PROSPECTS OF A PNEUMATIC PULSE METHOD OF DEHYDRATION OF THE SEWAGE SLUDGE

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Abstract
The most efficient way to dewater sewage sludge is the thermal drying, which simultaneously with the granulation allows obtaining the product in the form of granules, being a non-putrescible fertilizer that is also easy for transportation, storage and bringing into soil. When large volumes of sewage sludge are formed, which are unfit for use in agriculture, application of other utilization methods, such as burning, would be purposeful. The aim is to determine the optimum drying modes of sewage sludge with application of pneumatic pulse method at treatment facilities in the pilot project. To do this, it is necessary to develop a proposal for the design of operating model. The design and making of working model is necessary to determine the optimal conditions for sewage sludge drying at sewage disposal works. The drying process is provided to be realized in a closed-loop cycle (without emission into atmosphere). Due to inner recirculation of dry air, the installation heat consumption is reduced. Calculations have shown that there is economic expediency of using the pneumatic pulse method in sewage sludge thermal drying technology and possibility of using sewage sludge as an alternative fuel. Optimization of sewage sludge thermal drying process with the use of pneumatic pulse method will considerably extend the perspectives for utilization and further use of sewage sludge.

Key words: sewage sludge, pneumatic pulse method, dehydration of the sewage sludge, alternative fuel.

Introduction
Utilization of the sewage sludge (SS) is pressing, and it is crucial environmental and economic challenge. The task of the modern technology on treatment of the SS is to meet the contemporary challenge and transform SS into the environmentally safe product as well as apply the SS valuable components with the significant reduction of the sludge amount as a result of dehydration (Gusarevs, 2013). Reductions of energy consumption and capital investments during SS processing and recycling actions also have significant importance.

It is possible to distinguish the following main directions of the SS utilization:
- fertilization of the soil;
- burning;
- disposal (Gemste and Vucāns, 2010; Bārdule et al., 2011; Lazdiņa et al., 2011).

Utilization of SS, which is associated with their use in agricultural industry, is determined by their content of biogenic elements.

As a fertilizer, such SS may be used, which has been a subject to treatment that guarantees their subsequent non-putrescibility as well as the death of pathogenic microorganisms and helminth eggs, in accordance of the Cabinet Council No. 362 of May 2, 2006 (Noteikumi par notekūdeņu dūņu un to komposta izmantošanu, monitoring un kontroli, 2006).

The most efficient way to dewater SS is thermal drying, which simultaneously with the granulation allows obtaining the product in the form of granules, being a non-putrescible fertilizer that is also easy for transportation, storage and bringing into soil (Lazdiņa et al., 2013).

Possibility should be also taken into consideration that SS contains harmful substances, in particular the salts of heavy metals, chemicals, etc., which are subjected to a strict control over content of harmful substances in the ready product and its further use in agriculture as a fertilizer (Lazdiņa et al., 2007).

When large volumes of SS are formed, which are unsuitable for use in agriculture, application of other utilization methods, such as burning, would be purposeful.

SS may be considered as an alternative source of energy. The use of SS energetic potential should be economically reasonable. Calorific capacity of dry SS substance is 3 to 5 MJ kg⁻¹, which mainly depends on the ash content. Ecological problems of SS incineration are associated with flue-gas emission.

Thermal drying is mainly used at large sewage disposal works with the purpose to increase the calorific capacity of SS in the process of their further incineration. Thermal drying of SS for the use in agriculture is rarely applied due to high costs.

Application of pneumatic pulse method in the dewatering technology during the SS utilization allows us to considerably decrease the power consumption costs and capital investments. Carrying out the drying process at lower temperatures lets us to retain more biogenic elements.

The aim of this paper is to determine the optimum drying modes of SS with application of pneumatic pulse method at treatment facilities in the pilot project. It is necessary to develop a proposal for the design of acting model.
Materials and Methods
Based on data obtained from experimental module for SS drying with application of pneumatic pulse method, a proposal was developed for the design of acting model (Gusarevs, 2013). The scheme of the acting model is shown in Figure 1.

The design and making of operating model is necessary to determine the optimal conditions for SS drying at sewage disposal works. The drying process is provided so that it can be realized in a closed-loop cycle (without emission into atmosphere). Due to inner recirculation of dry air, the installation heat consumption is reduced.

The following significant indicators were taken into consideration when developing the proposal:
- investment expenses for drying equipment;
- service life and operational load of equipment;
- SS dewatering degree;
- power consumption in the drying process;
- SS calorific capacity;

Table 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value (without pulser)</th>
<th>Value (with pulser)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital investment</td>
<td>EUR</td>
<td>500000</td>
<td>500000</td>
</tr>
<tr>
<td>Equipment productivity*</td>
<td>m$^3$day$^{-1}$</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Guaranteed operation</td>
<td>days year$^{-1}$</td>
<td>min.342</td>
<td>min.342</td>
</tr>
<tr>
<td>Humidity at the inlet</td>
<td>g kg$^{-1}$</td>
<td>860</td>
<td>860</td>
</tr>
<tr>
<td>Humidity at the output</td>
<td>g kg$^{-1}$</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Electric power expended**</td>
<td>kW L$^{-1}$ H$_2$O</td>
<td>0.07</td>
<td>0.04</td>
</tr>
<tr>
<td>Received power</td>
<td>kWh</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Equipment service life</td>
<td>year</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Payback</td>
<td>year</td>
<td>12</td>
<td>6 -10</td>
</tr>
</tbody>
</table>

* Equipment productivity adopted according to PE 20000 (person equivalent).
** Costs are calculated on the evaporation of 1 L of water.
The studies should be further continued within the pilot project framework in order to identify the peculiarities of SS drying conditions in production environment.

Results and Discussion
Calculations performed are shown in Table 1. Performed calculations have shown:
- economic expediency of using the pneumatic pulse method in SS thermal drying technology;
- possibility of using SS as an alternative fuel;
- reduction of energy costs with the use of pneumatic pulse method in SS thermal drying technology;
- repayment of capital investments during the equipment operation period.

Conclusions
Optimization of SS thermal drying process with the use of pneumatic pulse method will considerably extend the perspectives for utilization and further use of SS. The studies should be further continued within the pilot project framework in order to identify the peculiarities of SS drying conditions in production environment.

References