BIOLOGICAL DENITRIFICATION OF WASTEWATER USING A HYBRID REACTOR

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by

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Certificate

This is to certify that the thesis entitled "Biological Denitrification of Wastewater Using a Hybrid Reactor" being submitted by Mr. S.Bhuvanesh is worthy of consideration for the award of the degree of Doctor of Philosophy. The thesis has been prepared under my supervision and guidance in conformity with the rules and regulations of Indian Institute of Technology Delhi and is a record of the original bonafide research work. The results presented in this thesis have not been submitted in part or full to any other universities or institutes for the award of any other degree or diploma.

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(S.BHUVANESH)

Abstract

In this work, denitrification of wastewater using a hybrid anaerobic reactor, developed at the Waste Treatment Laboratory in the Department of Biochemical Engineering and Biotechnology, IIT Delhi, under anoxic conditions has been studied.

The effect of wastewater characteristics, reactor operating conditions and reactor geometry on granulation and denitrification has been studied. The long start-up period, observed in several other systems using granular biomass, was not observed in the hybrid reactor. The reactor was able to handle a nitrate loading rate of 50 g NO_3-N/m^3.day at the end of 3 days start-up. At the end of 15 days, almost spherical granules with a settling velocity of 1.5 cm/s and a mean diameter of 0.5 mm were produced. By stepwise increment of the influent nitrate concentration, the removal rate reached 740 g NO_3–N/m^3.day with a removal efficiency of almost 100% at a hydraulic retention time of 6 h or higher. For complete denitrification, the ratio of the organic substrate required to the amount of nitrate nitrogen removed was as low as 2.2 g COD/g NO_3–N. The study was extended to a nitrified toxic industrial effluent. Denitrification was on par with the synthetic wastewater and efficiency of more than 95% was achieved.

To understand the cause of rapid start-up in the hybrid reactor, present knowledge of the granulation process has been reviewed and based on the experimental observation during the study, a hypothesis for the mechanism of granulation has been presented.

Finally, based on the data obtained with the laboratory-scale hybrid reactor, a mathematical model has been developed for the reactor. The model combines the biofilm flux and the bed fluidization to predict the reactor dimensions, substrate concentration along the reactor height and the fluidized bed height required for complete denitrification.

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