# 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 and cost-saving than conventional technologies. The previous year, the research initiated lab-scale experiments of new nitrogen removal technologies. The investigation involves applying the anammox, traditionally used for return water treatment, to nutrient removal.

## 2.Outcomes of This Year

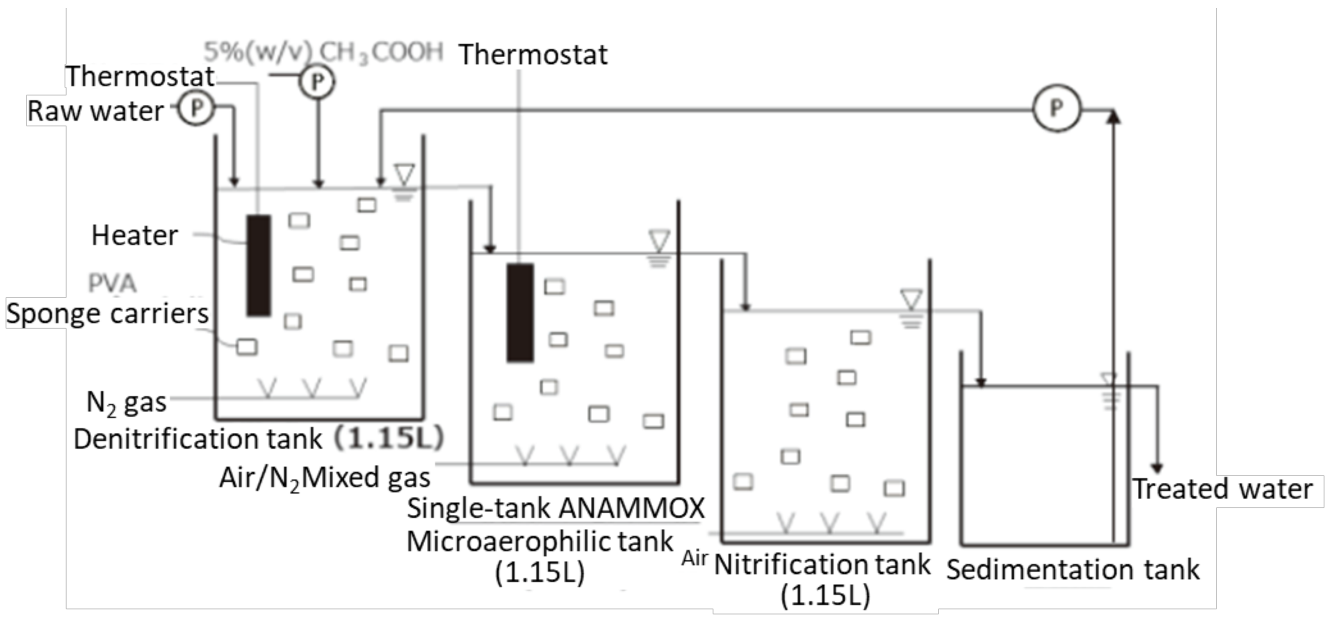


Figure 1 Laboratory experimental equipment

Last year's lab experiment incorporated a single-tank ANAMMOX process into a modified Ludzack-Ettinger process. The attempt allowed the process to improve nitrogen removal rates and save energy.

Figure 1 shows the lab-experimental apparatus, including a carrier-added microaerophile tank (single tank ANAMMOX). The experiments verified the nitrogen removal performance of the treatment process in a BOD inflow using synthetic wastewater.

## 1. Effect of BOD on single-tank ANAMMOX

Consecutive treatment experiments were conducted using only microaerophilic tanks at a low water temperature of 25°C and a low nitrogen concentration of 40 mg/L of NH4-N in the raw water. Here, BOD (acetic acid) was added to the raw water to confirm the effect of the single-tank anammox on nitrogen removal performance. Raw water BOD of 5 to 20 mg/L, the T-N removal rate was 20-50%, the same level as before the BOD addition. On the other hand, when the BOD of raw water is 20 mg/L or higher, the T-N removal rate drops below 25%, confirming the need to keep the influent BOD at a low concentration in the single-tank anammox process.

## 2. The performance of the modified Ludzack-Ettinger process combined with single-tank ANAMMOX

Another Experiment was conducted under the same low water temperature and low nitrogen concentration conditions as above with the nitrogen removal process shown in Figure 1. We attempted to increase the BOD concentration of the raw water to raise the C/N (carbon/nitrogen) ratio in steps. But there was concern that the treatment performance of the microaerophilic tank would decline as the influent BOD concentration increased. So, the condition changed to raise the inside circulation ratio according to the C/N ratio of the raw water (Figure 2.)

