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Experimental study on the removal of nitrogen and phosphorus from low C/N ration domestic sewage

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ABSTRACT

Using the domestic sewage disposed in the wastewater treatment plant in the southern suburbs of Changchun in Jilin province, China as the subjects, adopt SBR reactor respectively to take an experimental study on nitrogen and phosphorus removal at the low C/N condition. These results suggest, under the same hydraulic retention time, the effect is better on nitrogen and phosphorus removal of SBR reactor with the hydraulic retention time for 6h; solid retention time (SRT) and C/N ration have little effect on removal of COD in SBR reactor and COD removal rate is about 80% under all kinds of conditions; recommended the most suitable SRT of SBR reactor for 20d; the larger C/N ratio is, the higher TN removal rate of SBR reactor is, at optimum PH value is between 4~6.

KEYWORDS

SBR reactor;
Removal of nitrogen and phosphorus;
Domestic sewage.

INTRODUCTION

With low C/N ratio sewage increasing, the requirements of nitrogen phosphorus removal are continuously strict. When using traditional nitrification and denitrification processes to deal with low C/N ratio of urban sewage, due to the lack of carbon and nitrogen removal less efficient, how to increase more effectively a low C/N ratio of sewage nitrogen and phosphorus removal more, has become a hot and difficult research that drew the sewage treatment industry's attention[1]. Directing at the current technique of all kinds of biological nitrogen and phosphorus removal which the process is long and the energy consumption is high[2], from the view of energy efficiency and the actual operating results, with the SBR process for low C/N ratio of nitrogen and phosphorus removal of sewage, seek a more suitable for low C/N ratio environment and economic energy of sewage treatment system, and verify the operating parameters for sewage quality of small urban to guide the optimization of nitrogen and phosphorus removal process for providing a reference to the renovation of existing urban sewage treatment plant and development of the new technology.

EXPERIMENTAL

SBR reactor is made from plexiglass, and the upper part is cylindrical with 30cm diameter, 90cm height; and the round table-shaped lower part with a bottom of 10cm diameter, 10cm height which the effective volume is 50L, as illustrated in Figure 1. Reactor stirs by the mechanical stirrer; oxygenated by aeration head; supplied by air compressor; adjusting the air volume with glass rotameter; measuring dissolved oxygen concentration with a portable dissolved oxygen meter; using time relay to realize automatic switching of aeration; mixing and sedimentation.

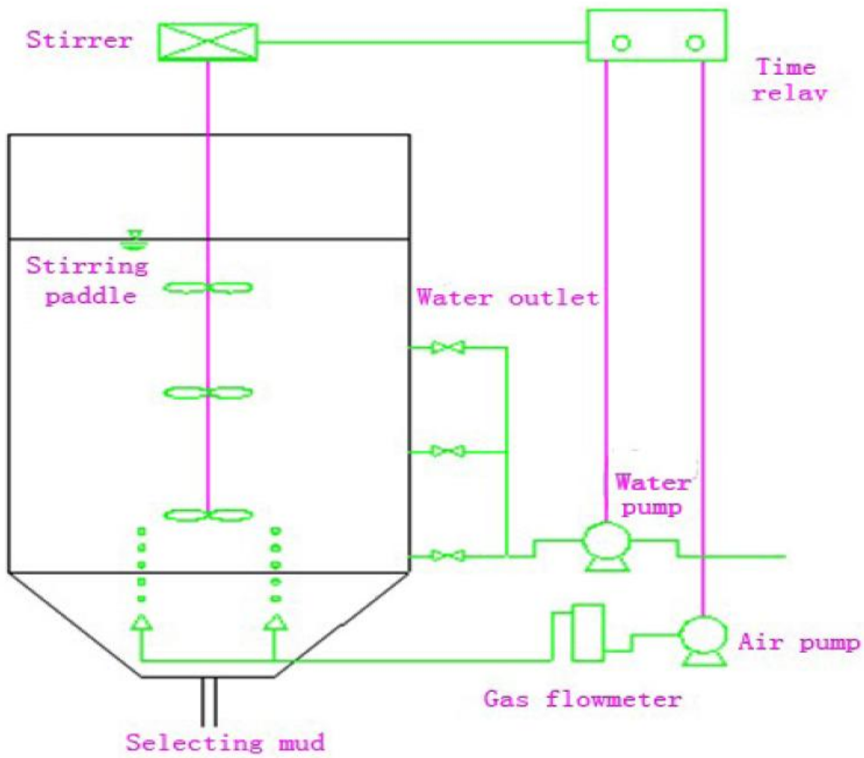

Figure 1 : SBR reactor equipment diagram

This experiment is conducted in a wastewater treatment plant in the southern suburbs of Changchun City in Jilin province, China. The object is a low C/N ratio of urban sewage, and the testing water is the wastewater from the plant after a fine grid of sewage and it first enters into hydrolysis-acidogenosis small test reactor, then into the test reactor. Specific span of water quality index during the test is in TABLE 1.

