Influence of operational parameters on GHGs abatement and leachate quality in Aerobic Anaerobic Landfill Method

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1. Introduction

The Aerobic-Anaerobic Landfill Method is a new landfill method that incorporated the advantages of aerobic-type landfill, while at the same time lowering operational costs. Air is injected into the solid waste of an anaerobic-type landfill at the appropriate stabilization phase to create an aerobic atmosphere in the solid waste layer, which enhances the decomposition of TOC and TN.During the decomposition of TOC, it can be expected that aerobic decomposition will restrain the emission of methane gas, as well as achieve an earlier stabilization of landfilled solid waste. In this study, an aerobic-anaerobic method is described to managing a landfill based on nitrification-denitrification processes, to determine the influence of aeration strategies (intermittent air injection) on the degradation rate and biological reaction rates of organic waste during landfilling.

2. Material and methodology

2.1 Experimental set-up

The research was carried out in four laboratory-scaled reactors made of Plexiglas cylinders (2 m height x 0.1 m diameter). Aeration pipes are installed at the bottom in aerobic reactors A, B and C to introduced air t at a rate of 0.5 l/min. Reactor D is operating as anaerobically. Reactors are covered by electric blankets and insulation materials to keep the ambitious temperature about 30 ± 1^0 C. Temperature probes were used to connecting with DECAGON Data logger for record the temperature. The lower part of the reactors consists of 15 cm gravel for easy efflux of leachate. The top surfaces (5 cm) reactors are open to the atmosphere and 360 ml of water per week was added to each reactor to simulate rainfall therefore it generates leachate. Cover soil was laid on at 10 cm layer. Gas samples were collected from nine sampling ports (at 20 cm intervals) of each reactor for analyzing the concentration of O_2, CO_2 and CH_4 composition. Each reactor has filled with 5 kg of organic solid waste collected from composting plant and the composition is mainly kitchen waste from restaurant, household and food industry and wood chips.

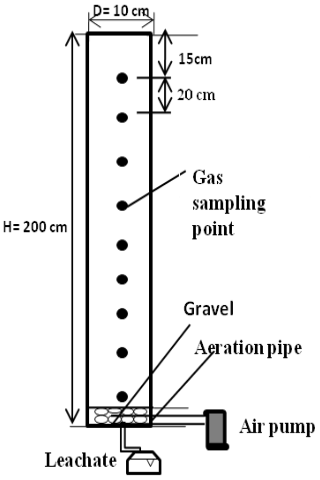

Fig.1: Drawing of column

2.2 Methodology

Before starting the experiment the characteristics of the wastes were analyzed by following standard methods. Total organic carbon and Total nitrogen were measured by using TOC-TN analyzer. Ion chromatography DX-120 was used to detect the concentration of NH_4^+-N, NO_2^-, and NO_3^- from leachate for checking the nitrification-denitrification processes. Gas samples were analyzed to getting the concentration of O_2, CO_2 and CH_4 by using GC-8PA and GC-2014.

Table 1. Air supply intervals of bioreactor landfill simulators

Parameter	Reactor A	Reactor B	Reactor C	Reactor D
Air injection interval	continuous	3 days/week	6 hrs/day (on week days)	No aeration

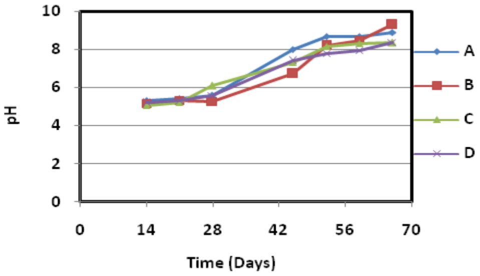

Fig. 2: pH changes with time

3. Results and discussion

Figure 2, pH curves show that pH values were 5-6 in the first 30 days in all reactors.

After 30 days pH values began to increase and reached more than 8 at 66 days. EC values are in increasing trend in all reactors and at day 66 it becomes in reactors A, B, C, D as 38.5, 33.3, 25.8 and 34.2 mS/cm respectively .ORP values in figure 3 were decreased until 45 days; indicated degradation is shifting from acidogenic phase to methanogenic phase in all aerobic reactors but in anaerobic case it becomes -49mV which means degradation is becoming slow and dissolved oxygen concentration is very low. Figure 4 shows TOC of leachate changes with time are high in day 45 day because of high ambient temperature and becoming decreasing trend until 66 days operation. Figure 5 shows T-N concentrations in fluctuating trend, and reactor C is showing lowest concentration. At day 60 CH_4 and CO_2 concentrations reached 0.06%and 8% in reactor C which are the highest concentrations among all reactors and reactor D also shows high CH_4 and CO_2 as well because anaerobic decomposition occurred under low level of O_2. It is observed that methane levels indicated the transformation of anaerobic to at least partial aerobic metabolism, CO_2 rises as O_2 is consumed and CH_4 production falls off; although CO_2 is also a greenhouse gas but less potent than methane. Figure 7 and 8 show CO_2 and CH_4 gases in different depths are in variation with O_2 concentration in figure 6. In aerobic reactors A and B, O_2 concentration is about 15-20%, relatively higher at the middle and bottom layers enhanced the organic-matter decomposition, nitrification and denitrification, and lowered the TOC and T-N concentration of the leachate. NH_4^+-N concentration was detected very high at day 28 in reactor B as 2409 mg/l, NO_2^--N and NO_3^--N were 1.02 mg/l and 44.4 mg/l

