Pilot experimental study on secondary effluent of printing and dyeing wastewater by lignite-coke biological aerated filter

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Biochemical tail water of Printing and Dyeing industry is a typical low load and refractory wastewater. Its COD concentration is between 150-200 mg/L. In this pilot study, the effect of lignite-coke and ceramic filter in BAF treatment of dyeing and biochemical tail water was investigated. By comparison with the laboratory scale test and parameter optimization, lignite-coke filter take obvious advantages on the terms of bleaching and biological bio-film. After several months of continuous lignite-coke BAF pilot operation, the results showed that: when the gas-water volume ratio is 10:1, the hydraulic loading is 0.2m3/m2h,the removal rate of COD beyond 50%, the COD of effluent is below 50 mg/L, the effluent is colorless and it meets requirements of design emissions, it also has a good prospect of engineering application.

Keywords: Lignite-Coke; BAF; Printing and Dyeing Industry; Tail Water.

1. Introduction

The production capacity of a south county's textile industry is more than 30% of the total output. Printing and dyeing industry is a high energy consumption and high pollution industry. With the high concentration of environmental problems, the raising utilization ratio of water resources and decreasing of wastewater discharge is necessary, so the reuse of tail water by advanced treatment is urgently.

The biological aerated(BAF) filter is the most widely used in advanced treatment process, filter is the base and key impact factor in BAF operation. Activated carbon, ceramsite and volcanic rocks is the commonly used filter. Activated carbon is expensive compare to ceramsite and volcanic rocks while the adsorption and microbial carrier capacity of ceramsite and volcanic rocks is weak. Lignite-coke is a new type of biological filter material in recent years. It has obvious advantages over the terms of adsorption macromolecular organic matter and decoloring. This study focuses on lignite-coke aeration biological filter, inspected on different physical and biological properties of filter,

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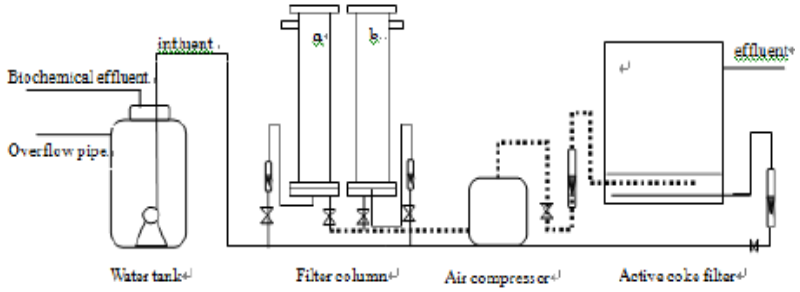
monitored the efficiency of filter processing, carried out small-scale tests on the basis of the pilot test, optimized and adjusted the process parameters, provided supports in dealing with the tail water of dyeing and biochemical engineering applications using lignite-coke BAF.

2. Material and Methods

2.1. *Experimental flow chart*



Note: a. ceramsite filter column, b. lignite-coke filter column.

Fig. 1. Experimental process.

2.2. *Laboratory instruments and equipment*

(1) Raw water tank, volume: 3.0 m^3

(2) Organic glass filter reactor, filter height:1.5 m

(3) Pilot scale equipment, volume: 7.17m^3, filter height:1 m

2.3. *Test methods*

Experiments were carried out in two different ways: Lab-scale experiment and Large-scale experiment.

2.3.1. *Lab-scale experiment*

Using two different kinds of lignite coke and ceramsite in filter, particle size is 3~8 mm, carried on parallel comparison test. Biological filter column design flow is 1.0 L/h, empty bed residence time is 8 h, filter height is 1.5 m.

2.3.2. *Large-scale test*

Start running stage from 150 to 200 L/h of the flow of continuous water of biological aeration filter, control the intake air quantity of 2.0-2.2 m^3/h of BAF. After the domestication for a period of time in the cultivation, according to the

actual operation situation to adjust the water flow rate and air gradually to meet the design requirements, empty bed residence time is 5 h, filter height is 1 m.

The test has been running for about 7 month totally from March 16, 2012 to October 13, 2012.

3. Results and Discussion

3.1. *The analysis of performance of lignite-coke filter*

3.1.1. *The decolorization effect of lignite-coke*

Compared with the effect of the treated water after two different filter, ceramic and lignite coke filter both has a better removal effect to the color of the raw water. And the lignite-coke filter column has a more obvious decolorization, the treated water is colorless substantially. The main reason is the lignite coke contains a large number of pore structure, which have a better adsorption large to the molecular weight of dyeing wastewater color groups, so it can achieve a better effect of discoloration.

