



# Mechanism Study Of The Biological Membrane Surface Of Fly Ash-Aerated Concrete Packing Using Baf's Operational Impact

1Komal Meghraj Jagtap , 2Jayshree Madhukar Khatal Civil Engineering Department ,  
SPCOE&T Someshwar Nagar Pune University,India.412306

**Abstract:** the analysis of fly-ash aerated concrete particles added to BAF is the main topic of this work. The superiority of organic removing bacteria in biological film on the packing materials surface during the early stage of start-up is demonstrated by the comparative examination of the removal rates of COD and NH<sub>3</sub>-N during the start-up period. The comparative analysis of the removal rate of COD and NH<sub>3</sub>-N under the conditions of BAF operation in different gas-water ratios, hydraulic loading rates, and organic loads concludes that nitrobacterium becomes the primary ingredient of biological film after gradually maturing and surpassing organic removing bacteria during the BAF operation period. It also concludes that the nitrobacterium biological film is easily attached to the surface of fly-ash aerated concrete particles.

**Keywords-** nitrobacterium, organic eliminating bacteria, fly ash, aerated concrete particles, and biological film.

## I. INTRODUCTION

Drawing on feed water filter experience, BAF is a new sewage treatment method that was developed in the late 1980s and early 1990s. It is based on the common bacteria filter. The main component of the procedure is the packing materials, whose characteristics and cost directly affect its effectiveness and popularity. These days, the packing materials used in feed water filters are divided into two categories: inorganic and organic. Ceramicist, coke, quartz sand, activated carbon, zeolite, and so forth are components of inorganic packing materials. [1–3] Organic packaging materials include polypropylene, PVC, and polystyrene, among others. Due to their tiny density and tolerance to acids and alkali, organic packing materials are extensively explored; yet, their expensive cost raises governance expenses [4]. However, because of their high granule density, inorganic packing materials increase process energy consumption as compared to light packing materials. Activated carbon is 1.9 ÷ 2.1 g/cm<sup>3</sup>, quartz sand is 2.5 ÷ 5.8 g/cm<sup>3</sup>, and zeolite is 2:4 g/cm<sup>3</sup>, despite its considerable specific surface area density and resilience to acids and alkali. Fly-ash aerated concrete particles have a relatively low density and can float in water with little gas volume because of the sealing holes inside of them. They are produced by crushing bricks from aerated concrete fly ash manufacturers. As a result, they are inexpensive and easy to procure. In order to establish an experimental foundation for the use of fly-ash aerated concrete particles as biological concrete filter packing materials to treat sewage and achieve the reutilization of the fly-ash aerated concrete waste products, this experiment aims to investigate the viability and impact of using fly-ash aerated concrete particles as biological concrete filter packing materials. Numerous people have created hybrid biodegradation/adoption systems using zeolite and activated carbon. [5–9].

This paper examines the composition of the attached biological film on the surface of fly-ash aerated concrete particles packing materials and the relevant feature of fly-ash aerated concrete particles packing materials in BAF by analyzing the removal rules of pollutants during the start-up process of fly-ash aerated concrete particles and observing the effects of gas water ratio, hydraulic loading, and organic loading on the removal of COD NH<sub>3</sub>-N.

## I. MATERIALS AND METHOD

### A. Experimental Materials

The Yan Er Wan sewage treatment plant in Lanzhou, Gansu Province, provides the sewage used in the experiment. One fly ash aerated concrete's leftover crushing bricks are used to make the packing materials.

Lanzhou plant. Tables I and II display the sewage and packaging material properties

TABLE I. THE INDEX OF SLUDGE AND PERCOLATE

type	COD(mg/L)	NH <sub>3</sub> -N(mg/L)	SS(mg/L)
percolate	8000~10000	300~1000	200~300
sludge	160~230	40~78	30~40

TABLE II. THE PHYSICAL PROPERTY FLY ASH AERATED CONCRETE FILTER

features	specific surface area (m <sup>2</sup> /g)	actual density (g/cm <sup>3</sup> )	bulk density (g/cm <sup>3</sup> )	porosity (%)	particle size range (mm)
value of number	9.4	1.5	0.5	40	4~10

### B. Method of Analysis

The primary analysis test tasks include COD, NH<sub>3</sub>-N, SS, temperature, and so on. Analysis test methods include gravimetric method in SS, glassy-bulb thermometer in temperature, Nessler's Reagent spectrophotometry in NH<sub>3</sub>-N, and potassium dichromate oxidation in COD.

