Landfill Mining: An Option to Trigger Resources?

Prof. Dr.-Ing. Peter Quicker
RWTH Aachen University – Unit of Technology of Fuels

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Introduction
Introduction

Project structure

- Funding from Federal Ministry of Education and Research
- Project period: August 2012 – July 2015
- Project partners
  - Companies
  - Universities
  - Institutes
Introduction

Ambition & Approach

• Development of methods for recovery of selected resources from municipal waste and slag landfills
• Excavation and treatment of 8,000 Mg old-deposit (80s to 2010s)
• Study on landfill reclamation and resource usage:
  – Technology
  – Ecology
  – Economy
• Preparation of guidelines for the implementation of landfill mining projects
• Our task
  – Thermal recycling of RDF-fractions generated from landfill material
  – Pyrolytic treatment of mechanically generated metal concentrates (disintegration of composite material)
RDF-Production

Landfill material excavation
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Landfill Pohlsche Heide District Minden-Lübecke

Legende:
P = Probebohrung
R = Referenz
K = Kampagne
Kampagne mit ca. 2.600 m³ Gewinnung Deponat

1988-1991

1991-1995

1995-2002

1988-1991
Landfill material excavation
Landfill material excavation
Landfill material excavation
RDF-Production

Mechanical treatment of landfill material
Mechanical & thermal treatment of landfill material – Overview

Raw landfill material K1, 2 and 3

Interim storage

Pre-conditioning

Lightweight fraction

Heavy fraction

Raw landfill material RDF

Landfill material RDF

Plastics

Frischmüll (Hannover)

Fluff production

Cement plant

Commercial waste sorting plant

Fresh RDF (Minden)

EAB Bernburg

CHP Minden

EEW Hannover

MBA Pohlsche Heide

Sortieranlage HKW Minden

8000 t

ca. 25 t

ca. 180 t

ca. 100 t

ca. 75 t

ca. 80 t

Admixture

Leichtfraktion

Schwerfraktion

Admixture
Mechanical treatment of landfill material – Output

RDF material analysis (from mechanical-biological waste treatment plant in Pohlsche Heide)

- Sampling according to LAGA PN 98: Several samples (320 liter)

![Pie charts showing the composition of RDF material analysis from Pohlsche Heide.](image)
Mechanical treatment of landfill material – Output

Plastics 3-D
Mechanical treatment of landfill material – Output

Foils
Mechanical treatment of landfill material – Output

**High calorific material**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calorific value</td>
<td>9.800 – 17.300 [kJ/kg]</td>
</tr>
<tr>
<td>Chlorine content</td>
<td>up to 2.5 %</td>
</tr>
<tr>
<td>Ash content</td>
<td>ca. 30 – 42 %</td>
</tr>
<tr>
<td>Water content</td>
<td>ca. 11 – 40 %</td>
</tr>
</tbody>
</table>
Mechanical treatment of landfill material – Output
Mechanical treatment of landfill material – Output

Sorting residue
Combustion trials

Waste-to-energy plant EEW Hannover
Combustion test EEW Hannover

Plant layout
Combustion test EEW Hannover

Input

- Mono-combustion of landfill material RDF from MBT
- Combustion of crude landfill material in mixture with fresh waste
  - Ratio Landfill material : Fresh waste
    1 : 10, 1 : 5, 1 : 3
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Combustion test EEW Hannover

Input

Fresh waste

Landfill material RDF
Combustion test EEW Hannover

Flame image

- Fresh waste
- Landfill material RDF
- Landfill material – Fresh waste 1:3
Combustion test EEW Hannover

Bottom ash

Slag from fresh waste

Slag from landfill material
Combustion test EEW Hannover

Results

Steam mass flow

RDF from landfill material
Crude landfill material/ Fresh waste mixture

Steam mass flow [Mg/h]

Reference period 1
Trial period
Reference period 2
Combustion test EEW Hannover

Results

- HCl raw gas values (mean values over trial time)

![HCl concentration graph](image_url)

- Crude landfill material/ Fresh waste mixture
- Reference period 1
- Mono RDF
- 1:10
- 1:5
- 1:3
- Reference period 2
Results

- HCl clean gas values (mean values over trial time)

![HCl Concentration Chart]

- Limit value
- Crude landfill material/Fresh waste mixture

**Combustion test EEW Hannover**

**HCl Clean gas**
Combustion test EEW Hannover

Results

- $SO_2$ raw gas values (mean values over trial time)

![SO2 Levels Diagram](image-url)
Combustion test EEW Hannover

Results

- CO values (mean values over trial time)

![Graph showing CO concentration for different waste mixtures](image_url)
Results

- Moisture (mean values over trial time)

