Assessment of the evolution of waste biodegradability with time and operation conditions

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Introduction

In the context of sustainable development, it appears more and more important to understand and manage the evolution of waste biodegradation within a landfill to precise the duration of the aftercare period and to define landfill completion.
Analyses of biochemical characteristics and methane potential (BMP) of waste should enable to measure waste biodegradation degree. Furthermore, results of analyses performed on waste exposed to different treatment should confirm or not the efficiency of the treatment.

Research project

Drillings have been undertaken at different landfill sites:

Landfill	Country	Surface (m^2)	Mean thickness (m)	Age of waste (years)	Treatment
BUSTA	Italy	22500	30	0-5	Leachate recirculation
PASIANO	Italy	32000	12	1-4	-
HINES PIT	England	60000	20	3-11	-

Samples of row waste have been analysed for water content and sorted (quantification of the fraction of plastics, wood, textile, organic matter, glass, metals, stones and residuals). The organic biodegradable fraction has been analysed for solids volatile, cellulose, lignin, hemicellulose. BMP tests (Biological Methane Potential) have also been undertaken to assess residual methane in each sample. Moreover, biodegradation kinetic has been calculated from biogas production monitoring of waste samples put in "landfill conditions" (temperature, humidity and density measured at the moment of drilling).

Main issues

Using characterisation of waste (sorting) and results of different tests undertaken, some observations can be pointed out :

1) Assessment of the Municipal Solid Waste (MSW) biodegradability : the anaerobic biodegradability of the MSW is characterized by the measurement of the CH_4 potential,

the biodegradation of cellulose and hemicellulose (main biodegradable components) or indirectly the lignin content (Chandler relationship).
Data point out qualitative relationships between the CH_4 potential and the other physico-chemical characteristics of wastes, but the relatively low correlation coefficient make a quantitative assessment very unaccurate : r = 0.55 for CH_4 / Cellulose, r = 0.45 for CH_4 / Lignin, r = 0.57 for CH_4 / MSW (figure 1).
Finally, the measurement of lignin, hemi-cellulose and cellulose is based on the Van Soest and Wine method. For MSW, their complex organic composition and sometimes their high mineral matter content make the analyses representativity and accuracy critical.

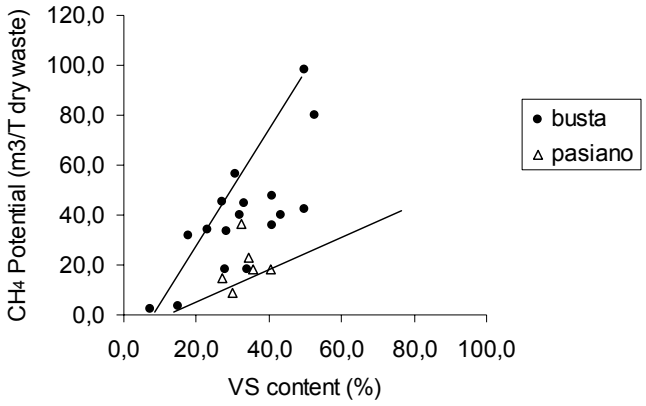

Figure 1 - relationship between the CH_4 potential and the VS content for MSW landfill samples

2) The Biological Methane Potential Test: For Pasiano and Busta landfills, there is no relationship between the residual CH_4 potential of the waste and their age in the range from 1 to 5 years. The characteristics of the waste as moisture or refuse-decomposing micro-organisms content are determinant for the start of the waste biodegradation since the matter exchanges inside the landfill are very limited and low (hence the leachate recirculation interest). This may explain the relative heterogeneousness of the methane potential distribution observed for these two sites.
The mean value of the CH_4 potential of Busta and Pasiano landfills are respectively 11 and 5 m^3 / T wet waste. These values are to compare to the methane potentials for a fresh MSW 50 - 60 m^3 / T wet waste (Aguilar 2000, Barlaz, 1997) and for pre-treated residual waste 1 – 2 m^3 / T wet waste (Binner, 1999).

3) Impact of leachate recirculation on the biodegradability state: the measurement of the waste moisture shows that the recirculation device, the low leachate volume introduced at present and the waste porous structure do not allow an uniform and significant water content increase within the landfill. However, when the waste is in contact with leachate, the degradation rate constant k is markedly increased (from 0,2 an^{-1} to 16 an^{-1}). This could be the consequence of the water supply and also of the repartition of micro-organisms and nutrients.

In conclusion, investigations on analytical tests need to go on to confirm their reliability. More results on waste with different age and treatment could help to propose parameters defining the “landfill completion” and the impact of leachate recirculation on the needed time before landfill completion.