MUNICIPAL LANDFILL LEACHATE TREATMENT USING LEACHATE RECIRCULATION, UASBR AND CONSTRUCTED WETLAND

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By

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CERTIFICATE

This is to certify that the thesis entitled "**Municipal Landfill Leachate Treatment Using Leachate recirculation, UASBR and Constructed Wetland**" submitted by Rajesh Taneja to the Indian Institute of Technology Delhi, for the award of the Degree of Doctor of Philosophy, is a record of bonafide research work carried out by him under our supervision. The thesis work, in our opinion, has reached the standards fulfilling the requirements for the degree of Doctor of Philosophy.

This is further certified that the research report and results presented in this thesis have not been submitted in part or in full to any other university or institute for the award of any degree or diploma.

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ABSTRACT

Objective of the present research work was to develop an integrated process to treat municipal landfill leachate with Upflow anaerobic sludge blanket reactor (UASBR) alongwith recirculation and to further treat the effluent with constructed wetland. The specific scope of the work was to investigate the leachate recirculation using single-pass and multi-pass recirculation of the leachate. Field setup consists of a recirculation column and a UASBR at the Okhla landfill site. Another experimental setup was operated in the laboratory at IIT Delhi which consisted of a UASBR and a number of constructed wetlands with macrophytes like Typha and Cannaalongwith a control unit having no macrophytes. Variation in COD, biodegradability (COD/BOD_5), heavy metals, alkalinity and pH were observed. The recirculated and diluted leachate (leachate + recirculation + sewage) was treated by UASB process at Okhla landfill site and at IIT Delhi site. The effect of hydraulic retention time (HRT) was observed. Wetland efficiency was evaluated for the treatment of the UASBR effluent by observing COD, pH, and alkalinity. The results have been presented by figures, tables and Box whisker plots for the explanatory statistical analysis.

The recirculation of leachate was addressed by passing the leachate repeatedly (multi-pass) through the same column so as to ascertain the changes in BOD_5, COD and BOD_5/COD. Single pass leachate was used to prepare the feed for the UASB by mixing it with screened domestic sewage. The reactor was started in the month of January 2009. Initially for two months reactor was operated using raw sewage from Okhla sewage treatment plant, and subsequently switched

to leachate and sewage (80%+20%). Hydraulic retention time (HRT) was 24h and reactor was operated under ambient temperature conditions. Average COD removal was 70% (60-73%). The organic loading rate (OLR) was 1.6-1.8 kg COD/m^3d. However, in the present case leachate used for UASB treatment had 0.15-0.35 BOD_5/COD ratio. Higher BOD_5/COD ratio could have given better COD removal efficiency.

UASB reactor at IIT Delhi was installed, so as to study the treatment process more precisely. This UASB reactor was fed using a mixture of single pass leachate obtained from Okhla landfill site and screened sewage from Okhla sewage treatment plant. COD of the feed was approximately 1500mg/L. After initial start-up, reactor was operated at different HRTs, i.e. 12, 24, 36 and 48h. Reactor was operated for about 12 months. Data is accordingly presented for 0-352 days. It is evident that there is substantial removal of COD by the UASB reactor. Results observed have supported the functional relationship between COD removal and HRT obtained from the experiments conducted for long durations (352 d). Heavy metals were monitored, both in the influent and effluent to the UASB.

Constructed wetland (CW) was used to treat the effluent from the UASBR at IIT Delhi site. Effluent from the UASB reactor was passed to control unit (without vegetation), constructed wetlands with Canna (CWC) and constructed wetland with Typha (CWT). pH, alkalinity and COD of influent and effluent from the constructed wetland for all 3 units, i.e. CW, CWC and CWT were monitored. The HRT for wetlands is reported in terms of empty bed residence time. Flow rate through the constructed wetlands was 8 L/d. Total volume of each unit was 40L (media + roots), so HRT was 5 d. Probably higher HRT may result in higher COD removal.

Constructed wetland consists of packed media reactor, packed with gravel and plant roots, which may act as filter. Suspended solids were measured as turbidity. It is evident that turbidity removal is excellent which is added advantage of using constructed wetlands.

On site recirculation has established the utility of recirculation to reduce the organic and metal load for the main biological treatment system. UASB based pilot plant at the Okhla landfill site was first of its kind in India. Operational parameters and efficiencies obtained, which will provide basis for the design of full scale plant. HRT has been optimized, 24-36h, HRT can be used to design UASB to treat leachate. Dilution of leachate using sewage could provide an economic alternative. UASB can be satisfactorily operated at 1.5 kg/m^3d. Constructed wetland has emerged as a secondary or tertiary treatment for the leachate treatment. Both, Canna and Typha can be used in the constructed wetlands. Constructed wetland at 5 d HRT (empty bed residence time) could bring COD to 80-120mg/L. Finding suggests that combination of recycle of leachate, UASB and constructed wetland could be considered a novel technology since energy consumption is minimal as a result of use of anaerobic process and natural process. There is sufficient data available as part of this work, so as to install an integrated plant for the treatment of municipal landfill leachate.

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