Development of high-rate nitrogen removal process Using attached biofilm on graphite

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Introduction

Many real plants of anammox are operating in Europe. More than 100 plants such as DEMON methods. Not widely used in Japan. Large amount of inoculum required so that difficult startup. Currently it is necessary to purchase from European P company etc.
Graphite has been reported to have the effect of promoting bacterial growth when added to the medium. In this study, graphite particles were used as attached carriers and characteristics of nitrification treatment and anammox treatment were examined. Furthermore, hybrid treatment (SNAP treatment) was carried out using the obtained microorganism attached carrier, so it is reported.

Object

Reduced startup with anammox treatment characteristics using graphite part
Target: 1 month of denitrification rate 1.0 kg – N / m^3 ・d

・Clarification of processing
1. Nitrification
2. Anammox treatment
3. SNAP treatment

Materials and Method

・Experimental equipment and operating method

1.Nitrification :20 mL of graphite particles (packing ratio: 1%) and 78 mL of activated sludge were charged into a reaction vessel volume of 1.55 L and aerated. Wastewater was used as synthetic waste water, and nitrification was performed at a retention time of 24 to 12 h. Water temperature was controlled at 30 ℃, pH 7.0 to 8.0.

2.Anammox treatment :Reaction tank volume and graphite packing rate were the same as in the previous section1, 78 mL of anammox sludge was charged and stirred at 160 rpm. Treatment was carried out with wastewater (ammonia, nitrous acid, trace element containing, T - N 100 - 2020 mg / L) at a retention time of 24 – 6 h. Water temperature was controlled at 30 ℃, pH 7.0 to 8.0.

3. SNAP treatment: The anammox carrier cultured in Section 2 was charged to the reaction vessel (nitrification tank) in Section 1 so that the ratio was 1/1 of the nitrification carrier / anammox carrier. SNAP treatment was performed with wastewater (NH_4- N 200 mg /l) at a retention time of 12 h. The reaction tank DO was controlled around 1, pH 7.5 to 8.0.

・Pellet
Graphite particles with a particle size of 2-1000 μm

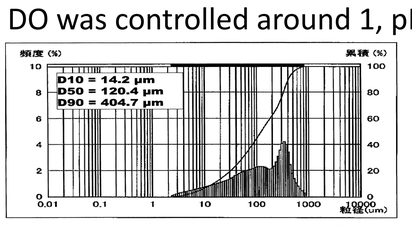

Fig.1 Particle size distribution chart of graphite

Fig.2 graphite

Result and Discussion

1.Nitrification
At the 12th day of operation, the nitrification rate reached 90% or more and became nitrate type, but it shifted to the nitrite type for about 3 months from the 162nd day and the nitrification rate was seen to decrease.
Then it stabilized to nitrate type.
The concentration was gradually increased, and the maximum nitrification rate was 1.74 kg-N / m^3 ・d at 176th day.(Fig.5,6)

2.Anammox treatment
The nitrogen removal rate was 1.06 kg-N / m^3 ・d on the 26th day of operation, and the nitrogen removal rate stabilized at 80%. After 26th day, reddish brown granules were formed with graphite as the nucleus, and the nitrogen removal rate was further improved. On day 228 the maximum nitrogen removal rate of 6.54 kg-N / m^3 ・d was obtained. Especially at the first month of operation, the nitrogen removal rate was 1.0 kg – N / m^3 ・d more and the result was extremely fast rising.（Fig.7)

3.SNAP treatment
Although the growth promoting mechanism of graphite particles is unknown, it is conceivable that zeta potential and particle diameter are may be important.
Further, SNAP treatment was carried out to obtain a nitrogen removal rate of 60 to 80% at a load of 0.42 kg-N / m^3 /・d. (Fig.8,9)
We found that graphite particles can be feasible as carrier.
Graphite operating with nitrification and anammox was sampled and zeta potential was measured. If only graphite is used, the zeta potential is distributed to -100 to 40 mV, but sharp peaks of -30.9 mV for nitrification and -26.6 mV for anammox are obtained after accumulation culture(Fig.10)

Table.1 Synthetic wastewater（Nitrification）

Component	Concentration(g/L)
NH_4Cl	2.675～120.38
$NaHCO_3$	2.343～70.29
$NaHPO_4$・$12H_2O$	0.231～6.93

Table.2 Synthetic wastewater（Anammox）

Component	Concentration(g/L)
NH_4Cl	3.8～178.8
$NaNO_2$	4.9～230.5
$NaHCO_3$	10.0～94.5
KH_2PO_4	0.5～1.1
$MgSO_4$・$7H_2O$	6.0～13.5
$CaCl_2$・$2H_2O$	0.6～1.4
Trace Element Solution Ⅰ(※1)	1～45 (mL/L)
Trace Element Solution Ⅱ(※2)	1～45(mL/L)

