VII-40 NITRIFICATION BY USING A DOWNFLOW HANGING SPONGE REACTOR FOR THE POST TREATMENT OF THE EFFLUENT FROM UASB REACTOR

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1.INTRODUCTION

The UASB technology has been successfully developed for treatment of certain kinds of wastewaters. The wide application of UASB reactor is mainly due to its high efficiency of organic removal and its high cost-effectivity. However, with regard to the elimination of nitrogen compounds this reactor is little effective. It is well known that nitrogen in form of ammonia needs to be removed from wastewater because of their harmful effects when discharged into waterbodies, like DO depletion or eutrophication. In view of this deficiency of UASB reactor, consequently, a post treatment system is necessary. We proposed a simple and cost-effective process by using a downflow hanging sponge reactor for the reduction of ammonia concentration in the effluent from UASB reactor. This paper presents a summary of the reactor performance for a start-up period of 30 days operation.

2.MATERIALS AND METHODS

A schematic diagram of the system is presented in Fig.1. The reactor was fabricated from sponges (polyurethane foam) with a dimension of 1.5×1.5×1.5cm bounded to a vertical nylon string (total length : 200 cm). Influent stream was sent to the top of the reactor by a peristaltic pump, and then the influent was tricked down through the sponges. The reactor had a total void volume of about 0.244 l (the void ratio of the sponge : 0.803) with a specific surface area of 405 m^2/m^3. The main function of the reactor is to polish up the quality of the effluent from UASB reactor prior to discharge to public surface waterbodies in the following aspects: elimination of ammonia present in the effluent of an UASB reactor, and reduction of suspended solids by entrapment into the sponges.

Before start up, the sponges were submerged in aerated activated sludge for one day for inoculation. The effluent from an UASB reactor treating domestic wastewater was used as the influent feed. The experiment was operated at a temperature of 25°C. The influent and effluent were taken as the sample for daily analyses.

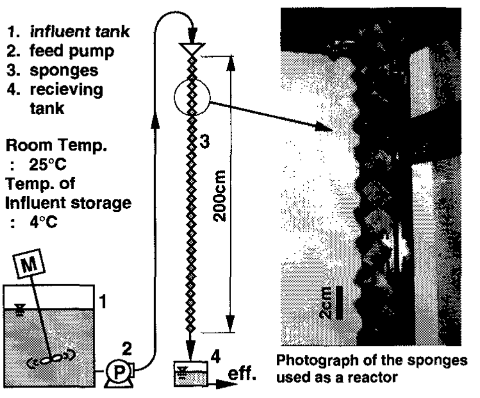

Fig. 1 Schematic representation of the reactor used in this study

3.RESULTS AND DISCUSSIONS

Fig. 2 shows the time courses of total and soluble COD of the influent and effluent from the reactor. Table.1 gives representative characteristics of the influent. The average of total COD concentration in the influent stream was 164mg/l, and the average of soluble COD in the influent amounted to 71mg/l, and thus approx. one-second of the influent total COD was occupied by particulate COD.

In spite of fluctuating the influent COD, there was a stable COD removal, exhibiting the total COD of 58 mg/l (Fig.2). As a result, the reactor achieved the COD removal of 63% on average throughout the whole duration. With regard to SS removal, the UASB reactor achieved almost 100%, resulting from no SS detected in the effluent. This indicates that the organic removal by the reactor can be accounted for by entrapment of particulate COD as well as soluble COD consumption by aerobic microorganisms inhabited in the sponge media.

Fig.3 shows the time courses of nitrogen concentrations in the influent and effluent. The reactor

Tabel 1. Characteristics of the influent wastewater and operating conditions

Parameter	max.	min.	ave.	STD
CODT (mg/l)	378	77	164	76
CODS (mg/l)	113	30	71	22
NH4-N (mg-N/l)	57	10	32	12
SS (mg/l)	207	17	72	49
VSS (mg/l)	132	3	42	35
pH	7.3	7	7.05	0.1
DO (mg/l)	6.1	1.08	3.02	1.2

Operating conditions
Flow rate : 3 l/day
Temperature : 25 °C

demonstrated a fairly good performance in nitrification, with a ammonia removal of 85%, even though the influent ammonia concentration was greatly fluctuated from 10 to 57 mg-N/l. The dissolved oxygen concentration in the reactor was in a range of 7 to 8.5 mg/l, while the DO of the influent were around 3 mg/l. This suggests that the reactor has a sufficient function in spite of intaking only the oxygen in the atmosphere.

