The Research on Operation Parameters Optimization of BAF

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Keywords: Biological Aerated Filter; Filter velocity; advanced wastewater treatment; gas-water ratio

Abstract. The experiment adopted dynamic continuous test, discussing the change of filter velocity, gas-water ratio and water temperature for the stable operation influence of BAF. By comparing the removal efficiency of COD, NH_3-N and turbidity of effluent under different filter velocity, gas-water ratio and water temperature conditions, system determined the best operation parameters for BAF. The result showed that the removal efficiency of system was best when filter velocity was 6m/h, gas-water ratio was between1:1 and 1:2. The effluent quality met urban wastewater reuse related standards. Water temperature had a certain effect on effluent quality, but it was not the main influence factors.

Introduction

Biological Aerated Filter (BAF) is wastewater treatment process according to filter process principle of water supply on the basis of ordinary bio-filter in the 80s to 90s. BAF possess many characteristics, such as high load capacity, large hydraulic load, short hydraulic retention time and high-quality water[1]. As a new type of water treatment technology, it has a wide range of application and promotion in many countries and regions.

BAF degrades organic matter by biofilm which is attached to the surface of filter material.It has the great significance that BAF posses suitable environment in order to largely grow microbes, so BAF can run efficiently in the environment. There are many factors which affect running effect that include hydraulic load , gas-water ratio ,running mode, water temperature, microbial concentration and so on[2,3,4].

The experiment regarded the secondary clarifier effluent from shenyang northern wastewater treatment plant as the research object. Filter velocity, gas-water ratio and water temperature would be discussed as the main influence factors in order to point suitable operation process parameters for BAF. The effluent can be recycled.

Materials and methods

The experiment device. The test taked two up-flow biological aerated filters. BAF was composed of two Φ 120mm and 3.5 meters high organic glass columns that was filled with biological ceramsites. The first filter column used 4-6mm ceramsites, the second filter column used 3-5mm ceramsites. Firstly, the secondary clarifier effluent of wastewater treatment plant was influent of the first filter column, and then effluent of it stored in balance tank. Secondly, the water pump ascended water into second filter column. Compressed air pumps provided aeration.Rotor flow-meter measured water and gas. Filter columns installed of water inlet, supporting plate, supporting layer, filler, water outlet from top to bottom. Perforated pipe installed under supporting plate, meanwhile, pressure port of filter column side at intervals of 200mm connected with pressure measuring plate in order to determine pressure change of each point.

Test water and test items. The test was taked in the north wastewater treatment plant of Shenyang. Two-stage effluent of wastewater treatment plant was as raw water. Water quality was that COD was 30-100 mg/L, NH_3-N was 1-28 mg/L, turbidity was 4-15 NTU, SS was 3-25mg/L, T was 9.8-26.7℃.

Test items adopted method respectively. NH_3-N was sodium reagent photometric method. COD was potassium dichromate method. Turbidity was photoelectric method.T was thermometer method.

Star-up of BAF[5,6,7]. The star-up of BAF adoptsed Compound Inoculation. The compound inoculation was carried out in 2 stages:Firstly, The filter was filled with activated sludge, and oxygen was Continuously supplied by he aircompressor. Secondly, after the secondary clarifier effluent flowed into BAF at low rate for a period of time, inlet velocity was increased until the media of BAF were covered with stable biofilm.

Results and discussion

Filter velocity on the impact of BAF. Influent and aeration content was changed, but gas-water ratio was 1:1at this stage. BAF stably runed for a period of time when filter velocity was 2,4,6,8,10,12 m/h respectively. At this time, influent and effluent quality were tested.By comparing the average influent and effluent quality in the condition of the various filter velocity, research on the change of filter velocity influenced treatment effect.

Effect of filter velocity on COD of effluent. From Fig. 1, we can see that COD of effluent showed ascendant trend along with the increase of influent quantity and filter velocity under the condition of COD of raw water stability. When filter velocity was less than 6m/h, ascendant trend was not obvious. When it was greater than 8m/h, COD of effluent was more than 40mg/L. At the same time ,the removal rate decreased with the increase of filter velocity. This was because organic matter of raw water was degraded by the role of biodegradation and filter interception when filter velocity was less than 6m/h. While it improved further, biodegradation capacity attained saturation. Water and gas capacity added because of increase of it simultaneously. The result was that part of the biofilm flowed out with effluent and the removal rate of COD reduced.

Effect of filter velocity on NH_3-N of effluent. From Fig. 2, we can see that NH_3-N of effluent showed evidently ascendant trend along with the increase of influent quantity and filter velocity when NH_3-N of raw water was little changed. As it was greater than 8m/h, NH_3-N of effluent was more than 2mg/L. Similarly ,the removal rate decreased with the increase of filter velocity.The removal rate would rapidly decline when it was over 8m/h. The removal rate was only 65% when it was 12m/h.The main reason was that NH_3-N of raw water was in the scope of degradation capacity in BAF. While water capacity added, NH_3-N already exceeded degradation ability. The results showed that NH_3-N of effluent increased, the removal efficiency decreased.