Fig. 2. Comparison of the effect of different filter media.

3.1.2. *The performance of biofilm*

For the filter, its compactness, interception and expansion of these indicators are important factors related to filter performance and biofilm aeration culture. The effect of bio-filter filter and biofilm in the biological phase is not only closely related to culture conditions of domestication, but also related to the structure and the characteristics of filter material. Inoculated lignite sludge to two filter column observed at the bottom after 30 minutes aeration approximately, to observe the compactness; Pumped into approximately 200mL to the two columns from the bottom of the filter using a peristaltic pump, observed the situation of sludge trapped after 3 hours aeration; Consecutive two days by aeration, filtration column expansion was observed. Figure 2 respectively show

the compared result of ceramic filter and the lignite coke filter in compactness, interception and expansion and other aspects.

(a) compactness (b) withholding (c) expansibility

Fig. 3. Filter material surface biofilms.

Diagram (a) shows that there is an obvious sludge sink in the ceramsite filter column supporting layer, which through the retainer layer and reached with water, but lignite coke packing lignite sludge was concentrated in the filter column packing, retainer, only a small amount of powdered lignite-coke was found the sludge, which can account for the lignite coke packing density is better than that of ceramsite filler. (b) shows that the sludge has obvious heterogeneity between ceramsite distribution, more suspended sludge is found in supernatant fluid after a period of aeration, water, and withholding is poorer to sludge, but lignite coke filter column has no significant between activated coke particles in the sludge.(C) suggests that ceramsite filter column packing height did not change obviously through continuous aeration, and lignite coke filter column filler loading height decrease from 1.2 m to 1.1 m , how much bubble is analyzed from a filter pillars, the bubble in the lignite coke filter is significantly less than the ceramsite filter column on pillars. After a period of train, it can be seen that there are a lot of microbes with biological activity in the biofilm, by further observation of lignite coke filter material with a microscope, as shown in Figure 4,the microorganisms in the biological filter column is in good condition, and has a high activity, it also can be better to degradation and removal of pollutants, which means on the degradation of pollutants in sewage removal.

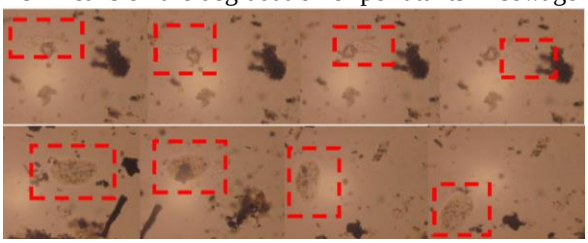


Fig. 4. The route of large organisms.

3.2. *Operation effect*

3.2.1. *Lab-scale experiment*

After seven months of dynamic running with Biological lignite coke biological filter and ceramsite filter, the results shown that COD of effluent with lignite coke filter column is relative to the minimum, which is obvious lower than that of ceramsite filter column. It can be seen from the actual running water and chromaticity index testing, the water of lignite coke aeration biological filter is low chroma, closely to colorless, and also has a better treatment effect. The main reason is that the pore structure of lignite coke hole have a larger proportion, especially for the adsorption of larger molecular weight material, making water chromaticity significantly reduced.

The Figure 5 shows that processing water effect of lignite coke of biological filter column is better than the ceramsite filter column, when water within a certain range of water quality fluctuation, COD of effluent with lignite coke filter column has remained steady at around 50 mg/L.

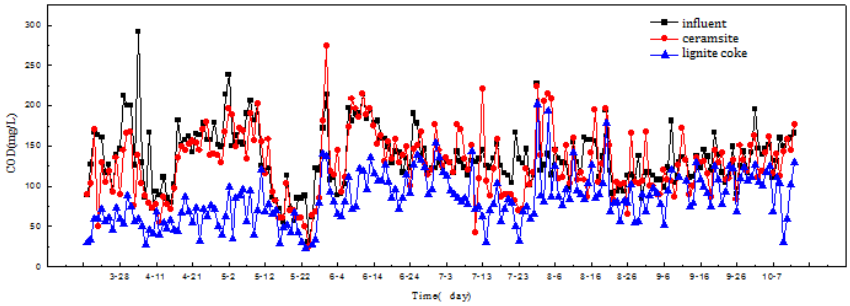


Fig. 5. Changes of COD in filtered water column

According to the in and out of the poor level of COD value calculation, the adsorption of lignite coke accumulated up to 20 mg(COD)/g(lignite coke),which is obviously better than that of the ceramsite filter material.

