

APPLICABILITY OF UASB REACTOR FOR LEACHATE TREATMENT: A CASE STUDY FOR OKHLA LANDFILL

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Abstract

This study reports applicability of Upflow Anaerobic Sludge Blanket (UASB) reactor to treat the leachate from a municipal landfill located in Delhi. The effect of feed composition for the treatability of leachate was evaluated. A 2.8 l reactor was operated at an organic loading rate (OLR) of 3.00g chemical oxygen demand (COD)/l-d corresponding to a hydraulic retention time (HRT) of 12 h under continuous feeding for over 8 months. Varying concentrations of leachate were mixed with synthetic wastewater on the basis of COD. The raw leachate samples were collected from Okhla landfill site. Average COD of the leachate varied between 8,880 and 66,420 mg/l during the study period. Leachate was suitably diluted to achieve the desired organic load. Synthetic feed was prepared, using sucrose and leachate from the Okhla landfill site. After the start up period of two months, concentration of leachate was steadily increased from 30 to 80%, resulting in corresponding decrease of sucrose in the feed. The removal efficiency of soluble COD ranged between 91–67% for fresh leachate and decreased drastically from 90 to 35% for old leachate. After stabilization, the reactor was re-fed with 60% leachate and this concentration was increased up to 70%. The efficiency varied from 81–65%. The reactor performed more efficiently for the treatment of fresh leachate as compared to old leachate.

Keywords: Municipal landfill, leachate treatment, UASB reactor

Introduction

Landfill leachate emerging from landfill areas are wastewaters posing a threat for the environment. Leachate is high strength wastewater that contains high concentration of organic matter, ammonium nitrogen, heavy metals and contains some hazardous organic chemicals. Therefore it cannot be directly introduced to any disposal site and its collection and treatment are necessary to avoid any possible future environment hazard. Attributing to the varying characteristics of leachate, its combined treatment with domestic sewage makes it more feasible (Diamadopoulos *et al.*, 1997).The

present study focuses on the combined treatment of leachate with domestic sewage, by biological process, in particular by anaerobic process viz; UASB reactor.

Methods

The 2.8 l UASB reactor was constructed of plexi-glass and seeded with 1.5 l of anaerobic sludge. The feed was prepared by mixing synthetic wastewater and leachate collected from Okhla landfill. This study was carried out for 141 days. Leachate samples, collected at different time periods were treated during the study. Since, the characteristics of leachate varies significantly with time which also affects its treatability, the entire operation period was divided into four phases, namely, A (day 0–38), B (day 39–114), C (day 115–124) and D (day 125–141). Each phase represents different leachate used for the treatment. The reactor was operated at a HRT of 12 h corresponding to an OLR of 3 Kg COD/m³-day. During the start up period of two months, reactor was fed only with synthetic wastewater. Later leachate was introduced at 30% and increased in steps of 10% on COD basis, resulting in corresponding decrease of Sucrose in the feed. The reactor was monitored daily for temperature, pH, alkalinity, COD and flow rate.

Results and discussion

Figure 1 presents the variation in COD removal, pH and alkalinity with the change in Leachate concentration in feed. Efficiency of the reactor was evaluated in terms of COD removal.

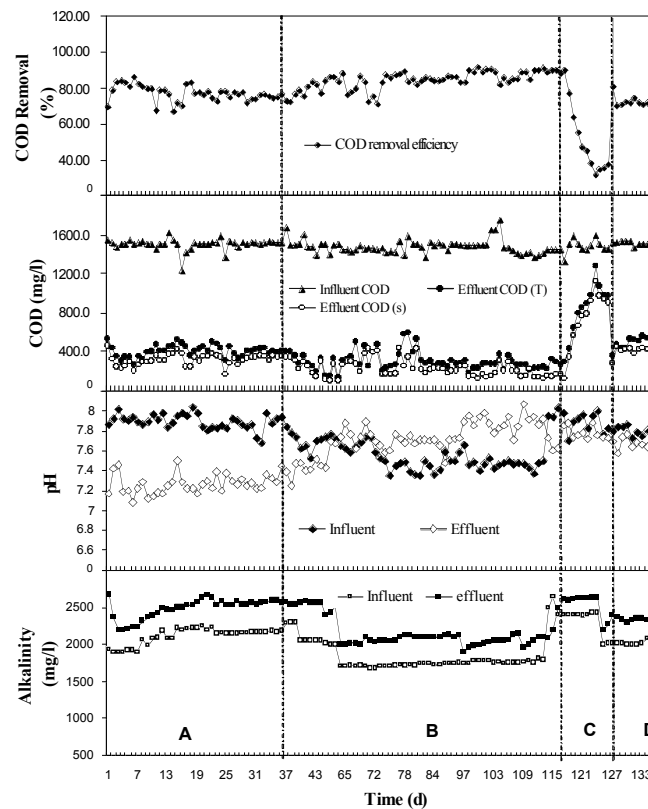


Figure 1. Performance of UASB reactor. (a) variation in COD removal efficiency; (b) variation in total(T) and soluble(S) COD in influent and effluent; (c) variation in pH; (d) variation in alkalinity. Phase: (A) day 0 – 38; (B) day 39 – 114; (C) day 115 – 124; (D) day 125 – 141

