Biodrying for Mechanical Biological Treatment of mixed municipal solid waste and potential for RDF production.

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- Tunisian National Agency for Waste Management (ANGed). University of Innsbruck
- Lahmeyer GKW Consult GmbH
- STE, Tunis
- University of Tunis
Overview

- Collection and sorting, composting, incineration of medical wastes and sanitary landfills starting to be implemented.
- Recycling, reuse and resource recovery still at the initial stages.

no separate collection with high percentage of uncollected waste

2-5% of material are recovered as recyclable materials

sorting and composting facilities are being operated with limited capacity

Mixed domestic solid waste

Collection and transfer (municipal waste)

Waste treatment plant

Compost (poor quality)

City dumpsite

most of the waste directed to open or controlled dumpsites.

Other sources (commercial, industrial, hospital)
failure of treatment plants was due to:

- the mismanagement of the plants
- the selection of inappropriate technology for the local conditions  
  - high operating costs
  - frequent mechanical breakdowns
- lack of understanding of the composting process
- untrained personnel for the operational procedures  
  - poor maintenance
Current situation

- heavy metals
- organic pollutants
- physical risks
  (sharp objects, glass and the aesthetical problem of plastic)
The aim of this Study

- Assess the performance of Biological drying process of solid waste, by aerated windrow composting/stabilization, was investigated
- Investigate the potential for RDF produced by using the biological drying/stabilization process
- The economic feasibility and financial risk of the project proposal is evaluated by carrying out a capacity analysis.
Materials and methods

Input material

<table>
<thead>
<tr>
<th>Trials</th>
<th>Quantity of waste (t)</th>
<th>Number of windrows</th>
<th>Beginning of trail</th>
<th>End of trail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>110</td>
<td>2</td>
<td>25/06/2014</td>
<td>15/07/2014</td>
</tr>
<tr>
<td>2</td>
<td>96</td>
<td>1</td>
<td>04/08/2014</td>
<td>28/08/2014</td>
</tr>
<tr>
<td>3</td>
<td>98</td>
<td>1</td>
<td>03/09/2014</td>
<td>23/09/2014</td>
</tr>
<tr>
<td>4</td>
<td>145</td>
<td>2</td>
<td>27/10/2014</td>
<td>19/11/2014</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>1</td>
<td>02/12/2014</td>
<td>17/12/2014</td>
</tr>
</tbody>
</table>
Materials and methods
Materials and methods

Receiving 100 tonnes of waste
Turning waste
Build the windrow
Laying the membrane
Setting up the Wireless Temperature Sensor
Overall view
Experimental monitoring
Results

mass balance

![Bar chart showing mass balance over summer and winter for input and output with categories: water, RDF, <80mm, and Dry matter.]

Screening at 80mm

![Graph showing screening results for trails 1 to 5 with categories: mass loss during 3 weeks drying, < 80 mm at screening, >80mm (RDF). A pie chart showing total mass balance with 35%, 24%, and 41% for different categories.]
RDF characterization

- others
- metals
- others combustible
- nappies
- textiles
- other plastics
- plastic film
- cardboard
- paper
- organics
### Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>summer trial</th>
<th>winter trial</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DM_input (%)</strong></td>
<td>47 44 54 47 48</td>
<td>47</td>
<td>48</td>
</tr>
<tr>
<td><strong>LHV_input (MJ/Kg)</strong></td>
<td>16.04 16.79 17.94 15.56</td>
<td>16.24</td>
<td></td>
</tr>
<tr>
<td><strong>DM_output/RDF (%)</strong></td>
<td>75 69 50 67</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td><strong>LHV_output/RDF (MJ/Kg)</strong></td>
<td>18.87 20.61 19.96 18.87</td>
<td>19.58</td>
<td></td>
</tr>
<tr>
<td><strong>Ash_output/RDF (%)</strong></td>
<td>31.9 17.6 20.3 23.8</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

The dry matter of the input and the produced RDF
Heavy metals

Cd (mg/kg)

Cr (mg/kg)

Ni (mg/kg)

Hg (mg/kg)

Zn (mg/kg)

As (mg/kg)
Proposed RDF Facilities for the Arab region

Strategies

- the recovery of RDF + recyclables
- the recovery of RDF + recyclables + fine fraction is further stabilized before landfilling

Option 1
50,000 Mg/a

Option 2
100,000 Mg/a

Option 3
Stabilized material for landfill 100,000 Mg/a

Option 4
Compost like output 100,000 Mg/a
Strategy 1, biological drying, RDF production and recyclable material recovery.

- **Household waste**
  - Bulky waste removal
  - Bag opening
  - Metal separation

- **Screening**
  - <150-200mm
  - >150-200mm

- **Biological drying**
  - Metal separation
  - Screening 60mm
  - <60mm

- **RDF preparations**
  - Density separation
    - low
    - high

- **Landfill**

**Water and mass loss**
- 30-40%

**Dried material to landfill**
- 35-40%

**Raw waste**
- 100%

**RDF**
- 20-25%

**Metal**
- 2-4%
Strategy 2, biological drying, RDF and stabilized material production and recyclable material recovery.
The cost of each plant includes:

- Total capital investment.
- Operation and maintenance cost.

