The Efficiency of Nitrogen Removal in Humus Activated Sludge Process and the Analysis of Dominance Nitrobacteria

Song Weihua [a], Ren Xiaoshuai [a]

1The City College of Jilin JianzhuUniversity, Changchun 130000, China.

[a]E-mail address: swh_123@163.com

Abstract. According to compare two kinds of process: conventional SBR and humus activated sludge process, the efficiency of Nitrogen removal was be investigated. The results show that the removal of NH4+-N by the SBR filled with humus soil was be enhanced, the time in nitrification was be shorten. Also, through the invesgation of the microorganism, the quantity of the Nitrobacter in humus activated sludge process was larger than conventional. The results would be the foundation to study ahead.
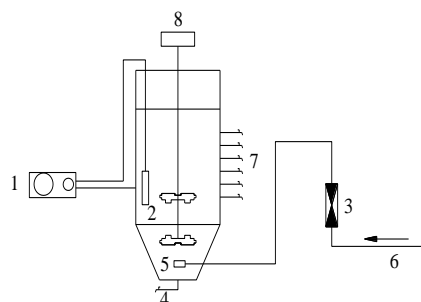
1. Introduction

Developing an effective and economic method for nitrogen removal with biological ways is a focal point throughout the world. The organic solid and the dissovled organic matter in the soil particals can be degradate by the soil bacteria. Basic on this mechanics, some foreign researchers studied the microorganism by separating, verificating, enriching the soil bacteria. After fixing the bacteria on the pack. They put the feed into conventional SBR. Under soil bacteria's action, the metabolism of the bacteria was accelerated. In this procedure,the organic pollutant can be decleared, such as nitrogen ,phosphorus and the matter which can produce odor. Stebilization of the sludge can enhance the efficiency of sludge concentration and sludge dewatering. This process was called Humus Activated Sludge Process (HASP) [1]. It was used in some foreign countries [1]. The main part of HASP is the pack which was filled in the humus soil reactor. The feed can accelerate the metabolism, and react with the activated sludge, also, the pack offers the specific for the growth of the microoganism. Microelement trace element which the bacteria requaires is supplied by the feed, also the active agent and sludge culture was the other fuction. By comparing the bacteria in two kinds of SBR, the result shows that there are some differences between two processes. Obviously, the HASP is better than coventional processes.

2. Materials and Methods
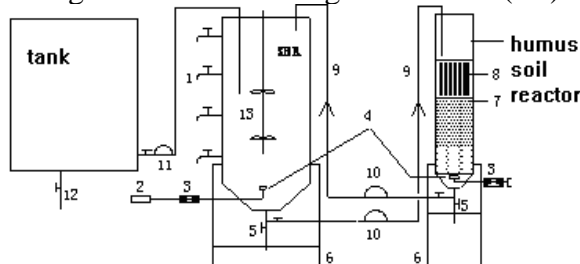
2.1 Experimental condition

In this research, the Sequential Batch Reactor (SBR) process has been adopted. It has widly used thoughout the world because of its advantages, such as compeletly nutrient removal and has no secondary pollutant, etc. Fill, react, settle, draw, idle were the five steps of a typical SBR. It can achieve anaerobic, anoxia, aerobic environment in one reactor. Comparison experiment was set, one is conventional SBR (R1), and the other is SBR which was packed with humus soil (R2).

R1 shows in figure 1.It was an acryl glass cylindrical column with 16 cm of interdiameter and 70 cm of height. The total effective volum is 12.5L. R2 shows in figure 2.It has the same SBR with R1, but connects with a humus soil reactor. The humus soil reactor is an acryl glass cylindrical column with 7 cm of interdiameter and 80 cm of height. The total volumn after packing the fee is 1.2L.

1.Temperature controler 2. Temperature bulb
3. Air rotameter 4.mud pipe 5.aeration head
6. Compressed air 7.outlet8.mixer

Fig. 1   Schematic diagram of SBR (R1)

1.Sample connection 2.air pump 3.flowrator
4. Aeration head 5. Mud pipe 6.support frame 7.stone
8.humus soil 9.recycle sludge pipe 10. retern sludge pump
11.pump 12.discharge valve 13.mix plasm

Figure 2 .The systematic diagram of Humus Activated   Sludge Treatment process(R2)

2.2 Parameter conditions

The parameter shows in table 1.

Table 1. Main parameter in two process.

		R1	R2
MLSS (mg/L)		4000	4000
Temperature (℃)		25±1	25±1
Applied aeration (m3/h)		0.6	0.6
One operation period (10h)	Aeration time(h)	6	6
	Mixing	2	2
	Settle	2	2

In humus soil reactor, the sludge takes from the SBR was inoculated,the dissovled oxygen maintains 0.5mg/L with the aeration.The MLSS keeps 8000 mg/L.In one period,the temperature is 25±1℃, aeration time is 12h,settling for 12 hours.The second morning, 0.6L sludge from SBR and the humus soil reactor was exchanged, then begins next cycle of operation .

2.3 Microorganism Detection [2-6]

1. The Most Probable Number was used in the experiment .Different nutrient medium was chose and to create anaerobic, aerobic environment to culture bacteria.

2. The sludge which was taken from the reactor in regular time will be settled and detected. The sludge would be diluted and cultured.

3.   Results and Discussion

R1 and R2 was operated for several periods. After they were stabilized, the experiment would be started by comparing the efficiency of the nitrogen removal between two processes. NH4+-N load is 34mg/L.

