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Topic 3. Pilot, field and laboratory scale experiments.

Monitoring of sealing properties of ash liners in landfills by means of resistivity and induced polarisation measurements in Sweden

G. THAM*, R. SJÖBLOM**, T GUSTAFSSON ***

* *Telge AB, Holmfastvägen 31, Box 633, SE-151 27 Sweden, gustav.tham@telge.se*
** *Tekedo AB, Spinnarvägen 10, SE-611 37 Sweden, rolf.sjoblom@tekedo.se*
*** *Uppsala university, Dag Hammarskjölds v. 10B, SE-751 05, Sweden*

Abstract

Many landfills in Sweden as well as in Europe are subject to closure in the near future. Some two thousand hectares of landfill area in Sweden will have to be covered. The material requirement is on the order of one hundred million tonnes. The legal requirement to the meet in the EU Landfill Directive is that the maximum amount of leachate generated and should be less than 50 litres per square metres and year for a non-hazardous waste deposit and 5 litres for hazardous waste. The construction of the landfill cover at Tveta Återvinningsanläggning (Tveta Recycling Plant) system consists of a gas drainage and foundation layer directly above the waste followed by a water sealing layer of ash, drainage layer, protection layer and finally a vegetation layer. The total thickness is more than three metres.

Today, some six hectares of landfill have been covered. The liner of ash is monitored by lysimeters placed below the ash liner. The lysimeters register gases, water, settlements etc The system is stationary and must be very robust in order to last for many years in a tough environment.

In the future, a more flexible, field adapted, system should be used where one can measure randomly the percolation of water through the liner. It is also desirable that such a system be durable and that it can be constructed from inexpensive recycled materials. A project was therefore initiated in 2004 based on induced polarisation method. Initially, related information was sought for the use of such methods in e.g. earth science and heterogeneous materials such as ashes, gravel, sand classified as secondary construction materials for landfill covers.

Large emphases have focused on using ash material as more than one million tonnes of ash is produced every year in Sweden. The purpose is therefore to se if ash can be used instead of virgin materials. A change in resistivity in the ash liner would indicate the transport of chloride through the liner.

The conventional way has been to install lysimeters below the ash liner. The lysimeter boxes are connected to logging station placed above the ground (see picture).

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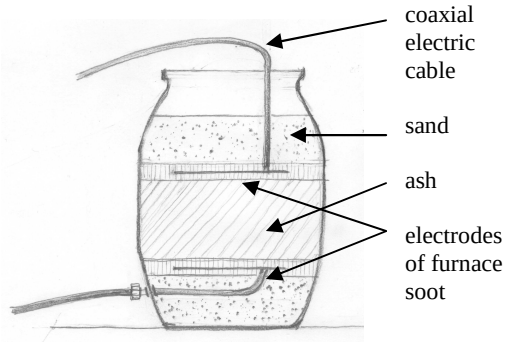
The principle of induced polarisation will not be described here. Instead, this study will focus on the results of the practical application and the results of laboratory at drum tests at Uppsala university. The results of this work are based on earlier experience with measuring e.g. bentonite clay.



In the laboratory 100 litre drums were filled with the same materials as in the field and compacted. Two electrodes were placed above and below the compacted ash as shown in the Figure.
The materials were subjected to water infiltration, thus simulating natural rainfall.

A Solartron 1260 Impedance/Gain-Phase Analyzer was used in the frequency range 1 Hz – 1 MHz. The laboratory test samples were placed in a Faraday Cage. The drums of plastics are well isolated.

Within the six hectares subject to closure a special area was set aside for the experiment. Blast furnace soot was used for the electrodes. No penetration of the seal was required since wiring was attached by aid of copper plates to two electrodes above the seal. These upper electrodes were some distance apart and interacted through the seal and through a large electrode underneath.

The results from the laboratory scale as well as the drum tests were very successful and no problems were encountered in terms of background noise or other instability. The field tests were unstable. Search for the cause of this inconsistency in relation to the other tests eventually unveiled that an instrument will have to have a special design in order for it to manage measurements in real earth. Background interference was found to be low, and the potential for obtaining good results with proper instrumentation was assessed to be good.

The conclusion is that the method is suitable for measuring water and salt content as well as ageing of the ash. For filed application, special equipment designed for measuring in real soil must be used. In general, it should be emphasized that this application requires considerable theoretical knowledge until a matter of routine has been established. The results obtained indicate that the method can be applied for monitoring seals over very long times using inexpensive recycled materials and simple installations. In this way, the feasibility of using recycled materials for seals for landfills can be demonstrated, and confidence earned for such approaches.

References

Sjöblom R, Gustafsson T, Tham G. *Monitering av tätskikt i deponier med impedansspektroskopi* (Monitoring of seals in landfills using impedance spectroscopy, in Swedish but with summary in English). See also references in this document.