Geoelectrical monitoring during waste biodegradation process at laboratory scale

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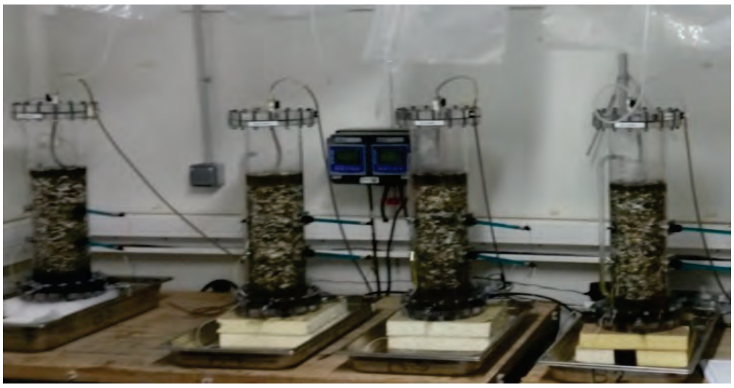
Waste storage is the most commonly waste treatment method used around the world because it is a relatively simple and economical way for solid waste management. For this reason, non-hazardous waste disposal facilities formerly operated as mere filling pits are nowadays complex structures whose objective is to reduce environmental impacts and enhance biogas production. Waste storage industry professionals are currently interested in a spatializing method that can monitor waste biodegradation state in landfill. The transformation of solid waste into biogas carried out by microbial populations brought into play during the anaerobic digestion, involves changes in the physicochemical parameters of the medium. Indeed porosity, leachate conductivity, microbial growth, for example will be changed during the waste biodegradation cycle. This is those changes in the physical and chemical properties of the waste mass that could be detected by geophysical methods. For this reason three geophysical methods have been chosen to monitor the waste biodegradation state on landfill: Electrical resistivity, Induced polarization, Spectral induced polarization.

In order to evaluate the potential and limits of the chosen geophysical methods, an experimental laboratory device has been build. One kilo of municipal solid waste has been shredded, poured in four laboratory cells (Figure). Three were saturated with water and the same mechanical characteristics to get repeatability and the last one placed at field capacity. All cells were then placed at 35° C in order to increase the biodegradation kinetic. Not to influence the electrical measurements, the columns were made of colourless Plexiglas (PMMA) and are equipped with two pairs of measurement electrodes, a pair of stainless steel and two of non-polarizable ($Cu/CuSO^4$). Furthermore, analyses on the biogas and the leachate production allow following the waste biodegradation evolution.



The four experimental cells filled with waste

Measures started since March 2016 for the oldest and January 2017 for the youngest until now. The results show that the resistivity is mainly governed by the water content of the medium. Indeed, the resistivity was recalculated on the basis of water content and leachate conductivity measurements using an Archie law and these results compared to resistivity measured are superimposed but diverge on the end of the biodegradation process, suggesting that the transformation of organic matter into biogas could induce changes in the waste matrix. The induced polarization measurements always show a low chargeability at the beginning of the biodegradation process which increases progressively over time. A "low" chargeability for a young waste and a "high" chargeability for a waste at the end of biodegradation process is measured whatever the cell conditions observed. These results show that the induced polarization methods could be more sensitive than the resistivity for monitoring the waste biodegradation evolution at landfill scale.