DIMINUTION OF NITRATE LEVEL FROM WATER USING LOW-COST ADSORBENT – RICE HUSK

Satwik T S[1], Dr. H B Aravinda[2]

[1]Post Graduate in Environmental Engineering, BIET College, Davanagere-577004, India [2]Head of the Department, Department of Civil Engineering, BIET College, Davangere

---

Abstract *Nitrogen present in the form of nitrate contaminates surface as well as ground water very easily due to its high solubility. The use of a low-cost adsorbent has been studied to replace the current costly method of removing nitrate from water. The objective of this work is the study of adsorption of nitrate containing solution, by using low cost adsorbent activated Rice Husk. Nitrate solution with known concentration had been prepared. Then liquid phase adsorption has been carried out by using these rice husk adsorbent and result has been investigated by batch mode. The UV- Spectrophotometer is used to estimate the nitrate concentration after the use of the adsorbent. Studies revealed that the maximum nitrate removal efficiency was obtained using batch adsorption studies conducted for a reaction time of 60 minutes using 2 grams adsorbent per 100ml of the water sample. Optimization of process parameters such as reaction time and adsorbent dosage were also studied to find out the maximum removal efficiency.*

Key Words: Nitrate, Adsorbent, Rice Husk, Low-Cost, Adsorption, Agitator, UV Spectrophotometer.

1. INTRODUCTION

The sources of water viz. surface sources and subsurface sources are highly contaminated by nitrates which is very harmful to the human beings as well as to the environment. Nitrate concentration in surface waters and ground waters have increased substantially over last 30-40 years. Particularly wells in the agricultural areas are more prone to nitrate contamination as their concentrations levels frequently crossing the WHO guidelines value of 10mg/l.

Nitrogen may be present in the form of nitrate or ammonia. Even though nitrates have been defined as the non-objectionable final end product in aerobic treatment of sewage, yet its concentration in potable waters are controlled, because larger concentration (above 45ppm) may cause nitrate poisoning in infants.

The increase in the concentration of the nitrates directly affects the human population by causing cancer and it has been found that increased nitrate concentration can cause blue baby disease (methemoglobinemia) in infants.

Increased nitrate concentration in lakes can cause eutrophication which causes oxygen depletion in the water bodies hence aquatic life may not get proper oxygen for survival and if the water body gets eutrophicated then there will be no proper penetration of light deep into the water bodies.

There are several ways in which nitrate can be removed viz. adsorption, absorption, denitrification, chemisorption.

1.1 SCOPE

There is much to be done to reduce the concentration of nitrates in drinking water sources, industrial effluents, agricultural wastewater and domestic wastewater. It has a wide range because the high concentration of nitrate in drinking water, wastewater and industrial effluents can damage the environment as well as human life.

- A high concentration of nitrates in the environment in water bodies will result in eutrophication which poses a risk to aquatic life, as these nitrates are the main contributors to the enrichment of nutrient capacity.
- Nitrates can spread widely in water supplies.
- A higher concentration of nitrate in the water causes blue baby disease (methemoglobinemia) in new-borns.

1.2 OBJECTIVES

The main objective of the study is to find the cost-effective adsorbent for the removal of nitrates. Although there are several methods to reduce nitrates, the adsorption method finds the most effective method because it is economical, simple, it takes less time.

- The main motto is to find the feasibility of rice husk in the removal of nitrate from water.
- To check the adsorption capacity of the activated rice husk.
- To find the optimal dosage and duration for which a maximum amount of nitrate can be eliminated.

2. MATERIALS AND METHODOLOGY

Activated rice husk is used as an adsorbent in the minimization of nitrate level from water. Rice Husk is basically the hard-protecting coverings of grains of rice. Rice Husk are the part of the chaff of the rice. The husk protects the seed during the growing season, since it is formed from hard materials, including opaline, silica and lignin. Rice husk is a bulky material, about 20% by volume of a rice paddy harvest consist of left-over husk. The properties of rice husks make them perfect for inclusion in

materials like cement, insulation and composites like particle board, as well as a renewable source of fuel and more. Rice husks are even used to help electrify villages in places like Myanmar, which grows more than 13 million tons of rice every year.

- Rice husk was collected from nearby rice mills. Initially the rice husk was sun dried for 7 days to remove the moisture content and then was converted into fine particles by repeated sieving.
- Particles passing through 300µ sieve and retained on 150µ sieve was collected.
- After obtaining the desired size rice husk, the rice husk was washed with distilled water to remove dirt, dust and other impurities.
- After washing the rice husk, it is to be oven dried at 105°C for 24 hours.

Fig 1: Rice Husk

2.1 ACTIVATION OF ADSORBENT

The dry rice husk is mixed with concentrated H_2SO_4 in 1:1 ratio. After proper mixing, it is again oven dried at 110°C for 24 hours. After drying, it is washed with distilled water to remove free acid and soaked in KOH solution to remove the remaining acid traces. It is washed with distilled water until the pH reaches 6.5 Finally, it is burnt in muffle furnace at 450°C for 5 hours (since adsorption increases with temperature and in order to increase the adsorption capacity of adsorbent it has to be heated at high temperature)

Fig 2: Activated Rice Husk

2.2 PREPARATION OF STOCK AND STANDARD SOLUTION

Stock solution: 0.386g of anhydrous potassium nitrate is dissolved in distilled water and make up to 1000ml with distilled water.

