FORCED AERATION UNDER A LANDFILL COVER

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Demonstration project

Following a feasibility study into options for reduction of landfill gas emissions Afvalzorg has carried out a demonstration project (September 2000 to September 2002). The air changes the anaerobic conditions inside the waste into aerobic conditions and the emission of anaerobic degradation products (e.g. methane) is interrupted. These products will be oxidized more efficiently in the aerated layer of waste as well as in the covering soil. The project aimed at promoting the activity of methane oxidizing micro- organisms in the top layer of the waste and the covering soil through oxygen supply. However aeration may reduce methane emissions through other mechanisms as well:

- inhibition of methane formation by introduction of oxygen;
- reduction of methane potential by aerobic degradation of organic material;
- very intensive gas extraction by ensuring higher suction than aeration rates.

As a result of aeration, a 2.5 m thick aerobic zone is created, that enables us to study processes that are expected to occur in aerobic landfills.

Goals

1. To demonstrate and determine the efficiency of methane emission reduction due to improved oxidation using forced aeration;
2. To obtain design criteria for forced aeration to enhance oxidation, resulting in reduced investment and operational costs in future applications;
3. To obtain information of the design and effects of forced aeration in an aerobic landfill

Equipment

On a surface of approximately 2 ha 400 lances with a length of 2.5 m are inserted in the slopes of several landfill cells. The waste in these cells is to a large extent combustible waste, landfilled between 1997 and 1999. The slopes are covered with 1.0 to 1.5 m of topsoil. The bottom 1.5 m of the lances is perforated. Air is intermittently introduced and extracted with a frequency of one hour.

Monitoring and results

Reduction of methane emissions was the main objective in this initiative, thus emphasis was on monitoring these emissions. Due to the location of the test area on the landfill, box measurements were unavoidable. Mass balance and mobile plume measurements were carried out to check the box measurements. Measurements were carried out both before (baseline), during and after the demonstration project, thus yielding a methane abatement efficiency. The results are listed below.
"Waste biofilter" samples were collected by means of drilling cores before and after the test. In the boreholes porous ceramic cups were installed to periodically extract water from the waste. Although it is almost impossible to close a carbon balance by means of comparing carbon emitted with carbon loss in the waste, valuable data with respect to methane oxidation activity, aerobic stabilisation, remaining methane forming potential and leaching behaviour of the waste can be derived.

Period	Method		Production modeled	Emission measured	Extraction measured	Oxidation estimated
11/1999	TDL		250 ± 50	240 ± 40	110	?
11/2000	TDL		380 ± 80	240 ± 24	245	?
11/2000	TDL	7,0 ha		160 ± 16		
11/2000	MBM	5,5 ha		185 ± 46		
11/2000	box	2,0 ha		224 ± 100		
02/2001	MBM	5,5 ha		118 ± 30		
02/2001	box	2,0 ha		22 ± 21	97 ± 19	55 ± 21
08/2001	MBM	5,5 ha		80 ± 20		
08/2001	box	2,0 ha		32 ± 20	78 ± 13	55 ± 21
08/2001	box/TDL	2,0 ha		13 ± 12		
01/2002	MBM	5,5 ha		95 ± 24	22 ± 5	
05/2002	MBM	5,5 ha		63 ± 16	40 ± 4	

Discussion and concluding remarks

Operational: In periods with frost (January 2002) frozen condensated water blocks the exposed pipes and both extraction and aeration are obstructed. After a period of two years soil around the lances was washed away through the combined action of water and gas transport. Occurence of preferrential pathways around the lances had to be corrected weekly by restoring the layer of soil around the lance. The lower lances had collected a lot of sediment and were blocked altogether. These operational problems combined with the importance of extraction suggest that focusing on extraction by means of horizontal drains and burried pipes would result in a simpler and more reliable method of methane emission reduction on landfill slopes. Such an approach would also result in a low methane LFG. Biofilters have a limited efficiency and (non)catalytic conversion is expensive. There is a need for cost-effective oxidation technology for this type of gas.

Methane emission reduction: Baseline and control emission measurements show a reduction of methane emissions of the entire landfill cell (5.5 ha) of approximately 60% after implementation of forced aeration and air extraction. Box measurements indicate that the reduction on the slopes (2 ha) where aeration takes place is much higher (90%). Data from the aeration system indicate that 30 to 50% of this reduction is caused by intensive gas extraction.

Methane oxidation: Before air injection, methane oxidation capacity of the top cover soil was estimated to be 2.6 $l/m^2/hr$ at maximum. This is in accordance with data from literature. The methane oxidation capacity decreases with increasing depth. As expected for the underlying waste the oxidation capacity is low (0.1 $l/m^2/hr$). Determination of the final oxidation capacity is in progress at this moment.

Aerobic landfill: On lab-scale aerobic conversion of waste was almost completed after half a year. The aerobic conversion by landfill aeration does not appear to lead to significant increases in waste leachability. This implies that, apart from DOC and redox conditions, leachate quality after landfill aeration is not expected to change dramatically. Conclusions with respect to process conditions for aerobic landfills can only be drawn when information from the core drillings from the field test becomes available.