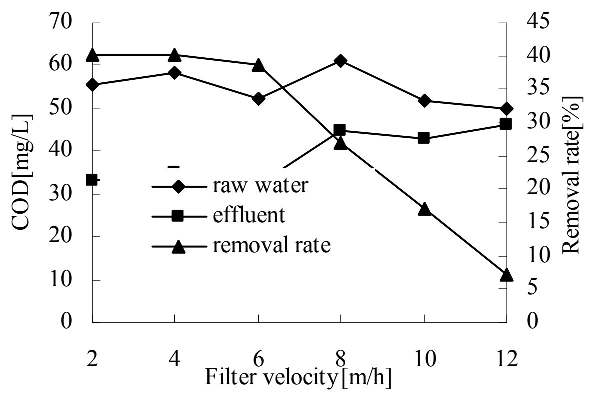

Fig. 1 Variety of COD by different velocity

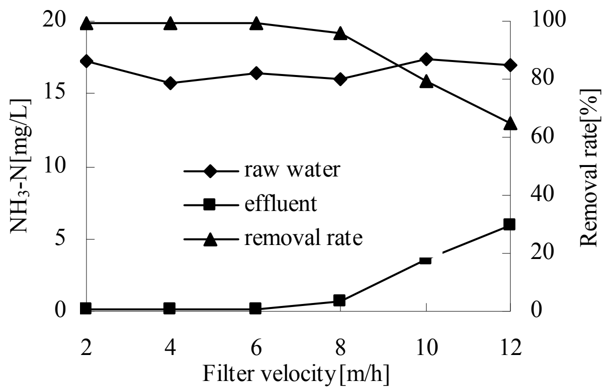

Fig. 2 Variety of NH_3-N by different velocity

Effect of filter velocity on turbidity of effluent. From Fig. 3, we can see that turbidity of effluent showed evidently ascendant trend along with the increase of filter velocity when turbidity of raw water was little changed. The removal efficiency decreased with the increase of filter velocity. when it was 8m/h, turbidity removal efficiency was only 22.7%. Because of increase of filter velocity, effluent would carry more SS, so water turbidity was higher also.

In summary, during the test for the secondary clarifier effluent from plant, when filter velocity was controlled 6m/h, COD, NH_3-N and turbidity met urban wastewater reuse related standards. 6m/h can be used as a reference filter velocity for advanced wastewater treatment.

Gas-water ratio on the impact of BAF. Gas-water ratio referred to the ratio of aeration and influent. It can directly affect the concentration of DO. Usually the more gas-water ratio, the smaller film transfer resistance relatively. In other condition same, DO is more in biofilm. Accordingly aerobic heterotrophic bacteria and autotrophic bacteria activity was higher also. Gas-water ratio was too high which not only can have negative effect for star-up of BAF, but also increases the power consumption and the running cost.

On the basis of preceding test, influent content was defined 70L/h（Filter velocity was 6m/h）. When aeration was 35, 70, 140, 210 and 280L/h respectively, gas-water ratio was 1:2, 1:1, 2:1, 3:1 and 4:1. By comparison of effect of gas-water ratio on treatment effect, the aim was to find the most economical and reliable gas-water ratio.

Effect of gas-water ratio on CODcr of effluent. From Fig. 4, when gas-water ratio was less than 2, COD removal effect was relatively good with the increase of it. Since then COD increased and removal rate decreased with the futher increase of it. This was because the proper increase of it can make DO increase in BAF which was in favor of the degradation of organic matter. While it was too high, SS and part of falling of biofilm which was intercepted reached water outlet with bubbles rising. The result was COD became high.

