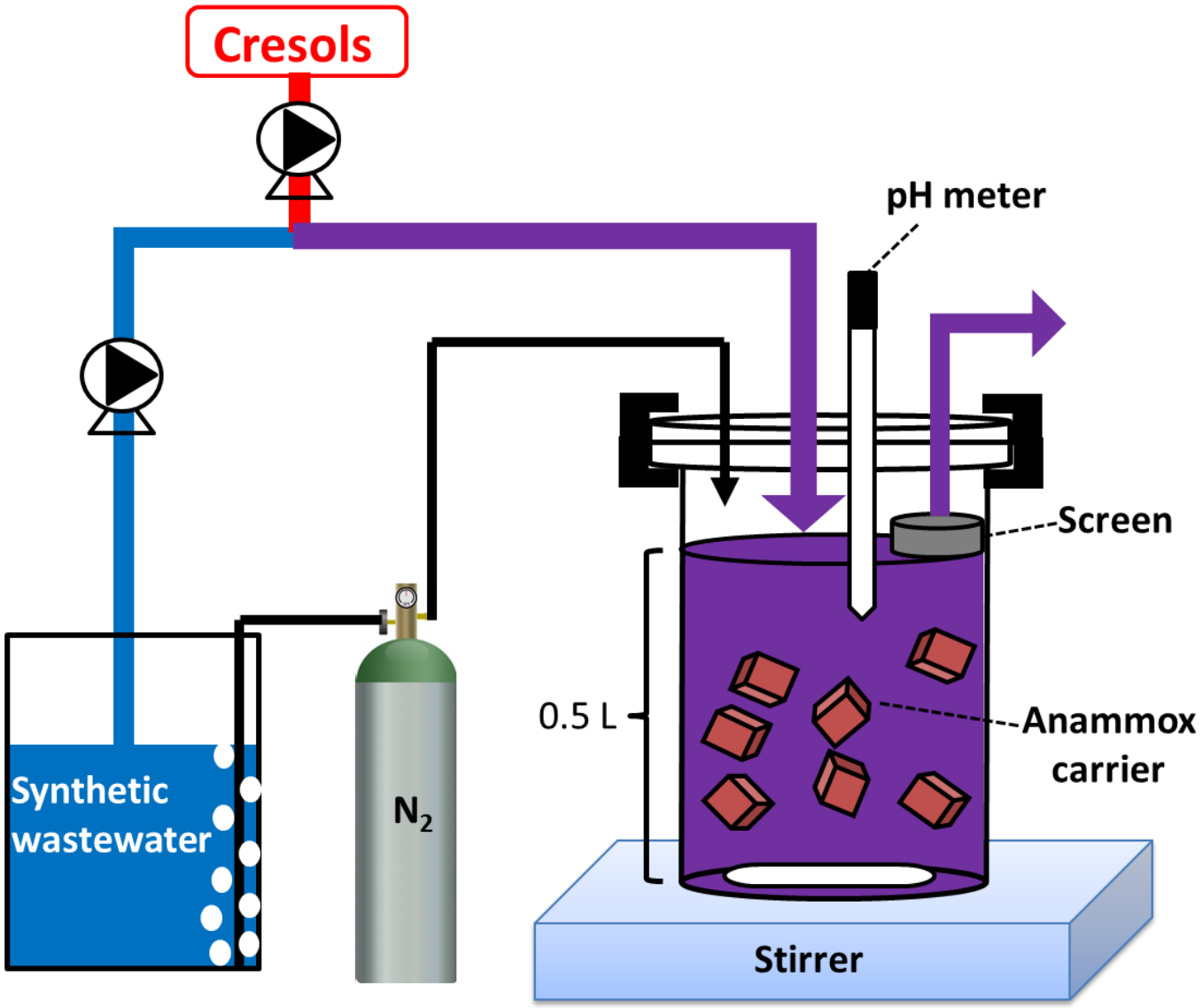
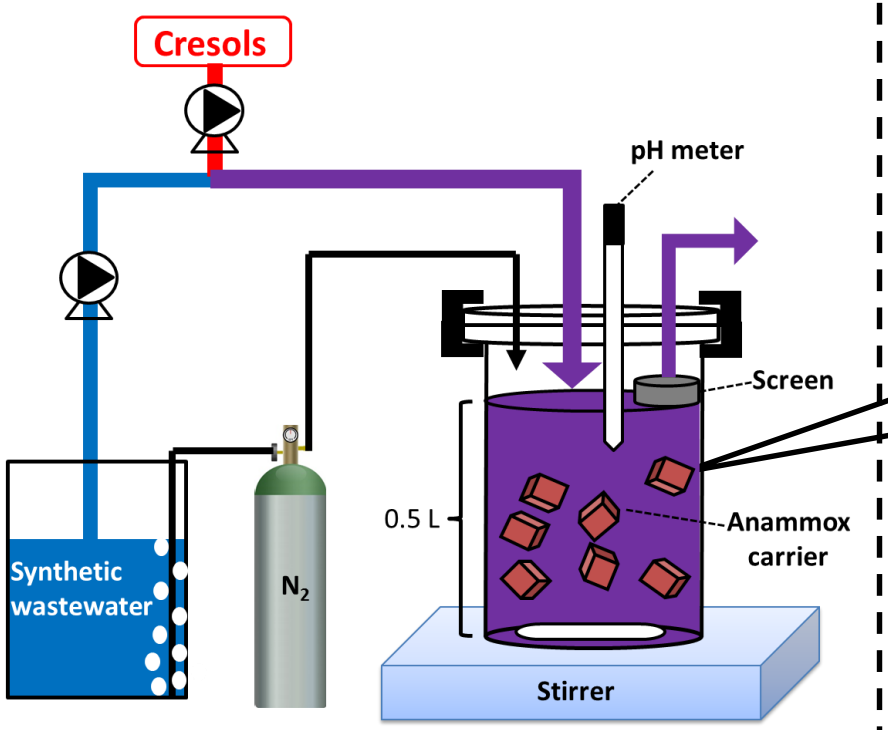
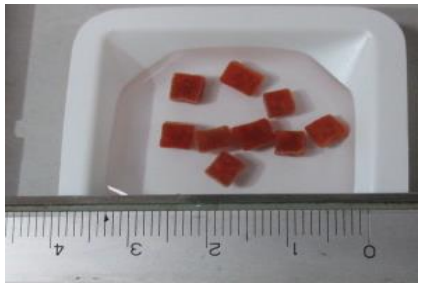