#### A. Experimental set-up:

The water temperature is between 15 and 26 °C, and the startup uses the "rapid row mud hang membrane law." Utilize sewage treatment plant activated sludge for material sowing. First, aerating the primary clarifier effluent in BAF for 48 hours.

After then, the entire sewage is released. Repeat again in the same manner as before, and we'll see that it's yellowish over the filter's surface. Last but not least, continue injecting the miscible liquids of percolate tap water and sewage (hydraulic loading 3.84 m<sup>3</sup>/m<sup>2</sup>•d, gas-water ratio 2:1), gradually increasing the percolate ratio (table III), and after three weeks, when the removal rate of COD and NH<sub>3</sub>-N remains at 50%, 45%, and higher, indicate the completion.

TABLE III. THE PHYSICAL PROPERTY FLY ASH AERATED CONCRETE FILTER

sewage: percolate: tap water	29: 1: 0	28: 2: 12	27: 3: 15
COD(mg/L)	374~426	488~644	700~756
NH <sub>3</sub> -N(mg/L)	48~108	41~100	44~114

Hang the film, maintain the hydraulic loading at 15.36 m<sup>3</sup>/m<sup>2</sup>•d (follow others' lead), and integrate the hands-on experience. [10,11] conduct a 23-day experiment using the gas-water ratios of 1:4:1:2:1:1:2:1:4:1:8:1 and 16:1.

As others have suggested, hang the film, keep the hydraulic loading at 15.36 m<sup>3</sup>/m<sup>2</sup>•d, and include the practical experience. [10,11] Use the gas-water ratios of 1:4:1:2:1:1:2:1:4:1:8:1 and 16:1 in a 23-day experiment.

## RESULT ANALYSIS

### A. Fly-ash Aerated concrete particles start-up

The COD and NH<sub>3</sub>-N removal rates are comparatively low during the startup phase. The removal rate varies significantly over the first ten days of operation. The rate of COD and NH<sub>3</sub>-N elimination remains constant after ten days. It suggests that adsorption is mostly responsible for the elimination of

packing materials from pollutants within the first ten days. The consistency change of feed water pollutants has a significant impact on adsorption; nevertheless, microorganisms have a buffering effect on the consistency of feed water pollutants. Packing material adsorption to NH<sub>3</sub>-N has not yet reached saturation, as evidenced by the steadily increasing tendency of NH<sub>3</sub>-N removal (although several points fluctuate due to the current change in feed water condition). The removal rate of COD and NH<sub>3</sub>-N exhibits a reversed trend at the early part and the same trend at the latter part of the fluctuation point of the pollutants' removal rate, indicating that the biological film including organic removing bacteria and nitrobacterium is progressively generated in the latter part. The superiority of organic removing bacteria in biological film is demonstrated by the removal rate of COD being steadier than that of NH<sub>3</sub>-N in the latter operating time.

#### *The impacts of gas-water to biological film*

Hydraulic loading is estimated to be 15.36 m<sup>3</sup>/m<sup>2</sup>•d based on the actual condition and the experience of the predecessors. Figure 2 displays the experimental results of the COD and NH<sub>3</sub>-N removal rate under various gas-water ratios. The gas-water ratio varies between 1:2 and 8:1, based on the trend of the COD removal rate. The amount of fluctuation rises to 76.3% when the gas-water ratio is as low as 1/2. The elimination rate of COD varies little when the gas-water ratio is high, up to 1/2. It is determined that the needs of dissolved oxygen heterotrophic bacteria may be met at a gas-water ratio of 1/2 and that the removal rate of COD is significantly impacted by either a higher or lower gas-water ratio.

