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NITROGEN AND CHEMICAL OXYGEN DEMAND REMOVAL OF NUTRIENT RICH WASTE WATER WHICH IS USED IN REACTORS

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ABSTRACT

A preliminary study on the organic removal efficiency of nitrogen and organic pollutants from a laboratory system was conducted. The study focused on the (Chemical Oxygen Demand)COD removal of nutrients from wastewater using two reactor setups. An aerobic reactor was used for the experiments. The goal of the study was to determine the steady state condition of organic pollutants' chemical oxygen demand(COD). Various tests were then conducted on different organic pollutants such as Nitrate nitrogen, Ammonia nitrogen, and NO2.

Keywords: *Organic Pollutants, Waste Water, Chemical Oxygen Demand.*

Introduction

Oceanic nitrogen pollution results in global warming that harms the marine ecosystem. Analysts from around the world led examinations that show human movement is drastically changing nitrogen cycles in Earth's seas, soils, and environment. Nitrogen delivered by human movement is liable for nitrous oxide and carbon dioxide contribution to the world's sea every year.

Fig. 1: Batch Reactors

The amassing of receptive nitrogen in the climate might be just about as risky as adding carbon dioxide to the environment [1]. Nitrogen can exhaust oxygen levels in the water and essentially affect environment, food creation, and biological systems all around the world [2], elevate eutrophication and poisonousness to sea-going organisms[3], and make a few issues when delivered into the climate [4] in light of the fact that it is very harmful when it is available in free structure at pH levels more prominent than.

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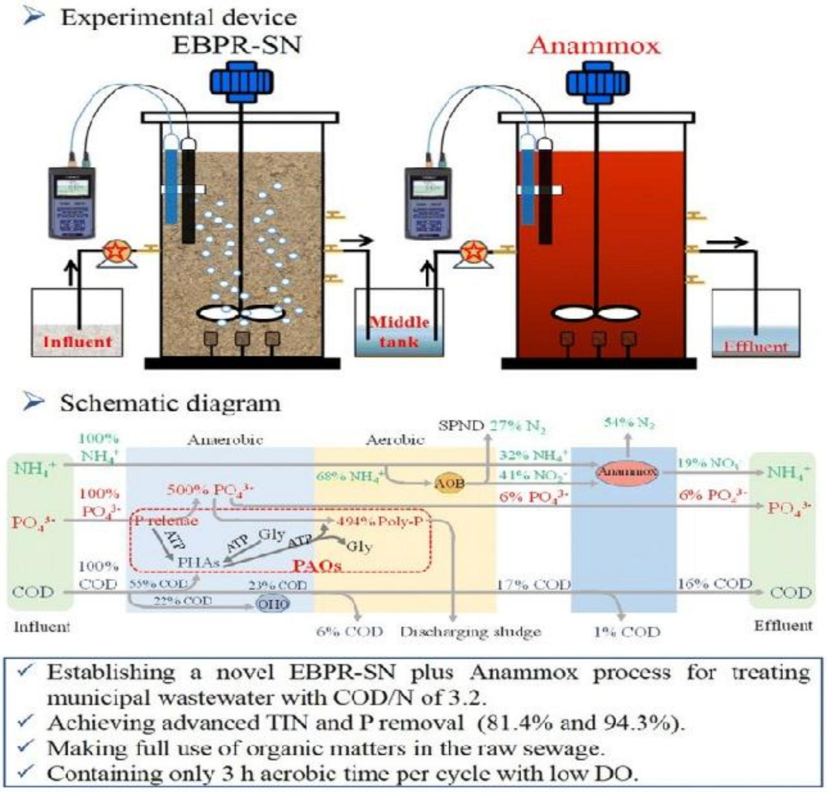

- ✓ Establishing a novel EBPR-SN plus Anammox process for treating municipal wastewater with COD/N of 3.2.
- ✓ Achieving advanced TIN and P removal (81.4% and 94.3%).
- ✓ Making full use of organic matters in the raw sewage.
- ✓ Containing only 3 h aerobic time per cycle with low DO.

Fig. 2: Experimental Device EBPR -SN

Because of this enormous test of the worldwide climate, it is thusly important to eliminate these pollutants from wastewater. As natural and regulative requirements increment, especially the Philippine Clean Water Act, there is an expanding accentuation on lessening nitrogenous substances in wastewater before its reuse or store. The treatment of wastewater by biological technology has been widely adopted due to its ease of operation and low pollution generation [6]. Nitrogen has traditionally been removed from wastewater through the combination of nitrification and denitrification processes [7]. Some researchers have focused on combining anaerobic and aerobic processes to improve process stability [8]. The reactor and the system can be configured differently.

