A STUDY ON PERFORMANCE OF ANAEROBIC EXPANDED BED REACTOR TREATING HIGH STRENGTH WASTE

by

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Submitted

In fulfillment of the requirements of the degree of Doctor of Philosophy

to the

INDIAN INSTITUTE OF TECHNOLOGY, DELHI

JULY 2000

Dedicated to

my beloved parents and wife

CERTIFICATE

This is to certify that the work which is being presented in the thesis entitled **"STUDY ON PERFORMANCE OF ANAEROBIC EXPANDED BED REACTOR TREATING HIGH STRENGTH WASTEWATER"** is an authentic record of experiments carried under my supervision.

It is further certified that the work presented in this thesis has not been submitted for the award of degree or diploma elsewhere. He has worked for an effective period of more than six years to complete this work.

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ACKNOWLEDGEMENT

It is with great pleasure that I express my profound gratitude for my supervisor Prof. B.K. Guha for his invaluable and consistent guidance throughout my research work. Without his affectionate involvement and help at all stages of the work it was not possible on my part to accomplish the task, his contribution is gratefully acknowledged.

I am extremely thankful to the Chemical Engineering Department, IIT Delhi for providing necessary research facilities during the course of this investigation, Prof. V.K. Srivastava, Prof. D.Subba Rao, Prof A.K Gupta, Prof. A.N Bhaskarvar and Dr. A.K. Saroha for their helpful and positive approach towards the study,

I wish to put on record my gratitude to authorities of JMI University, my parent organization, for providing me the opportunity to undertake this research work.

I am extremely grateful to all the members of my family especially my father Syed A. Salam whom I lost forever and Prof. Mukesh Khare Civil Engg. Department, IIT Delhi who have constantly been a source of inspiration for me.

I am thankful to my colleagues M. Muthukrishnan, Kanthi K. Verma and A. A. Khan and others for the support they offered and help they provided.

Finally, I reserve my affectionate appreciation for my wife and sons for the hardships they have shared during the course of this work.

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ABSTRACT

In India meat production has not yet attained the status of an industry. Most of the 3600 slaughterhouses in the country are poorly managed with respect to waste handling and disposal and thus offer the potential threat to the environment. Till now this wastewater has been treated by physico - chemical processes and only few instances are found where biological treatment especially anaerobic treatment is offered. Use of anaerobic expanded bed in treating this waste thus opens up a new area for development.

In the present study, anaerobic expanded bed reactors using granular activated carbon (GAC) and anthracite coal (AC) as support media have been investigated. The two different waste feeds used for operating the reactor were synthetic glucose mixture and slaughterhouse waste representing a complex concentrated waste.

During the batch assay test with slaughterhouse effluent, extremely slow rate of gas production was observed in some cases. This prompted detailed analysis of the effluent. This analysis revealed the presence of phenol in waste. It was due to the use of phenol based disinfectant in floor and tank washings. Further samples of slaughterhouse effluent were collected in such a manner that they were free of phenol. However, in order to study the effect of the presence of phenol,

experiments were carried out with varying concentration of phenols in this wastewater.

The sludge obtained from okhla sewage treatment plant anaerobic digester required an acclimation period of about 8 days , thereafter increasing the specific sludge activity to a maximum of 0.3 kg COD/Kg VSS-hr. Almost similar activity was noted in case of AC medium, while for GAC the activity was significantly higher at 0.48 kg COD/Kg VSS-hr. The rise in activity in case of GAC was linear during the acclimation period. At the test termination the percentage of biomass accumulated over was maximum. Also in the batch experiments initial colonization with anaerobic microbes was high in case of GAC as compared to AC.

The initial results on slaughterhouse effluent in suspended media show that the degradation rates pick up after initial time lag. Similar time lags were also visible in case of GAC and AC culture medium. With increase in period of acclimation the increase in activity was observed in all the three batch assay tests. It is noted that the time lag required in case of GAC is minimum compared to other two cases. The unusually high time lag prompted to analyze the waste thoroughly. It was found that the presence of phenol concentration was in the range of 400-800 mg/l. This contributed to large time lags.

In experiments where phenol was excluded from the feed an acclimation period required to achieve maximum specific activity was also minimum in case of GAC as compared to the other two i.e. suspended culture and AC support and was much less than that when phenol was present. Once it is properly acclimated, the presence of phenol upto 800 mg/l was found to cause no inhibition effect on anaerobic degradation in case of GAC supported system. However, in the other two cases of AC support and suspended medium similar effects were observed upto 400 mg/l of phenol only.

From these experiment it was established that initial adsorption of phenol takes place even when biofilm/colonization exists on GAC particles. On the other hand results showing the higher time lag and increased toxicity in case of AC particles indicate no adsorption but only biodegradation of phenol as indicated by higher volume of cumulative gas production.

In all the experiments related to initial colonization, the biomass accumulation was maximum on GAC medium. This was also indicated by the replicates analyzed. Also the ratio of attached biomass to suspended biomass is more than one in case of GAC and less than one in case of AC at the test termination.. It may be concluded that the adsorptive property of GAC and the concentration of soluble organic matter at the liquid/solid interface stimulate biogrowth and assimilation.

In AC support reactor the startup times were about 3-4 weeks and maximum treatment efficiency obtained at steady state was 69%. The rise in the suspended biomass layer was about the same as in GAC reactor.

While operating the GAC and AC reactor with feeds mixed with phenol, it was observed that after initial maximum removal rate of COD it declined and the outlet stream reached a steady concentration value. It is seen here that biodegradation was superimposed by a time depending mechanism i.e. adsorption. The lower degradation rate of the carbon system, despite higher biomass concentration, sustains the assumption that the inhibitory effect was imparted, At any stage the gas production and COD reduction was more in GAC reactor that in AC medium showing bioregeneration of carbon.

The reactors were shut for varying periods to study operations in non steady state operating time. In case of the GAC reactor the startup was more rapid as compared to AC reactor. Also reactor stability was excellent in spite of variations in organic loading. The recovery of process efficiency after fluctuations was observed to take less than a day.

The contribution of suspended biomass layer towards the overall rate of reaction was estimated by adjusting the extent of expansion so as to draw out the total layer. At the adjusted COD loading (due to reduced biomass) it was observed that the outlet COD concentration increased and similar increase in fat concentration was observed. It was confirmed that this flocculent layer was primarily responsible for the removal of fats and hence provides better overall COD reduction.

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