The ratio of dissolved oxygen concentration to microbial activity changes directly and noticeably when the amount of dissolved oxygen in water is insufficient to support bioactivity. However, when the dissolved oxygen concentration varies within a range that satisfies the requirements of microorganisms, the rate of biodegradation does not change much. Because they are undernourished, microorganisms will eat themselves when there is a high concentration of dissolved oxygen. [12]

The rate of NH<sub>3</sub>-N elimination increases, then decreases and finally increases once more. The procedure has a low variation rate of 8.9%. It demonstrates that the gas-water ratio has a minor impact on nitrobacterium activity. The removal rate of COD sharply declines over the later operation time (18 days later), while the removal rate of NH<sub>3</sub>-N increases. The outer membrane of the biological film is made up of organic removal bacteria, whose activity is intense, but the increase in the gas-water ratio increases the shear strain on the biological film and causes it to come off. As a result, the rate of COD elimination sharply declines. Nitrobacterium develops within biological film and experiences a partial loss; nevertheless, Nitrobacterium gains more oxygen as a result of the organics removal bacteria on the surface being lost, and as a result, its activity increases rather than decreases. Nitrobacterium firmly adheres to the surface of packing materials, as evidenced by the steady increase in the removal rate of NH<sub>3</sub>-N.

#### **B. *The impacts of hydraulic loading rate to biological film***

When experimenting with a gas-water ratio of 2:1, Table III displays the experimental results of the impact of various hydraulic loading rates on the elimination of COD and NH<sub>3</sub>-N. Both the COD and NH<sub>3</sub>-N removal rates go through a process of rising and then falling as the hydraulic loading rate increases when the rate is less than 30.72 m<sup>3</sup>/m<sup>2</sup>•d. Hydraulic loading rate is positively connected with organic load, meaning that an increase in hydraulic loading rate results in an increase in microbial activity, since it varies to a certain extent (no more than volume loading). The change in microbial activity is somewhat slower when it exceeds this range. In the meantime, the shearing action of current would result in the loss of some biological layer, and the rise in hydraulic loading rate would lessen the likelihood of contaminants coming into touch with the microbial surface. Thus, when the pollutant removal rate increases and decreases steadily due to the increase in monomer microbe activity, the chance of contact, and the decrease in volume dose, the pollutant removal rate reaches its maximum. This is also true for COD (15.36 m<sup>3</sup>/m<sup>2</sup>•d) and NH<sub>3</sub>-N (15.36 m<sup>3</sup>/m<sup>2</sup>•d). Until the hydraulic loading reaches its maximum. The COD removal rate sharply decreases when the removal rate exceeds 0.72 m<sup>3</sup>/m<sup>2</sup>•d. The clearance rate of NH<sub>3</sub>-N remains constant, dropping just 7.3%, while the lowest point falls 52.3% in comparison to the maximum position. This suggests that, in comparison to organic eliminating bacteria, the nitrobacterium's working efficiency remains constant.

#### *The impact of organic load to biological film*

The experiment is conducted with a gas-water ratio of 2:1 and a hydraulic loading rate of 15.36 m<sup>3</sup>/m<sup>2</sup>•d. The consistency of water feed COD has a positive link with organic load because the hydraulic loading rate is set. Thus, the investigation of the consistency of COD can be used to interpret the relevant organic load in the experiment. As table IV illustrates, the removal rate of NH<sub>3</sub>-N exhibits a tendency of increasing initially and decreasing subsequently with the increase in feed water consistency

when the organic load is limited at 9.03 kgCOD/m<sup>3</sup>•d. However, the rate of COD removal increases initially and then decreases until the organic load reaches 7.44 kg COD/m<sup>3</sup>•d, at which point it increases progressively. When sewage's nutrients are insufficient to meet the needs of microorganisms, microbial activity instantly rises as the organic load grows. When the needs of bacteria are met, microbial activity slows down after the organic load increases. This would have the effect of preventing some pollutants from breaking down and covering the biological films, which would hinder microorganisms' ability to come into touch with new pollutants. It might also result in a biological film oxygen shortage and a reduction in metabolic activity. When natural Since microorganisms are affected by organic load without forming a corresponding response mechanism, the removal rate of COD would immediately decrease if the load increased from 7.44 kg COD/m<sup>3</sup>•d to 7.84 kg COD/m<sup>3</sup>•d. As the amount of matrix available to microorganisms increases, the number and activity of microbes are progressively increasing along with the consistency of organic contaminants. As a result, the rate at which COD is removed naturally increases. However, the removal rates of NH<sub>3</sub>-N and COD drop significantly and continue to drop when the organic load reaches 9.03 and 11.0 kg COD/m<sup>3</sup>•d, respectively. This indicates that the biological film in packing materials has been damaged. The impact of biological film damage on nitrobacterium is greater than that of organic removing bacteria, as evidenced by the fact that the organic load corresponding to the falling removal rate of COD is higher than the organic load corresponding to the descending removal rate of NH<sub>3</sub>-N. According to theoretical study, the biological film would be covered by the increased pollutant consistency in feed water, which would adhere to the packing materials' surface. Pollutant thickness increases cause bacteria in the biological film to acquire less oxygen, which quickly results in the penetrating phenomena of BAF. But under the scenario of the regular operation of organic load, the removal rate of NH<sub>3</sub>-N varies steadily, suggesting the steady quantity of nitrobacterium in biological film adhered on the surface of packing materials.[13]

Evaluation of the packaging materials' face's biological film.

