World Applied Sciences Journal 7 (6): 731-734, 2009
ISSN 1818-4952

Composition of Toxic Leachate and Unstable Compost to Produce Biodegradable Material

Sarwoko Mangkoedihardjo, Yulia Maghriba and Rachmat Boedisantoso

Departement of Environmental Engineering, Laboratory of Ecotoxicology,
Sepuluh Nopember Institute of Technology, Campus ITS Sukolilo Surabaya 60111, Indonesia

Abstract: This paper reports a study of mixing two materials that were toxic leachate and unstable compost, aiming to produce biodegradable material. Various low levels of BOD/COD of leachate were mixed with various high levels of C/N of unstable compost. CO2 evolution test was performed to measure the degree of biodegradable materials. The leachate contained BOD and COD that were more than 100 and 500 mg L^{-1} respectively and represented by BOD/COD ratio of less than 0.1. The compost characterized by C/N ratio in the range of 15-20. Results showed that leachate and compost mixture produced biodegradable material. A mixture containing 20% leachate and 80% compost produced high level of biodegradable material.

Key words: Toxic leachate · Unstable compost · Biodegradable material

INTRODUCTION

Generated materials from solid waste disposal site required operation and maintenance in order to prevent long term soil and groundwater pollutions. The long term pollution was mainly due to slow release of toxic leachate and unstable compost that were generated from the remaining solid waste. Toxic leachate was characterized based on low level of BOD/COD ratio of less than 0.1 in which BOD and COD were higher than 100 and 500 mg L^{-1} respectively [1-8]. Unstable compost was characterized on high level of C/N ratio of more than 20 [9]. The high level of C/N ratio made a good condition for microbial growth that in turn adaptable to toxic leachate

Mixing the two materials were reasonably easy to handle and low cost because of both materials were produced at the same site. There was no external resources to be added in comparison with physical treatment such as hydrothermal [1-2, 5-6], photocatalitic ultraviolet oxidation [3] and ozonisation [10], chemical process using carbohydrate addition [4] and co-process of anaerobic and aerobic [7, 11].

Little was known concerning the biodegradability characteristics of leachate and compost mixture. Therefore, this current research investigated the composition of both materials that produce biodegradable organic matter. Success of this research could be used as bioremediation and phytoremediation of polluted soils, especially to prevent long term pollution of post closure of solid waste disposal site.

MATERIALS AND METHODS

Leachate and compost were collected from the final solid waste disposal in Surabaya. Chemical characteristics of both materials such as BOD, COD, N and VS were analysed according to Standard Methods [12]. CO2 evolution test was prepared as seen in Fig. 1 and the test procedures followed Llewelyn [9].

Transfer 100 g ± 2 g of the sample weighed to the nearest 0.1 g to the incubation vessel. Transfer approximately 250 ml of sodium hydroxide solution to the carbon dioxide scrubbing vessel and add 50 ml of water into the carbon dioxide collecting vessel. Attach and seal all lids and stoppers. Ensure the air inlet diffuser of the carbon dioxide scrubbing vessel reaches the bottom of the vessel. Ensure the air inlet tube of the incubation vessel reaches the bottom of the vessel. Ensure that the air inlet diffuser of the carbon dioxide collecting vessel reaches the bottom of the vessel. Switch on the air pump and adjust the airflow rate to approximately 25-75 ml/min measured using the air flow-rate meter at the outlet of each carbon dioxide collecting vessel. Equilibrate at 30°C for 72 hours. After 72 hrs equilibration remove

Corresponding Author: Sarwoko Mangkoedihardjo, Departement of Environmental Engineering, Laboratory of Ecotoxicology, Sepuluh Nopember Institute of Technology, Campus ITS Sukolilo Surabaya 60111, Indonesia

