Analysis and Research on Influence Factors of Anaerobic Ammonia Oxidizing Bacterial Activity

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Abstract: This paper probes into the anaerobic ammonia oxidation startup phase and the concentration of nitrate nitrogen, PH and temperature on the start stage, and the effects of nitrogen, the results show that:(1) The nitrate nitrogen concentration and enrichment of anaerobic ammonia oxidation bacteria biomass has certain relevance, and nitrate nitrogen concentration increases to a certain concentration, the biomass of anaerobic ammonia oxidation bacteria concentration and the activity of anaerobic ammonia oxidation bacteria has certain inhibition;(2) Anaerobic ammonia oxidation bacteria within the reactor at the optimum pH value, the reaction rate is the largest, and biological activity also relatively stable; Deviation from the optimum pH value, reaction rate and its stability are affected;(3) Under the condition of low temperature restrain the activity of anaerobic ammonia oxidation bacteria, when the temperature rose from 15 ℃ to 35 ℃, anaerobic ammonia oxidation reaction rate showed a trend of first increased and then declined slightly, the temperature is about 30 ℃, the anaerobic ammonia oxidation reaction rate is the fastest.

1 Introduction

With the continuous development of modern biological technology, biological denitrification new theory and new technology emerge in endlessly, such as SHARON (Single reactor for high ammonium removal over nitrite) process, OLAND process (oxygen limited sutrification and DE itrification), SND (Simultaneous nitrication and denitrification), A_2O process, SBR process, etc. [1]. But no matter what form of processing technology, based on the mechanism of biological denitrification and if get good denitrification effect, will be influenced by many factors, namely, water way, operation condition, reaction temperature, DO, sludge age, NO_3^-- N concentration, ratio of feed nutrition [2-11]. This article is based on the An/OSBR technology of anaerobic ammonia oxidation on which the nitrate nitrogen concentration, reaction temperature and pH were discussed.

2 Materials and Methods

2.1 Reactor system

The An/OSBR process is showed in Fig1, its methods of operation in Fig2, Laboratory scale reactor was made of acrylic sheet, high 40cm, diameter 10cm, mud pipe is at the bottom. Porous stones were used for micro-porosity aerator with an air blower aeration, the reactor equipped with stirrer to keep the uniformity of water and sludge, during un-aerated state or little aeration, temperature controller to hold at 25℃, DO, ORP and pH transducer to monitor the changes of DO, ORP and pH. The sludge age was controlled about 10 days by discharging excess sludge for the reactor system, so MLSS was maintained about 2500mg/L.

2.2 Feed and Inoculation sludge

The feed was imitated domestic sewage, in influent beer and peptone were added for COD, NaHCO3 to pH, NH4Cl for ammonia nitrogen,KH2PO4 for phosphate, MgSO4 and CaCl2 for Mg2+ and Ca2+, Adding trace element solution to meet the requirements of microbial growth and reproduction of activated sludge. In the process of the experiment, according to different test requirements, adjust the water content in time., the application is shown in table 1.

Inoculation sludge came from the secondary sedimentation tank of MUCT, which is laboratory scale reactor too. The mixed home sewage was treated in reactor from October 2007. The reactor reached steady state to remove phosphorus after ten weeks operation, it was the time to measure sample.

2.3 Test items and Analytical Methods

Wastewaterr sample for dynamic studies were collected from centrifuge supernatant after Centrifugation Determination, COD of sampl concentration was measured by Molybdenum Antimony Spectrophotometer Method, NH_4^+-N concentration was measured by Determination of Ammonia Nitrogen, NO_3^--N by N-(1-naphthy1)-ethylene diamine spectrophometor, MLSS by Filter Weight Method, SVI was measured according to standard method (SV30/MLSS).

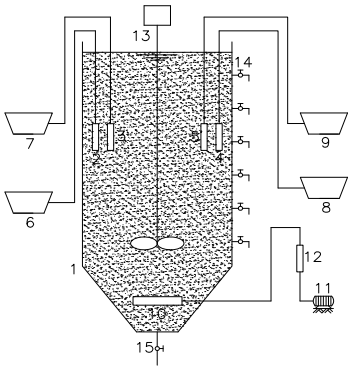

Fig.1.The configuration of An/OSBR process

1—Reactor;2—pH transducer;3—DO transducer;4—ORP transducer;5—temperature transducer;6—pH cryoscope;7—DO cryoscope;8—ORP cryoscope;9—temperature controller;10—Aeration head;11—air compressor;12—flow meter;13—mixing;14—sampling;15—outlet of sludge

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Table 1 Components of simulational wastewater and feature of water quality

Components of simulational wastewater		Minor factor		Quota of water quality	
Medical preparation	**Throws the increment /g·L^{-1}**	**compose**	**concentration/g·L^{-1}**	**item**	**concentration/mg·L^{-1}**
Beer wastewater	1.5~3.5mL/L	$FeCl_3$	0.9	COD	200~500
peptone	0.1	H_3BO_4	0.15	BOD	118~315
NH_4Cl	0.1	$CoCl_2$·7H2O	0.15	TN	23.5±1
KH_2PO_4	0.044	$CuSO_4$·5H2O	0.03	NH_4^+-N	21.1±0.8
$NaHCO_3$	0.16~0.8	KI	0.18	NO_3^--N	< 1
$CaCl_2$	0.01	$MnCl_2$·4H2O	0.06	NO_2^--N	< 1
$MgSO_4$	0.05	Na_2Mp·2H2O	0.06	TP	10.0±0.5
Minor fator liqud	0.6mL/L	$ZnSO_4$·7H2O	0.12	pH	6.9~7.1

