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Denitrification studies of sewage water for the percentage conversion of nitrate by using obligate aerobes derived from fruit waste

Seshagiri Murikipudi, Meena Vangalapati*

Department of Chemical Engineering, AUCE (A), Andhra University, Visakhapatnam-530003, Andhra Pradesh, (INDIA)

E-mail : meena_sekhar09@yahoo.co.in

ABSTRACT

Denitrification process is used for the treatment of sewage water. In the present study, optimization of the parameters like biomass concentration, pH, time and the percentage conversion of nitrate by using obligate aerobes are studied. By varying the parameters in the range of 0.5 to 5.0% (w/v), 6.0 to 10.0, 0 to 12 days for biomass concentration, pH, time and conversion of nitrate respectively. The optimized parameters at which the maximum denitrification is noticed and found to be biomass concentration of 1% (w/v), pH 9.0, time 8 days and more than 80% (nearly 83%) conversion of nitrates is noticed from the experimental work.

KEYWORDS

Denitrification process;
Obligate aerobes;
Conversion;
Nitrate concentration;
Fruit waste;
Optimization.

INTRODUCTION

Nitrate and nitrite are naturally occurring ions that are part of the nitrogen cycle[1]. Nitrate anion has both beneficial and harmful uses. On the positive side, Nitrates (NO3-) are essential plant nutrients that are important ultimately for protein synthesis. They are responsible for the growth of plants and also nitrogen fixation. Nitrates are found in nature since they are the end product of the aerobic decomposition of organic nitrogenous matter as well as the decomposition of organic micro-organisms. Nitrate and nitrite are the products of the oxidation of nitrogen (which comprises approximately 78% of the earth's atmosphere) by microorganisms in plants, soil or water. Nitrite oxidizes and forms as nitrate salts are used widely as inorganic fertilizers, explosives, oxidizing agents in the chemical industries, and as food preservatives especially to cure meats. Extensive utilization of synthetic fertilizers and Industries, human excreta, sewage disposal, cattle seepage, fertilizer industries, explosives industries, municipal waste and industrial effluents, particularly from food processing, release of improperly treated wastewater from industrial or municipal facilities are the causes of nitrate contamination[2] in natural water as well as ground water systems. Nitrates are entering into the atmosphere and can be converted to nitrous oxide (N2O), which a greenhouse gas is contributing to global warming acidic deposition and the formation of other secondary pollutants. Nitrate is one of the main contributors to eutrophication[3] of surface water. High concentration of nitrate in the ground water causes "blue baby syndrome". Nitrate ions enter the bloodstream through gills fish causes Methaemoglobinaemia causes respiratory distress because of the loss in oxygen-carrying capacity of blood. Nitrate in excessive levels can also be po-

tentially harmful to animals and can cause abdominal pains, muscular weakness and brown or chocolate colored blood.

Range of nitrates

The U.S. Environmental Protection Agency (EPA) sets Maximum Contaminant Levels (MCLs) for nitrogen in public drinking water systems as 10 milligrams per liter (NO3 –N mg/l) and nitrites as one milligram per liter (NO2 –N mg/l). The World Health Organization (WHO)[4] has prescribed the maximum permissible limit of nitrate in drinking water as 50 mg per liter, while IS-10500 prescribes 45 mg per liter as the maximum permissible limit in drinking water.

MATERIALS AND METHODS

The process is done in the presence of micro-organisms[5] called obligate aerobes and the process is done in fixed bed reactor. The microorganisms are cultivated in aerobic conditions as (w/v) %. The obligate aerobes convert the nitrates into nitrogen. The concentration of nitrate was determined by the diazocoupling reaction using sulfanilic acid and anthanilate as reagents.

Sewage collection

Sewage water is collected from the canals contained domestic waste water[6] which enters into the sea near Visakhapatnam. The sewage contains domestic waste water, hotel waste, municipal waste, animal excreta, land runoff[7], and various solid particles are also present in the sewage.

Preparation of obligate aerobes (mixed culture)

The culture is developed from rotten fruits. 10 g per 1000 ml of fruit mixture is taken in distilled water and kept for 40 days harvesting under aerobic conditions. The developed culture is used as biomass for denitrification process[8].

Estimation of nitrate concentration

The concentration of nitrate is estimated by using spectrophotometer[9,10]. The reagents used for this process are salfanilic acid, hydrochloric acid, methyl anthranilate and sodium hydroxide. Take 10 ml of sewage water and add 1 ml of salfonilic acid to diazotized to form nitrates. Then 1ml of 2mol/ l HCl is added to make the reaction faster and the contents are kept under shaking for 5 min to complete the diazotization reaction[11]. After the diazotization 1 ml of 0.5% methyl anthranilate is added to indicate the colour. Methyl anthranilate reacts with nitrates present in sample and forms brown red color. For this 2 ml of 2 mole/L NaOH is added to nutralised the acidic nature and 10 ml of distilled water is added for this and the color of the sample is estimated spectrophotometrically at 490 nm which gives the concentration of nitrate.

