

# Study on Treatment of Anaerobic Fermentation Liquid by A2N Denitrification and Phosphorus Removal System

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**Keywords:** Double sludge system, DPB, Low C / N ratio, anaerobic fermentation liquid.

**Abstract.** A2N (anaerobic / anoxic and nitrification) denitrifying phosphorus and nitrogen removal process is a new process which based on denitrifying PAOs anoxic phosphorus theory. The experiment used the continuous flow A2N system for dealing with the dilution of high concentration of anaerobic fermentation slurry. The average removal rate of COD is 91.02%; the average total removal rate of ammonia nitrogen is 91%, Removal rate of TP is 95%. So the system has better treatment effect for low carbon and nitrogen ratio sewage.

## 1. Introduction

With the eutrophication of water is becoming increasingly serious, the state launched ten water policy, and gradually improved sewage treatment standards. Because the city sewage C/N is generally low, which is not conducive to the efficient removal of nitrogen and phosphorus, but in this case the DPB can effectively remove nitrogen and phosphorus in water. The hydrolysis of intracellular DPB in the anaerobic environment of phosphorus, phosphate release into the mixture, while absorbing organic sewage in a large number of easily biodegradable COD<sub>RB</sub> and converted into PHB stored in DPB, In hypoxia, DPB use PHB as electron donor, with NO<sub>3</sub><sup>-</sup>-N as the electron acceptor, produced by degradation of PHB, for maintaining the life of most cells. A part is used for the excessive intake of inorganic phosphate in the form of Poly-p stored in the cell, while NO<sub>3</sub><sup>-</sup>-N is reduced to N<sub>2</sub> <sup>[1-4]</sup>. Compared with the traditional biological nitrogen and phosphorus removal technology, this technology can save the carbon source, aeration, discharge of sludge reduction.

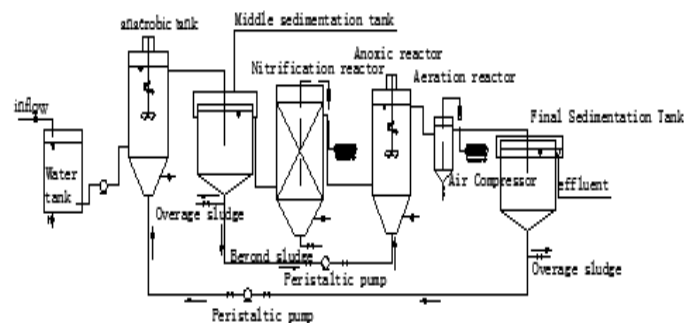


Fig.1 Process of A2N

## 2. Experimental equipment and sludge sources

The experiment device of A<sub>2</sub>N system is made of plexiglass, including anaerobic reactor, biofilm reactor, anoxic reactor, fast aeration reactor and two Sedimentation tank. DPB and nitrifying bacteria were cultured separately.

## 3. Results and discussion

### 3.1 Removal effect of COD.

The removal of organism is an important index to measure the process efficiency, A<sub>2</sub>N system takes COD as the main organic matter. Fig. 2 expresses the system's removal of COD, Fig. 3 expresses

the average concentration of COD in different reaction stages. The influent COD concentration of the system is 254.83 ~ 327.34mg/L, The average concentration of the influent is 279.28mg/L, the average effluent concentration is 25.23 mg/L, The average removal rate of COD is 91.02mg/L , it shows that the removal of COD is stable and efficient. From Fig.2 and Fig.3, it can be seen that the removal of COD is achieved by anaerobic process. The average removal rate of COD is 68.37%. In addition to the anoxic tank of COD with beyond sludge and the dilution effect of the backflow sludge, the main reason is in the process of anaerobic environment, DPB releases phosphorus, absorbs and converts COD to PHB, so the COD can be greatly reduced. After the membrane bioreactor, the concentration of COD Further decreased. In anoxic stage, the decrease of the amplitude is small, Even concentration rised, this is because a small amount of denitrification bacteria used the external carbon source fo denitrification, showing a decrease in COD concentration. The reason of the increase of COD is the inflowing of COD in beyond sludge.