Reactor





Operation

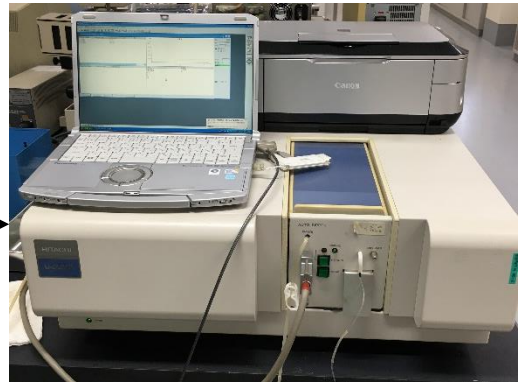
Temperature	30℃
pH	7.6
Stirrer	200 – 300 rpm
Condition	Dark

Synthetic wastewater

Substrates	*o*-cresol	*m*-cresol	*p*-cresol
	mg·L^{-1}		
NH_4^+-N	150	150	150
NO_2^--N	190	190	190
o-cresol	0 – 30		
m-cresol		0 – 150	
p-cresol			0 – 100

Samples

NH_4^+-N



Spectrophotometer (HITACHI, U-3900)

NO_2^--N, NO_3^--N

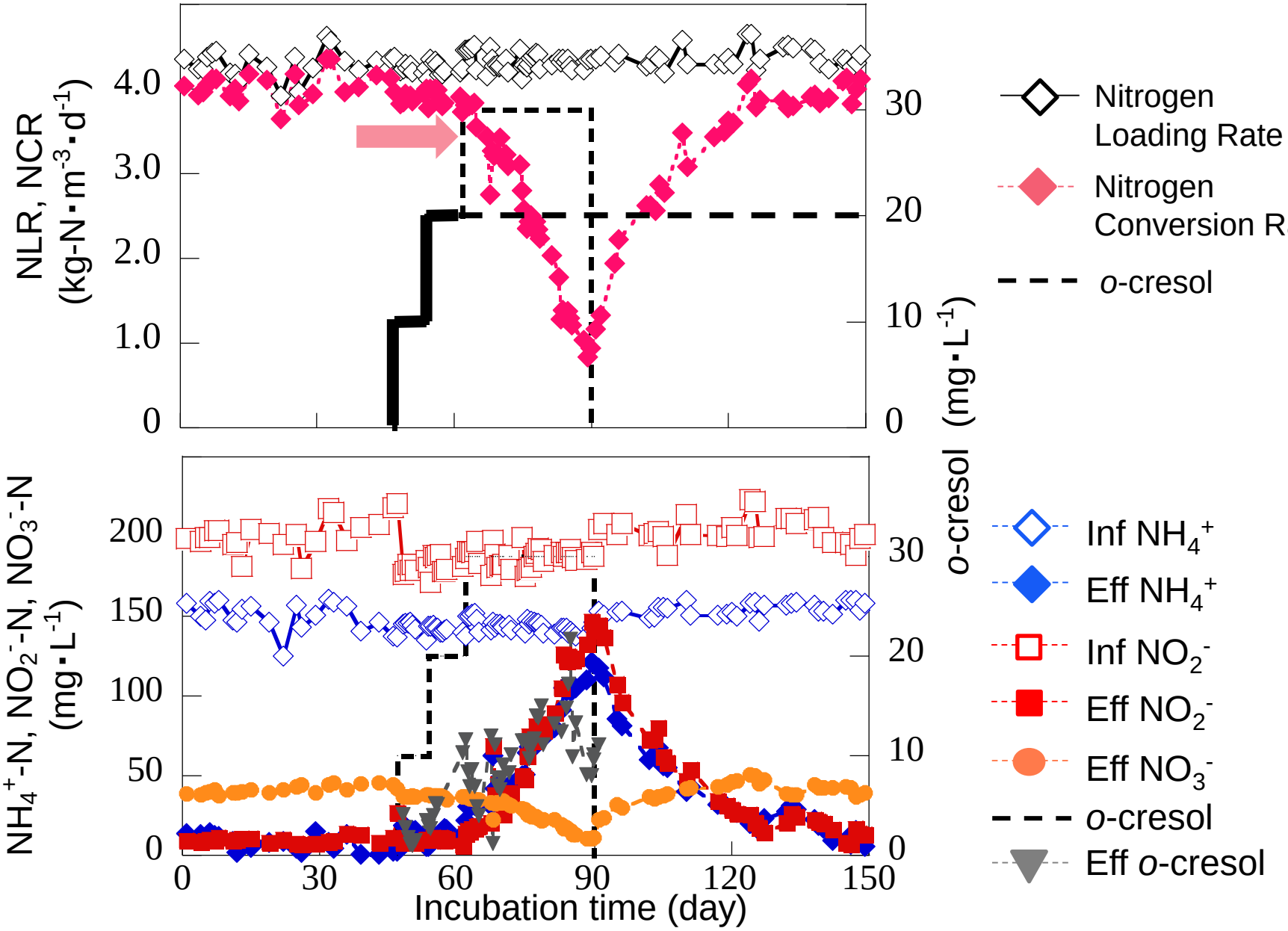
Column: Thermo AS12A
Eluent: Na_2CO_3 and $NaHCO_3$

Ion chromatography (DIONEX, ICS-1500)