SEM images of the fly-ash aerated concrete's face and features following the creation of a biological layer are shown in Figures 5 and 6. Comparative observation and preliminary evaluation reveal that virgulate nitrobacterium fills the micropores and tiny gaps on the packing materials' face, and that the biological film forms an inextricable shape. This indicates that the nitrobacterium has a large and stable population, making it easy for it to grow on the fly-ash aerated concrete's surface. This is consistent with the fact that NH<sub>3</sub>-N maintains a steady and high level clearance rate throughout the whole test procedure.

#### CONCLUSION

Writers and Affiliates : when fly-ash aerated concrete properties are applied to the BAF, a mixture of percolate, sewage, and piped water should produce the biological film. The nitrobacterium is outcompeted by the organic removing bacteria on the packing material's face.

The removal rate of NH<sub>3</sub>-N on the biological film of fly-ash aerated concrete packing materials consistently maintains greater than 90% under varying gas-water ratios (with the exception of 88% during the initial adaptive phase) and continues to increase when COD sharply decreases, demonstrating the nitrobacterium's secure adherence.

The removal rate of COD peaks at 78.3%, while the removal rate of NH<sub>3</sub>-N of fly-ash aerated concrete packing materials consistently maintains over 86% due to vary in hydraulic loading. The removal rate for COD varies more quickly when the hydraulic loading exceeds 30.72 m<sup>3</sup>/m<sup>2</sup>•d, even though the other two removal rates vary quickly when the hydraulic loading is less than that.

The elimination rate of COD from fly-ash aerated concrete packing materials has a larger volume of organic load thanks to diversified BAF operated by organic load. However, the rate of COD removal is relatively sensitive to changes in the organic load throughout the entire process.

The nitrobacterium biological film adhering to the fly-ash aerated concrete packing materials has better stability, as determined by scanning electron microscopy and the initial assessment; the removal rate of NH<sub>3</sub>-N in the operation test following biological film formation stays at a higher and stable level.

Therefore, it has been demonstrated that the nitrobacterium.

