Study on the Short-cut Nitrification which in a Sequencing Batch Reactor (SBR) under the Effect of Temperature and pH

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Abstract. In order to research the effect of temperature and pH on the short-cut nitrification, using simulation sewage water as test water, research the material changes in the SBR reactor by change the temperature and pH. The result show that the short-cut nitrification still can proceed when the temperature is at 18°C.And the average removal rate of ammonia nitrogen and the average accumulation rate of nitrite nitrogen are 80% and 66%, respectively. It indicates that low temperature make a big influence on nitrite bacteria .When the pH in the range of 7.7 to 8.5, it will suit for growth of nitrite bacteria and inhibit the activity of the nitrate bacteria while can achieve the maximum accumulation of nitrite nitrogen.

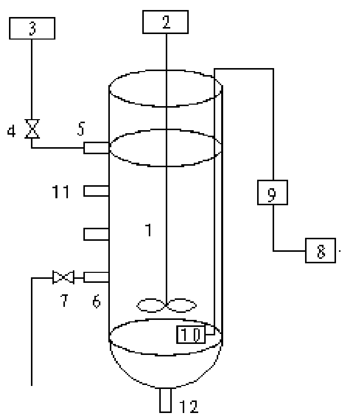
Introduction

In recent years, short-cut nitrification technology is a hot topic at home and abroad. It mainly controls the nitrification at nitrite stage, which resulting a large accumulation of nitrite, then to the gentrification [1]. Short-cut nitrification should prevent further nitrification of nitrite, so inhibit the growth of nitrate bacteria are the key to achieve short-cut nitrification. Temperature and pH are the important environment condition on the growth of microorganism, therefore research the short-cut nitrification should control the temperature and pH value in the reactor [2,3,4].

Test Materials and methods

The test apparatus and operation mode

The SBR reactor is used in this experiment, the schematic is show in Fig.1.The effective volume is for 9.5L.The temperature is kept at (25±1) °C through an electrical heater; Drum wind aeration is used in this test, and the dissolved oxygen concentration is controlled by the Rota meter; there is a mud tube at the bottom of the reactor.



1 SBR reactor; 2 stirrer; 3 water tank;
4 fill electromagnetic valve;
5 water inlet; 6 water outlet;
7 outlet electromagnetic valve;
8 air compressor; 9 gas flow meter;
10 micro porous aerator;
11 sample tap; 12 row mud tap

Fig. 1 The theory scheme of experimental setup

Test water and Analyze project

This test adopt simulation domestic wastewater as the test raw water, the water quality index is contain COD: 150~350mg/L, NH_4^+-N: 100~120mg/L, TP: 9.5~10.5mg/L, pH: 7.8~8.2.

Ammonia nitrogen (NH_4^+-N) and nitrite nitrogen (NO_2^--N) are analyzed by a UV/VS spectrophotometer. The dissolved oxygen concentration and pH are measured by a DO meter and portable pH meter, respectively [5].

Test methods

In the reactor, the DO concentration is controlled from 0.5 to 0.7 mg/L, the influent C/N ratio is 2:1, and the NH_4^+-N concentration is 100 ~ 120 mg/L, the system's pH is kept at 7.8 to 8.2 by the addition of $NaHCO_3$, and during the test the sludge concentration maintain about 3500 mg/L by irregularly row mud. The operation process consists of instantaneous inflowing water, anaerobic stirring, aerobic aeration, anoxia stirring, postposition aeration, precipitation, drainage and in idle. The operation cycle is control at 6h.

Results and discussion

Removal rate of NH_4^+-N and accumulation rate of NO_2^--N in different temperature

In this phase, controlling the temperature at 28°C, 23°C, 18°C, respectively, the system operates 8d at three different temperatures, synchronous detecting the various indicators. The result is shown in Fig. 2.