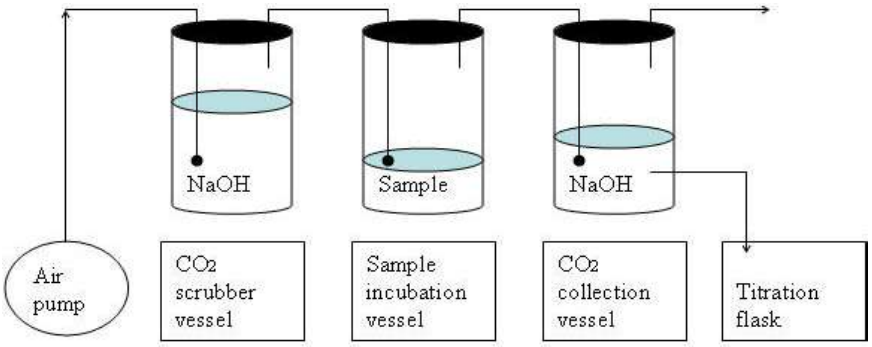

Fig. 1: CO2 evolution test

the collecting vessel containing water and connect a collecting tube containing 50.0 ml of 1 M sodium hydroxide. Change the collecting tube with another containing a fresh 50.0 ml of 1 M sodium hydroxide every 24 hours over a 4-day period. Do not turn off the air pump at any time or back-pressure may cause NaOH to siphon back to the pump. Maintain the temperature of the incubation units at 30°C at all times. Transfer the contents of the carbon dioxide trapping vessel into the titration flask with water washing. Add 20 ml of barium chloride solution to precipitate any carbon dioxide. Add two to three drops of phenolphthalein solution and titrate with 1M hydrochloric acid with vigorous stirring until the pink colour just changes to white (colourless in the case of blanks) with one drop of the acid. The rate of carbon dioxide evolution over 4 days is given by the following equations:

mg CO_2 evolved per 24 h time period = $\{[B_{vol}-S_{vol}]*44.2\}/2$

Total mg CO_2 = sum of mg CO_2 evolved over 4 days

mg CO_2/g VS/d = [Total mg CO_2] / [dry weight of sample * VS * t]

where:

B_{vol} = The volume in ml M HCl for the blank titre

S_{vol} = The volume in ml M HCl for the sample titre dry weight of sample is amended materials

VS = The mass of volatile solids / g of sample

t = The time in days

RESULTS AND DISCUSSION

Various levels of BOD/COD ratio of less than 0.1 for equal weight of leachate were examined for their CO2 production. The same treatments were carried out for compost that have C/N ratio between 15 and 20. Each perfomed the same result, i.e. CO2 production decreased over time (Fig. 2 and Fig. 3). Combination of the two m aterials produced increasing CO2 production that means the mixture became biodegradable (Fig. 4). The low level of biodegradability was characterized by high leachate level. Increasing level of compost significantly resulted in increasing level of biodegradability.