Theoretical hydraulic residence time (HRT) of the reactor was about 1.7 hours based on the void volume. However, the effective reactor volume may be lowered due to the entrapment of SS in the sponge media, which probably prevent full flow of wastewater into the sponges, and should reduce HRT. Even though the amount of entrapped SS increased with elapse of the cultivation time, the reduction of HRT did not seriously affect the reactor performance with respect to nitrification and COD reduction also, as shown in Fig.3.

Nitrogen mass-balances were made at different periods of the operation based on influent ammonium-nitrogen (Fig.4). In the effluent of the reactor, approx. 65% of influent NH_4-N was converted to nitrate and 10% of the influent NH_4-N was in form of nitrite, and 10% of the influent NH_4-N was remained unchanged, i.e. in form of ammonia. The unknown fractions of nitrogen in the mass-balance (0-10day:13%, 11-20day:6%, 21-30day:23%) were observed throughout the experimental period. It seems to be that the unknown fractions of nitrogen balance was probably due to uptaking of nitrogen by microorganisms grown in the sponges.

Fig. 5 shows ammonia, nitrite, and nitrate profiles along the reactor height at the 30th day. This profiles show a superb potential of the reactor on nitrification obviously. With passing the influent through the sponges, NH_4-N in the influent stream was immediately reduced, showing that about 90% of the influent ammonia was lowered at the half-point of the reactor height. With decreasing ammonia in the reactor stream, nitrite and nitrate were formed rapidly. However nitrite formed was consumed until the half-point of the reactor height, indicating that the nitrification was almost completed by a half length of the reactor height. Therefore, it can be expected that this reactor can allow more high loadings.

4.CONCLUSION

The hanging downflow filter reactor has an excellent performance on particulate COD removal and nitrification for the effluent of an UASB reactor treating domestic sewage. However denitrification was not observed in the reactor throughout the whole duration. If the reactor is improved to have a recirculation of the effluent and an anoxic zone at the top of the hanging sponges, it will be possible to remove nitrate through denitrification.

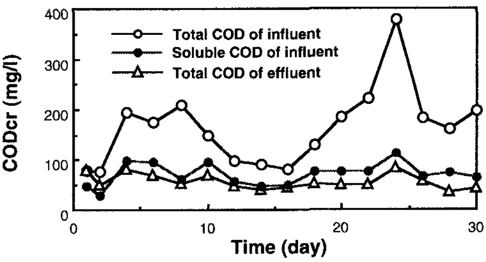

Fig.2. Time courses of total and soluble CODcr in the influent and effluent streams

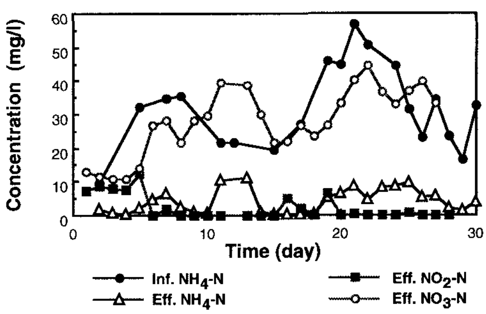

Fig. 3. Time courses of nitrogen concentrations in the influent and effluent streams

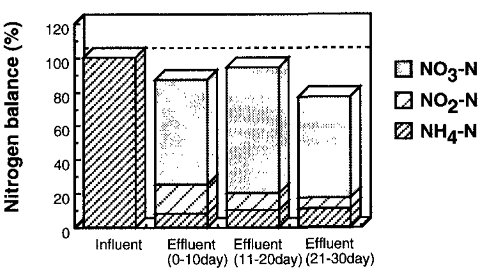

Fig. 4. Nitrogen mass-balance within the reactor based on influent NH4-nitrogen at different periods of operation

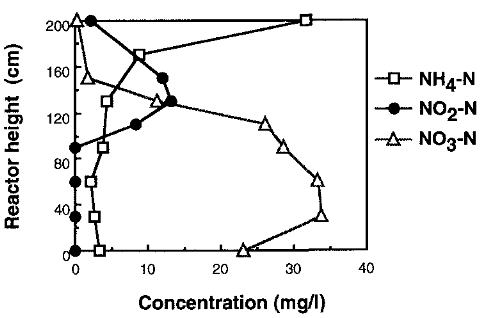

Fig. 5. NH4-N, NO3-N, NO2-N profiles in the reactor (at the 30th day)