Conclusion:

Influence of air supply at different interval and controlled operational parameters for the aerobic-anaerobic landfill method has been discussed using the lab-scaled column experiments. Based on the collected data, in case of air supply in 6hrs/day is showing the better improvement of leachate quality but increasing trend of emission of GHGs. In case of air supply 3 days/week, show improving the leachate quality and GHGS as well at 66 days of controlled operation. It can be concluded, based on the experimental data that keeping the other operational parameters in control condition, intermittent air supply has very convincing influence for the decomposition and stabilization of solid waste in landfill. This research will be continued for about one year and influence of all other parameters and reaction kinetics will be studied.

Reference

[1]Shimaoka et. al,.: Influence of air injection on the stabilization of landfill adopting theaerobic-anaerobic method. Sustain. Environ. Res., 21(4), 229-237 (2011)

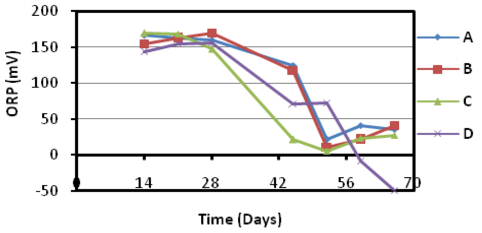

Fig.3: Changes ORP with time

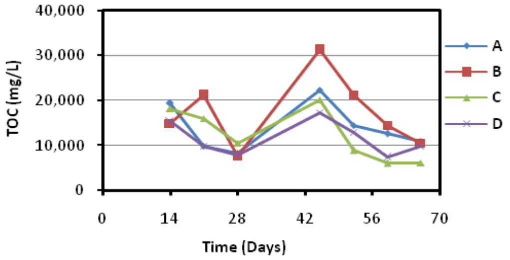

Fig.4: Leachate TOC changes with time

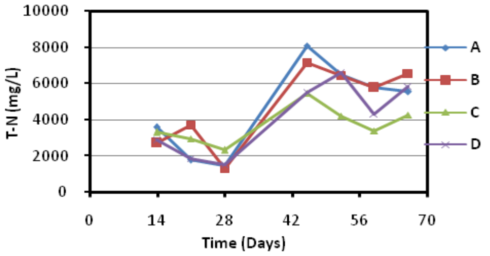

Fig.5: Leachate T-N changes with time

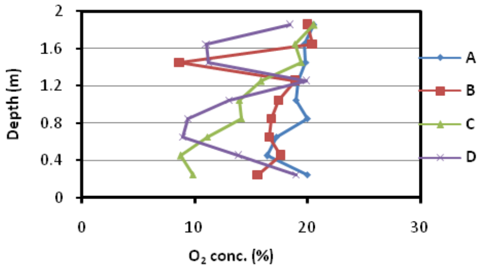

Fig.6: O_2 conc. (%) at day 60

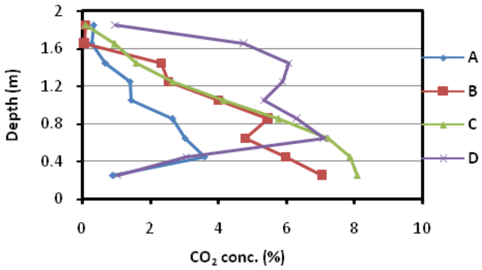

Fig.7:CO_2 conc. (%) at day 60

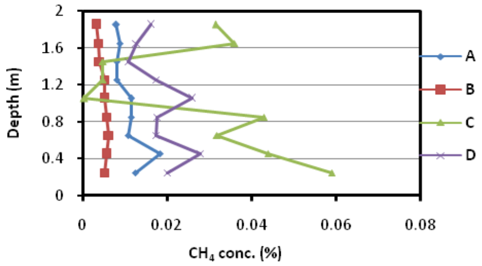

Fig.8: CH_4 conc. (%) at day 60