Evaluation of Nitrification with High Salt Concentration for Industrial Wastewater

Toyo University, Environmental engineering Laboratory　Oki R. Kitazawa T. Yamamori Y. Sumino T.

Introduction

・Biological nitrogen removal is the most commonly used system for the treatment of municipal wastewater.

Nitrification : $NH_4 \rightarrow NO_2$ Ammonia-Oxidizing bacteria
$NO_2 \rightarrow NO_3$ Nitrite-Oxidizing bacteria
Denitrification : NO_2, $NO_3 \rightarrow N_2$ Denitrifying bacteria

However, wastewater containing high salinity is known to significantly reduce the nitrification efficiency.

Background

・The maximum acceptable salt range have a wide range (2.5-5%)
・The effect of salt on nitrification does not give a clear answer.

Target

・The maximum acceptable salt range by immobilized microgram using entrapped and attached methods
・The effect of salt on nitrification activity

Materials and methods

・Experimental equipment and operating method

Experimental equipment consists three reactors; nitrification tank, denitrification tank, Oxic tank (Fig.1). The Influent (Inf) water flow in order nitrification tank to denitrification tank. The water of oxic tank discharged as effluent (Eff) water. Air was supplied nitrification tank and oxic tank. 3% Methanol was add as hydrogen donor in the denitrification tank. The oxic tank removed methanol.

・Wastewater

Inf water was an industrial wastewater generated from recovered rare metals. The wastewater had the following composition:NH_4-N 90-1510 mg/L, $NaHCO_3$ 3.0 g/L, $Na_2HPO_4 \cdot 12H_2O$ 0.25 g/L, 0.3-4% salt concentrations (mostly NaCl).

・Pellets

RUN1 used immobilized microgram using entrapped pellets and attached carriers （Table 1, Fig.2）. RUN2 used immobilized microgram using attached carrier and add an activated sludge.

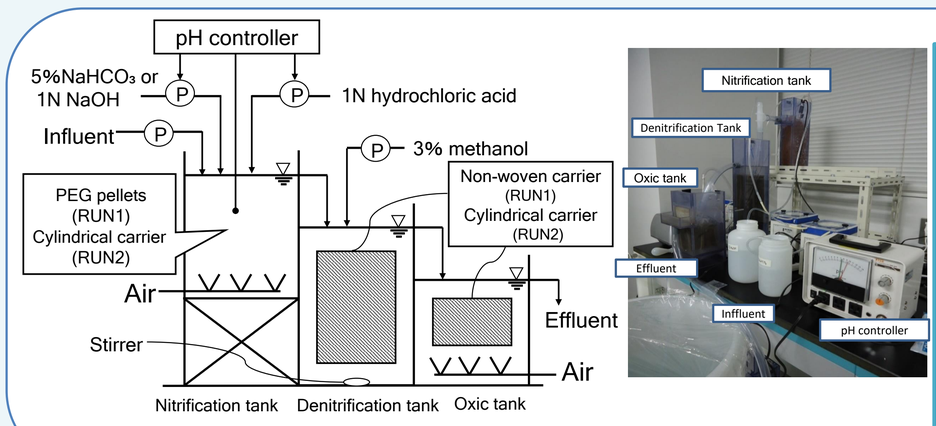

Fig.1　Beaker-scare reactors for evaluation of nitrification.

Operating Condition

・HRT　RUN1　32-50 h
　RUN2　28-48 h
・Ammonia Loading Ratio (ALR)　RUN1 0.1-0.5 kg-N/m³/d
　RUN2 0.1-0.6 kg-N/m³/d
・Salt concentration　0.3-4 %
・Setting Methanol/N Ratio　3-4
・Setting pH　7.2-7.5

Table 1　Pellets in each reactor

	Reactor	Pellets
RUN1	Nitrification tank	PEG pellet (Entrapped)*1）
	Denitrification tank	Non-woven carrier (Attached)
	Oxic tank	Non-woven carrier (Attached)
RUN2	Nitrification tank	Cylindrical carrier (Attached)
	Denitrification tank	Cylindrical carrier (Attached)
	Oxic tank	Cylindrical carrier (Attached)

*** 1) Most Probable Number of Nitrification pellets**
AH strain 4.10×10^8 cells/cm³（98%）
AL strain 6.56×10^6 cells/cm³（2%）

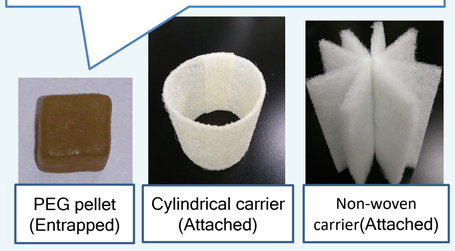

Fig.2　Used Pellets

Results and discussion

・RUN1 (Immobilized microgram using entrapped method)

RUN1 increased salt concentration in the Inf water from 160 day. Nitrification rate was obtained 0.31 kg-N/m³/d and Eff T-N was obtained ＜2.1 mg/L under 3.8% salt concentrations (Fig3, 5) .

