European Workshop

Thermal Treatment of Sewage

Sludge for CHP Applications

Percentage of Sludge Volumes by Disposal Channels in EC, 2002 and 2009

Key:
Inner Circle = Year 2002
Outer Circle = Year 2009

- Other
- Composting
- Thermal
- Landfill
- Agriculture
Price Trends by Services in EC, 2002

- Thermal
- Composting
- Agricultural Recycling
- Landfill
- Transport

Price Range (EURO per wet ton)

= Average Price
Water Content

Weight-Loss of 1 ton Sewage Sludge throughout typical Sludge Treatment Route

- Thermal Drying (cell and chemically bonded water)
- Dewatering (bonded and capillary water)
- Thickening (bonded and capillary water)

Dewatering
Thickening
Thermal Drying
Dry Substance

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**Bio Solids Use and Disposal**

<table>
<thead>
<tr>
<th>Waste to energy by incineration of sludge cake at 20 – 40 DS with power production</th>
<th>Waste to energy by incineration of dried sludge at 90 % DS</th>
<th>The agricultural use of the dried sewage sludge as fertilizer and for the soil improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incineration and energy recovery of sewage sludge at an average DS content of 25% results in a power production of 250 – 300 kW/TDS. The incineration plant itself has a typical parasitic power load of 250 – 300 kW/TDS. The final product from the plant is an ash that can be used as a raw material for manufacture of civil engineering products.</td>
<td>Energy recovery from a plant processing dried sewage sludge at 95% DS results in a power production of 700 – 1000 kW/TDS. The plant itself has a typical parasitic power load of 300 – 330 kW/TDS. The final product from the plant is an ash that can be used as a raw material for manufacture of civil engineering products.</td>
<td>Total Dry Substance on oats / container</td>
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<tr>
<td></td>
<td></td>
<td>Fertilizing without</td>
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<td></td>
<td></td>
<td>sewage sludge 17.6</td>
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<td></td>
<td></td>
<td>with sewage sludge 1000 kg N / ha 37.6</td>
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<tr>
<td></td>
<td></td>
<td>with sewage sludge 2000 kg N / ha 45.9</td>
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<tr>
<td></td>
<td></td>
<td>with sewage sludge 4000 kg N / ha 49.6</td>
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<tr>
<td></td>
<td></td>
<td>with sewage sludge 8000 kg N / ha 48.9</td>
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<tr>
<td></td>
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<td>with artificial fertilizer 1000 kg N / ha 42.9</td>
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</tbody>
</table>

- Sewage sludge has a positive effect on plants and enables high yield
- Even overdosed the fertilizing effects remain due to high buffer capacity of sludge
- The organic compound of the sludge increase the humus content of the soil.

**Conclusion:**
Sewage sludge is a high efficiency Nitrogen fertilizer with additional ability to improve the soil due to the organic matters contained in the sludge. It also serves as a fuel resource for energy production. In both cases drying is the most beneficial way for its preparation.
Thermal Drying of Sewage Sludge

Convective Drying
The sludge is directly dried by the flue gas or hot air and the humidity is discharged.

- flue gas or hot air
- gas and water vapour

Contact Drying
Heat is transported via a lateral surface to the sludge. The humidity evaporates and is discharged.

- air
- water vapour

- heating medium
Drum Drying System - Direct heated system

- Fuel
- Dewatered sludge
- Crusher
- Mixer
- Drum dryer
- Separator
- Screen
- Dried material
- Offgas treatment (e.g. biofilter)
- Condenser
Daldowie (Glasgow)

- **Plant Type:** 12 Centrifuges
  - D7LL, 6 Drum
  - Drying Lines DDS 40

- **Input:** Industrial and municipal sludge

- **Dewatering:** from 2 to 28 % TS

- **Drying:** from 28 to 92 % TS

- **Final Product:** 1 – 6 mm granulate

- **Evaporation rate:** 22,000 l H₂O / h

- **Start up:** 2002
Louisville and Jefferson country (USA)

• Equipment Type: 4 x DDS 90

• Inlet: Biosolids, at 22% TS

• Product: 92 % TS; 1 – 4 mm Granulate

• Evaporation: 36.000 kg H₂O / hr

• Start up: 2002
Bran Sands

The peripheral equipment comprises:

• 3 parallel gas turbines (fired by natural gas, 5 MW each), supplying hot exhaust air (approx. 430 °C) as heating energy to the dryers and, more importantly, producing electric current supplied to the national grid.