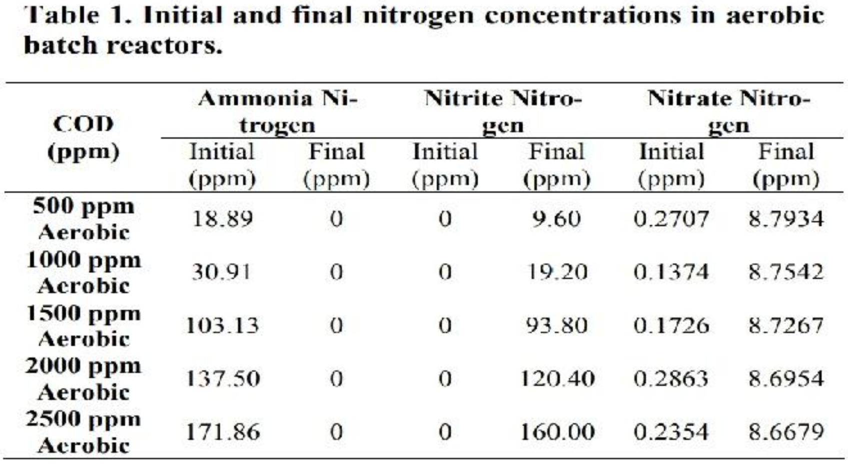

Table 1. Initial and final nitrogen concentrations in aerobic batch reactors.

COD (ppm)	Ammonia Nitrogen		Nitrite Nitrogen		Nitrate Nitrogen	
	Initial (ppm)	Final (ppm)	Initial (ppm)	Final (ppm)	Initial (ppm)	Final (ppm)
500 ppm Aerobic	18.89	0	0	9.60	0.2707	8.7934
1000 ppm Aerobic	30.91	0	0	19.20	0.1374	8.7542
1500 ppm Aerobic	103.13	0	0	93.80	0.1726	8.7267
2000 ppm Aerobic	137.50	0	0	120.40	0.2863	8.6954
2500 ppm Aerobic	171.86	0	0	160.00	0.2354	8.6679

A couple of reactor frameworks can be utilized [9]. Utilizing traditional nitrification and denitrification frameworks, nitrogen and COD can be taken out all the while. Because of the expanding monetary expenses of customary wastewater treatment advances, new nitrogen expulsion advances have arisen throughout the course of recent years. Inventive microbial nitrogen evacuation processes incorporate the Single Reactor System for High Ammonium Over Nitrite (SHARON), which includes part change of ammonium to nitrite, the Anaerobic Ammonium Oxidation (ANAMMOX) process, which includes anaerobic oxidation of ammonium, as well as the Completely Autotrophic Nitrogen Removal Over Nitrite (CANON) process, which includes nitrogen expulsion inside one reactor under oxygen-restricted circumstances.