Under 4% salt concentrations, nitrification rate decreased and NH_4-N and NO_2-N increased in the nitrification tank. From 380 day, RUN1 diluted 0.3 salt concentration. Nitrification activity recovered and nitrification rate was obtained 0.4 kg-N/m³/d and Eff T-N was obtained ＜10.0 mg/L again.

・RUN2 (Immobilized microgram using attached method)

RUN2 increased salt concentration in the Inf water from 120 day. Nitrification rate was obtained 0.29 kg-N/m³/d and Eff T-N was obtained ＜5.0 mg/L under 3.8% salt concentrations (Fig4, 6) .

Under 4% salt concentrations, nitrification rate was decreased and, NH_4-N was increased in the nitrification tank. From 310 day, RUN2 diluted 0.3% salt concentration in the Inf water. Nitrification activity recovered. Nitrification rate was obtained 0.4 kg-N/m³/d and Eff T-N was obtained ＜5.0 mg/L again under 3.8% salt concentrations.

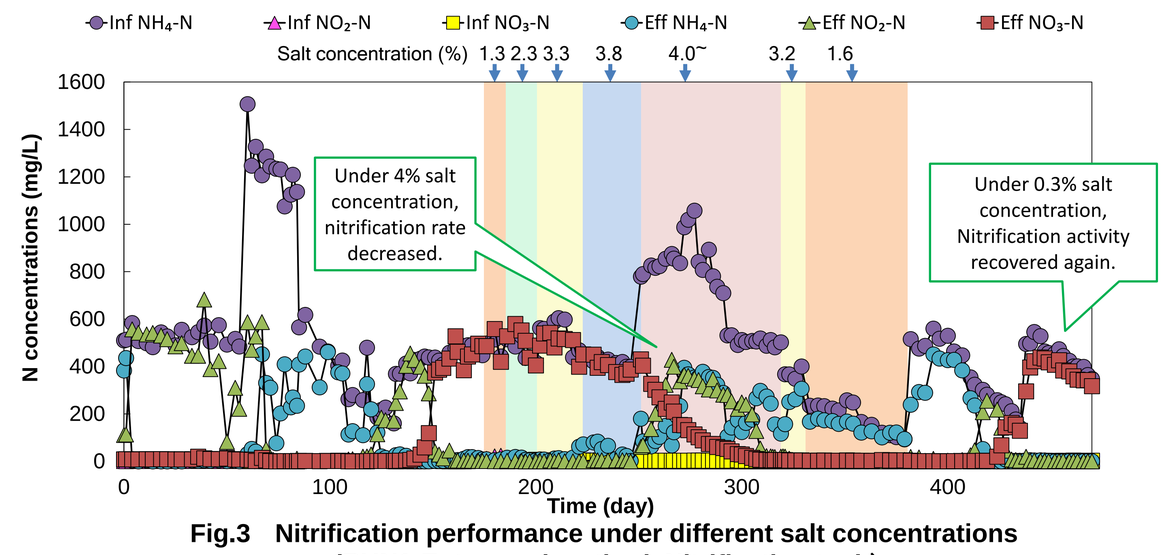

Fig.3　Nitrification performance under different salt concentrations (RUN1:Entrapped method, Nitrification tank)

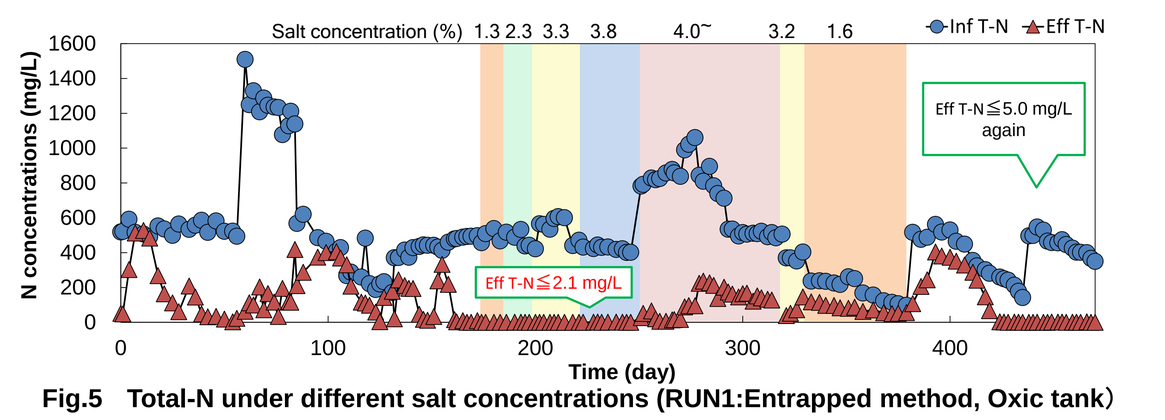

Fig.5　Total-N under different salt concentrations (RUN1:Entrapped method, Oxic tank)