1ml of stock solution represents 100µg of Nitrate.

Standard solution: About 100ml of stock Nitrate solution is dissolved in distilled water and make up to 1000ml with the distilled water to get desired concentration.

1ml of standard solution represents 10µg of Nitrate.

2.3 PREPARATION OF STANDARD GRAPH

Main principle of spectrophotometer is to find absorbance of any sample against a specific wavelength. For Nitrate, the wavelength is 220nm. Solutions of concentration 10ppm, 20ppm, 30ppm, 40ppm and 50ppm are prepared. Initially blank reading is taken with distilled water and then using these standard solutions in spectrophotometer, a standard curve is obtained.

Nitrate Concentration (ppm)	Wavelength (220nm)
0	0
10	0.205
20	0.384
30	0.544
40	0.7
50	0.862

Table 1: Standard graph

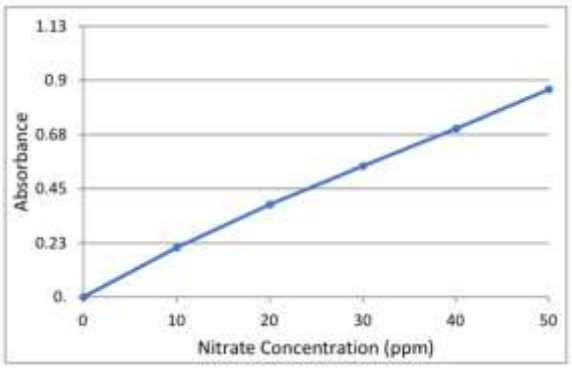

Fig 3: Standard Graph

2.4 TEST PROCEDURE

Initially stock nitrate solution is prepared by using Potassium Nitrate. From this solution, desired standard solutions were prepared. Using these standard solutions in Spectrophotometer, a standard curve is prepared. By this standard curve, which is mainly based on absorbance at particular wavelength of 220nm, a nitrate concentration can be found.

3. RESULTS

3.1 EFFECT OF ADSORBENT DOSAGE

100ml water sample was taken in a 7 conical flasks and varying dosage of adsorbent was added to each of them i.e. 0.1g, 0.5g, 1g, 1.5g, 2g, 2.5g and 3g respectively. They were allowed to mix properly in agitator for 1 hour at 180 rpm.

Initial concentration = 100 ppm

Dosage (g)	Nitrate concentration after treatment (ppm)	% removal of nitrate
0.1	45.29	54.71
0.5	11.15	88.85
1	22.70	77.30
1.5	13.58	86.41
2	0.94	99.06
2.5	7.4	92.6
3	11.7	88.3

Table 2: Effect of adsorbent dosage

From the table, it is clear that the maximum removal of nitrate was found to be 99.06% with the remaining nitrate concentration of 0.94 ppm and it occurs at the adsorbent dosage of 2g.

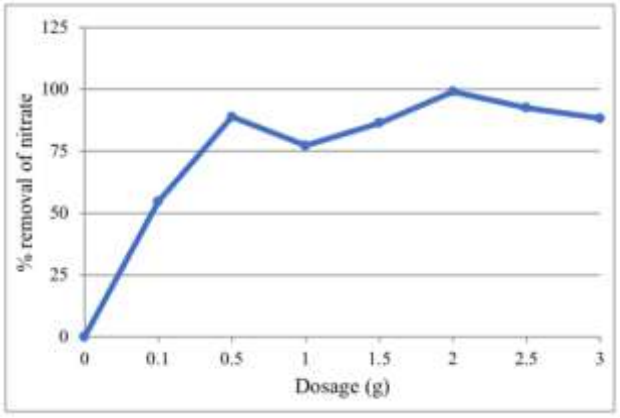

Fig 4: Effect of adsorbent dosage

From the graph, the nitrate removal efficiency was found to be maximum for the adsorbent dosage of 2g and the efficiency was found to be 99.06%.

3.2 EFFECT OF CONTACT TIME

100ml of water sample was taken in 4 conical flasks and 2g of adsorbent was added to each of them and allowed to mix in agitator for different time interval i.e 30 mins, 60 mins, 90 mins and 120 mins respectively.

Initial concentration = 100 ppm

Time (mins)	Nitrate concentration after treatment (ppm)	% removal of nitrate
30	9.15	90.85
60	0.96	99.04
90	6.79	93.21
120	7.86	92.14

Table 3: Effect of contact time

From the table, it is clear that the maximum removal of nitrate was found to be 99.04% with the remaining nitrate concentration of 0.96 ppm and it occurs at 60 mins.

