Long-term emissions from mechanically biologically treated waste: Influence on leachate quality

Mark Griffith and Cristina Trois*

CRECHE (Centre for Research in Environmental, Coastal and Hydrological Engineering), School of Civil Engineering, Surveying and Construction, University of KwaZulu-Natal, 4041 Durban, South Africa

Abstract

Long-term emissions from municipal solid waste landfills can be reduced by mechanical-biological treatment (MBT) of waste prior to disposal. The pretreatment accelerates waste degradation resulting in a reduction of the landfill's polluting potential. This study reports on the applicability and efficiency of MBT in Durban, South Africa. Waste treatment in passively aerated open windrows, using the Dome Aeration Technology (DAT), was identified as an appropriate technology due to low construction and operational resource requirements. Three self-aerated windrows were set up at the Bisasar Road Landfill in order to study the efficiency of the process for different composting timeframes (8 and 20 weeks). The 'post-landfilled' behaviour of the pretreated material was analysed in anaerobic lysimeters. The effect of different degrees of degradation was studied in relation to waste composition and rate of irrigation. The lysimeter tests demonstrated that the initial acidic inhibition that is characteristic of waste with high organic content can be eliminated through pretreatment. Notwithstanding the rapid onset of methanogenesis, high COD concentrations of non-degradable organics in the leachate remain after 200 d of testing. Despite the high COD levels, a clear benefit of waste pretreatment is the low concentration of ammoniacal nitrogen after only 8 weeks of composting. The results of this research can be used to define a framework for sustainable waste disposal, particularly in relation to the subtropical climatic conditions experienced in Durban, resource availability and waste composition.

Keywords: mechanical-biological treatment (MBT), landfills, MSW, leachate

Introduction

As a developing country, South Africa faces the challenge of meeting international standards in service delivery. Waste disposal, in particular, must be environmentally acceptable and economically sustainable. Currently, 95% of waste is disposed in landfills (DWAF, 1998a). It is well accepted that landfilling of large quantities of degradable organic material in a complex and heterogenic anaerobic environment, such as a landfill, will result in the formation of an inefficient biological reactor with the potential to produce persistent liquid and gaseous emissions. The significance of this problem has been recognised by the Department of Water Affairs and Forestry (DWAF) and the introduction of the *Minimum Requirements for Waste Disposal by Landfill* in 1994 was a crucial step in implementing more stringent landfill engineering guidelines to curtail long-term environmental impacts. The aim of the Minimum Requirements is to control landfill emissions through the 'concentrate and contain' approach, where the landfill is designed and operated as a multi-barrier system (DWAF, 1998a) in areas where significant leachate generation is expected, such as Durban. It must be remembered that in some of the drier regions of the country, leachate generation is sporadic or negligible (DWAF, 1998a).

A significant aspect of landfill management is the 'aftercare' period when, after closure, control of landfill emissions is still required. The reduction of pollution levels from landfills is dependent on the stabilisation of the degradable organic fraction in the waste and the removal of the soluble pollutants through a combination of biochemical reactions and physical leaching. These processes are directly related to the flux of moisture through the waste body; the very same process that current South African legislation aims at reducing. The multi-barrier landfill, may, therefore, constitute an efficient short-term solution but can prolong the long-term pollution risk indefinitely. This fundamental truth on the nature of modern landfills is well accepted by the scientific community (Robinson, 2000; Cossu et al., 2003). In Europe the focus has now shifted towards the stabilisation of waste prior to landfilling via thermal (incineration) or mechanical biological treatment (Stegmann, 2005). *The European Council Landfill Directives 1999/31/EEC* (LFD) require member states to only landfill wastes that have been subjected to prior treatment (Robinson et al., 2005a).

A comparative study of available waste pretreatment techniques was initiated in 2002 (Griffith, 2005) to identify suitable solutions for South Africa that could be implemented at national level into established waste management systems (municipal disposal units) as well as informal/rural communities. Factors such as low operational costs, zero/low energy input during the composting period, potential for labour-intensive operations and reduced machinery requirements were considered in the selection of appropriate technologies. The results of the study pointed to the dome aeration technology (DAT) treatment in passively aerated windrows as a suitable option (Paar, 1999a; b; Mollekopf et al., 2002; Trois and Polster, 2006). Experience in Germany has shown that 'chimney' technology can achieve 90% reduction of landfill emissions, making it an appropriate technique for countries where pretreatment is still not a minimum requirement (Münnich et al., 2006).

A pilot project was designed to study the applicability of aerobic waste composting to the South African waste management context and prevailing subtropical conditions. This paper

* To whom all correspondence should be addressed.
☎ +2731 260 3065; fax: +2731 260 1411;
e-mail: troisc@ukzn.ac.za
Received 16 January 2006; accepted in revised form 10 March 2006.