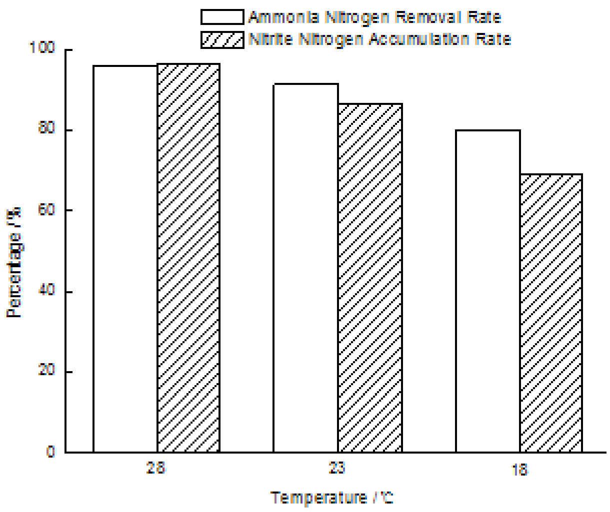


Fig.2 Removal Rate of Ammonia Nitrogen and Accumulation Rate of Nitrite Nitrogen in Different Temperature

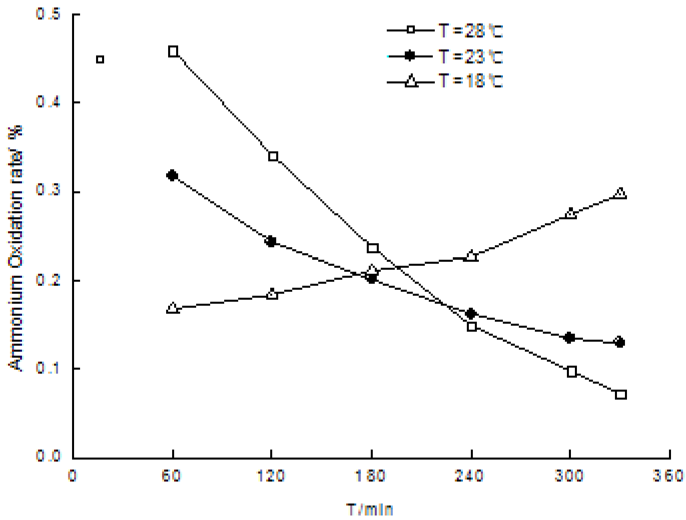


Fig.3 Ammonium Oxidation Rate in Different Temperature

Figure 2 shows that the system's removal rate of NH_4^+-N and accumulation rate of NO_2^--N at different temperature. It shows that when temperature is at 28°C, the average removal rate of NH_4^+-N and the average accumulation rate of NO_2^--N are all 96%; At 23°C, are 91% and 86% °C, respectively; While at 18°C, are 80% and 66% ,respectively. The removal rate of NH4+-N and the rate of NO_2^--N accumulation are reduced obviously with the temperature's decrease. This indicates that the activity of nitrite bacteria is inhibited. While the accumulation rate of NO_2^--N still keeps at above 50%, it can be explained that when the temperature is below 18°C, short-cut nitrification is still keeping operation. In order to not to destroy the short-cut nitrification of the system, this test is not discussed in the minimum temperature.

The Rate of Ammonium oxidation in Different Temperature

The oxidation rate of ammonium at different temperature is shown in figure 3. It can be seen that after 60 minutes, the oxidation rate of ammonium are 0.46 mg/L,0.32 mg/L,0.17 mg/L when the system are at 28°C,23°C,18°C. This indicates that the higher temperature in the system, the initial oxidation rate of ammonium is higher, while when the temperature at 18°C, the oxidation rate of ammonium has a rising trend, it can be seen that the oxidation rate of ammonium is related to the remaining concentration of NH_4^+-N in the reactor.

The Rate of NO_2^--N Accumulation in Different Temperature

Figure 4 shows in a single cycle of the system the changes of the accumulation rate of NO_2^--N at different temperatures. The test shows that when the temperature is below 28°C, the accumulation rate of NO_2^--N declined slightly, but it still can reach up to 95%. With the reaction time going, the lower temperature in the system, the decreasing trend of the accumulation rate of NO_2^--N more clear. At 18°C, the accumulation rate of NO_2^--N is only to 66%when the reaction to the end. It can be explained that low temperature has much more effect on nitrite bacteria than nitrate bacteria. Hence, it can be concluded that at the low temperature, the removal rate of NH_4^+-N can't be increased by extending the aeration time, this will reduce the rate of NO_2^--N accumulation instead.