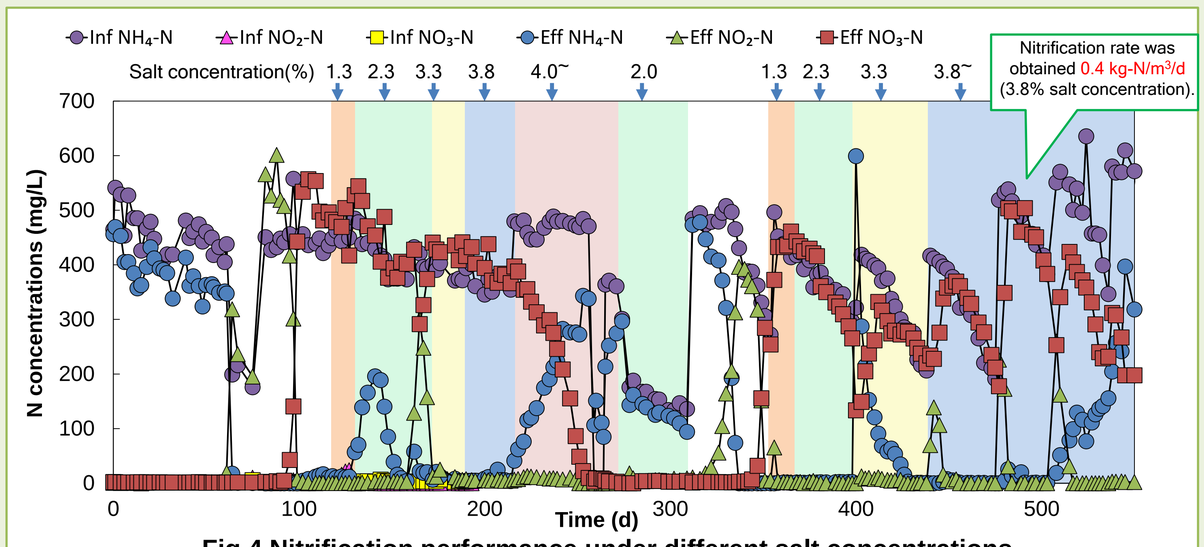

Fig.4 Nitrification performance under different salt concentrations (RUN2:Attached method, Nitrification tank)

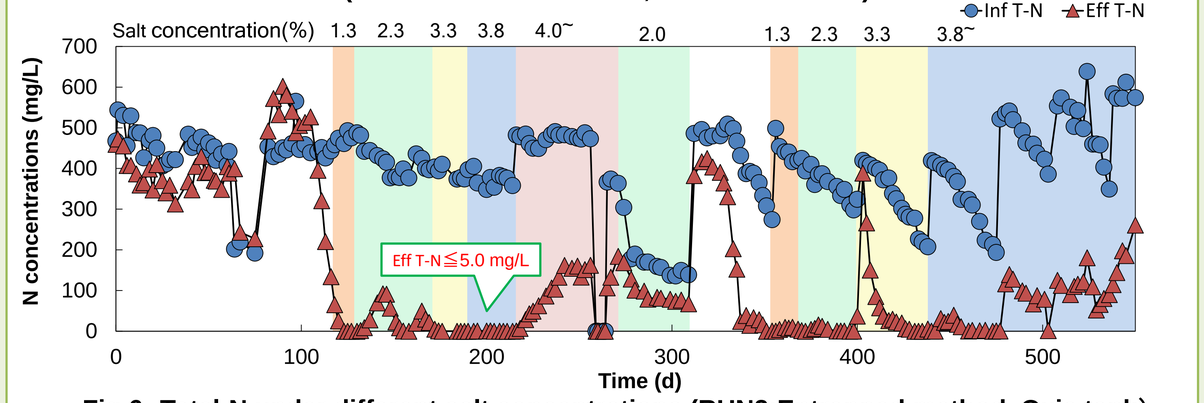

Fig.6　Total-N under different salt concentrations (RUN2:Entrapped method, Oxic tank)

Table 2　Real-time PCR in the pellets (RUN1, Nitrification tank)

Target	copy number (copy/g)
Nitrosomonas（*amoA*）	2.02×10^9
Nitrobacter（*norB*）	9.62×10^9
Nitrospira（16S rRNA）	none

Conclusions

- The maximum acceptable salt range by immobilized microgram using entrapped method (RUN1) and attached method (RUN2) were 3.8%.
- Under 3.8% salt concentrations, RUN1 and RUN2 archived Eff T-N ＜30mg/L in the industrial wastewater. Nitrification rate was obtained 0.4 kg/ kg-N/m³/d.
- Nitrification activity recovered under 0.3% salt concentration.