3.2.2. *Pilot-scale experiment*

Start running stage to 150-200L/h flow of biological aerated filter for water, control of biological aerated filter inlet air flow rate is 2.0-2.2 m^3/h, in the filter were acclimated for a period of time, according to the actual operation adjustment inlet flow rate and aeration amount gradually meet the design requirements. As seen from Figure 6, the influent COD in 38.41 mg/L to 294 mg/L range fluctuations, the average value for the 138.9 mg/L; COD of the effluent in the 14 mg/L to 158.6 mg/L range fluctuations, the average value for 81.9 mg/L. According to the import and the COD value of the water margin

calculation, the lignite coke cumulative adsorption amount reach the level about 22 mg (COD) /g(lignite coke).

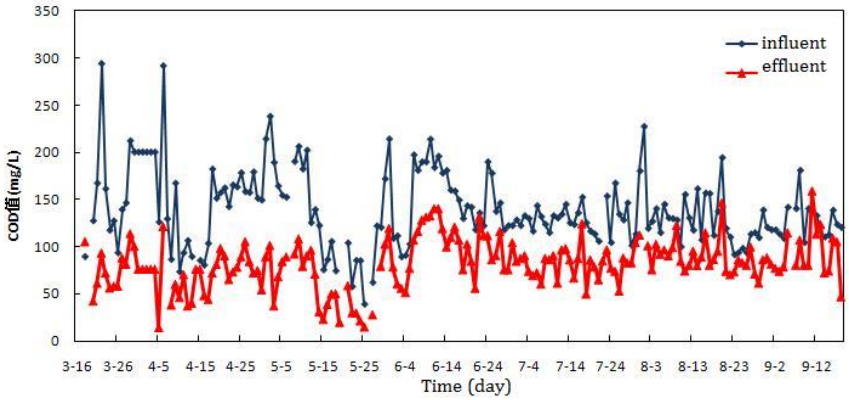


Fig. 6. The changes of COD in the biological filter.

The influent COD is about 100mg/L, and the effluent average value of COD is 34 mg/L, the removal rate was 40%.

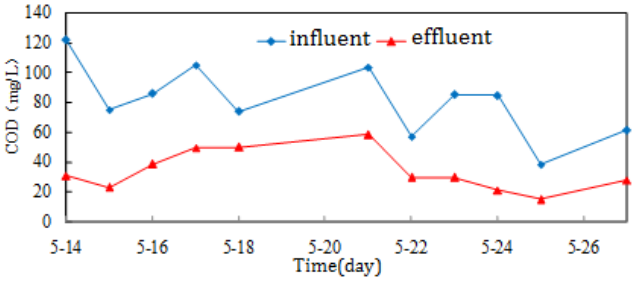


Fig. 7. The changes of COD content in the biological filter

3.2.3. *Operation control*

In terms of filter backwashing, of bio-active coke filter backwashing intensity and backwashing cycle do certain exploration, through the analysis of the actual situation, the backwashing parameters are that first with large volume (6-7 m^3/h) washed for 5 min, then the gas water backwashing water 3 m^3/h) washed for 10 min and finally washed with water for 5 min (tap water 3 m^3/h), pre backwash cycle for 7-10 days, after stabilization phase, can maintain 20-30 days backwashing a frequency.

4. Conclusions

BAF using filter of clay and lignite coke has a certain treatment effect in treating printing and dyeing wastewater secondary effluent, biological filter column

filled with lignite coke, there are significant advantages in the performance parameters, such as quality of effluent water, sludge growth and backwashing, lignite coke processing effect is better and more stable than that of ceramic filter, and will be able to meet the design requirements of the effluent.

Lignite coke bio-filter by physical adsorption and biodegradation enhanced purification ability of activated sludge flocs, the effluent COD and chromaticity were effectively removed. When the volume ratio of air to water at 10:1, hydraulic loading is $0.2m^3/m^2 \cdot h$, COD removal rate can reach more than 50%, the treatment of effluent COD stabilized at 50mg/L or less.

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