![Graph showing moisture levels](image-url)
Combustion test EEW Hannover

Results

• RDF monocombustion possible
• Raw gas values of RDF mono-combustion
  – HCl: significant increase by a factor of 2-3 → Exceedance of emission limit
  – SO₂: moderate increase
• Increase of lime milk consumption (ca. factor 2)
• Flue gas moisture noticeably higher
• Target value in steam production not reached because of low calorific value

• Crude landfill material only applicable in very high dilution with fresh waste (>1:10)
• Opinion of operator:
  Combustion of landfill material RDF in 1 : 1 mixture with fresh waste should be no problem
Combustion trials

Refuse-derived fuel power plant Bernburg
Combustion test EAB Bernburg

Plant layout

Quelle: www.eew-energyfromwaste.com 2014
Combustion test EAB Bernburg

Input

- Mono-combustion of landfill material RDF from preconditioning
  → 1 year storage (drying!) and post-screening (about 50 % mass loss!!!)
Combustion test EAB Bernburg

Input

RDF from fresh waste  RDF from landfill material
Combustion test EAB Bernburg

Input

RDF from fresh waste

RDF from landfill material
Combustion test EAB Bernburg

Flame image

RDF from fresh waste

RDF from landfill material
Combustion test EAB Bernburg

Results

• Steam production

Combustion of RDF from landfill material
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Combustion test EAB Bernburg

Results

• Emissions

Combustion of RDF from landfill material

Bicarbonate consumption

SO₂

HCl

HCl
Combustion test EAB Bernburg

Results

• Mono-combustion possible: No difference to normal operation
• No problems with material logistics
  Reason: Material was comparatively dry (1 year storage)
• Raw gas values RDF mono-combustion
  – HCl: significant increase by a factor of 2-3 to 2.400 – 4.700 mg/m³, i.N.
  – SO₂: unremarkable
• Consumption increase of sodium bicarbonate (ca. factor 2-3)
• Stable steam generation

• Operating staff:
  „Combustion behavior of landfill material RDF better than some fresh RDF“
Combustion trials

Cement plant CEMEX Beckum
Combustion test cement plant CEMEX Beckum

Plant layout

Quelle: CEMEX Deutschland 2014
Combustion test cement plant CEMEX Beckum

Input

• High-calorific material with 13 - 15 MJ/kg
• 2 Mg/h (= ca. 5 % of total FWL)
Input

RDF from fresh waste

RDF from landfill material
Results

- Troubles in conveying
  - Significant tendency to agglomeration
  - Bridging over screw conveyors
  - Blocking beyond rotary valve
Combustion test cement plant CEMEX Beckum
Combustion test cement plant CEMEX Beckum

Results

• Troubles in conveying
  – Significant tendency to agglomeration
  – Bridging by discharge screw conveyors (isolated)
  – Frequent damer to reduce impact on rotary valve

• Too high chlorine values
  – Values from analysis of CEMEX sampling: Average value: 2,45 %!
  – Too high chlorine content in hot meal
  – Too much chlorine in bypass dust
  – Cl values in clinker (still) okay

• Massive incrustations in preheater tower
  – Higher pressure drop and personnel effort
Combustion test cement plant CEMEX Beckum

Results

- Due to difficult material handling reduction in throughput from 2 to 1.5 Mg/h

- Conveying problems and chlorine concentration led to test termination

- Conclusion
  - Troubles in conveying
  - Chlorine is biggest problem
  - Heavy metal content often above acceptance criterion
  - Drying necessary

- Operator: „Material is not applicable“
Conclusion
Conclusion

Landfill material

• Very heterogeneous with different compositions
  – Much inert material due to soil cover (ash content, fines)
  – High moisture content
  – High content of chlorine (from „0“ to 2,5 %) and sulfur possible
  – Dull and brittle plastic consistency (lack of plasticizer?)

• Untreated landfill material is only applicable in very high mixture

• Treatment to RDF necessary
  – Crushing
  – Fractioning (fine and heavy product separation)
  – Metal separation
  – (Storage for) Drying?

• (Very) low RDF production
Interim conclusion

Thermal treatment

• Incineration in WtE plant possible
• Recommended conditions
  – Treatment with separation of fines and metals
  – Drying (perhaps by storage) appears to be advantageous
  – Incinerator
    - Classical WtE technology with variable grate
    - With great effort (and in mixture) also for simpler systems applicable
  – Increase in raw gas values and consumptions of adsorbents expected
• Combustion of untreated material seems not to be reasonable
  → But what can be done with the separated fines?
• Application in cement plants not possible
• Landfill Mining only for material and energy recovery is unrealistic
  → Economical not feasible
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Prof. Dr.-Ing. Peter Quicker

RWTH Aachen University
52056 Aachen

www.teer.rwth-aachen.de