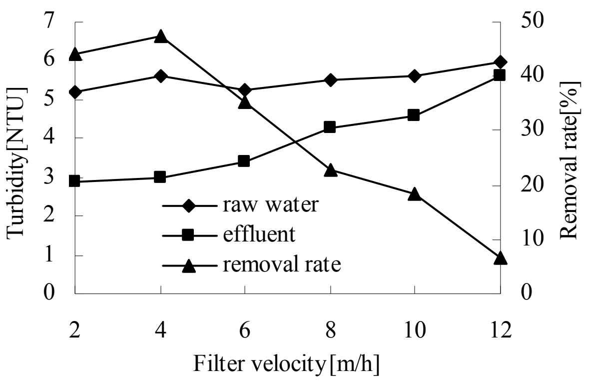

Fig. 3 Variety of turbidity by different velocity

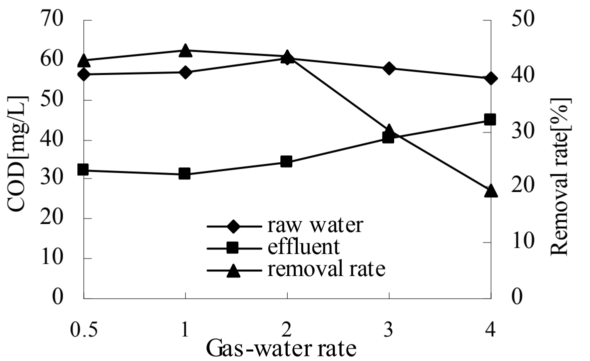

Fig. 4 Variety of COD by different gas-water rate

Effect of gas-water ratio on NH_3-N of effluent. From Fig. 5, NH_3-N of effluent was little changed with gas-water ratio increase. NH_3-N of effluent was basically stable below 1mg/L, at the same time, removal rate was above 95% as NH_3-N of influent was little changed.The main factors of NH_3-N removal was DO in the wake of biofilm stability. When gas-water ratio was 0.5, DO already met nitrification need for NH_3-N of secondary clarifier effluent. Further increase of aeration won't produce too big effect on removal of NH_3-N.

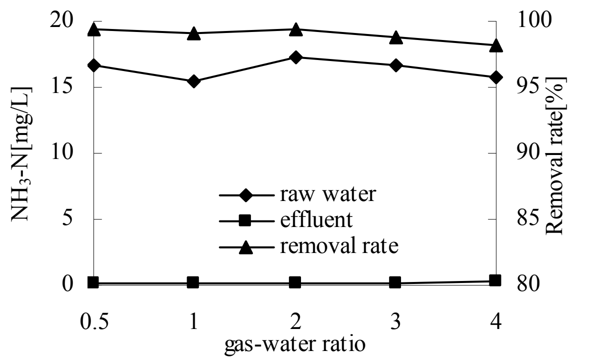

Fig. 5 Variety of NH_3-N by different gas-water rate

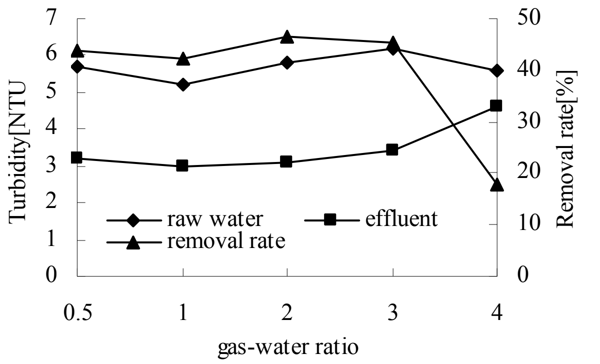

Fig. 6 Variety of turbidity by different gas-water rate

Effect of gas-water ratio on turbidity of effluent. From Fig. 6, when gas-water ratio was less than 3, turbidity of effluent was basically in the same level. But when it continued to increase, the effluent turbidity would increase sharply. The reason was the same with effect of gas-water ratio on COD of effluent.

In summary, in the condition of sufficient DO, gas-water ratio should not be too high. Exorbitant gas-water ratio was not only a large amount of energy waste, but also had influence on effluent quality. Considering conditons, it was appropriate between 1:1 and 1:2 for advanced wastewater treatment.It can be adjusted according to the water quality appropriately.

Water temperature on the impact of BAF. Temperature was an important factor which can effect on biofilm activity. During a year experiment, Water temperature changed largly. The maximum temperature reached 26.7℃, the minimum temperature reached 9.8℃.Under influent quality similar conditions during the test, the research was carried out by elected different periods of temperature data.

By comparing of the highest temperature and low temperature, COD removal rate of effluent improved 19.23% with temperature increasing from 32.16% to 51.39%.Meanwhile, NH_3-N of effluent maintained low level which was less than 1mg/L. The removal rate maintained more than 95%. Turbidity of effluent maintained relative stability in BAF. The removal rate was steady and going up.

The results showed that temperature raised microbial activity and organic matter degradation was enhanced. Moreover, BAF always held a good nitrification, so the removal rate kept high level.In summary, water temperature had certain effect on BAF process.But it was not the main factor.

Conclusions

1) When filter velocity was controlled 6m/h, CODcr ,NH_3-N and turbidity met urban wastewater reuse related standards. 6m/h can be used as a reference filter velocity for advanced wastewater treatment.

2) In the condition of sufficient DO, gas-water ratio should not be too high. Exorbitant gas-water ratio was not only a large amount of energy waste, but also had influence on effluent quality. It was appropriate between 1:1 and 1:2 for advanced wastewater treatment.

3) During the experiment temperature was not the main factor.Even through low temperature and turbidity in the winter, the effluent had remained relatively stable that basically satisfied urban wastewater reuse related standards.

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