※1 EDTA=5 g/L,FeSO4=5 g/L
※2 EDTA=15 g/L, ZnSO4・7H2O= 0.43 g/L, CoCl2・6H2O= 0.24 g/L, MnCl2・4H2O= 0.99 g/L, CuSO4・5H2O= 0.25 g/L, NaMoO4・2H2O= 0.22 g/L, NiCl2・6H2O= 0.19 g/L, H3BO4= 0.014 g/L

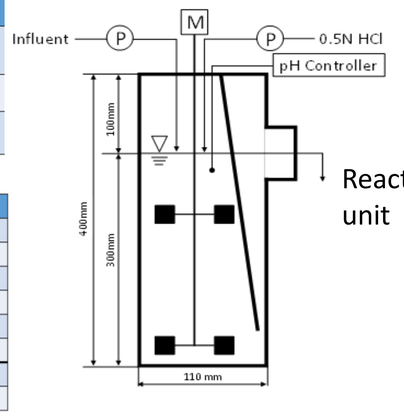

Fig.3 Schematic Reactor

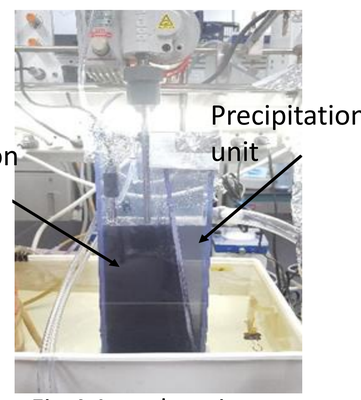

Fig.4 Actual equipment

Nitrification

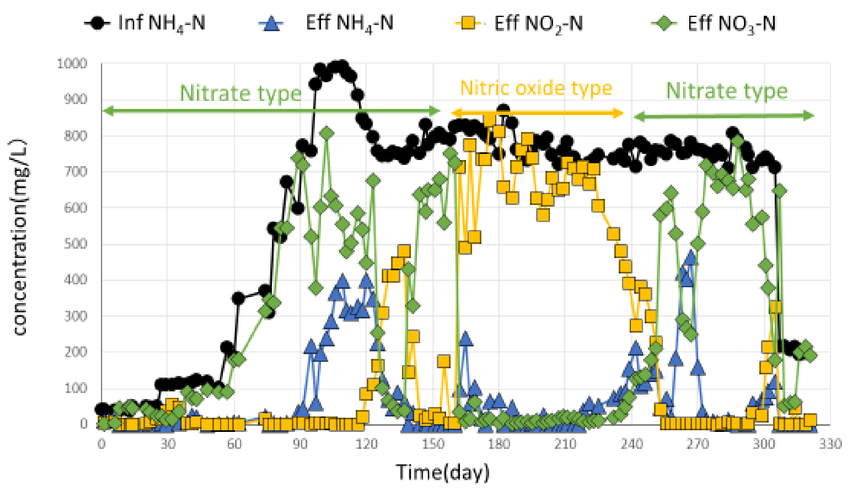

Fig. 5 Time courses of influent and effluent nitrogen concentrations

Nitrification

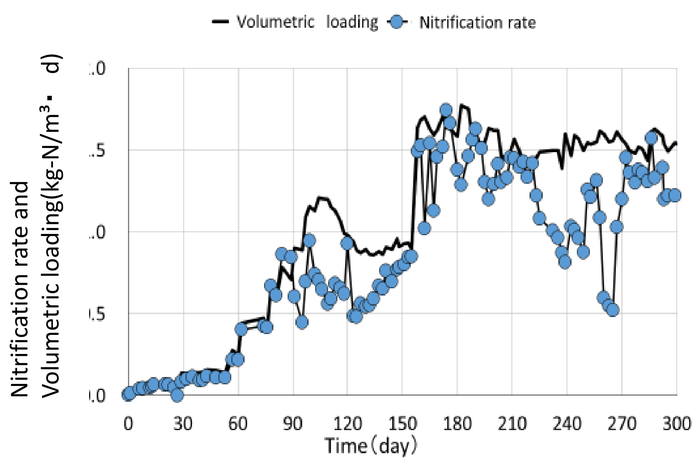

Fig. 6 Time courses nitrification rate and volumetric loading

Anammox

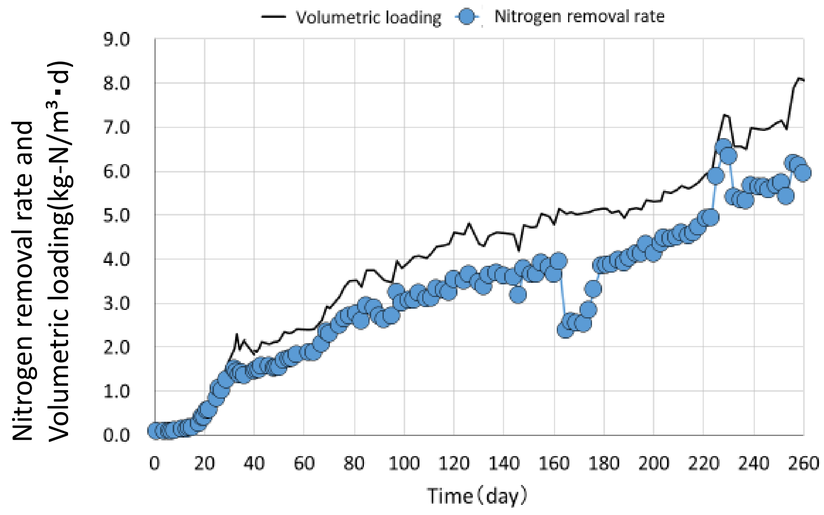

Fig.7 Time courses Nitrogen removal rate and Volumetric loading

SNAP

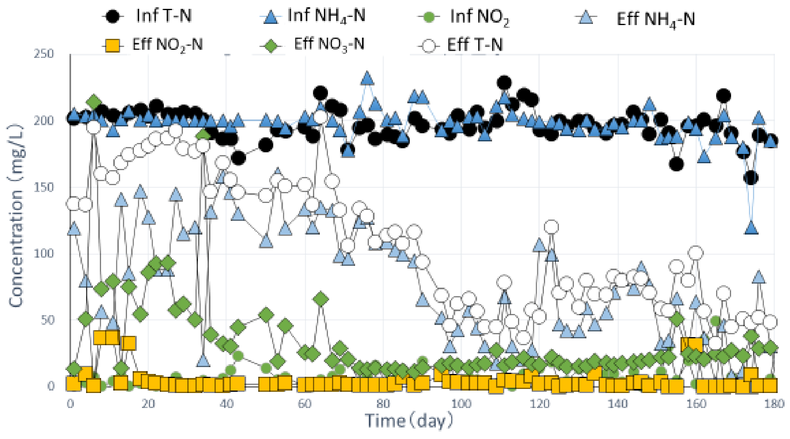