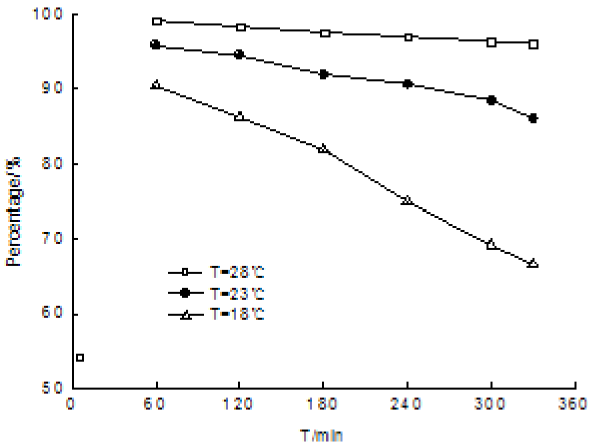


Fig.4 Accumulation Rate of Nitrite Nitrogen in Different Temperature

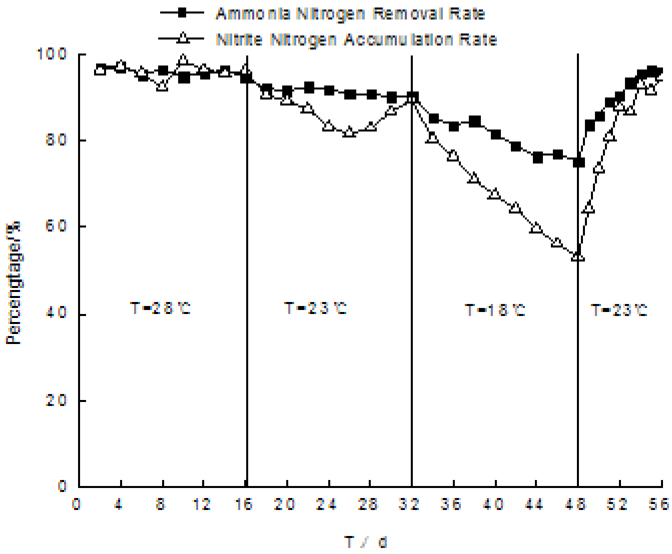


Fig.5 Operational Results in Reducing Temperature

The effect on the stability of continuous operation system by changing the temperature

In this phase, make each reaction cycle time is 480 minutes , including inflow water 5 minutes , aeration 330 minutes , the sedimentation 60 minutes, drainage 10 minutes , idle time 75 minutes. Make the system continuously operates 16 days at 28°C,23°C,18°C,respectively. After return the temperature of the system back to 28°C, continuing to run 8 days. The result is showed in figure 5.

Figure 5 shows that when the temperature drops from 28°C to 23°C, the change of NH_4^+-N removal rate has a little change, while the accumulation rate of NO_2^--N change a lot. When the temperature drops to 18°C, the removal rate of NH_4^+-N drops more obvious, while the accumulation rate of NO_2^--N reduces more rapidly, it shows that low temperature have much more influence on nitrite bacteria than nitrobacteria. When the temperature is returned to 28°C, the system only runs 8 d, the removal rate of NH_4^+-N and the accumulation rate of NO_2^--N rapidly pick up to above 90%, it can be seen that low temperature can keep the short-cut nitrification running in a short time, when the temperature rise again, it can make the system restore a good running effect. The experiment shows the system can adapt to the temperature fluctuations in a short time.

The effect on the rate of NH_4^+-N removal and NO_2^--N accumulation in different PH value

In this phase, the method of one-time adding alkali is adopted. Researching the effect on the removal rate of NH_4^+-N and accumulation rate of NO_2^--N under different inflow PH value by taking three feature points respectively at pH = 6.9, pH = 7.7 and pH = 8.5 .

