

Scientific fundamentals of landfill stabilization, a project proposal

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Introduction

Currently a feasibility study for a project: “Sustainable emission reduction at the existing landfills Kragge and Wieringermeer” is being carried out within the framework of the *Dutch Foundation for Sustainable Landfilling*.

If feasible, the idea is to carry out two full-scale pilot projects in which a number of different measures will be undertaken in order to enhance landfill stabilization. The question at hand is whether stimulation of these processes on existing landfills can also lead to a significant reduction of the potential emission as a result of which less stringent aftercare or discharge from aftercare would be possible. An important basic assumption is that discharge from aftercare is preferred above eternal aftercare. The foundation is convinced that the EU Landfill Directive provides the possibility for aftercare that is tailor-made to the real risk of emissions from the waste body.

This presentation is aimed to introduce a research project proposal which will be submitted to the Dutch Science Foundation immediately after the workshop, in order to obtain funding for a parallel fundamental research project. The goal of the presentation is to initiate a discussion with all the experts present in order to improve the quality of the research proposal.

Hypothesis

The potential emission of a landfill is determined by a complex of factors. The organic material present in the waste body and the extent to which it has been converted is of major importance for the potential emission of a waste body. Organic material determines to a large extent, but not exclusively, the geochemical conditions in the waste body and consequently the speciation of dissolved organic carbon (DOC), heavy metals and other compounds such as ammonium, nitrate, sulphate and methane. In particular the role of mineral phases, clay, Al-, Mn- and Fe-oxides should not be underestimated.

Stabilization of organic matter occurs because degradation by micro-organisms leads to conditions in which the potential emission of a huge number of compounds is substantially reduced. This is partly due to arising conditions with minimal solubility of a huge number of compounds (heavy metals, sulphides, ..) and partly because compounds themselves are degraded or converted (organic micro pollutants). The conditions for optimal growth of micro-organisms is determined by a number of factors such as moisture, pH, temperature, presence of nutrients and inhibitors. The hypothesis that forms the basic assumption of this project is that in all landfills degradation by micro-organisms is

present (methane is produced). This degradation is far from optimal because the conditions in the landfill differ very much in a spatial sense. The main causes for this spatial variability in degradation conditions are related to variability in the presence of water. In addition to completely dry zones there are also hydrophobic zones. When there is insufficient moisture micro-organisms can not grow, small amounts of moisture are accompanied by high dissolved salt concentrations etc. On the other hand stagnant water is also not beneficial because a low degree of percolation and exchange could result in high salt concentrations, low pH values etc. Optimal conditions include sufficient and moving moisture everywhere in the waste body. An aim of the pilot project is to demonstrate that technical measures based on infiltration (remove dry areas), recirculation and perforation of impermeable layers (enlarge mobility, remove stagnant zones) result in a sustainable reduction of potential emission in the long term. The challenge for the pilot projects is to demonstrate this reduction of potential emission at short term (3 to 5 years), especially in comparison with the time scale of the emission process (decades to centuries).

Towards a parallel research project

The two pilot projects will be very much focussed on the practical application of measures which enhance stabilization. Therefore, there will not be much room for addressing research questions focussed on the more fundamental issues concerning landfill stabilization. The infra-structure and effort spent for the two pilot projects, however, offer a unique opportunity to try to obtain funding for such a research project. The Dutch Science Foundation has a program in which we will apply for funding for a parallel more fundamental research project.

Research project

In principle, the research project will have the same goals as the pilot projects. I.e., find the optimal means towards sustainable emission reduction at existing landfills. However, the project will focus on the more fundamental questions underlying the issues of emission reduction. Some of these questions are:

- How can we quantitatively measure the effects of the implemented measures?
- How predictable are the effects of the implemented measures, on the short term as well as on the long term?
- What are the underlying processes, in what detail do we need to measure these processes?
- What is the consequence of the inherent landfill heterogeneity?
- What is an acceptable uncertainty in predictions of future emissions?

In order to answer these questions, we strongly believe in the power of (conceptual) modeling. A wide range of landfill models exists and we plan to make as much use as possible of the existing modeling concepts by including the current approaches in a non-equilibrium thermodynamics frame work. The reason we want to start with such a frame-work is because we believe that thermodynamic principles provide us with good means to quantify the different relevant processes at a range of scales. In addition it provides us with a mathematical framework for including all the relevant scientific disciplines such as hydrology, microbiology, geochemistry, geotechnology, etc.

In the presentation we will elaborate on the types of questions which we want to address. We will present our research approach, both experimentally as well as theoretically. Based on our presentation,

we hope to start an in-depth discussion about our approach. In this discussion we would like to get feed-back which will help us to improve the quality of our proposal. The proposal will be submitted to the Dutch Science Foundation in the week after the workshop.