TABLE 1 : Test water quality (mg/L)

Water quality index	Concentration range	The average concentration
SS	83～154	118
COD	82~223	152
NH_3-N	20~45	30
TP	2.3~7.5	4.8
TN	30~55	40

During the experiment, the main test specifications and test methods refer to “Methods of Monitoring and Analysis of Water and Wastewater” (4th Edition)[3].

RESULTS AND DISCUSSION

Effects of hydraulic retention time

At the water temperature is 20 ± 5 □, by the way of changing the water cycle processing to examine the effect of hydraulic retention time on the treatment efficiency of SBR reactor. Test starts from lasting 4h, and then 6h, 9h, 12h. Each hydraulic retention time running for 10d, it comes to the relationship between COD, NH3-N, TN, TP average removal rate and the hydraulic retention time.

The effect of period running time on nitrification and phosphorus removal in SBR reactor, as illustrated in Figure 2.

From the results of Figure 2, specific analysis is as follows: □ COD removal efficiency: the longer hydraulic retention time is, the higher COD removal rate is. □ NH3-N removal efficiency increases with the hydraulic retention time rising. □ When the hydraulic retention time is 4H, TN removal rate is 66%; when the hydraulic retention time increases from 6h to 12h, TN removal rate increases 5% on average, so the removal rates of this period can be considered to be little affected by residence time. □ The effect of SBR reactor for TP removal is better, and increases with the cycle running time increasing. In SBR reactor, the removal rate at cycle running time is 6h increased by 20% than 4h, while the ratio at 12h only increased by 3% than 9h. In summary, it is recommended that SBR reactors cycles running time is 6h.

Solid retention time (SRT) impact on treatment effect

The cycle running time of SBR system is controlled for 6h, specific operational processes are illustrated in Figure 3.

Investigate SBR reactor treatment efficiency when SRT is 10d, 15d, and 20d. In order to obtain a stable test results, each SRT run two cycles in a row, and it comes to the relationship between COD, NH3-N, TN, TP average removal rate and SRT. Effect of SRT on the treatment efficiency of SBR reactor illustrated in Figure 4.

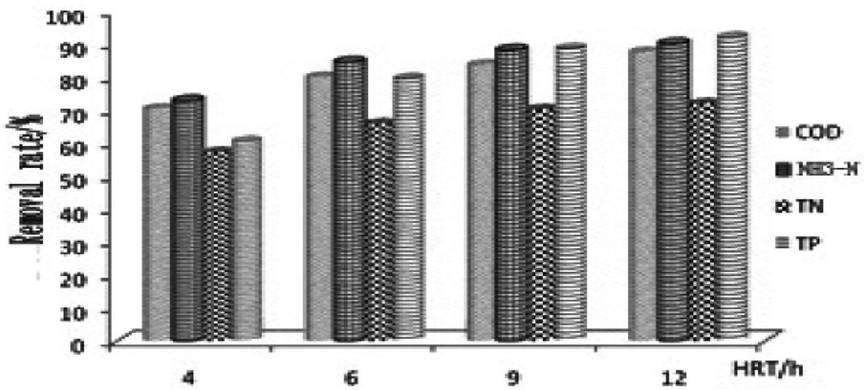

Figure 2 : Effect of cycle operation time of nitrogen and phosphorus removal in SBR reactor

