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Laboratory tests using electrical resistivity monitoring to study biogas and leachate migrations in waste mass

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Waste management is a major issue in France controlled by strict rules to guarantee the reduction of the toxicity of the waste and to limit the impact on the environment and on the human health. The storage is the oldest waste treatment used by the operators and it must be considered as an industrial process when we observe the technologies and the management tools applied.
Biodegradation of Non-hazardous household waste is mainly controlled by two key parameters: moisture content and temperature. Whereas temperature is impossible to modify by any process economically profitable, moisture content can be modified by liquid reinjection in waste mass. This technic of leachate recirculation is associated to "bioreactor landfill" where horizontal pipes or wells are used to achieve this goal. For industrial operators, the objective is to find techniques of measurement to evaluate at large-scale, the diffusion of leachate in the porous medium. Among the geophysical methods available, the electrical resistivity tomography (ERT) has demonstrated its potential. The leachate recirculation events are considered as short periods of time compared to the kinetic of waste biodegradation or to the evolution of their mechanical characteristics. This assumption allows to associate electrical resistivity variations recorded to moisture content modifications. Whereas increasing of moisture content is linked to decreasing of electrical resistivity, positive variations of resistivity have been often observed and attributed to artefacs of inversion process or to a potential effect of biogas migration, which is the aim of this study.
Laboratory tests have been conducted in order to follow the evolutions of electrical resistivity measurements for various conditions of saturation and drainage of waste mass and variations of biogas pressure. Waste samples were collected before landfilling, and then shredded to 10 mm of diameter, mixed with water to achieve initial volumetric water content equal to 0.34 m3/m3 and compacted in a cylindrical cell of 0.220 m3 to achieve a density equal to 0.45.
Distributions of apparent electrical resistivity were recorded from 52 electrodes allowing 524 quadrupoles with current circulations mainly horizontal, vertical and diagonal. The inversion process used BERT software with cell geometry taken into account as well as an optimization of the inversion parameters carried out for the laboratory tests performed.

Evolutions of electrical resistivity distributions were clearly observed for the different hydraulic conditions from dry state to saturation and the field capacity. At field capacity, the test cell was closed from the atmospheric pressure and the waste mass has been saturated progressively from the bottom to the top to increase the biogas pressure in the unsaturated waste. From laboratory tests, no variation of electrical resistivity was notified during the increase of biogas pressure, even for value around 0.300 bars, higher than the range of pressure recorded in landfill.

These laboratory tests were performed with no leachate flows and biogas migration which are the conditions of recirculation event in bioreactor landfill. Research works are in hand to continue the understanding of ERT monitoring results recorded during leachate flows or biodegradation of waste body.