Revenues:

- Sale of produced RDF.
- Recycled materials.
- Gate fee.

Assumptions

- Plant work for 4000hr/yr.
- 2 shifts daily each shift is 8 hours.
### Capital costs and assumptions

<table>
<thead>
<tr>
<th>Option</th>
<th>Capacity</th>
<th>Quantity (Mg/a)</th>
<th>Capital investment (Million Euro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RDF production and recyclables recovery.</td>
<td>50000</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>RDF production and recyclables recovery.</td>
<td>100000</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>RDF, recyclables recovery and stabilized material for landfilling.</td>
<td>100000</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>RDF, recyclables recovery, compost-like output (CLO) and inert material for landfilling.</td>
<td>100000</td>
<td>14</td>
</tr>
</tbody>
</table>

**Annual cost:**

- Net equity percentage: 30 %
- Useful economic life: 15 years
- Interest (inflation adjusted): 5 %p.a.
- Insurance, Revisions: 2 %p.a.

**Expenses:**

- Removal costs for residues and transportation: 10 € / Mg
- Maintenance costs: 100 € / h
- Electricity consumption costs: 80 €/ MWh
- Personnel costs (1 man): 12000 €/a
- Number of necessary persons: 40
- Effective: 480000 €/a
Gate fees and RDF selling price

<table>
<thead>
<tr>
<th>Revenue</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate fee</td>
<td>10, 20, 30, 40</td>
<td>€ / Mg</td>
</tr>
<tr>
<td>Sale of RDF</td>
<td>15, 20, 25, 30</td>
<td>€ / Mg</td>
</tr>
<tr>
<td>Sale of recyclables</td>
<td>50</td>
<td>€ / Mg</td>
</tr>
<tr>
<td>Sale of compost like output</td>
<td>10</td>
<td>€ / Mg</td>
</tr>
</tbody>
</table>
Revenue from the suggested options

<table>
<thead>
<tr>
<th>Waste Quantity (t)</th>
<th>Alternative 1: 50,000 t/a drying and RDF production</th>
<th>Alternative 2: 100,000 t/a drying and RDF production</th>
<th>Alternative 3: 100,000 t/a with stabilization</th>
<th>Alternative 4: 100,000 t/a with compost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-tax profit (€/a)</td>
<td>Pre-tax profit (€/a)</td>
<td>Pre-tax profit (€/a)</td>
<td>Pre-tax profit (€/a)</td>
</tr>
<tr>
<td>37,500</td>
<td>-63</td>
<td>854</td>
<td>894</td>
<td>1,280</td>
</tr>
<tr>
<td>50,000</td>
<td>49</td>
<td>1,298</td>
<td>1,352</td>
<td>1,867</td>
</tr>
<tr>
<td>62,500</td>
<td>181</td>
<td>1,743</td>
<td>1,810</td>
<td>2,454</td>
</tr>
<tr>
<td>75,000</td>
<td>314</td>
<td>2,187</td>
<td>2,268</td>
<td>3,040</td>
</tr>
<tr>
<td>100,000</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>125,000</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>150,000</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Parameter:
- Capital investment: 8,12,14 MioEUR
- Net equity: 30 %
- Useful economic life: 15 years
- Interest (inflation adjusted): 5 % p.a.

Costs:
- Effective personnel costs: 480,000 EUR/a
- Maintenance: 100 EUR / Op hour
- Removal of residues: 10 EUR / Mg
- Electricity consumption: 80 EUR / MWh

Earnings:
- Waste accretion fee: 20 EUR / Mg
- RDF sale: 30 EUR / Mg
- Sale of recyclable material: 50 EUR / Mg
- Sale of compost: 10 EUR / Mg


Conclusions

- RDF production considered a good alternative for the region
  - the reduction of the moisture content
  - increase in the calorific value
  - decrease leachate production
- The biodrying process dried the waste within 3 weeks.
  - efficient screening of the waste
  - Easley separate the recyclables and high calorific components from the organic fines fraction.
- High capital investment is needed to set up a RDF plant.
- return on investment is not guaranteed to treat the designed waste quantity for all cases.
- The selection of the appropriate solution for MSW must be based on many factors, such as the availability of land for disposal
  - market for recyclable material
  - the need for energy production
Cooperation between municipalities cement industries and international waste companies

- Owners of the waste
- Ability to collect gate fees
- Companion to decision-makers

- Owners of the facilities to utilize RDF.
- Investment capability
- Willing to reduce the energy cost

- Owners of the Know-how.
- Experienced in this field.
- Investment capability
Separation at source „Wet“ and „Dry“ is the trend in the world.
Thank you for your attention