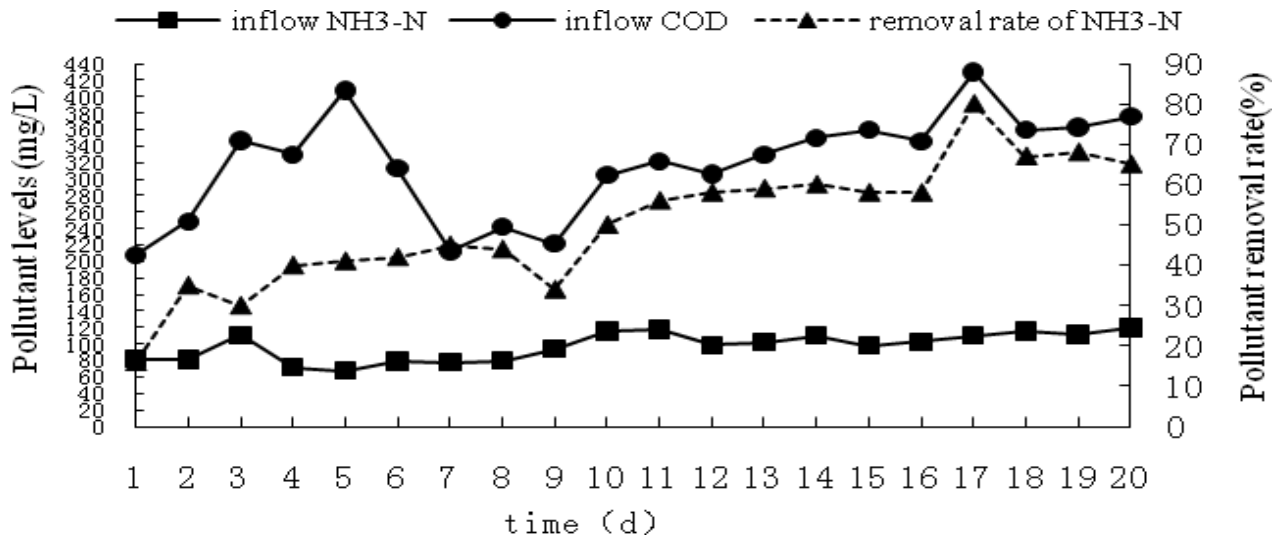


Figure 1. Pollutant removal rate in hang during the film.

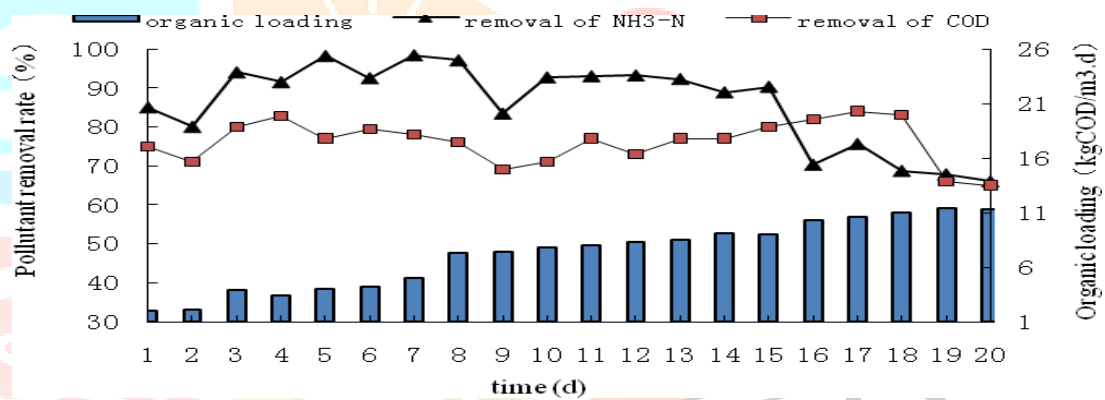


Figure 2. Pollutant removal rate in different organic loading.

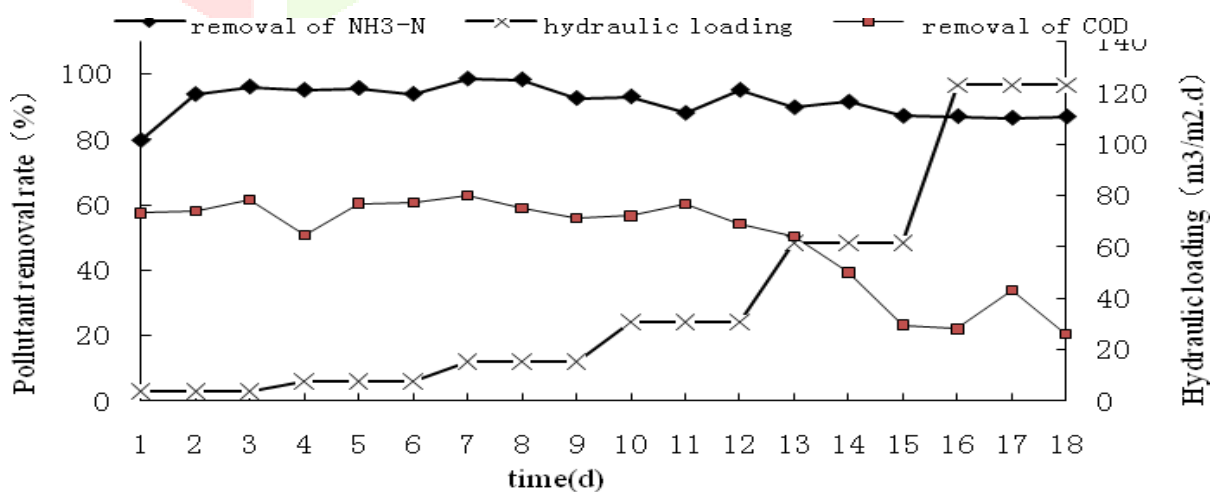


Figure 3. Pollutant removal rate in different hydraulic loading.

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