Fundamentals and new developments in the in-situ aeration of landfills

Session Chairs:
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Background:

Landfilling is the main disposal option for Municipal Solid Waste (MSW) worldwide. However, depending on the specific waste characteristic (e.g. amount of organic matter), landfill operation technique and climatic conditions, significant emissions in terms of biogas and polluted leachate might occur. Therefore the creation of sustainable landfills has become a fundamental objective in waste management in recent years.
Today landfills can be constructed and operated on a high technical standard (including pre-treatment, LFG collection & utilization, leachate collection & treatment etc.), but it usually take very long time periods until conventional anaerobic landfills reach a level of environmental acceptable emissions. Further more numerous old landfills exist to which the above mentioned systems have never been applied.
In this context the in situ aeration of landfills can be described as an instrument for the controlled (and sustainable) conversion of conventional anaerobic landfills into a biological stabilized status. Although the general aim of landfill aeration is more or less similar, the application of landfill aeration follows different strategies depending on the geographical region, the specific legislation and the available financial resources. Whereas in Japan the "semi aerobic landfill" is practiced especially for enhanced biological degradation, landfill aeration in the US follows mainly the intention of a fast recovering of landfill space and the production of stabilized waste material. In Europe, however, the aerobic in situ stabilization aims for a sustainable and controlled reduction of pollutant emissions from (old) landfills in order to reduce the period and expenditure of landfill aftercare significantly.

Objectives:

The subject of the session was to discuss open questions regarding the following aspects:

- Criteria: When to start and complete landfill in situ aeration?
- Monitoring: Which parameters are useful? Where and when to measure them?
- Emissions: Balancing and substance flow analysis during in situ aeration: A tool for determine the endpoint of aeration?
- Processes: Impact of aeration on leachate quality and waste material
- Landfill body: How to keep the waste in an aerobic state after completion of aeration?
- What are suitable treatment options for the off gases? Do we need them at all?
- Application boundaries: How to implement in situ aeration on large landfills?
- Semi Aerobic Landfills: An efficient tool for the accelerated stabilization of Solid Waste or a controlled loss of energy?

Results:

The session was subdivided into two parts, whereas the first one addressed the state of the art of landfill in-situ aeration in Europe and Asia. The second part focused on operation strategies, processes in the aerated landfill body and stabilisation criteria.

The first two introductory presentations (R. Stegmann: Current developments and results of the low pressure landfill in-situ aeration in Germany; S. Cestaro: Full schale application of aerobic in-situ stabilisation of an old landfill in north Italy) provided comprehensive information about current full-scale projects. During the discussion it became clear that landfill aeration, at least in the understanding of Europeans, should be mainly used for an accelerated and controlled conversion of a previously anaerobic landfill (after completion of LFG utilisation) into a widely stabilised status showing very low residual emissions. In this context the question if the landfill becomes aerobic or anaerobic after the aeration was completed was addressed. At the moment there are several indications that the landfill probably might become anaerobic again. However, the remaining gas production rates tend to be very low and leachate quality significantly improved in comparison to strict anaerobic landfills.

The semi-aerobic landfill concept was introduced by H. Yoshida (Construction and performance of semi aerobic landfills & Modelling of heat and gas transport). During the discussion the application range for semi-aerobic concepts was clarified. Obviously the waste composition in Japan favours this method, as mainly waste low in organics, is landfilled. Therefore a concept aiming in achieving a widely aerobic waste body right after the landfill operation ended seems advantageous as LFG emissions can be minimised and leachate quality improves in comparison to anaerobic landfills. On the other hand semi-aerobic landfill concepts are also tested in a few landfills in China and Malaysia.

The second part of the session was introduced by three presentations (Y. Tojo: Investigation on characteristics of waste and leachate of an old closed landfill; M. Ritzkowski: Changes in the leachate quality during landfill in-situ aeration; N. Berge: In-Situ removal of ammonia-nitrogen from bioreactor landfills). A discussion on processes, emissions and monitoring followed. Nitrogen in the leachate has been identified as one of the main parameters for determining the success of biological stabilisation measures. The nitrogen dynamic under aerated conditions has been comprehensively investigated in the last years and the significant potential of in-situ landfill aeration towards nitrification and de-nitrification has been proven. However, there are still open questions regarding the influence of higher temperature levels as they might occur during aeration. The results by Nicole Berge et al. showed that these processes are not significantly inhibited at temperatures around 45°C.

Finally, questions regarding the completion of in-situ aeration were discussed. R. Prantl (Stabilization Criteria to define the completion of landfill aeration) gave a useful input for further reflections as he presented some values, based on the results of an Austrian in-situ aeration project. It became clear that these parameters (describing the solid material, the leachate and the gas phase) are more or less site specific and might vary according to the subjects of protection concerned. However, based on the values presented the discussion, not only regarding the completion of in-situ aeration but also the completion of landfills (i.e. the end of aftercare) can be further developed.