Figure 6 shows the average removal rate of NH_4^+-N and the average accumulation rate of NO_2^--N when the systems are respectively at pH = 6.9, pH = 7.7 and pH = 8.5. Figure 7 shows the change rule of PH value in corresponding reaction cycle. According to compare figure 6 with figure 7, the pH value is rising at the beginning of the reaction when the pH is at 6.9,after 120minutes the pH value is return to 6.9, this inhibit the activity of nitrifying bacteria and result to the decrease of removal rate of NH_4^+-N. When pH = 6.9, the initial pH value increases , but when the reaction proceeds to 120 minutes , pH value reduces to 6.9 which makes nitrifying bacteria inhibited , so the nitration cannot proceed as normal that the NH_4^+-N removal rate drops . When pH = 7.7, the PH value drops to 6.7 as the reaction proceeds to 120 minutes, after this the nitration cannot proceed and the nitrifying bacteria is inhibited. While when pH = 8.5, it still remains 7.0 at the end of reaction so nitration reaction can proceed normally. When pH = 7.7 and pH = 8.5, the accumulation rate NO_2^--N reaches up to above 95%, this indicates that when the PH value is between 7.7 to 8.5 , it not only suits the growth of nitrite bacteria but also inhibits the activity of nitrobacteria, so increase the accumulation rate of NO_2^--N .

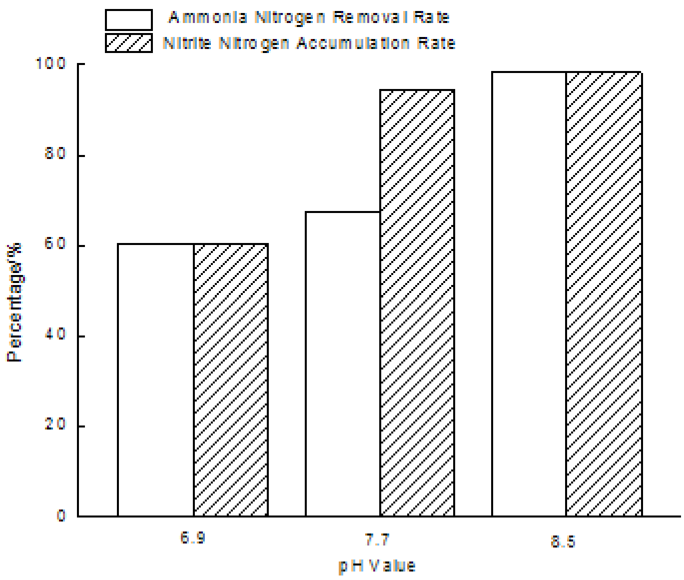


Fig.6 Removal Rate of Ammonia Nitrogen and Accumulation Rate of Nitrite Nitrogen in Different Ph

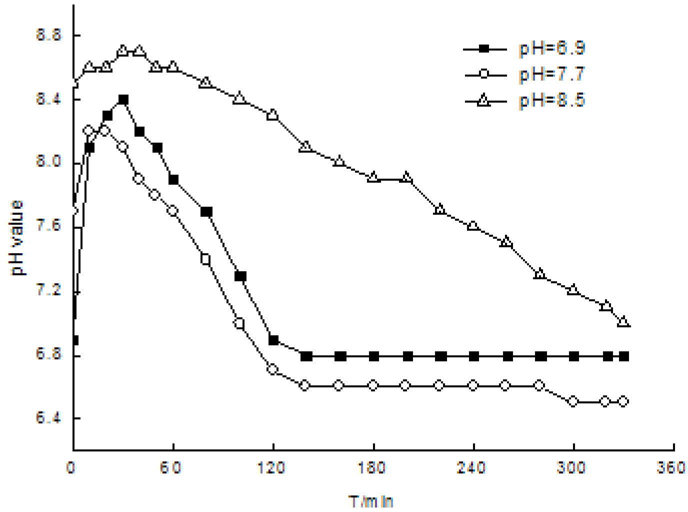


Fig.7 Variation of pH Value in Different inflow Ph Value

Conclusions

1) The system can perform the short-cut nitrification when the temperature control above 18°C in SBR reactor, but the effect of the short-cut nitrification is not good under the low temperature.

2) The higher the temperature, the faster of the initial ammonium oxidation rate, with the reaction proceed, the ammonium oxidation rate is relate to the concentration of remain ammonia in the reactor.

3) When the temperature is low, the activity of nitrifying bacteria is restricted, and it will have a big influence on nitrite bacteria than nitrobacteria.

4) When influent pH value is between 7.7 and 8.5, it will suit for growth of nitrite bacteria and inhibit the activity of the nitrate bacteria which can achieve the short-cut nitrification process.

References

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