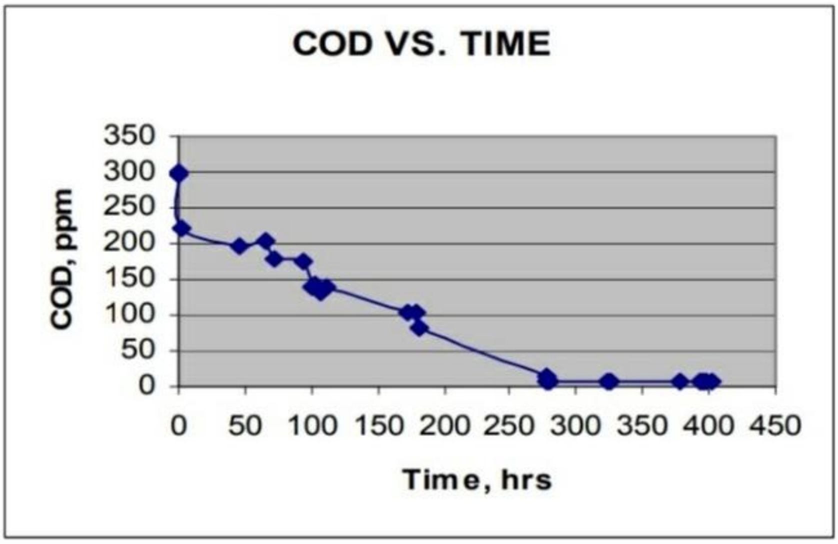

Fig. 3: COD V/S Time

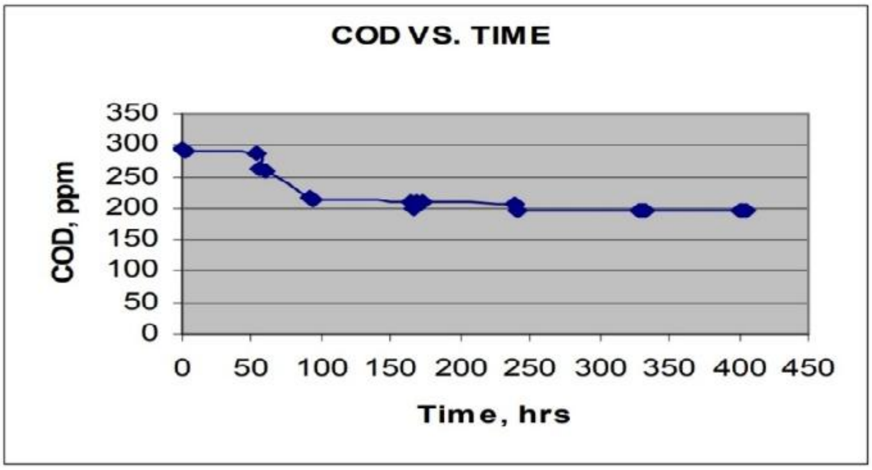

Fig. 4: COD V/S Time (Continuous anaerobic)

Material and Methods

Anaerobic and aerobic reactors were used for the experiments. The continuous aerobic reactor consisted of acrylic boards with a working volume of 5 liters and was powered by an air pump for the aerobic zone. As an alternative, a continuous anaerobic reactor was made up of a 4-liter Erlenmeyer flask equipped with a magnetic stirrer and stir bar that allowed continuous stirring within the reactor. A photograph of the reactors used in this study is shown in Figure 1.

The sample solution and samples for analysis were fed into the port and withdrawn from the port. The effluent from both reactors was collected in two buckets of 20 liters each. The laboratory reactors were seeded with sludge from the DLSU Sequencing Batch Reactor (SBR) wastewater treatment plant. To feed the reactors, glucose was used as a carbon source and ammonium chloride as a nitrogen source. COD concentrations are approximately 300 ppm, while NH3-N concentrations are approximately 250 ppm. Anaerobic reactors and aerobic reactors were fed separately with this simulated wastewater. We performed COD tests, mixed liquor volatile solids (MLVS), temperature, and pH regularly to monitor the progress until steady state was achieved. Figure 2 shows batch reactors comprised of 5 1-liter Imhoff cones supported by iron stands and iron rings, each containing varying concentrations of wastewater. Aeration was provided by air pumps in each reactor. As shown in Table 1, NH3-N and COD in different concentrations were fed to the reactors to test the effect of different feed concentrations on nitrogen removal. In addition, batch mode operations were conducted using the same anaerobic reactor. The APHA Standard Methods [11] stipulate that all parameters in this study were analysed according to those procedures.

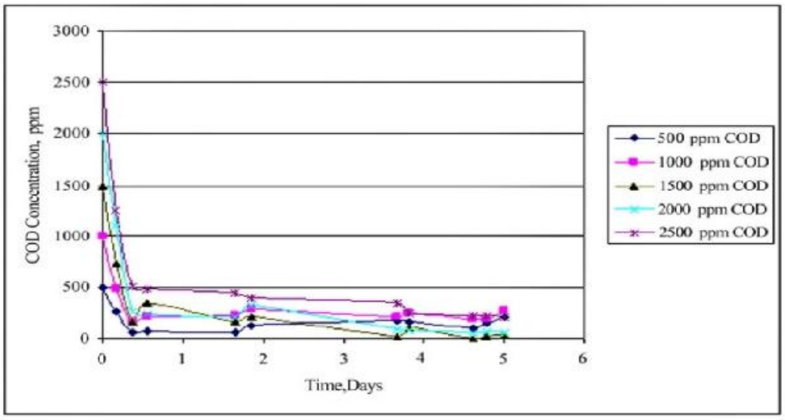

Fig. 5: COD Concentration profile in aerobic Batch Reactors

Results and Discussions

The concentration profile of COD in a continuous aerobic reactor and in a continuous anaerobic reactor were shown in Figure 3 and 4 respectively. Anaerobic reactor with high concentration profile is shown in Figure 4. The data revealed that aerobic bacteria can reduce organic pollutants in wastewater at a faster rate than anaerobic bacteria.

