NEW TECHNOLOGY TO ENHANCE METHANE OXIDATION AT LANDFILLS

Matti Ettala[1] and Petri Väisänen[2]

[1]Kuopio University, Matti Ettala Oy, Risto Rytin kuja 2 B 19, 00570 Helsinki, Finland, matti.ettala@co.inet.fi, [2]Elektrowatt-Ekono Oy, Tekniikantie 4 A, 02150 Espoo, Finland, petri.vaisanen@poyry.fi

Experimental field has been built in order to utilize methane oxidation capacity of the whole landfill top cover at the sites equipped with impermeable cover sealing. Landfill gas is discharged through the sealing layer via landfill gas wells to the drainage layer all over the landfill and finally through the oxidizing top cover. No pumps are needed. However, homogeneity of the top cover has to be taken care of in order to avoid shortcuts of the gas. 242 field measurements were made and only in seven cases methane concentration in the gas flow through the top cover were higher than 100 ppm. In four points methane and carbon dioxide concentrations were measured at 0-100 cm depth and effective methane oxidation was found. The technology can be economically applied at the landfills where active landfill gas utilization plant does not serve the purpose.

1. Introduction

Methane oxidation occurs in the upper part of the landfill. However, when soil with low hydraulic conductivity is used in the top cover, landfill gas is discharged from gas wells or gas vents and methane oxidation is decreased. When landfill gas quantity or methane concentration is low active gas extraction systems with combustion are not applied. Passive landfill gas venting systems have been combined with biological filtering units but because of low oxidation capacity the use of biofilters have not been economical and efficient enough. The aim of this study and technology is to utilize methane oxidation capacity of the landfill cover also at the sites where infiltration is avoided with sealing top cover.

2. Material methods

Experimental field 50m * 50 m was built in Lohja in Finland in January 2000. The key idea of the technology is to discharge landfill gas through the sealing layer via landfill gas wells not directly to the atmosphere but to the drainage layer. In the experimental field impermeable plastic film 6m * 6 m was installed above the gas well in order to prevent gas flow directly to the atmosphere. That is how landfill gas is delivered all over the field and gas flows through the oxidising top cover layer. No pumps are needed. Compost and composted fiber sludge were used as used as top material. Edge of the well is installed above the sealing in order to prevent flow of the water in the drainage layer via gas well into the waste fill (Fig.1).

The first measuring period was carried out in May 2000. Methane concentrations were measured from 121 sampling points with a flame ionization detector (FID). The diameter of the measuring chamber was 30 cm and the FID was connected to the chamber 5 to 10 minutes after chamber was set to the landfill surface. Soil temperature, wind speed, ambient pressure and relative humidity were also measured.

The second measuring period was carried out in September 2000. Methane concentration in the landfill surface was measured with similar arrangements to the first measuring period. The gas concentration in the landfill cover was measured from 4 locations at the surface, 30 cm, 50 cm, 70 cm and 100 cm below the surface. Higher concentrations of methane were measured with infrared analyzer and lower methane concentrations with FID. Carbon dioxide was measured with infrared analyzer. Oxygen was analyzed with an electrochemical cell. Soil temperature was measured at 30 cm, 50 cm and 70 cm depths.

3. Results and discussion

Difference between results of the two measuring periods can be explained with dry season before the period in September causing channeling in top cover. Distribution of the methane concentrations (Table 1) shows that only in seven cases methane concentration in the gas flow through the top cover was higher than 100 ppm.

In four points methane and carbon oxide concentrations were measured at 0-100 cm depth and effective methane oxidation was found (Table 2). Structure of the topsoil has to be controlled in order to keep gas flow even enough when oxidation capacity is concerned. So far only one experimental field has been built but three more will be built in year 2000. In the next fields different topsoil types are used in order to study oxidation capacity. Two fields will be equipped with gas tight distribution well with regulating valves and radial perforated pipes in the drainage layer in order to achieve controlled gas flow and make gas delivery more efficient and even.

Compared to direct landfill gas discharge to the atmosphere extra cost (5.000-10.000 EUR/ ha) of the new gas oxidation system includes doubling the amount of the wells and structures to deliver gas in the drainage layer with impermeable film above the wells or perforated pipes in the drainage layer. An active gas extraction and a separate biofilter as well as flares have high investment costs, typically over 150.000 $ per installation, also at small sites. Active gas extraction operation and maintenance costs are in the order of 10 % of the investment cost. In addition, separate biofilters may limit the after use of the landfill.

4. Conclusions

The new landfill gas distribution system via drainage layer can be effectively used to utilize methane oxidation capacity of the topsoil also at the site equipped with impermeable cover sealing. The cost of the system is low compared to separate biofilters and flares. The new landfill gas oxidation system can be applied at small landfill sites equipped with impermeable sealing when the landfill gas amount is small or methane concentration is too low for active gas recovery and combustion.

LIST OF FIGURES

Fig.1. Schematic picture of the new landfill gas oxidation system; (1) refuse, (2) impermeable sealing layer, (3) drainage layer, (4) top soil cover, (5) gas collection system, (6-8) distribution well through the sealing and (9) impermeable liner to prevent gas flow.

PCT patent pending

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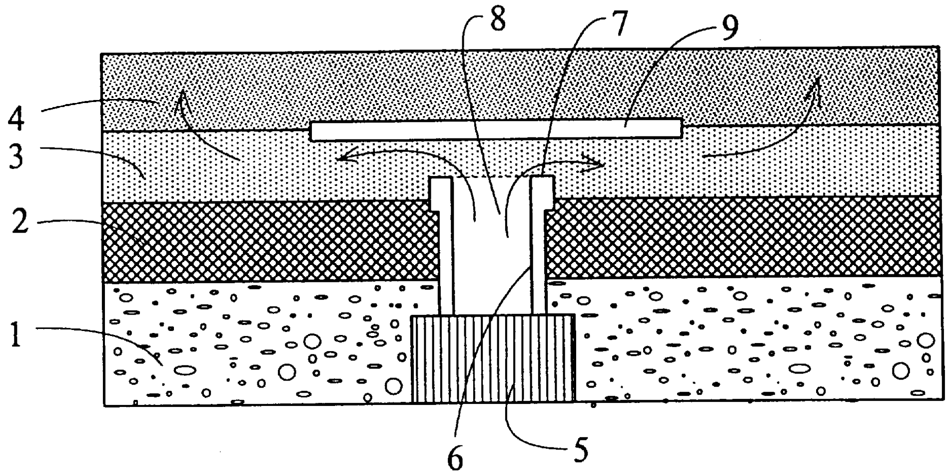

Fig. 1

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TABLE 1

Distribution of methane concentrations at Koivissilta experimental field, n=242, all values ppmv

Period	0-10	11-100	101-1000	>1000
May 2000	117	3	1	0
September 2000	110	5	4	2
Both	227	8	5	2

TABLE 2

Gas concentration at 0-100 cm depth at Koivissilta experimental field, all values ppmv

Depth cm	Measuring point 1	Measuring point 2	Measuring point 3	Measuring point 4
0	40	120000	1	23
30	210	420000	30	150000
50	5900	480000	136	70000
70	7800	500000	1000	440000
100	480000	510000	60000	550000