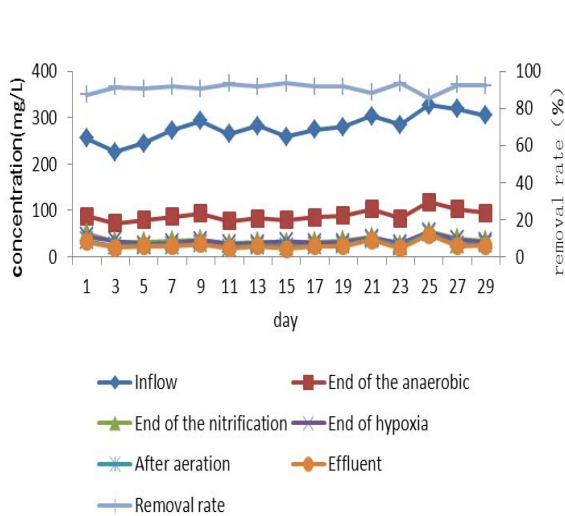


Fig.2 The COD removal efficiency

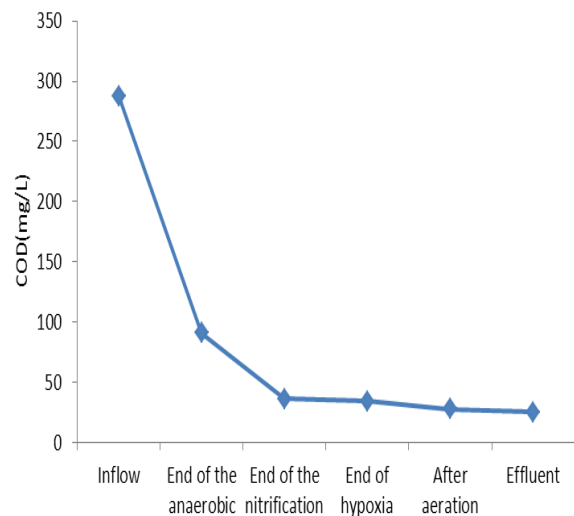


Fig.3 Variation of average COD concentration

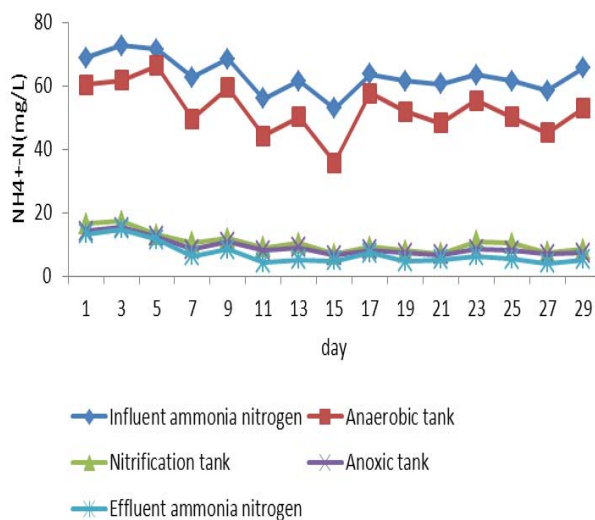


Fig. 4 NH<sub>4</sub><sup>+</sup>-N concentration at different stages in the system