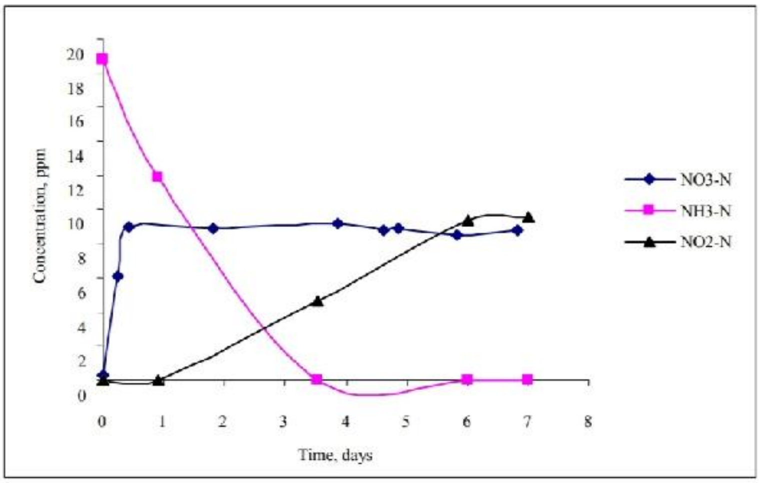

Fig. 6: Nitrogen Concentration Profile in aerobic batch reactor (500 ppm of COD)

Figure 5 shows the COD concentration profiles of five aerobic batch reactors with initial concentrations of 500, 1000, 1500, 2000, and 2500 ppm. Under aerobic conditions, COD was reduced by 71 to 97 percent in four to five days on average. According to the figure, the higher the COD concentration, the faster its degradation in its early stage as indicated by 2500, 2000, and 1500 ppm of COD. COD at 1000 and 500 ppm, on the other hand, takes more time to degrade. 71% of COD was removed despite a high COD loading. Due to the nearly identical carbon-to-nitrogen (C/N) ratios in all reactors, the lack of trend in these results may be related to the varying MLVS concentrations in the reactors. In the aerobic batch reactors, initial ammonia concentrations were 18.89, 30.91, 103.13, 137.50, and 171.86 ppm. Nitrite-nitrogen was not present in the wastewater sample, but nitrate was present in a small amount. With the help of ammonium oxidizing bacteria (AOB) that live in an aerobic environment, it was obvious that ammonia had been completely degraded to nitrite and nitrate after 5 days. Ammonia, however, takes much longer to degrade at higher concentrations.

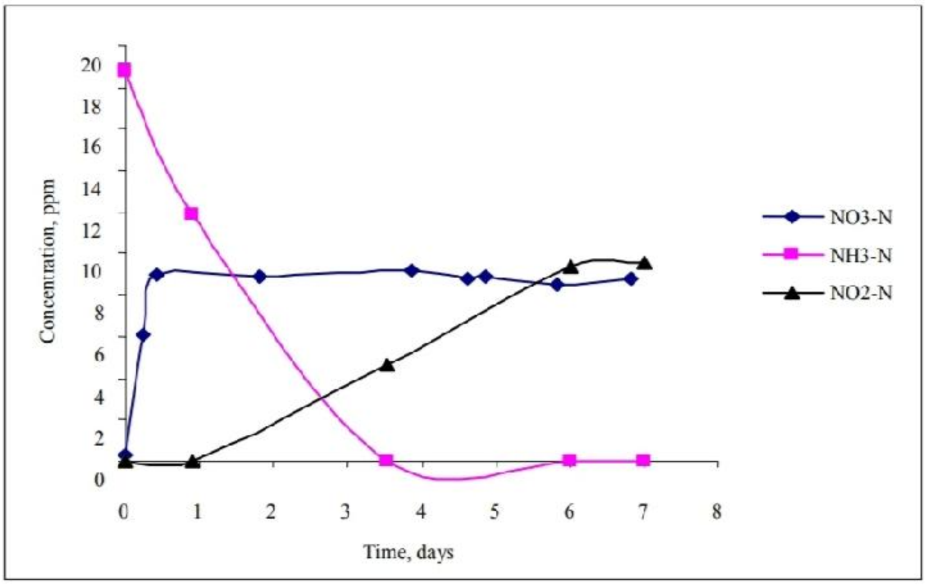

Figure 6. Nitrogen concentration profile in aerobic batch reactor (500 ppm of COD).

