Landfill Behavior of Mechanical-Biological Pre-treated MSW: Results of a Long Term Experiment

C. Felske AGR mbH/Department of Waste Management, University of Essen, Universitätsstr. 15, 45141 Essen
mailto: christian.felske@uni-essen.de
R. Widmann Deaprtment of Waste Management, University of Essen, Universitätstr. 15, 45141 Essen
mailto: r.widmann@uni-essen.de

Introduction

This presentation is based on the results of an eight-year experiment supervised by the Landesumweltamt Northrhine-Westphalia and conducted by the Waste Management Department of the University of Essen represented by Prof. Dr.-Ing. habil W. Bidlingmaier and Prof. Dr.-Ing. R. Widmann (Bidlingmaier et al., 2002).

Research Issues

In 1993, the need for alternatives to incineration in MSW treatment methods was pivotal to gaining Landesumweltamt support for this project. The research goals were

- to investigate the differences between mechanical biological pre-treated (mbp) and thermal pre-treated MSW in terms of both landfill behaviour and emissions. Aside from geotechnical parameters and settlement data, the project focused in particular on liquid and gaseous emissions including leachates and landfill gas, and

- to focus on appropriate landfilling techniques and technologies such as leachate and gas collection systems and landfill cover liners, with a view to future landfill policy in Germany after the year 2005 and the associated changes in landfill behaviour for sites containing mbp and thermal pre-treated wastes.

Material and Methods

The experimental apparatus consisted of two large-scale lysimeters. The design approximated real landfill conditions. Built on concrete foundations, the lysimeters consisted of steel silos 5.36 m in diameter and 5.13 m height. The mbp and thermal pre-treated MSW were installed to a layer thickness of 3.0 m, at a density of 0.92 t/m³ (water content 0.67) for mbp MSW and 1.33 t/m³ (water content 0.14) for the thermal pre-treated MSW.

Results

The quality and quantity of both leachates and gas in thermal pre-treated MSW remained stable, following the expected results. The higher organic content in the mbp MSW caused slightly higher but nevertheless constant leachate concentrations. To give one example, the TOC concentrations in the leachate from mbp MSW ranged from 106 to 853 mg/L compared

to a range of 5 to 97 mg/L measured for the thermal pre-treated MSW. No gaseous emissions were found in the thermal pre-treated MSW. In contrast, a gas concentration profile could be created for the lysimeter filled with mbp MSW, allowing gas flow processes to be elaborated.

In another experiment, the surface runoff from the installed mbp MSW was not as high as expected. The amount of leachate collected was similar to a common MSW landfill.

After a period of eight years, a further opportunity was given to examine the eluate and the geotechnical behaviour of the mbp MSW within the different layers of the lysimeter. The mbp landfill body proved to be stable and of low emissions, meeting the criteria of German regulations (AbfAblV, 2001). The proctor density was found to be 1.03 g/cm³ with a water content of 0.44. The range for saturated hydraulic conductivity was 8.85E-06 to 3.15E-05 m/s, which explains the high amounts of leachates measured. The residual organic fraction at the end of the experiment had an ignition loss of 26.20 % and TOC of 10.50 %. These values remained stable over the project duration. Biological activity was evaluated using the respiration activity after 4 days (AT_4). At 3.73 mg O_2/g, the biological activity of the mbp MSW was low, as expected.

Conclusions

Throughout this research project the thermal pre-treated MSW landfill body remained geotechnically stable and had no significant emissions. With respect to geotechnical and biological characteristics, the landfill behaviour of mbp MSW can also be described as stable and harmless to the environment. Certain questions still need to be answered about landfill emission paths, which is relevant information in determining appropriate landfill techniques.

The quantity of leachate found during the course of this projects revealed important information for the dimensioning of leachate collection systems. Considering the low gas production of mbp MSW, the erection of an active landfill gas collection and utilization system is uneconomical (Soyez, 2001). Flow processes within the high-concentration gas profiles found in the landfill body were elaborated. Microbiological methane oxidation within the cover layer of the landfill was found to be a feasible gas treatment technique for mbp MSW landfills (Soyez, 2001). Future research should focus on the flow properties of landfill gas within highly-compacted mbp MSW landfills in order to develop the passive gas collection system technologies required in the future.

Main References

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