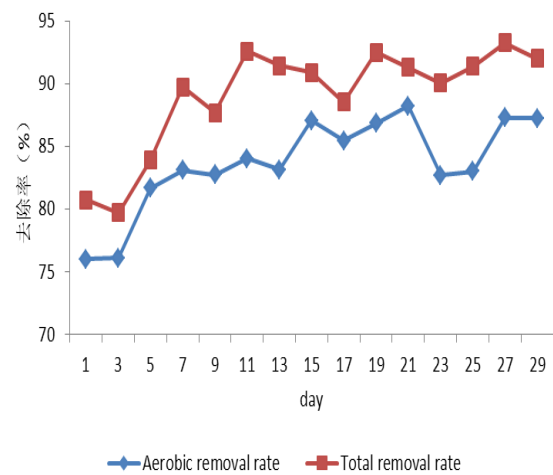


Fig. 5 removal efficiency of NH<sub>4</sub><sup>+</sup>-N

### 3.2 Removal effect of ammonia nitrogen

The ammonia nitrogen removal process of A<sub>2</sub>N is in Fig. 4 and Fig.5. The figures can be seen after the anaerobic tank, part of the ammonia nitrogen removes with the assimilation of microorganisms, part for the sludge return function. Therefore, the concentration of ammonia nitrogen in the anaerobic effluent has a certain rise, and the most important role is return sludge. The concentration of ammonia nitrogen is greatly reduced, after nitrification tank, the average removal rate is 83.6%, and then into

the anoxic tank and fast aeration stage, part of ammonia is removed, the average concentration is 7.11 mg / L, the average of total removal rate of ammonia nitrogen is 91%. Because the existence of the beyond sludge, the partial ammonia nitrogen enters into the anoxic tank with the sludge, leading to the increase of the concentration of ammonia nitrogen in the effluent, so the hydraulic residence time of the fast aeration tank should be appropriately increased. Effluent ammonia nitrogen concentration is one of the shortcomings of the denitrification and phosphorus removal system.

### 3.3 Removal effect of TN

The TN of A<sub>2</sub>N removal process is in Fig.6 and Fig7. Inflow TN concentration is between the 62.95~82.54mg/L, effluent TN concentration is between the 33.36~9.03mg/L, and effluent TN concentration gradually becomes small, effluent concentration reduced to below 10mg / L on the 27<sup>th</sup> and 29<sup>th</sup> day, TN removal rate of the system reaches more than 85%. TN in Sewage is mainly composed of ammonia nitrogen and organic nitrogen, after nitrification and anaerobic, TN decreases little. This is mainly microbial assimilation and nitrification tank biofilm has weak denitrification capacity. The TN removal is mainly in the anoxic tank. DPB uses PHB as electron donor, uses nitrate as electron acceptor, the nitrate nitrogen is converted to N<sub>2</sub>, finishing the removal of nitrogen and phosphorus, the average removal rate of TN in the process is about 75%. However, due to the effect of partial ammonia nitrogen in the beyond sludge, the removal of ammonia nitrogen by rapid aeration tank is not Satisfying, so the removal of TN is not enough.