2.4 Results and Discussion

From figure 2, anaerobic ammonia oxidation bacteria of nitrite is sensitive, the nitrate nitrogen concentration is lower on the activity of anaerobic ammonia oxidation bacteria effect is not obvious, with the increase of the nitrate concentration, When the concentration of nitrate nitrogen is 1.9 mmol/L, it began to show the inhibition of anaerobic ammonia oxidation reaction ; When the concentration of nitrate nitrogen is 4.9 mmol/L, the activity of anaerobic ammonia oxidation bacteria almost lost. Analysis of the reason may be increased with the increase of the nitrate nitrogen concentration of the denitrification reaction intermediates material is reduced, and then make the cause of the anaerobic ammonia oxidation reduction bacteria activity.then make the cause of the anaerobic ammonia oxidation reduction bacteria activity.

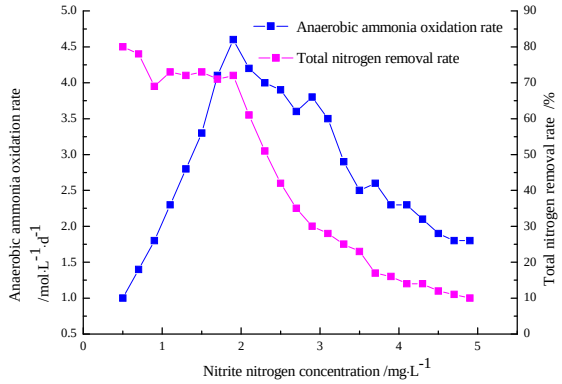

Fig 2 The curve of the relation of the sub-nitrate concentration and the ammonia oxidation rate of F1

From figure 3, when the temperature has risen from 10 ℃ to 45 ℃, anaerobic ammonia oxidation TN removal rate showed a trend of increase before falling. When the temperature has risen from 10 ℃ to 38 ℃, anaerobic ammonia oxidation rate continuously improve, when the temperature was 38 ℃, the maximum conversion rate, when the temperature more than 38 ℃, the anaerobic ammonia oxidation rate falling; When the temperature reaches 38 ℃, loss of anaerobic ammonia oxidation rate.When the temperature reaches 38 ℃, loss of anaerobic ammonia oxidation rate.

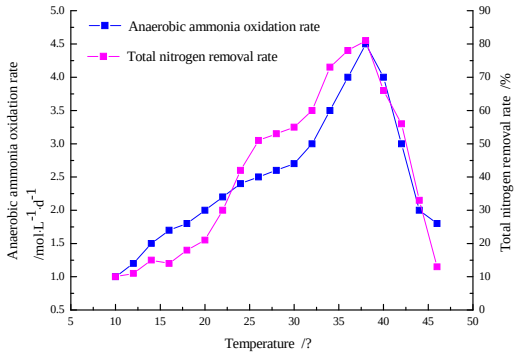

Fig 3 The curve of the relation of the temperature and the ammonia oxidation rate of F1

From figure 4, the activity of anaerobic ammonia oxidation bacteria is very sensitive to the change of pH, when the pH is less than 6, anaerobic ammonia oxidation will not occur, when the pH > 9, anaerobic ammonia oxidation also not going to happen, in pH6 ~ 9 interval, TN removal rate showed a trend of increase before falling. When the pH = 8.0, TN reached maximum conversion rate.

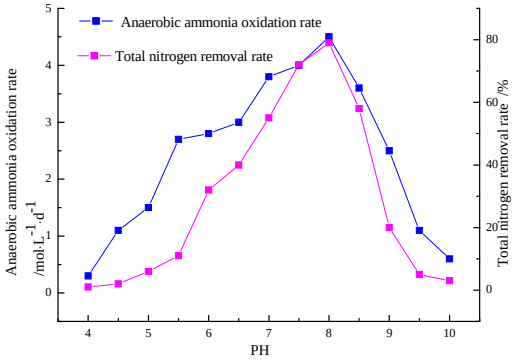

Fig 4 The curve of the relation of the PH and the ammonia oxidation rate of F1

3 Summary

(1) With the increase of the nitrate concentration, anaerobic ammonia oxidation reaction rate must change rule, when the concentration of nitrate nitrogen tendency from 0.5mmol/Lto 1.9 mmol/L, and the increase of nitrate nitrogen concentration is beneficial to accelerate the anaerobic ammonia oxidation reaction rate, in the land of the nitrate nitrogen concentration tendency for 1.9mmol/L reaction rate reached the maximum value. Then, with the increase of the nitrate nitrogen concentration anaerobic ammonia oxidation reaction rate declines, shows a certain inhibitory effect.

(2) The pH of the influence factors of anaerobic ammonia oxidation reaction rate is very important, the pH is too low, the influence of oxygen enrichment of ammonia oxidizing bacteria and grow. PH is too high, also can reduce the activity of anaerobic ammonia oxidation bacteria, in the pH = 6 ~ 9 range change, when pH = 8.0, TN reached maximum conversion rate.

(3) Temperature is one of the important factors that affect anaerobic ammonia oxidation bacteria. Under the condition of low temperature, the activity of anaerobic ammonia oxidation bacteria is reduced, affect the active transport rate of nutrients; Under the condition of high temperature, the structure of anaerobic ammonia oxidation bacteria will the degeneration occurs, even lead to the death of anaerobic ammonia oxidation bacteria. The optimum temperature for 38 ℃, achieve maximum conversion rate.

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