With 30% leachate in feed, efficiency remained higher than 80%. Later, as the leachate concentration in feed was increased from 30 to 70%, efficiency gradually decreased from higher than 80 to 75%, and remained at steady state with nearly 75% COD removal efficiency [Fig. 1(a), phase A]. The reactor efficiency reached a maximum of 91% during the study phase B, and was attributed to the use of fresh leachate in this phase. The reactor performance in this phase was found similar to the results of a UASB reactor fed on leachate (Kalyuzhnyi *et al.*, 2003). A sharp decline in the COD Removal efficiency occurred after day 114 [Fig. 1(a), phase C]. This is probably due to the old leachate with low COD used in the feed. Since the leachate had low COD, more quantity of leachate was used in order to maintain the OLR. This excess of leachate in the feed solution, proved to be highly toxic for the microbes, thereby reducing their activity, resulting in sharp decline in reactor efficiency from 90–35%. After phase C, the reactor was stabilized for nearly 1 month with only synthetic wastewater in feed. Leachate was again introduced in feed at 60% organic load which increased upto 70%. Efficiency varied between 81–65% during this phase (D).

Figure 1(c) presents the variation in pH of influent and effluent. The pH of the reactor was controlled by supplementing bicarbonate alkalinity to the feed. Throughout the study, effluent pH ranged within 7.0–7.75, which is appropriate for the growth of methanogenic bacteria. The Influent pH remained in the range of 7.5–8.0 being higher than the effluent pH except for period of days 39–114 [Fig. 1(c), phase B]. This may be due to the low pH 6.12, of the fresh leachate used during this operation period, which caused the decrease in pH of the feed and thus kept the influent pH, lower than the effluent.

Figure 1(d) presents the variation in influent and effluent Alkalinity. In the UASB reactor, the short chain fatty acids produced in the lower portion of the sludge bed, during the initial stages of acidogenesis, are converted to CH₄ and CO₂ in the upper part of the sludge bed, thereby increasing the alkalinity (Bal and Dhagat, 2001). The higher effluent alkalinity, indicates, efficient methanogenesis in the upper portion of the sludge bed. Similar result for increase in effluent alkalinity was reported by Kettunen and Rintala (1998), for a leachate fed, UASB reactor.

Conclusions

The objective of this study was to evaluate the effect of feed composition, for the treatment of municipal landfill leachate, by UASB reactor, under varying temperature conditions. The reactor attained maximum COD removal efficiency of 91%, for the treatment of fresh leachate, whereas, efficiency declined sharply from 90–35% while treating the old leachate. The organic loading rate and treatment efficiency were comparable to previous literature for leachate treated by a UASB process (Kalyuzhnyi *et al.*, 2003). Based on this and a long duration of constant removal efficiencies, it can be concluded that the UASB reactor operated successfully in treating the municipal landfill leachate, except for the operation period of days 115–124, when the reactor showed signs of system failure, characterized by a sharp decrease in COD removal efficiency. This indicates that, the process is likely to perform more efficiently with fresh or diluted leachates.

References

- Bal, A. S., and Dhagat, N. N. (2001). Upflow anaerobic sludge blanket reactor- a review. *Indian J. of Env. Health*, 43, 1-83
- Diamadopoulos, E., Samaras, P., Dabou, X., and Sakellaropoulos, G. P. (1997). Combined treatment of landfill leachate and domestic sewage in a sequencing batch reactor. *Water Sci. Technol.*, 36, 61-68
- Kalyuzhnyi, S., Gladchenko, M., Epove, A., and Appanna, V. (2003). Removal of chemical oxygen demand, nitrogen and heavy metals using a sequenced anaerobic-aerobic treatment of landfill leachates at 10–30°C. *Appl. Biochem. Micro.*, 109, 0273–2289

Kettunen, R. H., and Rintala, J. A. (1998). Performance of an onsite UASB reactor treating leachate at low temperature. *Water Res.*, 32, 537-546