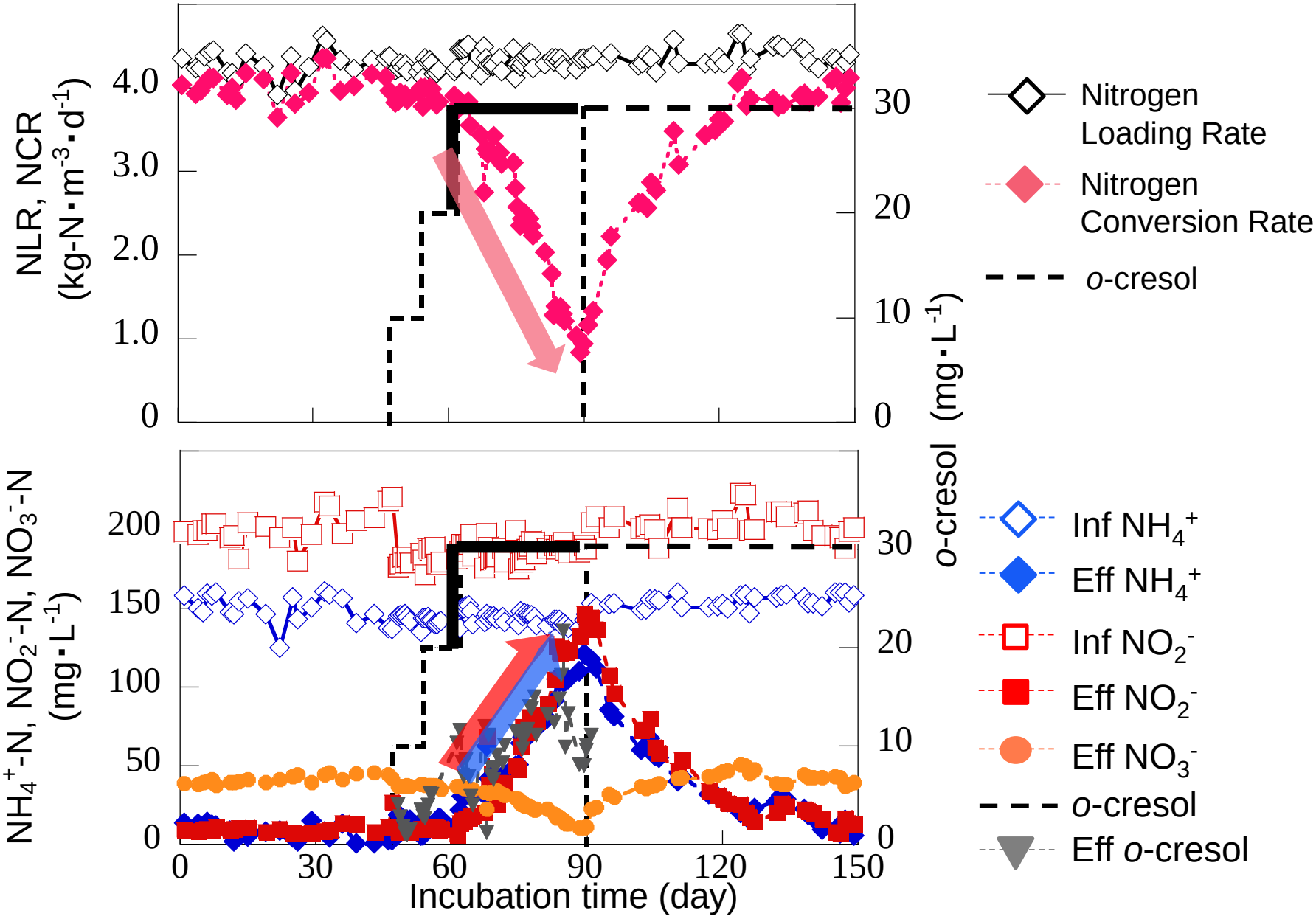
Cresols

TOC analyzer (SHIMADZU, TOC-L)

Results and discussion (*o*-cresol) 9



Results and discussion (*o*-cresol)



Anammox activity was inhibited when *o*-cresol concentration was 30 mg·L^{-1}.

Results and discussion (*o*-cresol) 11

Previous study

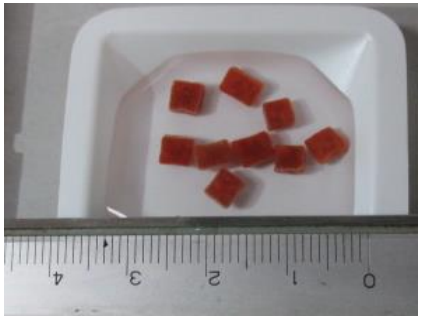
