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ORIGINAL PAPER

Removal of nitrate and COD from wastewater using denitrification process: kinetic, optimization, and statistical studies

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Abstract Denitrification process studies were carried out for removal of N–NO_3^- and organic carbon from waste water. Recent researches have shown the efficacy of N–NO_3^- removal process from synthetic waste water; however, they are lacking the data related to kinetics and optimization that may aid in developing guidance for field-scale implementation. Various incubation parameters were varied such as nitrate and carbon source keeping biomass concentration invariable. For nitrate variation two different nitrates were used such as potassium nitrate (KNO_3) and calcium nitrate [$Ca(NO_3)_2$] and for organic source glucose ($C_6H_{12}O_6$) and sodium acetate (CH_3COONa). The denitrifying bacteria were isolated from agricultural soil. The dentrification rates increased with the increase of nitrate as well as organic source. The denitrification rates were faster in case of CH_3COONa compared to $C_6H_{12}O_6$. The regeneration time was also calculated which varied 1–3 days. Analysis of variance studies indicated that both nitrate and organic concentrations played significant role in terms of dentrification as well as emission of nitrous oxide (N_2O) rates. Principal components analysis studies were also carried out. Optimization studies were carried out using response surface model to evaluate the incubation parameters to minimize the N_2O emission and at the same time maximize the removal efficiency of N–NO_3^- and COD.

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Introduction

Water is the source of life, and it plays an important role in supporting the life system. Due to increase of population, industrialization and agricultural activities the overall quality of water is in wane. The water is gradually being contaminated with various pollutants such as inorganic as well as organic nitrogenous compounds originating from agricultural and human activities. The toxic metal ions released from metallurgical activities along with organic compounds produced due to urbanization and industrial activities leads to the water contamination. The wastewater containing nitrogenous and organic compounds results in eutrophication, biochemical oxygen demand increase and thereby decreases the existence of water bodies.

Due to high solubility of nitrogen compounds in water, it cannot be removed chemically by precipitation. Wastewaters containing nitrogenous compounds are habitually treated bio-chemically by nitrifying as well as denitrifying bacteria (Kampschreur et al. 2009; Koren et al. 2000). Denitrification is a primary biological process in which nitrogenous compounds (oxidized) were reduced to atmospheric nitrogen (N_2) gas as a final product. In the denitrification process, the bacteria use NO_3^- or NO_2^- as an electron acceptor during respiration mechanism. The electron donor in the overall process for the heterotrophic microorganism are organic substrates such as acetate, various poly as well as monosaccharide's, organic acids like oxalic etc. (Pant et al. 2010; Rabaey and Verstraete 2005). The waste water emerging out of domestic, food processing, fermentation including sugar mills and poultry

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