Solar drying and auto-thermal fluidized bed incineration of sewage sludge and power generation
## Summary

### Basic data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sludge throughput DS</td>
<td>kg/h</td>
<td>700</td>
</tr>
<tr>
<td>Sludge before solar drying</td>
<td>kg/h</td>
<td>2'917</td>
</tr>
<tr>
<td>Sludge DS-content before solar drying</td>
<td>%</td>
<td>24</td>
</tr>
<tr>
<td>Sludge after solar drying</td>
<td>kg/h</td>
<td>1'928</td>
</tr>
<tr>
<td>Sludge DS-content after solar drying</td>
<td>%</td>
<td>~ 36</td>
</tr>
<tr>
<td>Lower heating value of the sludge DS</td>
<td>kcal/kg</td>
<td>3'600</td>
</tr>
<tr>
<td>Lower heating value of the sludge DS</td>
<td>MJ/kg</td>
<td>15.1</td>
</tr>
<tr>
<td>Ash content of the sludge DS</td>
<td>%</td>
<td>26.4</td>
</tr>
<tr>
<td>Ash quantity for phosphorus recovery</td>
<td>kg/h</td>
<td>185</td>
</tr>
</tbody>
</table>
**Process data**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal capacity FBI</td>
<td>MW</td>
<td>2.1</td>
</tr>
<tr>
<td>Auto-thermal incineration in the FBI at 870 °C</td>
<td>°C</td>
<td>870</td>
</tr>
<tr>
<td>Combustion air quantity</td>
<td>m_n³/h</td>
<td>4,000</td>
</tr>
<tr>
<td>Combustion air temperature</td>
<td>°C</td>
<td>≤ 150</td>
</tr>
<tr>
<td>Flue gas quantity (wet)</td>
<td>m_n³/h</td>
<td>5,800</td>
</tr>
<tr>
<td>Steam parameters</td>
<td>°C/ bar(a)</td>
<td>220 / 23</td>
</tr>
<tr>
<td>Steam production</td>
<td>t/h</td>
<td>3.1</td>
</tr>
<tr>
<td>Electric power production by ORC-unit</td>
<td>kW</td>
<td>300</td>
</tr>
<tr>
<td>Heat transfer from ORC-unit to solar drying plant</td>
<td>MW</td>
<td>1.4</td>
</tr>
</tbody>
</table>
## Summary

- **Excess energy production**

<table>
<thead>
<tr>
<th>Description</th>
<th>kW</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric power production by ORC-unit</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Power consumers of the plant</td>
<td>160</td>
<td></td>
</tr>
<tr>
<td>Excess electric power (to be fed into the grid)</td>
<td>140</td>
<td></td>
</tr>
</tbody>
</table>

- **Other**

<table>
<thead>
<tr>
<th>Description</th>
<th>m²</th>
<th>men/shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total space requirement</td>
<td>4’600</td>
<td>2-3</td>
</tr>
<tr>
<td>Operation personnel</td>
<td></td>
<td>2-3</td>
</tr>
<tr>
<td>Natural gas/light fuel oil</td>
<td></td>
<td>only for start-up</td>
</tr>
</tbody>
</table>
Sludge solar drying and incineration process – block diagram

- **Solar Drying**
- **Mechanically Dewatered Sludge**
  - 24% DS
  - **Fluidized Bed Incinerator**
  - 36% DS

- **Clean off-gas**
- **Flue Gas Cleaning**
- **Pre-heating**
- **Flue Gas De-dusting**
- **Power Generation**
- **Output Electrical Power**

- **Combustion Air**
- **Heat transfer**
- **Air/Off gas**

**Steps:**
1. Solar Drying
2. Mechanical Dewatering
3. Fluidized Bed Incinerator
4. Heat Recovery
5. Flue Gas Cleaning
6. Pre-heating
7. Flue Gas De-dusting
8. Power Generation
9. Output Electrical Power
Sludge solar drying and incineration – process flow

- Sludge 2917 kg/h, 20 °C, 24% DS
- Electric power ~300 kW
- Hot water 55°C
- ORC unit
- 35°C
- 150°C, ~5 t/h
- 20°C, 36.3% DS, 1928 kg/h
- Steam 1.7 MW, 220°C, 23 bar a
- Waste Heat Steam Boiler
- Flue gas 870°C, ~7 t/h, 5800Nm³/h
- Flue gas 220°C
- Air pre-heater
- 5800 Nm³/h
- 190°C, ~7 t/h
- Dust filter 1
- Condensate loop 200°C
- Ash
- Ash for future phosphorus recovery
- Ash Silo 1
- Ash Silo 2
- Ash to landfill
- 85°C, ~7 t/h, 5800Nm³/h
- Combustion air pre-heater
- ~5 t/h, 20°C
- Combustion air
- clean gas into atmosphere
- ash
- clean gas
- ID-fan, stack
Sludge solar drying performance (Turkey as example)
SolarPlus™ Heating system combined with Raschka’s FBI technology

Heating source:

- Solar Energy
- Surplus heat from Raschka incineration and power generation system
SolarBatch™ / SolarPlus™ Drying Plants

Electric Mole™
SolarBatch™ Drying Plant with FBI Incineration

Top View

Side View

Bunker 1

Bunker 2

Bunker 3

Sludge Handling Zone (covered or uncovered)

Heat Exchanger

MovVent™ Ventilation System

Electric Mole™ Sludge Turning Device

ForcedDiversionSystem™
Key advantages

- Self-sufficient, simple and smart plant for the disposal of sewage sludge
- Energy optimized process with creation of surplus power
- To be operated by small staff level
- Low maintenance because of minimum moving parts
- Buffer facility for highly dewatered (dried) sludge during hot season in order to compensate for period with less sunshine
- Robust and reliable process able to cope with variations of sludge conditions
- Obtaining clean ash for future recovery of valuable phosphorus
- Volume reduction >90%
Contact

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