

# Development of Next-generation Wastewater Treatment Technology Using New Biological Reaction

(Research of FY 2017-2021)

## 1. Purpose

This study aims to develop wastewater treatment technology using a new biological reaction, promising more energy-saving, cost-saving, and energy-recyclable than conventional technologies. The research includes extraction of promising technologies by a bibliographic survey, investigation of the R&D trend through a questionnaire to private companies, and bench-scale experiments to consider the feasibility of the next-generation wastewater treatment.

## 2. Outcomes of This Year

The results of a questionnaire survey on domestic companies in the previous year suggested that "room temperature Anammox" could be applied to wastewater treatment as new technology. On the other hand, the knowledge about nitrogen removability at water temperatures below 20°C was not enough.

This year, the researchers conducted laboratory experiments to understand the Anammox's treatment performance at influent with low water temperatures (10-30°C) and low nitrogen concentrations (NH<sub>4</sub>-N concentration: 40 mg/L or less.) We studied the treatment performance at low water temperature and the impact of water temperature on SNAP (Single Stage Nitrogen removal using Anammox and Partial nitritation) treatment in influent with low nitrogen concentration (table 1.)

Table 1. Overview of the experiment

Contents of experiment		Treatment performance of Anammox at low water temperature	The impact of water temperature in SNAP treatment of effluent with low nitrogen concentration
Equipmen	Volume	10L	1.55L
	Used carrier	PVA gel (sphere, $\phi$ 5mm)	PVA sponge (cube, 4mm)
	Mixing manner	Mechanical mixing	Aeration by mixed gas (air: nitrogen=1: 9)
Conditions	Seed sludge	Anammox sludge accumulated and cultured from return sludge of municipal WWTPs in Gunma prefecture	
	Water temperature	13-30°C	
	pH	7.0-8.0 (control with 0.5N hydrochloric acid)	
	Raw water	Inorganic synthetic influent (NH <sub>4</sub> -N concentration: 40-130mg/L NO <sub>2</sub> -N concentration: 40-160mg/L)	Inorganic synthetic influent (NH <sub>4</sub> -N concentration: 26-45mg/L)

## (1) Treatment performance of Anammox in low water temperature

A continuous treatment experiment of inorganic synthetic influent (T-N concentration: 80-290 mg/L) containing mainly NH<sub>4</sub>Cl and NaNO<sub>2</sub> was conducted using a fluidized bed carrier Anammox sludge cultured for a long time at a water temperature of 21-28°C was attached. As a result, the treatment performance at 13-30°C was confirmed.

- As total inorganic nitrogen (T-IN) removal rates, 0.3-0.7 kg-N/(m<sup>3</sup>·day) at 13°C and 0.4-0.9 kg-N/(m<sup>3</sup>·day) at 15°C were obtained, confirming the Anammox activity.
- The maximum nitrogen removal rate at around 30°C obtained in the past with the same system was 4.1 kg-N/(m<sup>3</sup>·day)\*, comparable to that of general anammox treatment at high concentration and medium temperature. The nitrogen removal rate decreased significantly with decreasing water temperature, showing less than about 0.3 kg-N/(m<sup>3</sup>·day) at low load in a typical anoxic tank.

\*Ohmori, Nakajima, Ishida, Sumino, Hashimono, and Aikawa; pp.49-51, Proceedings 2020 of the 57<sup>th</sup> Japan Annual Technical Conference on Sewerage

(2) Impact of water temperature on SNAP treatment of influent with low concentration nitrogen

The impact of water temperature was verified by continuous treatment of influent with low-concentration nitrogen ( $\text{NH}_4\text{-N}$  concentration: 26-45 mg/L), mainly composed of  $\text{NH}_4\text{Cl}$ , using the SNAP treatment, in which partial nitrification and Anammox reaction are performed in a single tank using a carrier with Anammox sludge attached.

- While nitrogen removal rates were as low as 0.09-0.13 kg-N/( $\text{m}^3 \cdot \text{day}$ ) at 20°C and 0.06 kg-N/( $\text{m}^3 \cdot \text{day}$ ) at 14°C, it suggested the possibility of partial nitrification and Anammox reaction in a single tank.
- Partial substitution of the SNAP treatment with aerobic and anoxic tanks in the sewage treatment process is expected to reduce the aeration and shorten the retention time.

### 3.Future Schedule

Anammox reaction was active even at low water temperatures, indicating the possibility of the SNAP treatment of influent with low-concentration nitrogen at low water temperatures. We plan to conduct bench-scale experiments using real wastewater to investigate the wastewater treatment process using the SNAP treatment.

Keywords: **ANAMMOX, low water temperature, influent with low-concentration nitrogen, SNAP treatment**