



Low Cost Nitrate Attenuation

Suraj Kumar S. & H. S. Ramesh, India



Preamble

Water is one of the most important commodities required to sustain life. The public has been more exacting in its demands and today water engineers are expected to produce finished water that is free from colour, turbidity, taste, odour and inorganic salts such as nitrates and few organic chemicals. Nitrate is both a natural and a synthetic ion. Under natural conditions, nitrate usually does not occur in drinking waters at levels which are concern to water utilities. However, heavy use of nitrate fertilizers, septic tanks for sewage disposal or animal feed-lot may cause high levels of nitrates in soil. Rainfall then washes the nitrate from soil into streams and groundwater which might then contaminate these sources of drinking water supplies. Nitrates can cause methemoglobinemia and interferes with the ability of the body in transport and distribution of oxygen to body cells.

Objectives

- To study the attenuation property of rice husk.
- Intensive experimental study on nitrate removal using low cost efficient media.
- Analytical study on the behaviour of nitrates in the media.

Experimental Methodology

Rice husk was selected as low cost material for this study. A tubular column provided with sampling points, a peristaltic pump, Sand (1 mm size), Rice husk (1 mm size), and Gravel (5 mm size). The tubular column fabricated for the experiment was a cylindrical column of 6.35 cm (2.5 inches) diameter with a height of 1m. Five sampling ports were provided in the column for sample collection at different depths when required. Both the ends of the cylindrical columns were open and stoppered with a cork with glass tubes fitted in them sufficient enough in diameter for the sample to enter and leave. A peristaltic pump was calibrated and using silicon tubes the sample stored in bucket was pumped into the column containing the media. Sand and rice husk are sieved to a size of 1mm, gravel of 5 mm size is used for experimental setup.

The rice is husk mixed with some percentage of sand

as rice husk is a low dense material. This was done to achieve better compaction. The rice husk and sand media was filled to a depth of 30 cm. Initially 50% rice husk and 50% sand were filled as the media. A constant head of 10 cm was maintained above the media using the peristaltic pump. The outflow rate was checked by collecting the sample in a beaker at an interval of one minute. The samples were also analyzed for nitrate concentration.

The same procedure was followed for the following media:

- a. 40%rice husk and 60% sand.
- b. 35% rice husk and 65% sand.
- c. 20%rice husk and 80% sand.
- d. 10%rice husk and 90% sand.

The outflow rates and the nitrate removal are compared in each case.35% rice husk and 65% sand was fixed to be efficient percentage of the media to be used.

To find the optimum depth, the detention time of the solution in the media and the amount of nitrate removal are the important parameters. The media was filed in the tubular column and a constant head of 10cm was maintained on the media. The depth of the media was varied to 60cm, 45cm, 30cm, 20cm and 10cm. At each depth, the outflow rate was calculated. The nitrate concentrations in the samples at different depths were experimentally calculated. The nitrate removal was estimated by taking the difference in concentrations before and after passing through the media. It was found that optimum depth for removal of nitrates was 20cm.

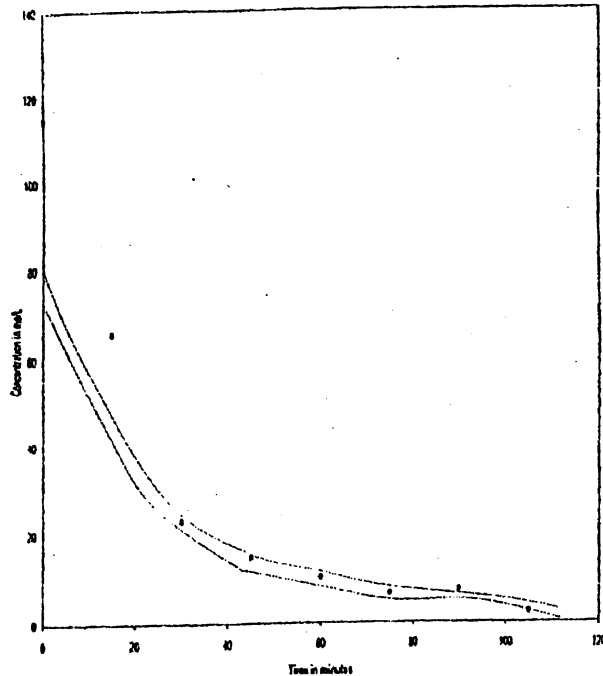
A contact weight of 3 grams of rice husk was taken in the conical flasks and nitrate solution was simulated. 50 ml of the solution was kept for agitation along with the contact weights and nitrate concentrations of each was noted after every ten minutes. The removal of nitrates was significant and hence it was concluded that the media is responsible for the removal nitrates.