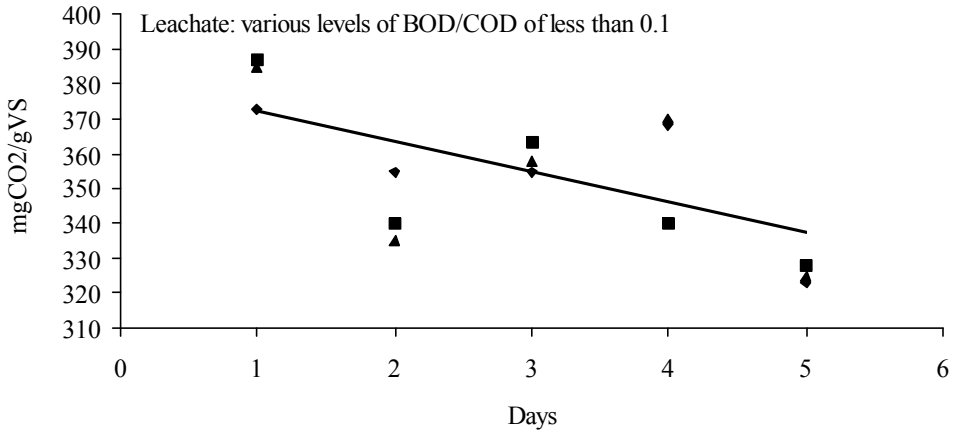

Fig. 2: CO_2 evolution for leachate

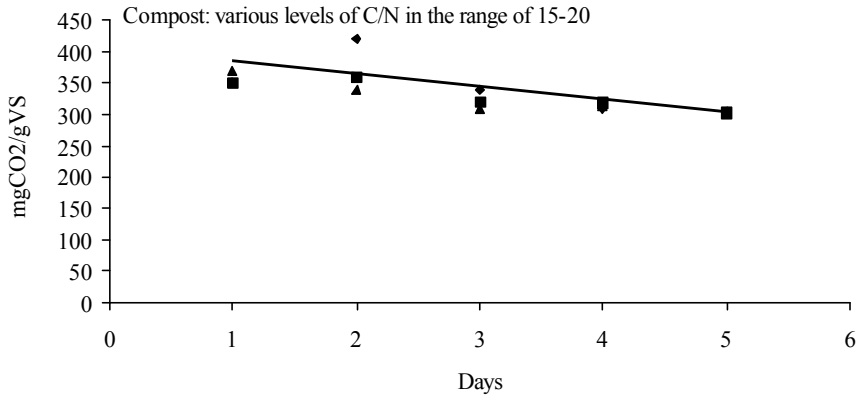

Fig. 3: CO_2 evolution for compost

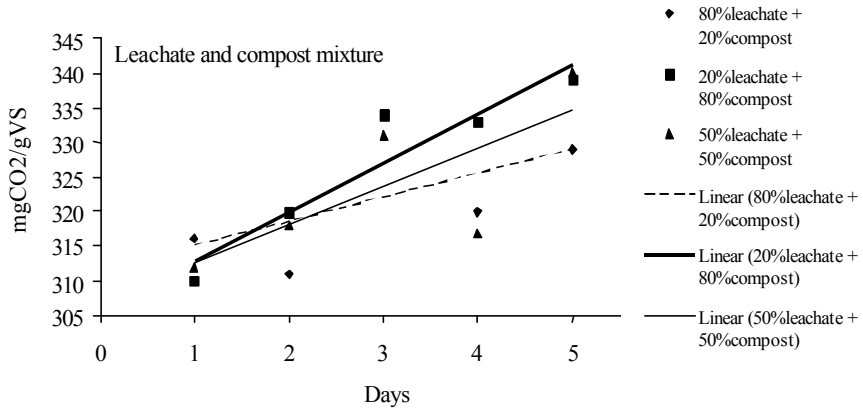

Fig. 4: CO_2 evolution for leachate and compost mixture

Table 1: Biodegradability level, pH and DO for leachate and compost mixture

Mixture	BOD/COD	pH	DO
20%leachate + 80%compost	0,45-0,46	7.0-8.0	3.0-4.0
50%leachate + 50%compost	0,43-0,44	7.0-8.0	1.0-2.0
80%leachate + 20%compost	0,38-0,42	7.0-8.0	0,5-0,7

In addition to the CO2 evolution test, the composition mixtures were evaluated for their biodegradability level, pH and dissolve oxygen (DO) (Table 1). The results showed that high compost level resulted in high BOD/COD ratio as well as DO level for aerobic condition.

CONCLUSION

A mixture of leachate and compost produced biodegradable material. Unstable compost would be a limiting material that can be used for attenuate toxic level of leachate. The mixture provided oxygen content at the level of aerobic condition.

ACKNOWLEDGEMENT

The Authors wish to thank LPPM ITS for financial support for this research project under the contract of Penelitian Strategis Nasional ITS No: 10473/I2.7/PM/2009 dated 1 April 2009.

REFERENCES

1. Kappeler, J. and W. Gujer, 1992. Estimation of kinetic parameters of heterotrophic biomass under aerobic conditions and characterization of wastewater for activated sludge modeling, Water Sci. Technol., 25(6): 125-139.

2. Henze, M., W. Gujer, T. Mino, T. Matsuo, M.C. Wentzel, and G.v.R. Marais, 1995. Activated sludge model No.2, Scientific and Technical Report No.3, International Association on Water Quality.
3. Bolduc, L. and W.A. Anderson, 1997. Enhancement of the biodegradability of model wastewater containing recalcitrant or inhibitory chemical compounds by photocatalytic pre-oxidation. Biodegradation, 8(4): 237-249.
4. De Lucas Martinez Antonio, Canizares Canizares Pablo, Rodriguez Mayor Lourdes, Villasenor Camacho José, 2001. Short-term effects of wastewater biodegradability on biological phosphorus removal. J. Environ. Engineering, 127(3): 259-265.
5. Seviour, R.J., T. Mino and M. Onuki, 2003. The microbiology of biological phosphorus removal in activated sludge systems. Microbiol. Rev., 27: 99-127.
6. Wei, Y., R.T.V. Houten, A.R. Borger, D.H. Eikelboom and Y. Fan, 2003. Minimization of excess sludge production for biological wastewater treatment. Water Research, 37: 4453-4467.
7. Borglin, S.E., T.C. Hazen and C.M. Oldenburg, 2004. Comparison of aerobic and anaerobic biotreatment of municipal solid waste. Air and Waste Management.Association, 54: 815-822.
8. Mangkoedihardjo, S., 2006. Biodegradability improvement of industrial wastewater using hyacinth. J. Applied Science, 6 (6): 1409-1414.
9. Llewelyn, R.H., 2005. Development of standard laboratory based test to measure compost stability. The Waste and Resources Action Programme. The Old Academy, 21 Horse Fair, Banbury, Oxon OX16 0AH.
10. Wang, Y., Min Yang, Jing Zhang, Yu Zhang, Mengchun Gao, 2004. Improvement of biodegradability of oil field drilling wastewater using ozone. Ozone Science and Engineering, 26(3): 309-315.
11. Rodrigo del Pozo, Didem Okutman Ta, Hakan Dulkadiroğlu, Derin Orhon and Victorino Diez, 2003. Biodegradability of slaughterhouse wastewater with high blood content under anaerobic and aerobic conditions. J. Chemical Technol. Biotechnol., 78(4): 384-391.
12. Standard Methods, 1995. Standard Methods for the Examination of Water and Wastewater. American Public Health Association/American Water Works Association/Water Environmental Federation, Washington DC, 19th Edn.