Study on Treatment of Domestic Wastewater by Biological Aerated Filter

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Abstract. Biological aerated filter (BAF) is a simple and efficient low-consumption urban wastewater treatment technology in line with China's national conditions, with the characteristics of land area, high treatment efficiency and convenient operation and management. In this paper, the experimental research and theoretical analysis of BAF treatment of domestic sewage are carried out. The results show that the time required to start the hanging film of BAF is short, and the removal rate of COD and NH$_4$-N is stable at about 75% and 60% respectively after about 24 days. When the aeration 0.25m$^3$/h was maintained, the average removal rate of COD reached 88.73%, the average removal rate of NH$_4$-N reached 65.49%, and the average removal rate of TP was 89.98%.

1. Introduction
China is a country with a lack of water resources, in recent years, China's domestic wastewater emissions increased year by year, a large number of sewage untreated emissions, and the result is pollution of the water environment, exacerbated the shortage of water resources. Capital and technology have become the two main factors restricting sewage treatment in China. The treatment and reuse of domestic wastewater has become a research topic for many scholars[1-6].

As a new sewage treatment technology, biological aerated filter has been applied in foreign countries. Operating experience shows that the process can significantly save infrastructure investment and reduce floor space, better effluent quality, low operating costs, convenient management; especially its modular structure is conducive to future expansion[7-11].

2. Materials and methods
2.1. Experimental materials
In this experiment, the KL-SWLC-1 type Biofilter produced by Colin in Wuhan was used, which combined the biochemical reaction with the adsorption filtration process to complete the same structure. The main test equipment has biological reaction filtration area, raw water tank, air pump, water pump, drainage equipment and so on. The total height of the filter is 1.5 meters, the bottom of the filter pool body is 0.4 meters in diameter square, 1.06 meters high, the effective volume is 0.17m$^3$. The lower part is fitted with a cuboid water tank with a length of 0.6 meters, a width of 0.42 meters and a height of 0.2 meters, and an effective volume 0.05m$^3$. The required air enters the lower end of the biological filter layer directly through the middle part of the Central cross aeration pipe of the filter.
2.2. Experimental materials
Water Sample: The nearest intake of domestic sewage, temperature 18.8~28.2°C, pH value 6.3~7.8.
Filter Material: Lightweight biological PVC filter material, as shown in Figure 2. The filter material is a bottom diameter of 1cm, high 0.9cm cylindrical hollow polyethylene filter material, and filter layer height of 0.4m.

2.3. Determination of water quality index
The relevant methods for the determination of water quality indicators were shown in Table 1

| Subject | Analytical method                                      |
|---------|--------------------------------------------------------|
| CODc    | Potassium Dichromate Method                           |
| NH4-N   | Spectrophotometric method of Nash reagent              |
| TP      | Molybdenum antimony anti-spectrophotometry             |

3. Results and discussions

3.1. Biological aerated filter Start
In this experiment, the hanging film of the biological aerated filter was activated by the method of inoculation and hanging film. First, the polyethylene filter material was soaked with the activated sludge inoculated for 5 days, during which the daily press C:N:P=100:5:1 to add nutrients. Then the soaked filter material was added to the reactor for stuffy exposure, and the aeration was kept 0.25m³/h. After 24 days, the removal rate of COD from the monitored effluent had reached more than 70%, the removal rate of NH4-N is basically stable at about 60%, so it is believed that the process of hanging film has been completed, the biological aerated filter reactor successfully started, into the normal operation stage. The filter material after the hanging film is shown in Figure 1 and 2.

![Figure 1. The packing linked to the membrane](image1)

![Figure 2. The photos of fillers in the electronic microscope vision of 400 and 1000 times](image2)

3.2. Removal of COD by BAF
When the aeration was 0.25m³/h, the removal effect of BAF on COD was determined, and the results were shown in Figure 3.
As can be seen from Figure 3, the change trend of COD in three inflow was basically consistent, which was gradually reduced from high to low. After running to 56h, the COD concentration remained stable. The average concentration of three primary water was 17.1.86mg/L, the average concentration of effluent was 19.37mg/L, and the average removal rate reached 88.73%.

3.3. Removal of NH₄-N of BAF
When the aeration was 0.25m³/h, the removal effect of BAF on NH₄-N was determined, and the results are shown in Figure 4.

As can be seen from Figure 4, the change trend of NH₄-N in three water inlet is basically consistent, which is gradually reduced from high to low, the average of three water inlet NH₄-N was 30.44mg/L, the average concentration of effluent was 10.51mg/L, and the average removal rate reaches 65.49%.

3.4. Removal of TP of BAF
When the aeration was 0.25m³/h, the removal effect of BAF on TP was determined, and the results are shown in Figure 5.
Figure 5. Aeration intensity of 0.125 m$^3$/h the TP concentration curve

As can be seen from Figure 5, the change trend of NH$_4$-N in three water inlet is basically consistent, which is gradually reduced from high to low, and the concentration of TP in water intake was 1.24mg/L, 1.52mg/L and 1.0659mg/L respectively. The average value was 1.2753mg/L. The TP concentration of effluent was 0.1247mg/L, 0.1534mg/L and 0.1055mg/L respectively. The removal rate of TP in biological aerated filter was 89.94%, 89.91% and 90.1%, respectively, and the average removal rate was 89.98%.

4. Conclusion

Biological aerated filter using "Inoculation activated sludge continuous flow culture" of the hanging film start-up mode is feasible, and the time required is short, about 24 days or so can be successfully hung film, COD, NH$_4$-N removal rate was stable at about 75%, 60%, respectively.

The biological aerated filter has a good removal effect on COD, NH$_4$-N and TP of domestic sewage. When the aeration was 0.25m$^3$/h, the average removal rate of COD reached 88.73%, the average removal rate of NH$_4$-N reached 65.49%, and the average removal rate of TP was 89.98%.

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