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Modeling Studies for the Percentage on version of Nitrate from steel industry effluent by column separation process

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ABSTRACT

Nitrates are widely used in chemical industries, Fertilizers, Explosive and mainly for food preservation. So many methods came to progress for controlling nitrates level in environment, it causes more amount of damage to nature and to aquatic life. In this study mainly pH TSS, TDS, BOD, COD and 96% highest percentage conversion of nitrate was found from the optimized conditions after 6 hrs and with same untreated sample for membrane percentage conversion obtained is 93% after 11 hrs. So column is best method for controlling nitrates from steel effluent. The final form of the proposed model equation for the percentage conversion of nitrate was $Ys=0.96(1-e^{-1.20t})$. Where Ys = percentage conversion of nitrate and t= conversion time (days).The model showed good agreement with experimental data by generating average absolute relative deviation (AARD) of about 0.94± 1.90% conversion of nitrate from steel industry effluent using column .

1. INTRODUCTION

Nitrates [1] are naturally present in soil, water, and food. In the natural nitrogen cycle, bacteria convert nitrogen to nitrate, which is taken up by plants and incorporated into tissues. Animals that eat plants use the nitrate to produce proteins. Nitrate is returned to the environment in animal feces, as well as through microbial degradation of plants and animals after they die. By the aerobic action of the nitrosomonas bacteria [2] in nitrogen cycle the nitrates converts to nitrogen. Nitrate salts are used widely as inorganic fertilizers [3], explosives, oxidizing agents in the chemical industries, and as food preservatives especially to cure meats. Natural process the is no contamination of nitrate by the 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 in natural water, ground water systems as well as atmosphere also. Nitrate contamination causes health hazards[4] like methemoglobinemia which losses the oxygen carrying capacity of hemoglobin, blue baby syndrome, headache, dizziness, vomiting, diarrhea, labored breathing Pregnant women are more sensitive to the effects of nitrate due to a natural increase in methemoglobin levels in blood during the later stage of pregnancy beginning around the 30th week. 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[5] of surface water. The U.S. Environmental Protection Agency [6](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) [7] 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. Here we are using column separation process which is suitable for separation and purification of both solids and liquids . usually adsorbent employed in column are silica, alumina, calcium carbonate, magnesia, starch etc. selection of solvent is based on the nature of the both solvent and adsorbent in this process silica is used as adsorbent which is available at low cost and 100mesh size is used .By this separation process or by any other separation processes we won't get 100% of separation.

2. MATERIALS AND METHODS

Conversion of nitrate was more important to remove contamination in steel industry effluent contain more amount of nitrates. This effluent was collected from steel industry.

2.1 Treatment Technique – column separation

Column separation was adopted as one of the technique for the removal of nitrates from the steel Industry Effluent. Mainly column can be used for many of separation process like nitrates, metals, oils and fats, etc. Here we used batch process because initially batch process afterwards we have to go for continuous process, so in batch process itself we got results. In the column adsorbent used is silica with 100 mesh size filled in the column up to 5 cm diameter of the column is 3cm and height is 30 cm as shown in figure 1.

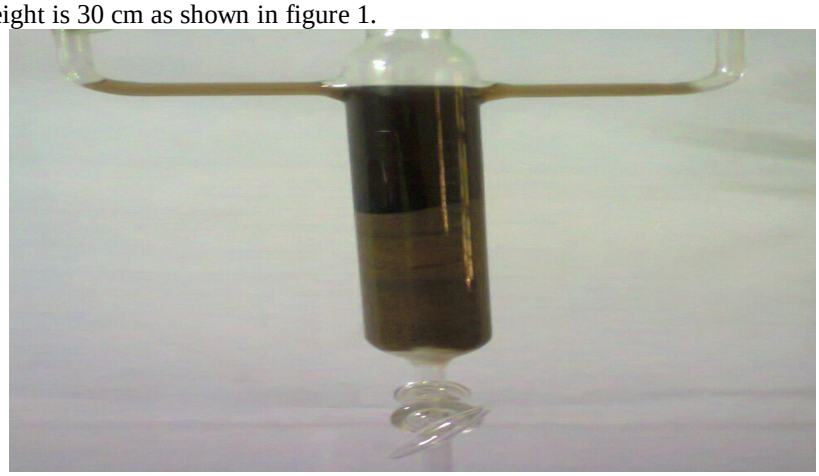

Figure 1: initially steel effluent into column

Initially 150 ml of steel effluent is taken into column as batch process. In the column constant flow rate is maintained, for every one hour sample is collected and collected sample is taken to calculate Ph, TSS, TDS , BOD, COD, Nitrates and % conversion of nitrates. After 7 hours we got optimized values. Finally after completion of process column is like this as shown in the figure 2.

