EMISSION CONTROL IN SANITARY LANDFILLS USING BIOSTABILISED MSW ORGANIC FRACTION

Aldo Muntoni
Department of Geoengineering and Environmental Technology, University of Cagliari, Italy

1. INTRODUCTION

To date, many of the composts produced in Italy from MSW rather than from organic matter deriving from separate collection do not meet legislative limits with respect to inerts, glass, paper, plastics and heavy metal content. Thus, the final destination of these composts is not use in agriculture, but disposal in landfills. Several tests on utilization of MSW compost in sanitary landfills were performed at the Department of Environmental Technologies of the University of Cagliari. Six types of MSW composts are under experimentation in order to verify their possible utilization as daily, temporary and final covering material. Tests have been made and are in progress in order to define physical parameters of compost (such as granulometry, permeability, void index, compaction rate, composition), bio-chemical parameters and characteristics (stabilization level, heavy metal content, possible interactions with MSW landfill leachate and biogas).

2. MATERIALS AND METHODS

Six types of compost were tested (identified as NR6, NR2, R6, R2, NR and CV) Particle size distribution was determined. In order to define the stabilization rate, respirometric tests were carried out using a common BOD device; 40 g of compost were diluted in 400 ml of standard solution. Oxygen consumption due to aerobic degradation was measured for a period of 5 days. Anaerobic digestion tests were performed to estimate the biogas production deriving from compost utilization in a sanitary landfill; 300 g of compost diluted according to a liquid-solid ratio of 2 were set inside artight glass bottles connected to a hydraulic gager in order to measure biogas production. The devices were placed in a thermostatic room regulated at a temperature of 30° C. Gas flow was recorded daily. Several leaching tests were carried out in order to define heavy metal mobilization and interactions between compost and MSW leachate; four types of leaching tests were performed using as extraction liquid: water acidified by means of C02 or acetic acid (recommended by Italian legislation), an acid phase and a basic phase MSW leachate. Leaching tests with MSW leachates were carried out following the same methods recommended for the test with acetic acid. Eluates of the leaching tests were analyzed. In order to measure the permeability, compost samples were compacted into steel cells using a Proctor device. Compaction was performed according to ASTM prescriptions.. Compacted composts were saturated with water and permeability was measured by means of a variable head permeameter. In order to investigate the possible removal of sulphur compounds and chlorinated hydrocarbons from biogas, two gasproof columns of plexiglass were set up and filled with refined and un-refined composts; compaction rate of composts was 530 kg/m³ for refined and 360 kg/m³ for unrefiend and the height of compost layers was 30 cm. The columns were connected to the biogas collection net of a MSW landfill and feeded with a daily flow of 15 ℓ/d. Gas composition inflow and outflows was analyzed by means of gas-mass-chromatography after the first day of feeding and then with the frequency of one week; the gas content of the following compounds was determinated: methane, carbon dioxide, nitrogen, oxygen, hydrogen sulphide, total mercaptans, monochloroethylen, dichloroethylen, trichloroethylen, tetrachloroethylen, chloroform.

3. RESULTS

Composts have an alkalinc pH (7,5-8,6), for this reason they could be considered as buffering material capable of avoiding excessive decrease of pH due to the high production of volatile acids typical of the first phase of waste anaerobic degradation (low pH values inhibit waste

stabilization) and limiting heavy metal mobilization and drainage incrustation. Unrefined composts are characterized by high content of plastics, incrts and glass. The presence of inerts and glass and the absence of refining treatment allows a fairly well-balanced size distribution which should allow good void index and permeability. The utilization of unrefined, well cured compost in a landfill does not lead to a consistent increase of biogas production from the waste mass. The low gas production renders unrefined composts the more suitable for utilization in a landfill. A general low mobilization of metals can be stressed. The negligible mobilization of metals from compost to eluates is probably due to the buffer characteristics of composts: eluates presented a final pH of 7-8. Cu, Pb and Zn, the main metals present in composts, were leached in small quantities, probably due to their anphoterism which allows release only at very low or very high pH values, conditions which are not common in a MSW landfill. Concentrations of heavy metals arc well below the common concentrations for MSW leachate. A general low mobilization of metals can be stressed. The negligible mobilization of metals from compost to eluates is probably due to the buffer characteristics of composts: eluates presented a final pH of 7-8. Cu, Pb and Zn, the main metals present in composts, were leached in small quantities, probably due to their anphoterism which allows release only at very low or very high pH values, conditions which are not common in a MSW landfill. Concentrations of heavy metals are well below the common concentrations for MSW leachate. Tests with basic leachate show a remarkable removal of Cr III, Cu, Ni and Zn; this means that contact between compost and leachates under basic conditions could improve inorganic load of basic leachates. This effect could be explained by adsorption or complexation phenomena which may prevail over mobilization effects probably because pH is not low enough. The low compaction rate and the favourable size distribution allow unrefined composts to keep a high permeability and render them suitable to be used as cover material in MSW landfills. Concerning tests on biogas, data show that the content of every considered trace component decreased after passing through the columns. No remarkable difference can be noticed between data concerning different composts or different sampling, except for sulphur compounds which were not removed after the second week of experimentation, therefore removal capacity does not seem to be correlated to the kind of compost used or to time (limiting the last consideration to the short period considered). The efficiency of composts as biofilters for biogas seem to be higher for chlorinated hydrocarbons than for sulphur compounds. Trichloroethilen reduction equal to 60% can be stressed. No effects on main biogas components (methane, carbon dioxide etc.) can be noticed.

4. CONCLUSIONS

The experiment allows the Authors to assess that:

a) use of MSW composts in landfills brings the following advantages;
   - compost can act as buffering material enhancing waste stabilization limiting and clogging of leachate draining system;
   - compost can decrease the content of some heavy metals in leachate basic conditions, while under acid conditions there is a negligible mobilization of metals from the solid malrix;
   - filtrations through compost layers can remove sulphur and chlorinated

c compounds from biogas.

b) further tests have to be carried out in order to evaluate the compost influence on the organic load of leachate and to understand which mechanism can lead to the removal of hazardous compounds from biogas by means of filtration through compost layers;

c) in order to keep sufficient permeability walues it is necessary to avoid refining treatments and improve curing phase;

d) well cured composts are more suitable to be used as cover material because;
   - they do not increase too much the organic load of the waste amount;
   - they have a lower moisture content which allow them to work as a control layer of water inflows;
   - they produce less biogas in anaerobic conditions,
   - they are less compactable and thus keep a high permeability.