- Carlos et al. (2015) reported anammox activity was decreased 60% when *o*-cresol concentration was 15 mg·L^{-1}.

Our study

- NCR didn't change until *o*-cresol concentration was 30 mg·L^{-1}.

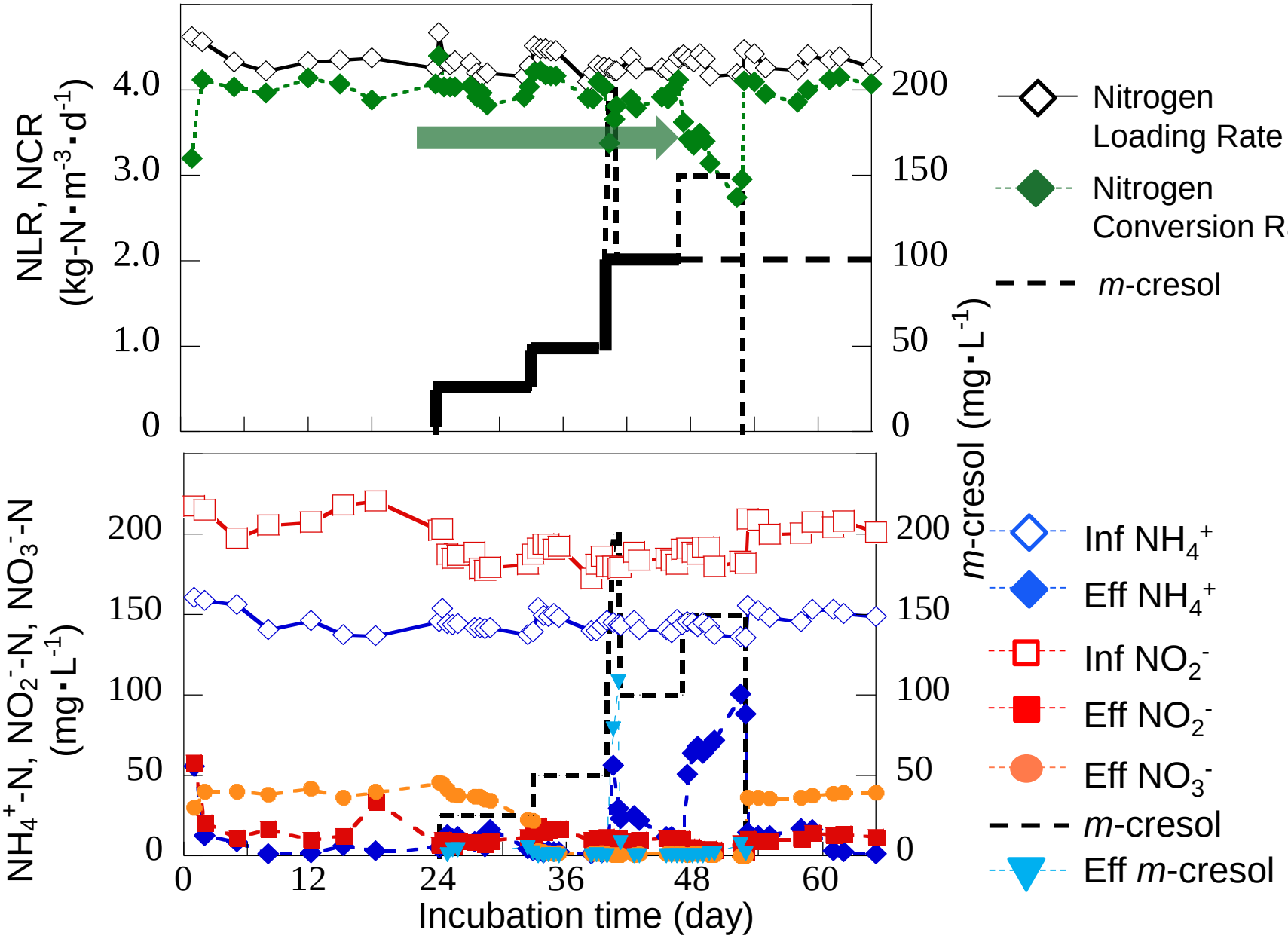
1. Difference of bacterial community composition
2. Difference of anammox regulation style