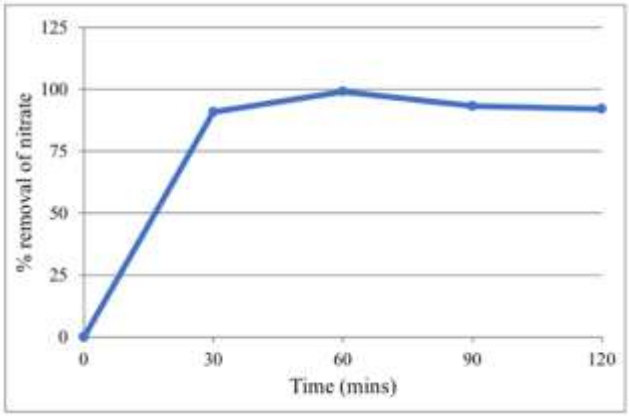

Fig 5: Effect of contact time

From the graph, it is clear that the removal of nitrate goes on increasing with time and reaches maximum and further increase in time decreases the efficiency of nitrate removal. It is found that the maximum removal efficiency was observed at 60 mins and the efficiency was found to be 99.04%.

4. CONCLUSIONS

- The rice husk can be used as an effective adsorbent to remove nitrates from water.
- It is found that characteristics of adsorbent such as its finess, etc. also affects the efficiency.
- It is found that adsorption increases with increase in the surface area.
- The efficiency of nitrate removal from water with activated rice husk has shown to be very efficient and cost effective.
- Nitrate removal from activated rice husk was maximum for adsorbent dosage of 2g and contact time of 60 mins.
- The maximum removal of nitrate from water was found to be 99.05%.
- The removal of 100mg/l nitrate from water using 2g adsorbent in 60 minutes with the efficiency of 99% will cost Rs 1.2

REFERENCES

1. E. Kowsalya, Mayukh Gangopadhyay, S. Sharmila, L Jeyanthi Rebecca "Reduction of Nitrate Level using Low
2. L. Shao, Z. X. Xu, W. Jin, H. L. Yin "Rice Husk as Carbon Source and Biofilm Carrier for Water Denitrification", Vol. 18, No. 4 (2009), 693-699 (2009)
3. Wasse Bekele, Gezahegn Faye and Nestor Fernandez "removal of nitrate ion from aqueous solution by modified ethiopian bentonite clay", IJRPC 2014, 4(1), 192- 201, ISSN: 2231-2781 (2014)
4. B. Kamarehie, E. Aghaali, SA. Musavi, SY. Hashemi, A. Jafar "Nitrate Removal from Aqueous Solutions Using Granular Activated Carbon Modified with Iron Nanoparticles", IJE TRANSACTIONS A: Basics Vol. 31, No. 4, (April 2018) 554- 563
5. Mansooreh Dehghani, Samaneh Shahsavani, Narges Shamsedini, and Mohammad Reza Javaheri "Removal of Nitrate from Aqueous Solution Using Rice Chaff", 2015 October; 6(5): e22843.
6. Layla Abdulkareem Mokif, Noor Alaa Abdulhusain, Shaymaa Obayes Hussein AL- Mamoori "The Possibility of Using the kiwi
7. Peels as an adsorbent for Removing Nitrate from Water", Journal of University of Babylon, Engineering Sciences, Vol.(26), No.(2): 2018.
8. Archna, Surinder K. Sharma, and Ranbir Chander Sobti "Nitrate Removal from Ground Water: A Review", ISSN: 0973-4945; CODEN ECJHAO E-Journal of Chemistry http://www.ejchem.net 2012, 9(4), 1667-1675.
9. M Suneetha and K Ravindhranath "removal of nitrates from polluted waters using bio-adsorbents", ISSN 2250- 3137 www.ijlbpr.com Vol. 1, No. 3, July 2012 © 2012 IJLBPR.
10. Gowtham Balasundaram, Dr Ananthasingh T.S, and Dr Anuragkandya "Removal of Nitrate from Ground Water Using Neem Leaves as Adsorbent", (ACBES-2017) May 22-24, 2017
11. Prabhat Kumarr Tiwar, Sanjay Saraswat, Ajeet Kumar, Dr. A.K. Saxena, Neha Surya "Waste Water Treatment by Unconventional Adsorbents", IJSRD - International Journal for Scientific Research & Development| Vol. 4, Issue 04, 2016 | ISSN (online): 2321-0613.
12. Lizmol A. Peechattukudy, R.M. Dhoble "Removal of Nitrate from Water by Adsorption – A Review", IJSTE - International Journal of Science Technology & Engineering | Volume 3 | Issue 09 | March 2017 | ISSN (online): 2349-784X.
13. Mohammad Hassan Shahmoradi, Behnoush Amin Zade, Ali Torabian and Mahdi Seyed Salehi "removal of nitrate from ground water using activated carbon prepared from rice husk and sludge of paper industry wastewater treatment", VOL. 10, NO. 17, SEPTEMBER 2015 ISSN 1819-6608.

BIOGRAPHIES

SATWIK T.S

Post Graduate Student
Dept. of Civil Engineering
BIET College, Davangere

Dr. H.B.ARAVINDA
Head of the Department
Dept. of Civil Engineering
BIET College, Davangere