ENERGY RECOVERY BY BIOLOGICAL UTILIZATION OF ORGANIC WASTES FROM HOUSEHOLD AND LANDFILLS

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Outline of the presentation

• Introduction - priorities of EU

• Idea of KLT-technology:
  Step I  – Mechanical
  Step II  – Biological
  Step III  – Thermal

• Experimental

• Results and Discussion

• Conclusions
Introduction

Priorities of EU solid waste management policy (Directives: 91/156/CEE, 91/689/CEE, 94/62/CEE) are as follows:
- waste separation and collection,
- recycling of materials,
- composting,
- recovery of energy from combustible wastes and use of landfills to deposit processed wastes (i.e. inertised).

Prohibition to deposit wastes of calorific value above 6 MJ/kg!

The main aim of this paper is to present the newly developed technology for energy recovery from municipal solid wastes, deposited mainly in unauthorized, old landfills with fresh organic fraction of municipal wastes (OFMSW) by mechanical, biological and thermal processes.
The Idea of KLT to degrade together old wastes with fresh MSW

Fresh MSW of high BOD_5  Wastes from old landfills of high COD & low BOD_5
Step I – Mechanical

Washing of solid wastes (leaching)
Changes of COD versus washing time
Changes of dry mass versus washing time

![Graph showing changes of dry mass versus washing time. The graph includes lines and data points indicating different conditions with and without baffles and their corresponding times.]
Washing of wastes in a double-drum coaxial mixer
Step II – Biological
Methane fermentation (for high BOD suspension)

**Bioreactor:**
- Vol. 30 dm³
- Temperature - 37°C
- HRT – 20 days

**Analytics:**
- Dry mass, Organic dry mass (VSS), COD,
- Elemental analysis C,H, N,O, S
- pH, redox potential,
- Temperature,
- Alkalinity,
- Biogas volume and content,
Step II – Biological
Methane fermentation: biogas yield - 550 dm$^3$ kg$^{-1}$ dm$^3$ added
Biogas production rate - 3.40 dm$^3$ dm$^{-3}$ d$^{-1}$
Methane content in biogas – 50-60 % Vol.
Step II – Biological Aerobic process (for low BOD rinsed water)

Bioreactor:
- Volume: 6 dm³
- Temperature: 37°C
- HRT: 3-5 days
- Aeration: 240 dm³/h (1 vvm)

**COD reduction**: 8%
**Organic dried matter (V.S.S.) reduction**: 10-14%

<table>
<thead>
<tr>
<th>HRT [d]</th>
<th>(O_2) concen [ppm]</th>
<th>Conduct [mS/cm]</th>
<th>V.S.S. reduct.</th>
<th>COD reduct.</th>
<th>(BOD_5/COD)</th>
<th>TOC/TN</th>
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<td>8,47</td>
<td>0,155</td>
<td>9,26</td>
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Step III – Thermal
Biodrying of eluted solid fraction

- Bioreactor Volume - 240 dm³
- Temperature of inlet air - 30- 35°C
- Cycle duration- 10 -12 dni
Step III – Thermal

Temperature of the top and bottom layer of composted biomass and air above the bed
Step III – Thermal
Biodyring: Humidity and temperature of outlet air

<table>
<thead>
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<th>Time [days]</th>
<th>Relative humidity [%]</th>
<th>Temperature [°C]</th>
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</tr>
<tr>
<td>10</td>
<td>75</td>
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</table>

- **Temperature**
- **Humidity**
Step III – Thermal
Biodrying of eluted solid fraction

Initial moisture content: 0.8 – 0.85 kg kg$^{-1}$
Final moisture content: 0.3 - 0.4 kg kg$^{-1}$
Step III – Thermal
Biodyring products

Gross calorific value - 12.5 - 16.5 kJ g⁻¹
Net calorific value - 11 - 15 kJ g⁻¹

Pyrolysis (100 - 400ºC): carbonisate, gas (CO₂, CO, H₂, CH₄) & tar
Further pyrolysis (400 - 800ºC) and gasification: gas (CO, H₂)
1. The experiments carried out at big laboratory scale confirmed that the use of
   a) hydromechanical preparation process,
   b) liquid anaerobic and aerobic treatment and
   c) authotermal biodrying process
   enables quick and efficient decomposition of organic matter and energy
   recovery from waste.

2. The double-drum mixer with the perforated internal drum with the inclination
   angle of the axis 30° fulfills the conditions required to carry out the periodic
   leaching of municipal solid waste. Applying additional stirrer units
   (baffles) accelerates the leaching process by several percent.

3. It is possible to introduce OFMSW and landfill deposits to the sewage sludge
   sequence of the oversized wastewater treatment plants by conducting the
   biological processes in anaerobic and aerobic sequence.
Conclusions

4. In autothermal biodrying with heat (170-250 W/m³ raw waste) generated during composting, a 50% decrease of water content in the waste was obtained.

5. The net calorific value of dried waste material (11000 kJ/kg) and their heat of combustion (12200 kJ/kg) were satisfactory for production of alternative and low-cost fuels e.g. in the form of briquettes.

6. Developed technology for innovative treatment of organic fraction of solid household and deposited waste aims at reducing the volume of waste disposed in the landfills, processing the waste disposed in the landfills to make them harmless.
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