Figure 2: After completion of process

2.2. Estimation of nitrate concentration

The concentration of nitrate was estimated by using spectrophotometer [8] for every one hour until optimized values obtained .

Reagents required:

1. salfanilic acid,
2. hydrochloric acid,
3. methyl anthranilate and
4. sodium hydroxide.

Steps to be followed

Step 1: Take 10 ml of effluent and add 1 ml of salfanilic acid to diazotized to form nitrates.

Step 2: Then 1ml of 2mol/ l HCl was added to make the reaction faster and the contents are kept under shaking for 5 min to complete the diazotization [9] reaction.

Step 3: After the diazotization 1 ml of 0.5% methyl anthranilate was added to indicate the color.

Step 4: Methyl anthranilate reacts with nitrates present in sample and forms brown red color.

Step 5: For this 2 ml of 2mole/L NaOH was added to neutralize the acidic nature and 10 ml of distilled water was added for this, and the color of the sample was estimated under 490 nm spectrophotometrically to get the concentration of nitrate.

2.3. Modeling of conversion of nitrate

In order to describe the nitrate conversion from sewage water the following hypothesis were used. The mass transfer coefficient is constant. The conversion of nitrate diffusion phenomenon by biomass derived from rotten fruits under aerobic conditions. The final form of modeling equation [10] was obtained from the conversion of nitrate

$Ys= B (1-e^{-Dt})$

Where

Ys = percentage conversion of nitrate.

T= conversion time (days) and

B and D are equation constants.

3. RESULTS AND DISCUSSIONS

3.1. Percentage conversion of nitrate

As the reaction proceed, denitrifying the effluent and converts the nitrates into nitrogen and releases to atmosphere. The concentration of nitrates is decrease as the time proceeds and the conversion increases [11]. From the optimized conditions the percentage conversion is found to be 96% and it remains constant from 6hr to 7hr. The results are shown in table 1 and figure 3.

Table 1. Percentage conversion of nitrate with time

Retention Time, hr	% Conversion of nitrates
1	91.56
2	92.11
3	92.48
4	94.53
5	94.99
6	96.66
7	96.66

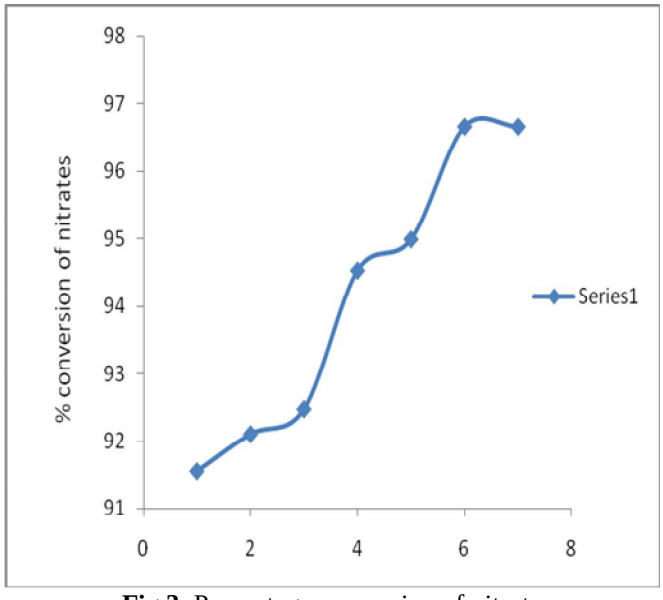

Fig.3. Percentage conversion of nitrate

3.2. Modeling of conversion of nitrate by using membrane:

To describe the conversion of nitrate in effluent using column. The highest percentage conversion of nitrate was found to be 96 % from the optimized conditions table 2 and we can directly conclude here, it is the highest % conversion of nitrates when compared to column process. The final form of the proposed model equation for the percentage conversion of nitrate was [12],[13]

$Ys=0.96(1-e^{-1.20t})$.

Where

Ys = percentage conversion of nitrate

t= conversion time (days) and
The model showed good agreement with experimental data by generating average absolute relative deviation (AARD) of about 0.94±1.90% conversion of nitrate from steel industry effluent using membrane.

Table2:

Parameter	TSS(ppm)	TDS(ppm)	pH	Time (hr)	BOD (ppm)	COD (ppm)	Concentration of nitrates(ppm)	% conversion of nitrate
Membrane Treated	118	1873	7.02	7	31	220	40	96

4. CONCLUSION

The highest percentage conversion of nitrate was found to be 96 % from the optimized conditions in column, when compared with membrane. The final form of the proposed model equation for the percentage conversion of nitrate was $Ys=0.96(1-e^{-1.20t})$. Where Ys = percentage conversion of nitrate and t= conversion time (days).The model showed good agreement with experimental data by generating average absolute relative deviation (AARD) of about 0.94± 1.90% Conversion of nitrate from steel industry effluent using column.

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