Fig. 6: Nitrogen Concentration Profile in aerobic Batch rector (500 ppm of COD)

The nitrogen concentration profile in aerobic batch reactors is shown in Figures 6 and 7. NH3-N was used at the lowest concentrations in Figure 6 and at the highest concentrations in Figure 7. In Figure 6, it is very evident that 18.89 ppm NH3-N was totally degraded after 3.5 days, whereas 171.86 ppm NH3-N was completely degraded after 5.5 days. Furthermore, the time to degrade NH3-N was found to be dependent on the feed concentration: the higher the NH3-N concentration, the longer the time required to degrade it under the same conditions as the feed concentration. Furthermore, both reactors showed increases in NO2-N and NO3-N concentrations. NH3-N was converted to NO2-N and NO3-N by ammonium oxidizing bacteria (AOB) in aerobic environments. In contrast, NO2-N levels increased in both reactors while NO3-N concentrations increased slightly. As a result of ammonia's higher affinity to oxygen than nitrite oxidizing bacteria (NOB), it was suspected that the concentration of dissolved oxygen in the reactor limited further oxidation of nitrite to nitrate. A pH-uncontrolled reactor may result in partial nitrification as a result of partial nitrification. For low conversion of nitrite to nitrate, the presence of inhibitors for nitrite oxidizing bacteria can also be possible, however the microorganisms can adapt to the inhibitor after a long period of exposure and decrease its inhibition effectiveness [12].

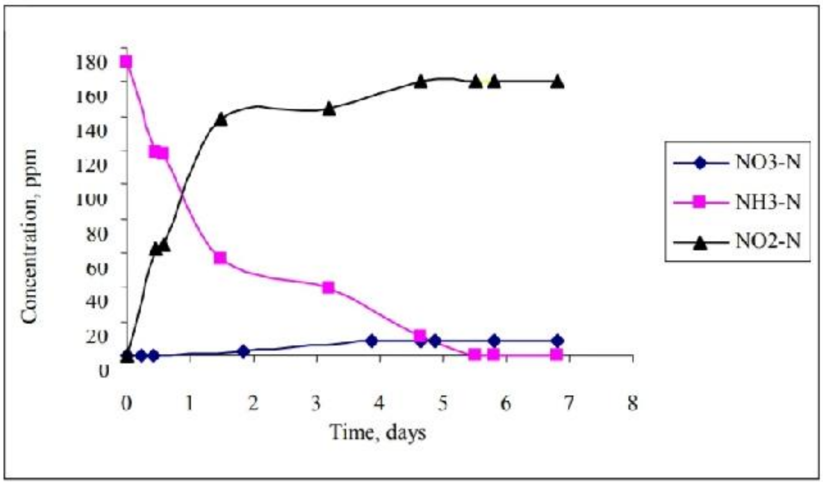

Figure 7. Nitrogen concentration profile in aerobic batch reactor (2500 ppm of COD).

Fig. 7: Nitrogen Concentration profile in aerobic batch reactor (2500 ppm of COD)

In an anaerobic batch reactor, Figure 8 illustrates nitrogen concentration profiles of 50 ppm NH3-N and 1000 ppm COD. Anaerobic environments should not produce ammonia, only nitrates and nitrites. In order to convert ammonia into nitrite and then into nitrate, autotrophic nitrifiers need oxygen. According to the results of the experiments, ammonia concentration increased slightly. Ammonia is formed when the protein content of wastewater dissociates in water, creating ammonia. Due to the ammonification of organic nitrogenous compounds under anaerobic conditions, the effluent ammonia concentration sometimes exceeded the influent ammonia concentration in the previous study [13]. Under anaerobic conditions, some organic compounds tend to degrade into simple organic acids, alcohol, and the like rather than to CO2 and H2O, which also limits COD reduction. Nitrite was initially not present in the reactor and remained constant throughout. Additionally, under anaerobic conditions, the 0.3 ppm nitrate nitrogen was totally degraded due to the denitrification process, which reduced nitrate to nitrogen gas. A reduction in COD in anaerobic environments may be attributed to biomass synthesis and methane production [15,16]. Mixed liquor volatile solids (MLVS) were used to measure the time course of biomass growth. As MLVS concentrations increased in the two reactors, nitrogen and COD may have been removed.

Conclusion

- A 98% reduction in COD was obtained with the same HRT Reduction of 34 % in aerobic reactor compared with anaerobic reactor
- As a result, anaerobic bacteria have a slower growth rate in the reactor Degradation of organic materials.
- Nitrite accumulation and a low nitrate concentration.There was an observation of an aerobic reactor because of low activity of NOB, possibly as a result of inhibitors or uncontrolled conditions. During nitrification, the reactor pH is high.
- Aerobic processes require more aeration time and They produce a lot of sludge, but they can get rid of it The nitrogen atom of ammonium.
- Anaerobic treatment methods generally have advantages. Increased organic loading rates and production. We produce a relatively high amount of biogas, but relatively less effluent Concentration of ammonia and inability to remove it. Its disadvantages include nitrogen.
- Based on the above findings, it is more likely that Combination anaerobic/aerobic system that is easy to use Nitrogen and COD can be removed simultaneously.

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