Studies on nitrate removal were conducted on the simulated sample and the field sample obtained from a nitrate contaminated sample from a hand pump. Further the graphs were plotted based on the observations. Interpretations on behaviour of nitrates in the media were arrived at. The media was tested for degradation and was found that it degrades within five days. The

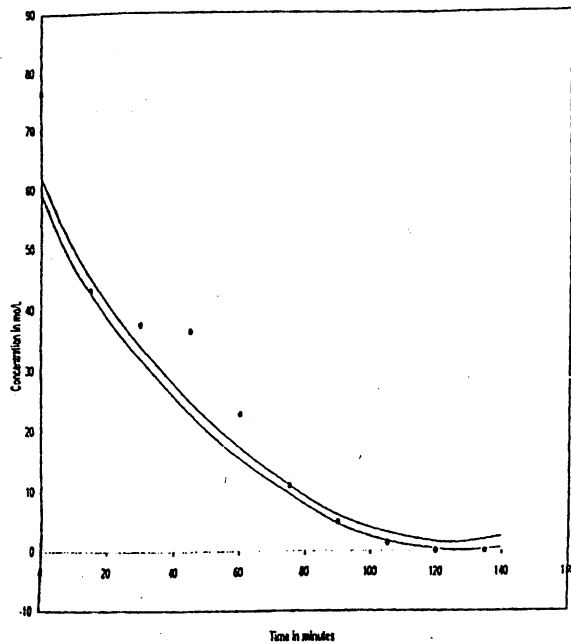
graphs below depict the adsorption studies, nitrate removal through the media with respect to time (simulated sample) and nitrate removal through the media with respect to time (field sample) respectively.

From the behavioural plots above it is clear that the nitrates are removed from nitrate contaminated media with the help of the media. An equation was arrived at based on the behavior of the graphs.

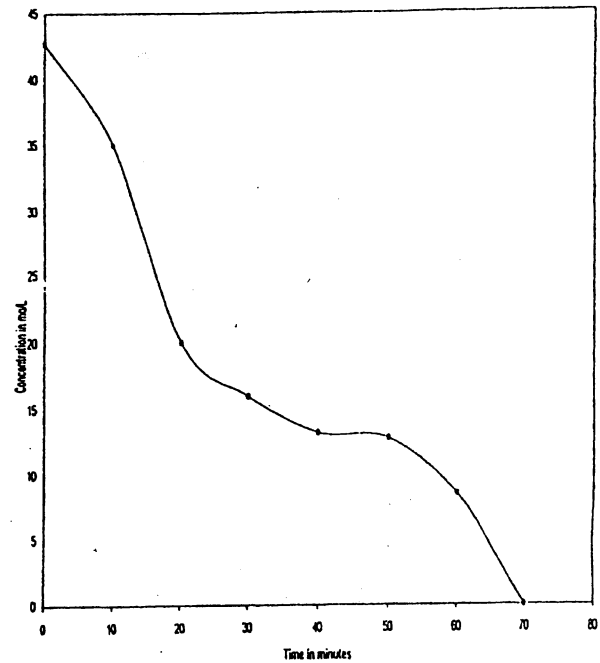
Nitrate Removal (Simulated Sample)



Nitrate Removal (Field Condition)



Adsorption Studies (Nitrate Removal)



The equation is of the form:

$$Y = Y_o + Ae^{((-X_o + X)/t)}$$

Where,

Y = Time required for the nitrate removal to X mg/L.

$Y_o = 0$, $X_o = 0$, A and t are constants.

X is the required concentration of nitrate in mg/L.

Conclusions

- The media is efficient in removal of nitrates.
- It can be used for moderating groundwater contaminated with nitrates.
- Media degrades on retainment of moisture for a few days.

Recommendations

- The media can be used as a household filter for treatment of water from nitrates.
- Rigorous studies on rice husk may be carried out on various other critical inorganic parameters.

Limitations

- There is a possible degradation of the media, if the moisture is prevalent for a long period without constant run.

SUJIT KUMAR S., Final year student, Department of Environmental Engineering, SJCE, Mysore.

H. S. RAMESH, Professor, Department of Environmental Engineering, SJCE, Mysore.