ABSTRACT

With increasing demand for reducing pollution and treating polluted water, researchers are trying out various technologies to purify water effectively and at economical cost. The entire research was initiated from the findings on the basis of the detailed chemical analyses of a large number of ground water samples collected in and around Bangalore. These water samples were thoroughly examined for different impurities and it was concluded that for a number of water samples, the concentrations of nitrate were found to be more than permissible. The present study was, therefore, aimed to remove nitrates from ground water. Reverse osmosis and Electro-dialysis techniques, which are normally adopted in practice to remove nitrates from water, are generally found to be quite expensive. The work presented in this thesis is an attempt to remove nitrates from ground water using biological denitrification which is equally effective and much more economical. In the biological denitrification, with the employment of a number of micro-organisms, nitrate present in the water is first converted to nitric oxide, and subsequently to nitrous oxide. Finally, nitrogen gas is allowed to be formed and then expelled from the water. Bacteria those are known to denitrify the water have been found to be generally more effective either in the absence of oxygen or in the presence of a very small quantity of oxygen. From the literature survey, it has been noticed that a number of bacterial species, such as genera of Bacillus, Chrombacter, Paracoccus, Corynebacterium, Pseudomonas, Spirillum, Thiobacillus and Xanthamonos, have been generally identified as possible denitrifiers. Heterotrophic microbes are generally used to denitrify water using ethanol, methanol, sucrose, cellulose and fructose, as the possible carbon source. Recently, the interest has been shifted to using natural cellulose rich carbon sources for achieving biological denitrification. Keeping this in view, in the present thesis, by using two different Pseudomonas strains, namely, Pseudomonas flourescence and Pseudomonas stutzeri, biological denitrification was carried out by taking raw cotton fiber as the carbon source. A numbers of batch studies, for both the strains, were performed over a period of twelve days for each selected cotton consumed to nitrogen in nitrate removed ratio (mg/mg) to assess the appropriate carbon to nitrogen ratio for the growth of the microorganism and to monitor the extent of denitrification achieved, and
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(iii) to assess the optimum conditions needed for the suitable functioning of the entire process of denitrification.

The data from the batch studies showed that optimum cotton consumed to nitrogen in nitrate removed ratio (mg/mg) ratio was around 3 for both the microbial strains. It was also found that the microbial strains followed Monod Growth kinetics and the limiting substrate for the growth of microbial strains was nitrate. The Dry Cell Mass to be maintained in the continuous reactor was found to be below 1 DCM/l. The process was modeled to check the suitability of Monod growth kinetics using regression analysis.

The results obtained from the batch studies were implemented in a Heterotrophic Denitrification Reactor (HDR) column which was packed with chosen mass of cotton which was inoculated with microbial strain. In HDR column, denitrification process was carried out at different flow rates and at different temperatures. Each experiment in HDR column was monitored for a period of 90 days. It was found that both the microbial strains can be used to achieve an average efficiency of above 85% to remove nitrate. The optimum flow rate was found to be 7.5 ml/minute for the strain of *Pseudomonas flourescence* and 5.0 ml/minute for the strain of *Pseudomonas stutzeri*. The optimum temperatures were found to be 30±1°C and 40±1°C for *Pseudomonas flourescence* and *Pseudomonas stutzeri* strains, respectively.

The experimental results from HDR column at different flow rates and temperatures were also simulated using Response surface methodology. It was seen that the model predicted the actual response to a satisfactory extent.

Based upon the research study, of biological denitrification, used in this thesis, a design methodology for continuous filter has been developed and discussed. It is expected that the study will be helpful in implementing the technique for the removal of nitrate from ground water on a commercial scale.