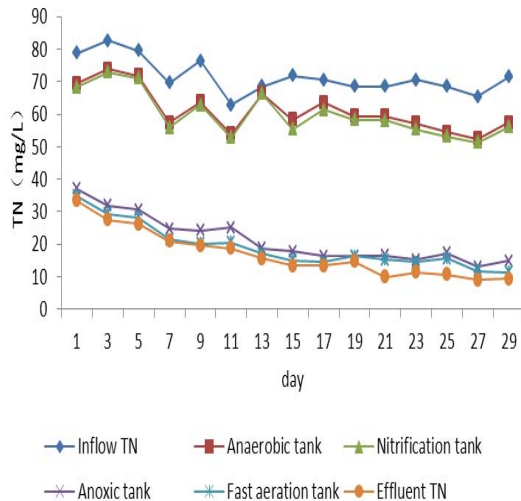


Fig. 6 TN concentration at different stages

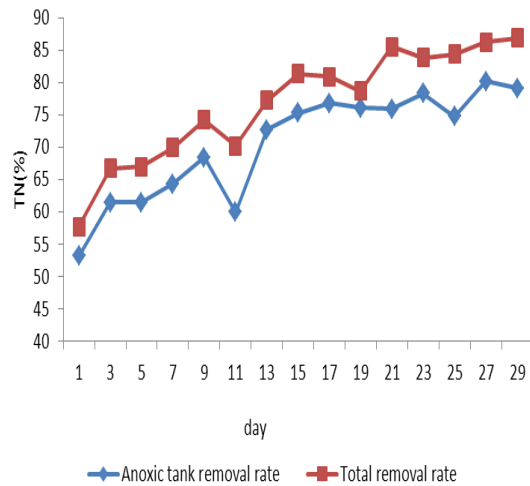


Fig.7 The removal efficiency of TN

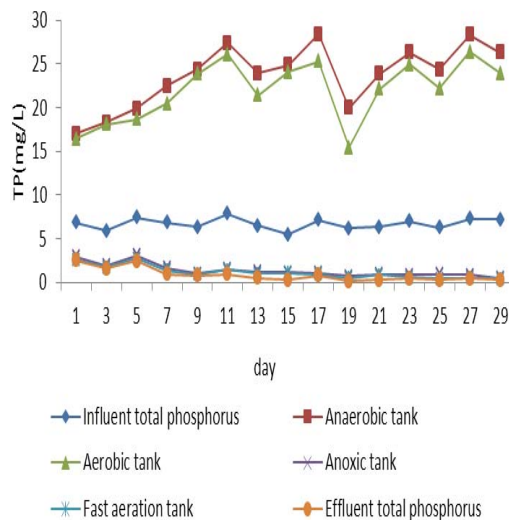


Figure 8 TP concentration at different stages

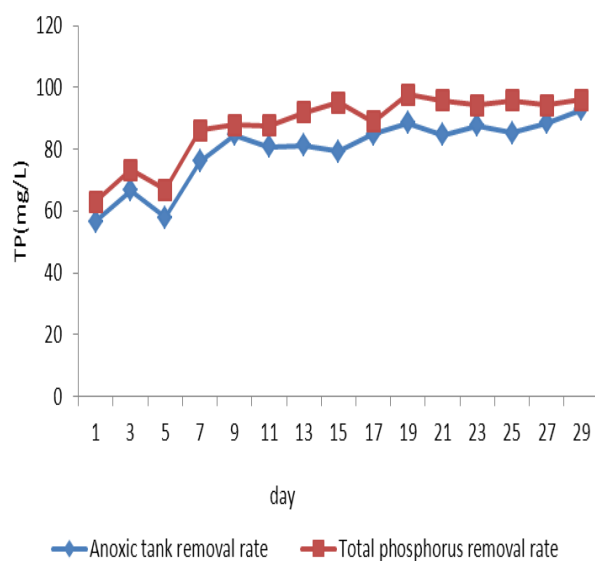


Figure 9 The removal efficiency of TP

### 3.4 Removal effect of TP

The TP of A<sub>2</sub>N removal process is in Fig. 8 and Fig9, which can be seen within the first few days of the start-up phase, the TP removal rate is not stable. After the adaptation to the load of microorganism, removal rate is increased gradually, TP removal rate is maintained at 95% in the final days, and effluent TP concentration is below 0.5mg/l. It can be seen from the figures that the TP removal is mainly in the anoxic tank and few in the fast aeration tank and the nitrification tank. Effluent TP concentration appears some fluctuations,, the reason may is the anaerobic tank sludge contains too much oxidized nitrogen, which influences the system releasing effect of phosphorus in the anaerobic period , DPB cannot fully release phosphorus.

## 4. Summary

The system continuously runned for 31 days, the A<sub>2</sub>N system has better treatment effect for low carbon nitrogen ratio of sewage. The influent COD concentration is 254.83 ~ 327.34mg/L, the average effluent concentration is 25.23 mg/L, the average COD removal rate is 91.02mg/L, which shows the DPB has stable removal rate of COD. The ammonia nitrogen average removal rate is 91%; TN concentration is between 62.95~82.54mg/L, effluent in the last stage is below 10 mg / L, removal rate reaches more than 85%; influent TP concentration is 632 ~ 9.23mg/L, TP removal rate remains at 95%, effluent TP concentration is below 0.5mg/L.

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