THE SOLAR DRYING PLANT IN MALLORCA: THE DRYING PROCESS IN WASTE MANAGEMENT

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Abstract: The solar drying plant in Mallorca belongs to the Consell of Mallorca and is manged by TIRME, S.A. The plant has been designed for drying 30,000 t/year of dewatered sludge (27% DM) up to 70% of DM. The plant is in full operation since August 2008 with 12 drying chambers with a total drying area of 17,000 m². The plant has 24 e-moles® units that with the rest of the elements is managed from a centralized control unit. The control system also integrates de deodorization units (scrubbers). Three chambers can improve the drying capacity by using residual heat.

Keywords: solar drying, sludge, waste management

INTRODUCTION

The waste management system in Mallorca has developed since 1990 to the present.

The first sectorial director plan had as the main goal to close the municipal uncontrolled landfills with a unique treatment, the incineration, and with different transfer stations in order to guarantee an equal distance between the origin and the final place for all the municipalities.

The plan approved in 2000 adapted the system to the European policies, diversifying the treatment according to the selective collection and including in its scope the management of the sludge from the waste water treatment plants.

The provided treatments for the sludge management are anaerobic digestion and composting.

At least, the 2006 revision continues with this model, incorporates a new waste flow, the refuse from the construction and demolition waste, bulky waste and end-of-life tires. As new facilities, the plan foresees the expansion of the incineration plant, with two new lines, and the solar drying plant. The final target is “zero landfill” for the residues that go into the system.

WHY A SOLAR DRYING PLANT?

Technical reasons

The remove of water content from the sludge is essential for its later treatment. The sludge has much water and it involves a great volume and a big quantity of water to be transported and managed. From a content of 95% in sludge it is possible to obtain a water content between 70 and 80%. It means high remained water, with difficult storage, use restrictions and elevated manage costs.

Also the incineration of mechanical dewatered sludge is only possible with an additional combustible, with a complementary energy help.

The energetic rising costs make that the conventional thermal drying will be more and more difficult to justify in economical terms.

For these reasons, sludge remove is in Europe more and more complex and expensive. In fact in many countries the sludge treatment and disposal is the main cost in global waste water treatment.

In difference with mechanical dewatered sludge, the dried sludge is biologically stable. Its water content is minimal, it does not smell and it is suitable for several final managements: incineration, agriculture and others.

Additionally, the patented process Thermo-System is characterized by low economical investment and low operation costs.

Specific reasons

First of all, although there were different installations, there was not enough treatment capacity, mainly in summer, when the sludge...
generation increases, largely by the tourism effect. In fact, the population in Mallorca during the summer grows noticeably.

In relation with the previous reason, it was necessary a regulation between compost demand and consumption. In summer, when there is more sludge and more compost is produced, there is less compost demand in the island.

In the 2000 Plan, an extension of several composting plants was planned, but in 2006 the extension was cancelled.

Lastly, the fertilizer regulations are every time stricter and the accepted levels of determined substances in compost, like heavy metals, are very restrictive.

**TECHNICAL DESCRIPTION**

The solar drying process takes place inside the drying chambers, like greenhouses, where the transformation of radiation into heat is used. The process takes place because of the increasing temperature and the air movement/exchange, with the e-moles® units as the clue.

There are five factors that are critical from a physical point of view to obtain an effective drying:
- Drying air temperature
- Drying air humidity
- Air flow speed
- Superficial structure for the material
- Sludge temperature

The total automatic control of the process keeps all the mentioned variables constantly at their optimal point, taking into account weather conditions and sludge properties.

**Dump Technology**

The e-mole® unit is an automatic robot made with stainless steel with the task of mixing and aerating the sludge, with an operation range of 2-95 % DM. In the plant of Mallorca there are 24 e-moles® units.

**Residual heat use**

The solar drying plant of Mallorca incorporates the use of residual heat in a 25% of its drying area, heating the air through heat exchanges in the cover, next to the recirculation fans.

The hot water comes from the biogas engine in the anaerobic digestion plant, managed also by TIRME, from the combustion gases and from the refrigeration system. In this way it is possible to obtain a maximum of 750 thermal kW in 3 chambers.

It allows to increase the drying efficiency and to balance seasonal oscillations.

**RESULTS**

The drying efficiency of Mallorca’s plant is 1-1,7 t/m² and year.

The thermal energy consumption is totally covered by the solar drying and the residual heat. The consumption of electricity is between 55-60 kWh/t. The main consumers are the fans and also it is important the energy needed by the deodorization system, with two scrubbers. Also the residual heat use increases the electrical consumption. Anyway the

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**Table 1. Plant main characteristics**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Treatment capacity</td>
<td>30,000 t/year with 20-30 % DM</td>
</tr>
<tr>
<td>Drying achievement</td>
<td>60-80 DM</td>
</tr>
<tr>
<td>Plant data</td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td>20,000 m²</td>
</tr>
<tr>
<td>Warehouse cover</td>
<td>Security glass</td>
</tr>
<tr>
<td>Thermal recovery</td>
<td>Until 250 kW</td>
</tr>
<tr>
<td>Useful drying area</td>
<td>17,260 m²</td>
</tr>
<tr>
<td>Configuration</td>
<td>12 chambers</td>
</tr>
<tr>
<td>Final destination</td>
<td>Energetic valorization</td>
</tr>
</tbody>
</table>

*Plant Technology*
consumption of electricity is clearly below the conventional dryers.

The dried sludge obtained has between 25-35 % DM and a calorific value of 1800 kcal/kg, which is very similar to a municipal waste. The density is about 0.6 t/m³.

**CONCLUSIONS**

The solar drying plant allows the treatment of 30.000 t/year the sludge from waste water treatment plant until near 80 % DM.

The efficiency of the plant is quite high, and satisfy the objectives of limit the investment and the operation costs.

The main advantages are:

- A high durability, due to very few component are in contact with the sludge.
- Very robust and stable related to breakdowns. The exchange of the e-mole® is very simple.
- Reduced operation costs, easy maintenance. Minimum energetic cost and low staff costs.
- High availability
- Esthetics and resistance cover with glass isolation.

Fig. 4. Air view of the plant