When the raw water C/N ratio was 0.5 (circulation ratio 1.0), the T-N removal rate averaged only 54%, but the anammox contribution rate averaged 17%. The anammox contribution ratio is the contribution of the microaerophilic tank to the total nitrogen removal in the process. The result showed that the microaerophilic tank effectively raised the nitrogen removal rate to a certain level.

On the other hand, when the C/N ratio was greater than 1.0, the overall process nitrogen removal rate increased to more than 70%, but the anammox contribution decreased to 9%.

When the C/N ratio is 0.5, the influent BOD concentration in the microaerophilic tank is less than 15 mg/L. If we can find the conditions to maintain this range, a process using microaerophilic tanks can achieve a realistic nitrogen removal rate while keeping the internal circulation ratio low.

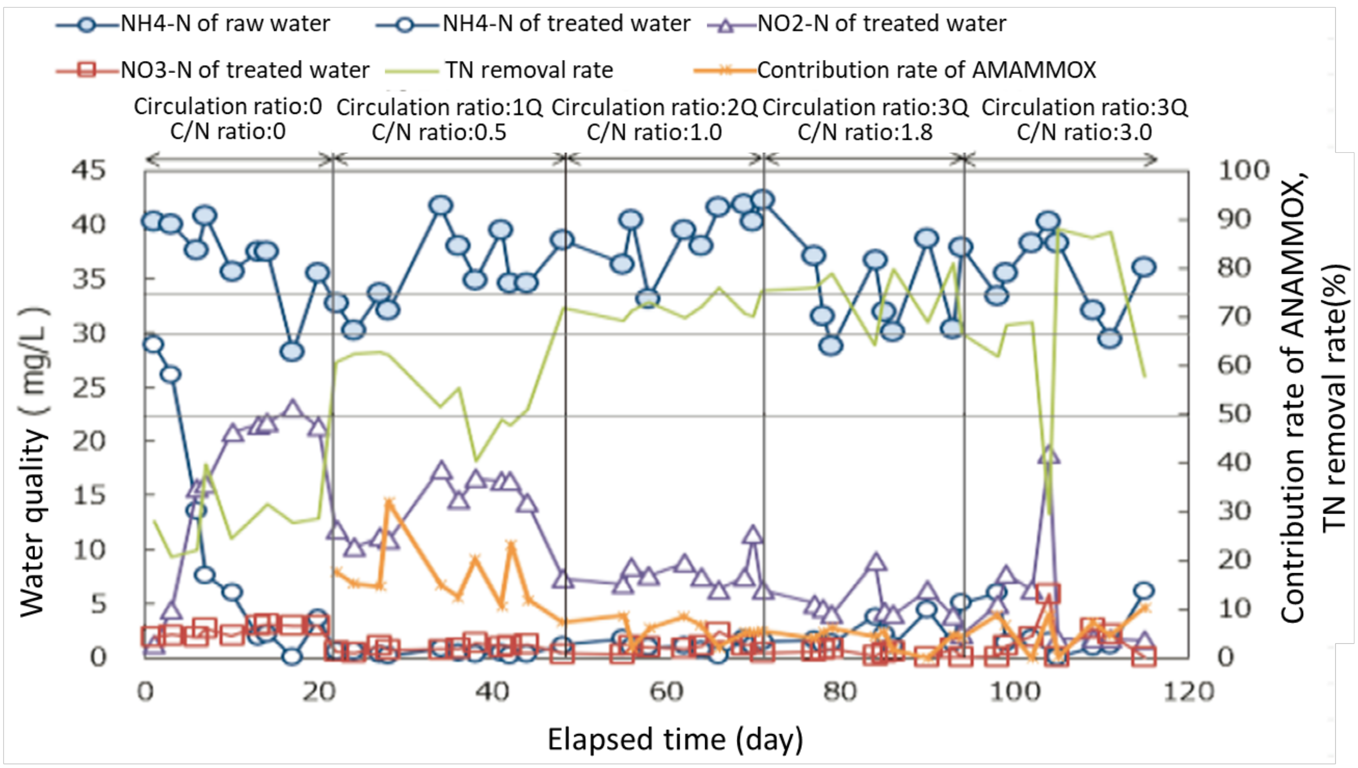


Figure 2 Transition over days

## 3.Future Schedule

The following year, we will prepare an experimental unit of the nitrogen removal process incorporating the microaerophilic tank described above, with a treatment capacity of 2.4 m3/day. Using this scale-upped bench experimental unit, we plan to conduct ongoing treatment experiments of actual sewage to confirm the nitrogen removal performance and treatment characteristics.

Keywords: **Single-tank ANAMMOX, low water temperature, Effluent with low-concentration nitrogen**