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, which promises to be more energy-efficient and cost-effective than conventional technologies.

The ANAMMOX reaction, which has been conventionally used in the sidestream treatment, was selected as a new nitrogen removal technology in the previous year. Basic experiments for treatment performance and properties were conducted under advanced wastewater treatment conditions, which include low water temperature and nitrogen concentration.

2. Outcomes of This Year

Continuous treatment experiments were conducted on a laboratory scale in the past year. The modified Ludzack-Ettinger process incorporating a single-tank anammox tank (microaerophilic tank) was expected to achieve a realistic nitrogen removal rate for raw water with low water temperature and nitrogen concentration while keeping the internal circulation ratio (R) low.

This year, laboratory experiments using the apparatus shown in Figure 1 continued to confirm the effects of treatment parameters such as water temperature, raw water concentration, and internal circulation ratio on nitrogen removal performance.

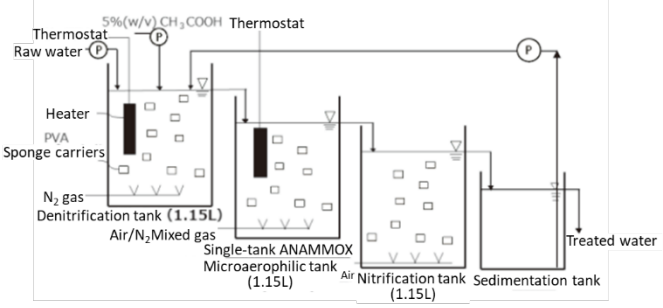

Figure 1: Laboratory experimental device

At the same time, the lab plant was scaled up to a bench scale and started its operation.

(1) Confirming how treatment requirements affect nitrogen removal performance

The test was conducted at 20°C to 15°C water temperature, with raw water of 0.5 to 3.0 C/N (carbon/nitrogen) ratio and 0.5 to 3.0R.

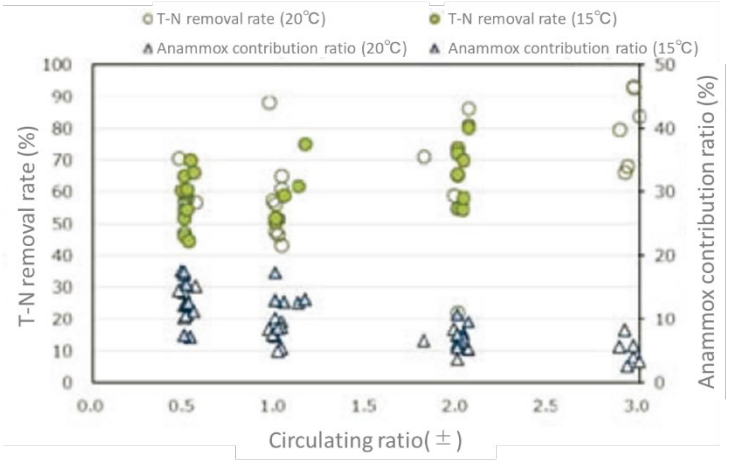

Figure 2: Circulating ratio's impacts on the T-N removal rate and anammox contribution ratio

Under a C/N ratio of 2, the T-N removal rate improved as R was increased, as in the normal modified Ludzack-Ettinger process. In contrast, the anammox contribution ratio (the contribution of the amount removed in the microaerophilic tank to the total amount of T-N removed) tended to be higher when R was low (0.5-1.0). (Figure 2)

Figure 3 shows a relationship between the TOC (total organic carbon) concentration of influent in a microaerophilic tank and the T-N removal rate in the tank. When the TOC concentration is kept below 30mg/L, the T-N removal rate probably exceeds 20%.

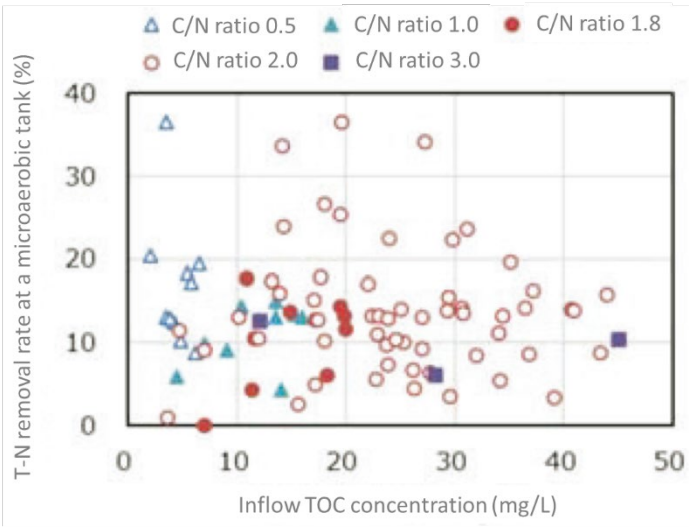

Figure 3: Relationship between inflow TOC concentration and T-N removal rate at a microaerobic tank

As a result, the entire process can be expected to achieve a T/N removal rate with lower R (0.5 to 1.0), that is, less electricity, than the modified Ludzack-Ettinger process in the range of raw water C/N ratio below 2.0 and influent TOC concentration in the microaerophilic tank is less than 30 mg/L.

(2) Bench plant start-up

At the JS R&D Experimental Center, a bench plant with the same tank configuration as in Figure 1 (two trains of each 100L/d treatment capacity) was installed. The bench plant start-up operation was conducted using sewage (clarified water).

3. Summary of the Entire Research Period

Anammox was selected as a research target from the literature survey on new technologies, and a research and development trend survey was conducted. Laboratory experiments confirmed that anammox could remove nitrogen even at low water temperatures and nitrogen concentrations.

The requirements of C/N ratio and microaerophilic tank influent quality were studied for an energy-saving advanced treatment process promising a nitrogen removal rate equivalent to the modified Ludzack-Ettinger process.

After FY2022, we will continue studying the effects of SS inhibition on the bench plant and treatment performance under low water temperatures.

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