• a complete sewage treatment plant for the filtrates produced in the sludge dewatering stage, for treatment up to receiving water grade.
Fluidised Bed Sludge Drying Plant

Dewatered Sludge → Mixer → Fluidized bed drier → Thermooil circuit

Thermooil circuit → Main fan → Screen → Condenser

Screen → Aspiration filter → Cooler

Cooler → Sludge to product storage

Crusher → Sludge to product storage

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Palm 1

• Plant Type: CDS 60 fluidized bed dryer

• Feed: bio and DAF sludge, Dewatered to 35 % DS

• Product: 95 % DS;
  1 – 4 mm Granulate

• Evaporation: 6.000 l/h H₂O - design

• Start up: 1999
Palm 2

- Plant Type: CDS 20 fluidized bed dryer
- Feed: bio sludge, Dewatered to 16 % DS
- Product: 95 % DS; 1 – 4 mm Granulate
- Evaporation: 2.000 l/h H₂O - design
- Start up: 2002
Belt Drying System

Option 1: Belt Dryer direct fired and air recycling loop

Option 2: Belt Dryer with closed loop and indirect heating with burner

Option 3: Belt Dryer with closed loop and indirect heated with waste heat
Altenrhein (Germany)

• Equipment Type: Belt dryer (BDS)

• Inlet: Biosolids, Inlet Consistency at 28-30 % TS

• Product: 92 % TS; Granulate

• Evaporation: 400 kg/hr H₂O

• Start up: 2002
Comparison of the different dryer types

<table>
<thead>
<tr>
<th>Granulate</th>
<th>DDS</th>
<th>CDS</th>
<th>BDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dimensionally stable, round granules of 2 to 4 mm; Virtually dust free</td>
<td>Dimensionally stable, round granules of 2 to 4 mm Virtually dust free</td>
<td>Dimensionally stable, round granules of 1 to 8 mm</td>
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<tr>
<td>Energy sources for drying</td>
<td>Natural gas</td>
<td>Steam @ 10 bar saturated</td>
<td>Natural gas</td>
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<tr>
<td></td>
<td>Bio-Gas</td>
<td>Thermal oil</td>
<td>Bio-Gas</td>
</tr>
<tr>
<td></td>
<td>Exhaust gases from gas turbine</td>
<td>Exhaust gases from gas engine</td>
<td>Steam @ 4 bar saturated</td>
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<td></td>
<td>Exhaust gases from gas engine</td>
<td>Exhaust gases from thermal oil</td>
<td>Exhaust gases from coal fired power plants</td>
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<tr>
<td></td>
<td>Wood-gasification process gas</td>
<td>Hot water</td>
<td>Exhaust gases from processes at low temperature (~ 140°C)</td>
</tr>
<tr>
<td></td>
<td>Thermal Oil</td>
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</tbody>
</table>
Combination of dryers with CHP processes
Block Flow Diagram
Eco-Dry Principle Block Diagram

- Dewatered Sludge to Dryer
  - Granulat to Secondary combustion
    - Flue gas recirculation
      - Combustion air
      - Cooling Water
      - Heat exchanger
        - Offgas treatment
          - Exhaust air
      - Ash Storage
        - Final product
  - Incinerator
    - Combustion air
    - Cooling Water

Cyclone furnace

- Secondary chamber
- Burner
- Primary chamber
- Hot gas
- Exhaust duct
- Hot cooling air
- Ground granulate and conveying air
- Combustion air supply
- Start up burner
- Cooling air supply
- Ash supply
Drying and Incineration with combined Heat and Power

**Steam Boiler**
- Flue gas: 16.800 Nm³, 850°C, 7.204 kW
- Granulate: DS: 92%, 1.587 kg/hr, 6.245 kW
- Wet sludge: 5.615 kg/hr, DS: 26%, Heat input: 2.941 kW

**CDS dryer**
- Granulate: 3.174 kg/hr
- Wet sludge: 5.615 kg/hr, DS: 26%, Heat input: 2.941 kW

**Flue gas cleaning**
- Flue gas: 33.602 Nm³/hr, 180°C, 4.769 kW

**Power Generation**
- Steam: 12.575 kg/hr, 400°C, 40 bar, 11.178 kW
- Steam: 10.580 kg/hr, 180°C, 10 bar, 9.697 kW
- 1,565 MW elec.

**Stack**
CO₂ Balance

Disposal

-61,032 t CO₂/a
(+ 3,796 t CO₂/a)
(+ 6,332 t CO₂/a renewable)

CO₂-Reduction: 85%

Dewatering

Erdgas: 2,128,000 Nm³/a

Drying

CO₂-Reduction: 91%

Incineration

-64,828 t CO₂/a
(+ 6,332 t CO₂/a renewable)

Savings Natural Gas 2,128,000 Nm³/a

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