Granular



Gel carrier

Results and discussion (*m*-cresol)12



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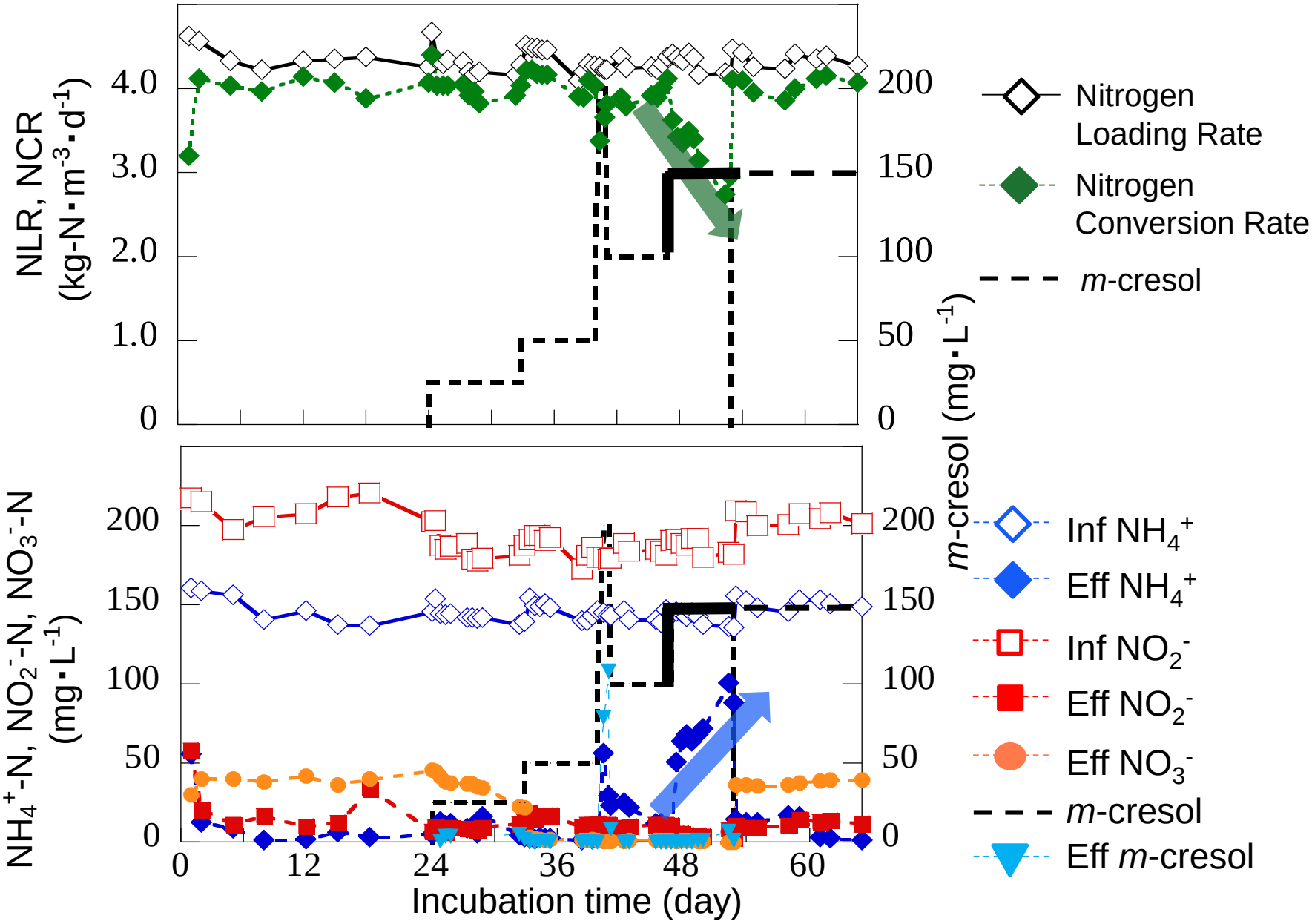
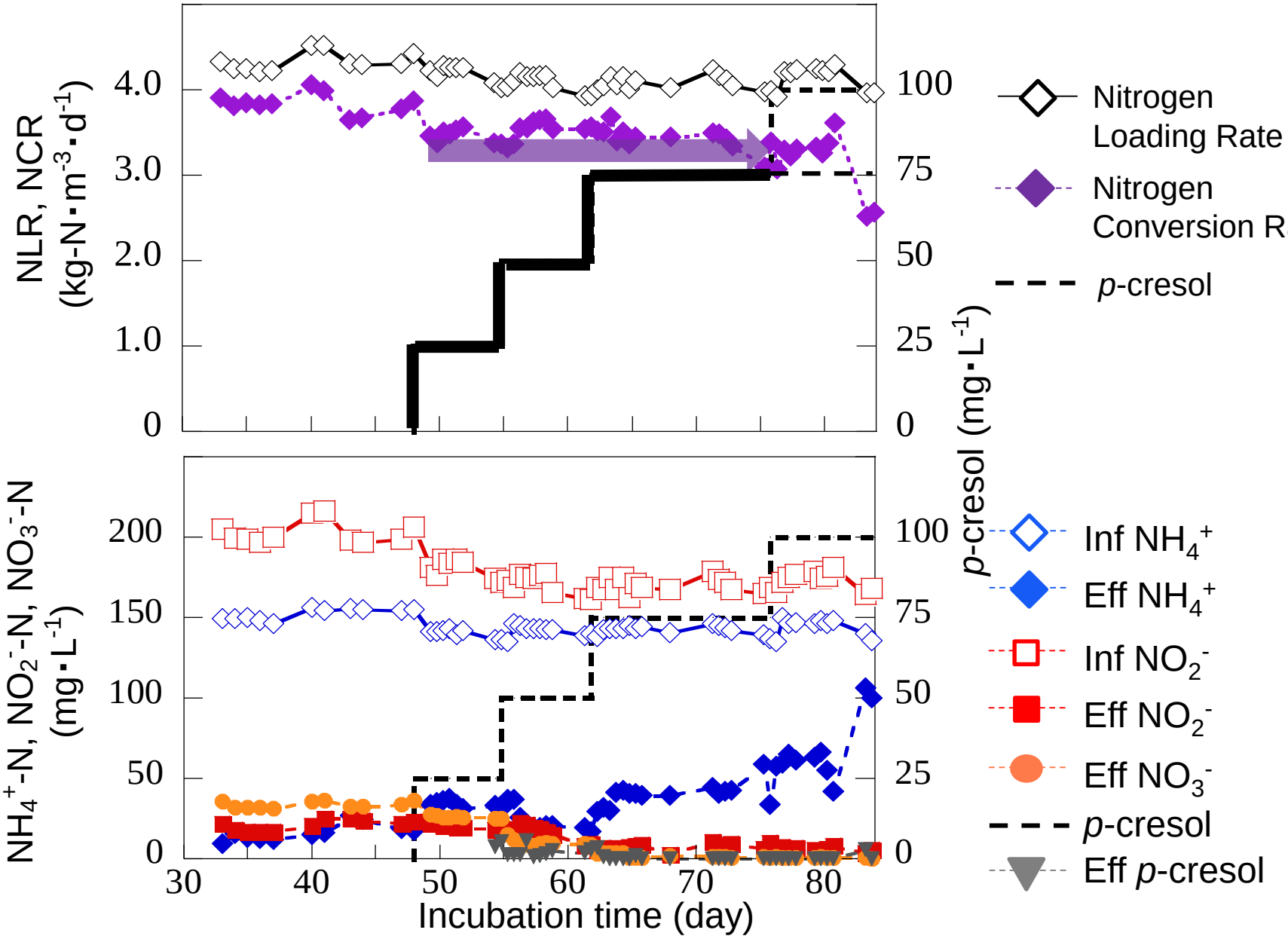
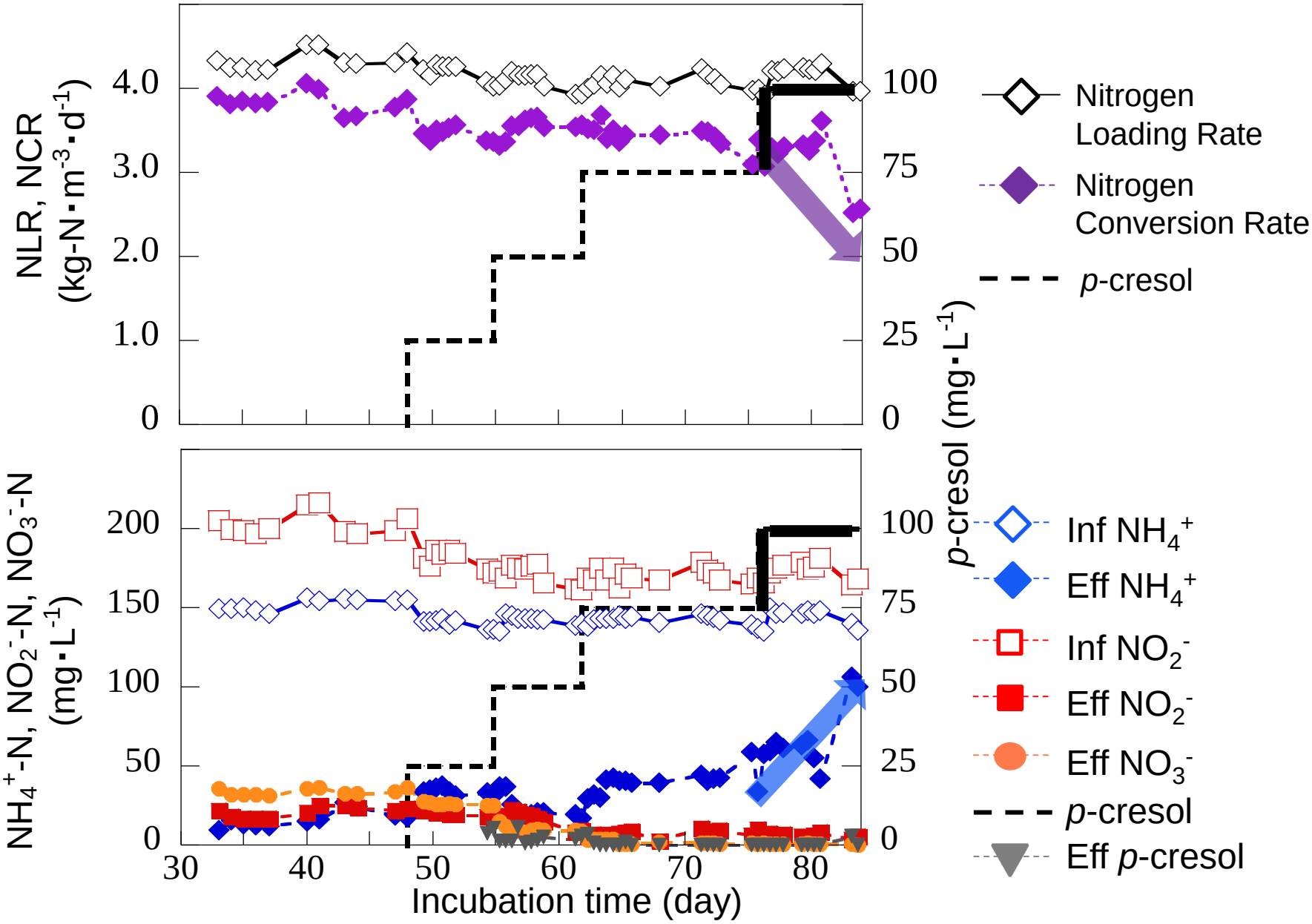


