Novel approach for treatment of low calorific landfill gas

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Presentation Detail

1. Introduction to Biocovers & Biofilters for methane oxidation
2. Report on the use of biocovers for landfill gas oxidation on two Austrian landfill sites
3. Potential for application of Bio-Based Landfill Methane Mitigation Systems in Ireland
Bio-Covers

A landfill biocover is a porous medium placed on top of the waste to reduce fugitive methane emissions.

Microbial oxidation system instead of Thermal oxidation

Biocovers are a low cost, low technological approach to mitigate greenhouse gas emissions from landfills.

Utilised at selected landfill sites across Europe (Denmark, Austria & Germany), the United States and Australia.

Biocovers may be used as a stand-alone system or combined with an active gas extraction system for flaring or power generation.

Biocover material:

# 1  Timber chippings and compost mixture

# 2  Compost with a clay material mix.
Typical Landfill Biocover System
Biocover Windows

Å Biocover material is set out in discrete areas across a mineral capping layer above the waste.

Å Example below is an experimental design used at Fakse landfill site in Denmark

Å 10 biocover windows with a combined area of 5000m² were set out over a landfill of 12 hectares

Å Principle for methane emissions reduction is the same as biocover systems except that the landfill gas is channelled towards the biocover windows for treatment
Biocover Windows - Fakse Landfill Site, Denmark
Biofilters

- Biofilters are constructed as separate units
- Landfill gas is fed via pipes either passively or actively by pumping
- Used where gas flows have fallen to a level where flaring is no longer practical
- Biofilters may be installed on or adjacent to the landfilled waste

Active biofiltration system typically comprises:
  - Conventional landfill gas extraction system
  - vertical / horizontal gas wells + blowers
  - mixing the landfill gas with air
  - Discharge collected gas through discrete biofilter units
Biofilter Design

- **Oxidation Layer**: Compost & Timber Chippings
- **Gas distribution layer**: Coarse gravel deficient in lime (Ø 16/32 mm)
- Landfill

**Crucial!!**
Passive Biofilters

- Geomembrane
- Gas Intake
- Gas Distribution Medium
- Biofilter Material
- Soil Cover
- Waste
Biofilters: active venting

- Air Intake
- Landfill Gas Intake
- Exhaust Gas
Austrian Field Visit

- Contact made with Prof. Marion Huber-Humer, Institute of Waste Management. BOKU-University Vienna,
  Two Landfills visited – 5th June 2012
- Ameis & Tulln, near Vienna
- Landfills closed & aftercare managed by Waste Management Department of Lower Austria Government

- Biocover use in Austria (2009)
  - 5 older landfills with biocovers covering the entire or at least the main part (2/3) of the landfill surface
  - 2 landfills with bio-windows integrated in an (cohesive) existing landfill cover
Ameis Landfill Site

- Location: 50 km north of Vienna
- Detail: Closed in 1996
- Active & passive gas control
- Flare operates for 5 hrs /day [set in youngest waste (1986 – 1996)]
- Enclosed flare capacity: 100 m³ / hr [operates @ 30% CH₄]
- Biocover over areas where CH₄ ≤ 30%
- Leachate: Extensive re-circulation system in place
- Capping: Mineral & geo-synthetic liner
Aerial Photo – Ameis Landfill Site
Diagrammatic representation of biocover over Ameis landfill site

VARIANT A

40 cm Compost/Sand (70/30)
80 cm compost

VARIANT B

120 cm Compost/Sand (70/30)

30 cm sand even-layer

8 – 9 m MS waste
Side Slope construction at Ameis

Geo-synthetic clay liner required along steep slope to prevent fugitive gas emissions
Installation of biocover at Ameis landfill site
Vegetated biocover at Ameis landfill site – June 2012
Enclosed Flare at Ameis landfill site