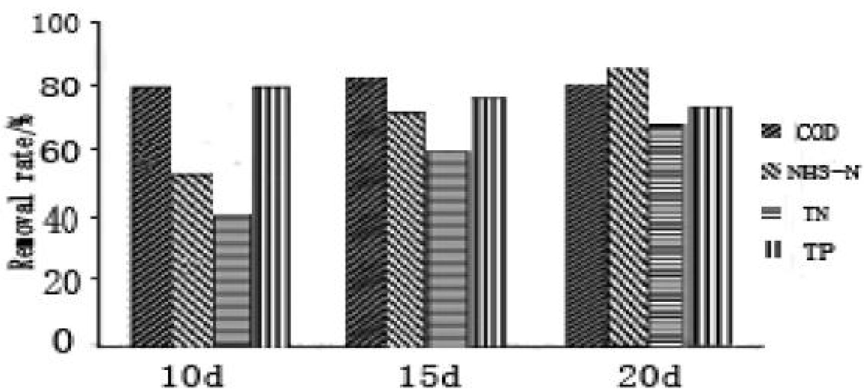

Figure 3 : Influence of sludge age on the treatment effect of SBR reaction

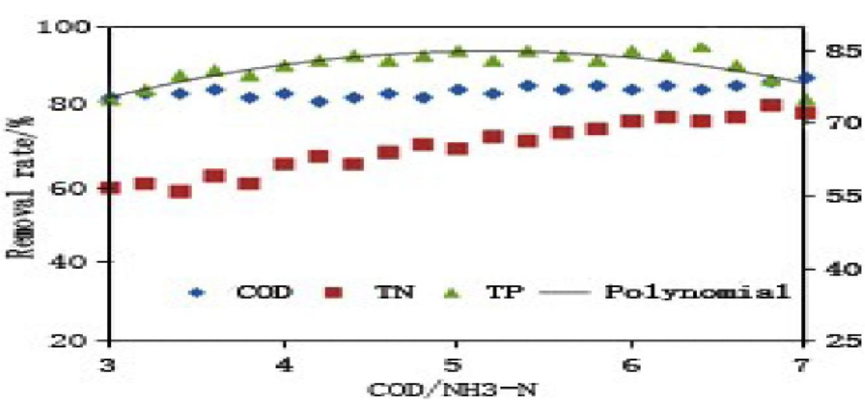

Figure 4 : Effect of C/N ratio on the treatment effect of SBR reaction

From Figure 6 concludes that: □ SBR reactor removal works best, and removal rate is 80%. □ With the increase of SRT, SBR reactor for the removal efficiency of NH3-N shows an increasing trend, when the SRT is 20d, SBR reactor removal works best, and the removal rate is 85%. □ SBR reactor TN removal rate increases with SRT rising. □ The TP removal efficiency shows a decreasing trend. When SRT is 20d, SBR reactor TP concentrations of effluent is 1.4 mg/l. To sum up, SBR optimum SRT is 20d.

Effect of temperature on the treatment efficiency

The cycle running time of SBR system is 6h, SRT of SBR system is 20D,so obtain the relationship between the average removal rate of COD, NH3-N, TN, TP and the temperature.

Effects of temperature on the treatment efficiency by SBR reactor are shown in Figure 4, The temperature in figure is the actual water temperature inside the reactor. From Figure 8, □The higher the temperature is, the higher the COD removal efficiency of SBR reactors is, which SBR reactor effluent is better. When the temperature is below 10 ° c, SBR reactor removal works best, and removal rate is 70%; When the temperature rises to 25□, SBR reactor removal rate is 85%. □SBR reactor for removal efficiency of NH3-N increases with temperature increasing. When the temperature is below 10 □, fillers A/A/O reactor removal rates is 50% and SBR reactor removal rate is 60%; Removal efficiency works best at 25□, and the removal rate is 85%. □ SBR reactor TN removal efficiency shows an progressively increasing trend, when the temperature is below 10 □, and SBR reactor removal rate is 50%; When the temperature rises to 15 □, the removal rate increases to 55%; The removal efficiency is further enhanced, removal rates is more than 70% for temperature continued to go up to 25□. □ As the temperature rises, TP removal efficiency has improved, the temperature has little effect on the removal efficiency of SBR reactors, the removal rates range is 6% during the whole process.

In summary, as the temperature rises, each reactor COD, NH3-N, TN, TP removal rates is increasing. For low temperature wastewater, the overall treatment effect of SBR reactor works best.

Effects of C/N ratio on treatment efficiency

The cycle running time of SBR system is 6h that SRT respectively is 15d and 20d. Explore the relationship of each reactor for COD, TN, TP average removal rate and the C/N ratio which use actual urban sewage as testing water. Effect of C/N ratio on treatment efficiency of SBR reactor, as illustrated in Figure 5.

Comprehensive results of Figure 10, concrete analysis is as follows: □ SBR reactor COD removal rate is 85%. □ With the C/N ratio increases, SBR reactor TN removal rate shows an progressively increasing trend, when the C/N ratio increases to 7, SBR reactor removal rate increases to 80%, TN removal efficiency is better. □ When the C/N ratio increases from 3 to 6, TP removal rates gradually increase; when C/N ratio is between 4~6, TP removal rate reaches the maximum; when the C/N ratio increased from 6 to 7, TP removal rates decrease. In SBR reactors, when the C/N ratio increases from 3 to 6.4, TP removal rate gradually increases, maximum removal rate is86% achieved as C/N ratio is 6.4; When the C/N ratio is larger than 6.4, TN removal rate is on the decline, when the C/N ratio is 7, TP removal rate drops to 75%.

CONCLUSIONS

1. Solid retention time (SRT) and C/N ratio have little effect on COD removal efficiency of SBR reactor and COD removal rate is about 80% under all kinds of conditions; As the hydraulic retention (running cycle) time and temperature increases, COD removal rate shows a progressively increasing trend.
2. The longer Hydraulic retention time is, the higher SBR reactor NH3-N and TN removal efficiency is, but increases marginally. Under the same hydraulic retention time, SBR reactors nitrogen and phosphorus removal efficiency is better, recommended hydraulic retention time for 6h.
3. NH3-N and TN removal rate of SBR reactor increases along with the increase of SRT, however,TP removal rate is the reverse. The optimal SRT of SBR reactor is 20d.
4. The temperature has little effect on phosphorus removal of SBR reactor; it is better suitable for low temperature wastewater treatment in SBR reactor.

5. The larger C/N ratio is, the higher TN removal rate of SBR reactor is and with the C/N ratio increases, the SBR reactor removal rate increases, firstly,TP removal rate increases and then decreases for the optimal range between 4~6.

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