RESULTS AND DISCUSSION

Effect of biomass on nitrate concentration

Biomass is the major parameter in the denitrification process. In these process different amounts of biomass ranging from 0.5 to 5.0 grams taken in different flasks contains 100 ml of sewage and the contents are kept for 3 hr incubation. After incubation the concentration of nitrate is estimated by spectrophotometer. The concentration of nitrate decreases from 0.5 to 1.0 (w/v) % and it remains constant up to 2.0 (w/v) % then it starts increasing from 2.0 to 5.0 (w/v) %. From this results it shows that the optimum value of biomass for the denitrification process was found to be 1.0 (w/v) %. The results are shown in figure 1.

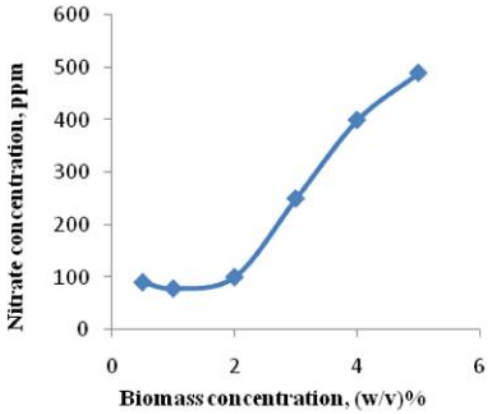

Figure 1 : Effect of biomass on nitrate concentration

Effect of pH on nitrate concentration

pH places a major role in sewage water denitrification. To optimize the pH for this process different pH samples of sewage from 6.0 to 10.0 are taken in different flasks. In every flask the biomass is added and kept for aside for 2 hr then nitrate concentration is estimated. First the nitrate concentration is decreases from pH 6.0

to 9.0 after that the concentration increases from pH 9.0 to 10.0. From the results the concentration of nitrate is low at optimum pH 9.0. The results are shown in figure 2.

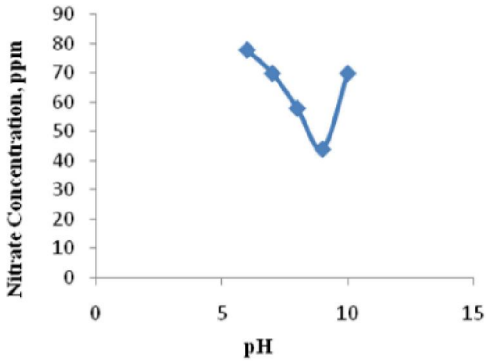

Figure 2 : Effect of pH on nitrate concentration

Effect of time on nitrate concentration

Time places a vital role in every process. The time for denitrification of sewage is estimated by taking one liter of sewage and adds biomass in a beaker. The nitrate concentration is estimated for every 24 hrs. Every day the nitrate concentration is estimated from day 1 to till it comes stable. From day 1 to day 8 the nitrate concentration is decreases gradually and it is stable until day 12. Continuously the nitrate concentration decreases from day 1 to day 8 then it comes to stable for 5 days. By this the optimum time for denitrification in this process is found as 8 days. The results are shown in figure 3.

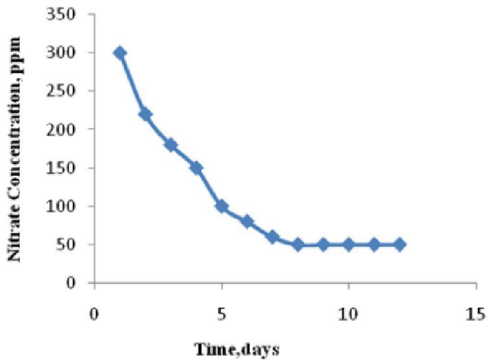

Figure 3 : Effect of time on nitrate concentration

Percentage conversion of nitrate

As the reaction proceed the obligate aerobes[12] denitrifying the sewage and converts the nitrates into nitrogen and releases to atmosphere. The concentration of nitrates is decrease as the time proceeds and the conversion increases. From the optimized conditions the percentage conversion is found to be 83% and it remains constant from day 8 to day 12. The results are shown in figure 4.

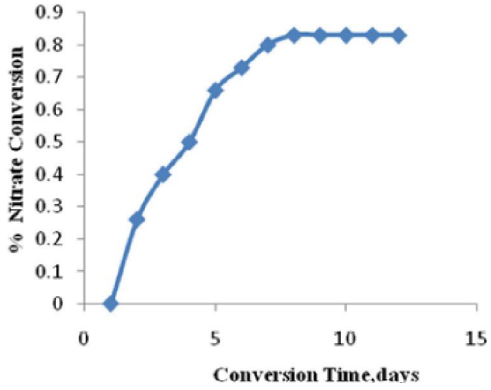

Figure 4 : Percentage conversion of nitrate

CONCLUSIONS

Experiments were performed for sewage water denitrification to estimate and optimize the parameters like biomass concentration, pH, time and the conversion of nitrate by using obligate aerobes. By varying the parameters like biomass concentration, pH, time and conversion of nitrate in the range 0.5 to 5.0% (w/v), 6.0 to 10.0, 0 to 12 days respectively. The optimized parameters at which the maximum denitrification is noticed and found to be biomass concentration of 1%(w/v), pH 9.0, time 8 days and more than 80% (nearly 83%) conversion of nitrates is noticed from the experimental work.

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