Flare capacity: 100 m³ / hr [operates @ 30% CH₄]
Tulln Landfill Site

- **Location:** 45 km north east of Vienna
- **Detail:** 500,000 m³ waste insitu
- **Closed in late 1980’s**
- **Flare operates for 2 - 3 hrs /day [set in youngest waste (20 yrs old)]**
- **Enclosed flare capacity: 300 m³ / hr [operates @ 30% CH₄]**
- **Leachate:** Extensive re-circulation system in place
- **Capping:**
  - ⅓ top capped with mineral liner (70 / 30 - clay : compost)
  - Remainder LLDPE liner on slope towards leachate lagoons
- **LF Gas issues relating to hot spots around leachate recirculation chambers ~ 10,000 ppm**
Aerial Photo – Tulln Landfill Site
Vegetated biocover at Tulln landfill site
Vegetated biocover at Tulln landfill site
Leachate Collection Ponds
Leachate Recirculation Chamber
Patchy vegetation outlining gas hot spots
Critical Factors in Biocover Design

- Coarse materials, high porosity =>
- Lower thermal conductivity =>
- Good temperature insulation effect =>
- Providing suitable temperature conditions during winter for methane oxidation

Biocover Operating Parameters

- Typically:
  - 4 – 5 litres CH₄ / hr / m² ~ 100 – 120 litres CH₄ / m² / day
  - Lower limit of biocover use ~ 50 litres CH₄ / m² / day
  - Upper limit of biocover use ~ 250 - 280 litres CH₄ / m² / day
    - (approx. 420 – 460 litres LF gas / m² /day)
Gas Fluxes (FID Survey) measured on Test Cells of varying design in Field Trials

**Cell Emissions**

- **Cell 1:**
  30 - 60 litre LF Gas /m² d

- **Cell 2:**
  20 - 90 litre LF Gas /m² d

- **Cell 3:**
  30 – 960 litre LF Gas /m² d

- **Cell 4:**
  30 - 370 litre LF Gas /m² d

- **Cell 5:** Uncovered landfill (control)
  50 - 1,960 litre LF Gas /m² d
Austrian Limits for Landfill Gas Fugitive Emissions from Biocovers

- **Hot Spots:** 10kg CH$_4$ / m$^2$ / yr
- **Total Site:** 5kg CH$_4$ / m$^2$ / yr
- **Flux box test per 500m$^2$** to determine total site emissions
- **4 x FID tests per year** required for detection of volatiles – (set according to German standards)
- **Biocover is only a temporary cover (max. 20 years)**
- **After this requires mineral / LLDPE liner**
Austrian Biocovers use - 2009 Data:

Â 5 older landfills with biocovers covering the entire or at least the main part (2/3) of the landfill surface

Â 2 landfills with bio-windows integrated in an(usually cohesive) existing landfill cover
Application of Bio-Based Landfill Methane Mitigation Systems in Ireland

• Low cost / low technological approach to oxidation of landfill gas

• Huge Potential -
  - Old (abandoned) landfill sites (Tier 1 & Tier 2 assessments)
  - Lean gas @ increasing number of operating sites / near completion
  - Biocovers may be suitable for MBT / Residual Landfills (Bottlehill)
  - Severe Financial Constraints at present
  - Biocovers / biofilters may offer a solution (temporary)

• Irish Climatic Conditions Ideal
  - Low temperature extremes (esp. in Cork)
  - Higher rainfall {1300 mm / yr in Cork vs. 700mm / yr Vienna}

• Biofilter units to be designed in to nest phase capping @ KRLF
  - Units to be covered, well insulated and equipped with an irrigation system
  - Consideration to be given to irrigation with pre-treated leachate - effectively seeding the biofilter units with active enzymes
  - Biofilter units to be brought in to operation on an incremental basis – results driven and proofing of methane oxidation
Gas Collection Network for next Phase of Restoration – Kinsale Road LF
Recommended Websites

- CLEAR - Consortium for Landfill Emission Abatement Research
  - http://ch4ox.lmem.us/index.html

- MiMethox - Mikrobielle Methanoxidation in Deponieabdeckschichten
  - www.mimethox.de

- Leitfaden Methanoxidationsschichten, Wien, Oktober 2008
  - Guide for Methane Oxidation Layers (Biocovers)
  - Editor: Marion Huber-Humer
References


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Thank You