Anammox activity was inhibited when *m*-cresol concentration was 150 mg·L^{-1}.

Results and discussion (*p*-cresol) 14



Results and discussion (*p*-cresol) 15



Anammox activity was inhibited when *p*-cresol concentration was 100 mg·L^{-1}.

Conclusions

1. *o*-cresol
   - NCR decreased when *o*-cresol concentration was **30 mg·L^{-1}**.
2. *m*-cresol
   - NCR decreased when *m*-cresol concentration was **150 mg·L^{-1}**.
3. *p*-cresol
   - NCR decreased when *p*-cresol concentration was **100 mg·L^{-1}**.

1. Cresols affects anammox process.
2. The effect of cresols on anammox process varies according to the location of substituent.

Thank you for your attention.

Nitrogen Loading Rate ($kg\text{-}N \cdot m^{-3} \cdot d^{-1}$)

$$= \frac{(\text{Inf } NH_4 + \text{Inf } NO_2) \times \text{flow rate}}{\text{Working volume}}$$

Nitrogen Conversion Rate ($kg\text{-}N \cdot m^{-3} \cdot d^{-1}$)

$$= \frac{\{(\text{Inf } NH_4 + \text{Inf } NO_2) - (\text{Eff } NH_4 + \text{Eff } NO_2)\} \times \text{flow rate}}{\text{Working volume}}$$

Rudolphi et al. (1991) reported denitrification bacteria can degrade cresols.