Fig.8 Time courses of influent and effluent nitrogen concentrations

SNAP

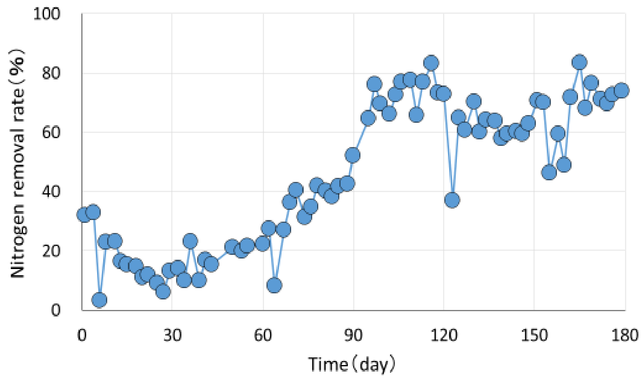

Fig.9 Time course of nitrogen removal rate

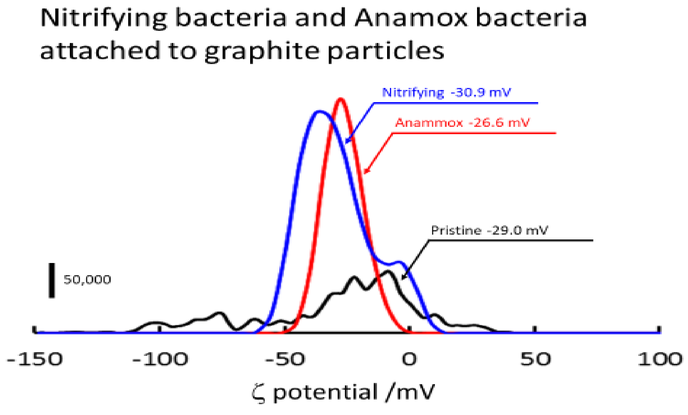

Fig.10 Result of zeta potential

Conclusions

・Nitrification
The maximum nitrification rate was 1.74 kg-N / m^3 ・d. It tends to be a nitrate type as compared with conventional carriers.
・Anammox
A nitrogen removal rate of 1.26 kg-N / m^3 ・d was obtained in one month.
High-speed startup possible. A maximum nitrogen removal rate of 6.54 kg-N / m^3 ・d was obtained on day 228 of operation.
・Snap
Load 0.45 kg - N / m^3 ・d, average removal rate 66.5% (60 - 80%) The maximum removal rate was 83.2%

Next step
Design of Pilot plant that sludge blanket type