3.1 Process performance of R1 and R2

Figure 3 shows the profile of NH_4^+-N in R1 and R2 reactor. In R2, the NH_4^+-N concentration was decreased quickly after aerating for 120min.It mainly due to the low COD load in the system. Until 270 min, the nitrification was finished.The degradation of organic matter in R1 was delayed 30 min than

R2.So after aerating 150 min, the organic in system became undegradated, and nitrification began. NH_4^+-N concentration decreased until 330min.Then the concentration maintains in this arrange.

After aeration, NH4$^+$-N keeps about 8.1mg/L in R1, 6.2mg/L in R2. Obviously, the efficiency of nitrogen removal in R2 was 7% highly than R1.So it can be got the conclusion that the humus soil contributes to the performance, it makes the nitrification accomplish completely and shorten the aeation time and improve the efficiency of NH_4^+-N removal.

Figure 4 shows the profile of NO_3^--N and NO_2^--N in R1 and R2.The NO3$^-$-N concentration increased after 150min in R1, 120 min in R2. The quantity of increased NO_3^--N is less than the degree of decreased NH_4^+-N, especially in R2. In R2, from 120min to 240min, NH_4^+-N changed 17.0mg/L, but NO_3^--N changed 9.1 mg/L.The phenomence also can be observed in R1. All the phenomence suggested that SND (Simul taneous Nitrification and Denitrification). In SND, the sdsorbed organic matter was used by denitrification bacteria and the denitrification was accomplished in aeration conditions.
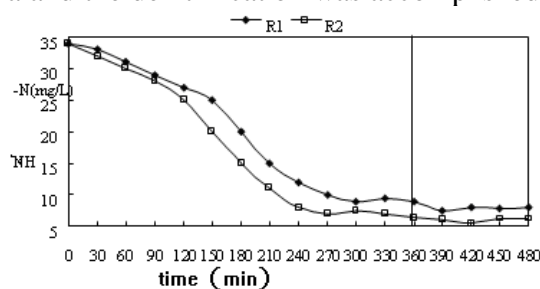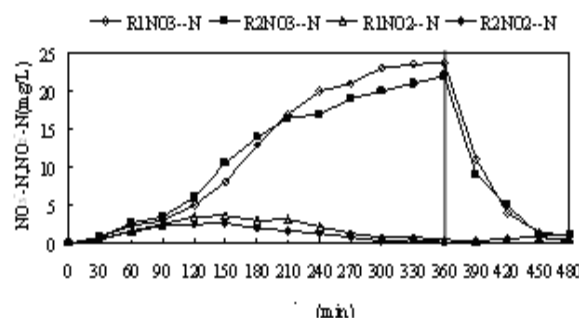

Fig. 3 The profile of NH3-N in R1 and R2 SBR reactor

Fig.4 The profile of NO3--N and NO2--N in R1 and R2 SBR reactor

3.2 The quantities of microbial community in R1 and R2

To detail the difference of the microbial commununity in two biological processes, nitrification bacteria was chosen to be detected .The results shows that (1) There's no nitrobacteria in blank sample. (2) There's no nitrobacteria in R1 and R2's raw water. (3) The nitrobacteria numbers in R1 shows in table 2. (4) The nitrobacteria numbers in R2 shows in table 3.

Table 2. MPN for nitrobacteria in R1

Diluted concentration	Tubes that bacteria grew inside	Quantitive index
10^{-1}	3	3
10^{-2}	3	3
10^{-3}	2	2
10^{-4}	0	0
10^{-5}	1	1
10^{-6}	0	0
10^{-7}	0	0
10^{-8}	0	0
10^{-9}	0	0
10^{-10}	0	0

From Table 1, quantitive index is 3 2 1. Approximate value is 15.0.So the nitrobacteria numbers of the sample R1 is 1.5×10^3 cfu/ml.

From Table 2, quantitive index is 3 3 0. approximate value is 25.0.So the nitrobacteria numbers of the sample R2 is 2.5×10^8 cfu/ml.The numbers of nitrobacteria in R2 is 100,000 times in R1.The results show that the quantities of nitrification bacteria in HASP was obvousily highly than Conventional Activated Sludge Process, it mainly because of the humus activated sludge can accumulate the growth of the microorganism, the feed also can provide the space for the growth.According to metabolism, the nitrogen can be removal, the organic, phusphorus and the odor can be decleared. This is the reason why the time of the nitrification can be shorten and the nitrification efficiency can be improved.

Table 3. MPN for nitrobacteria in R2

Diluted concentration	Tubes that bacteria grew inside	Quantitive index
10^{-1}	3	3
10^{-2}	3	3
10^{-3}	3	3
10^{-4}	0	0
10^{-5}	2	2
10^{-6}	2	2
10^{-7}	3	3
10^{-8}	3	3
10^{-9}	0	0
10^{-10}	0	0

4. Conclusion

In this study, Humus Activated sludge process was applied to treat domestic sewage comparing with conventional activated sludge process. As a result, the new process exhibited superior process performance. It has superior efficiency of nitrogen removal and the reaction time was shorten. According to the investigating, the quantity of the nitrification bacteria, the Humus Activated Sludge Process indicates special characteristics. It makes the bacteria reproduce quickly and the quantity was increased more quickly than R1. This regular was the similar as the regular of nitrogen removal.

Acknowledgements

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