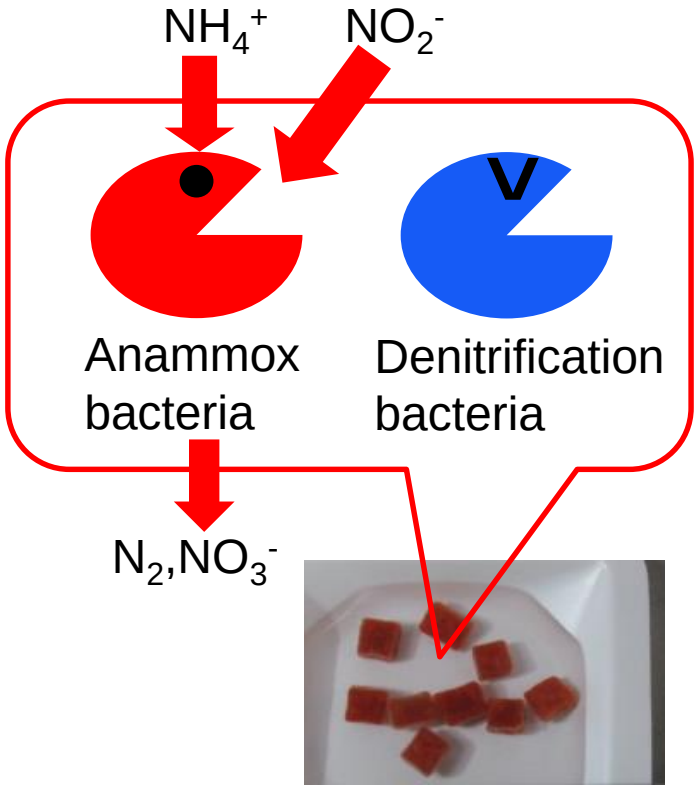
- *o*-cresol is degraded by denitrification bacteria using **CO_2**.
- *m*- and *p*-cresol are degraded by denitrification bacteria using **H_2O**.

Our study

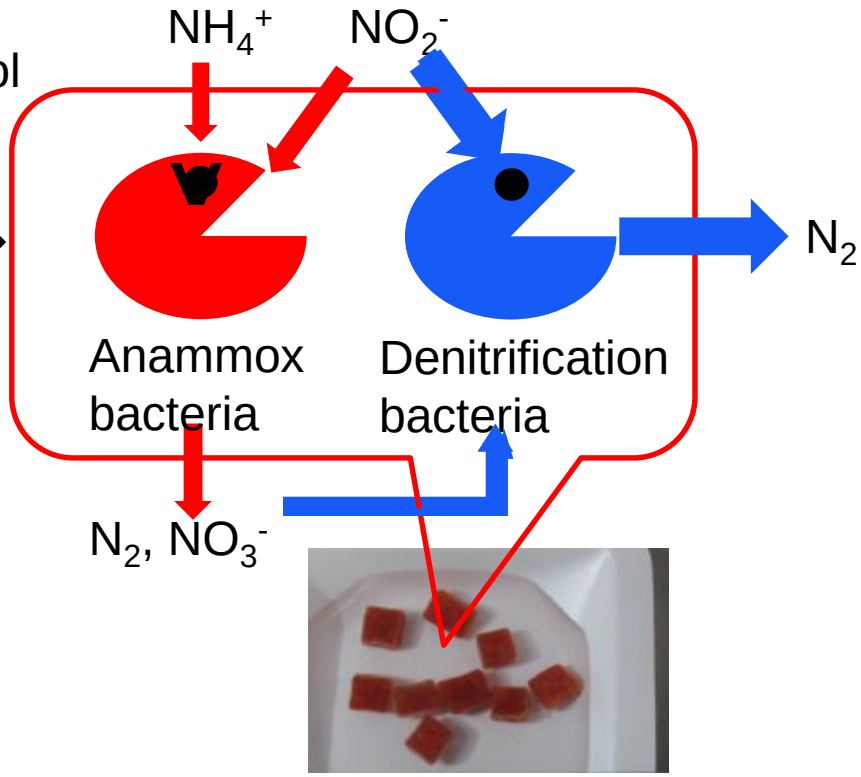
- A synthetic wastewater didn't contain CO_2 because it was aerated by N_2 gas.

➡ Denitrification bacteria couldn't degrade *o*-cresol.

Initial condition



m- or *p*-cresol



Anammox process products nitrate and nitrogen gas.

Anammox process can't run because nitrite is lack.