THERMAL AND ELECTRIC ENERGY PRODUCTION USING PRIMARY SIEVED SOLIDS FROM MUNICIPAL WASTEWATER, AS GASIFICATION FEEDSTOCK

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The high energy requirements of extended aeriation WasteWater Treatment Plants (WWTPs), due to the fact that all solids enter the aeration tank is a crucial issue, which results to high operational cost and inefficient performance of municipal WWTPs.

A viable solution for the enhancement of WWTPs performance could be a process for the removal of biosolids upstream of the aeration tank using a rotating belt filter (microsieve), followed by drying, gasification and combustion of the produced syngas for energy production.

The treatment of municipal wastewater by microsieving has been investigated and resulted to reduction of TSS, BOD_5 and COD by 29.2±9%, 14.0±6% and 16.5±6%, respectively. The reduction rates are similar to those that can be achieved by primary clarification; however, higher removal rates are expected if a cloth filter with smaller pore size will be used.

What is of primary interest to the performance for the downstream aerobic treatment, is not just the TSS concentration, but the size of the suspended particles. Microsieving results to the selective reduction of the larger particles, thus increasing the digestibility of wastewater (*Figure 1I*). In detail, the average size of the suspended particles has been shifted towards lower sizes for the treated wastewater, while the presence of particles larger than 500μm has been completely eliminated.

The average solids content of Primary Sieved Solids (PSS) has been measured as 39.5±4%, which is approximately double, compared to that of primary dewatered solids. The percentage of volatile solids on a dry basis have been measured as 83.5±1%, which is significantly higher compared to primary biosolids (*Figure 1II*).

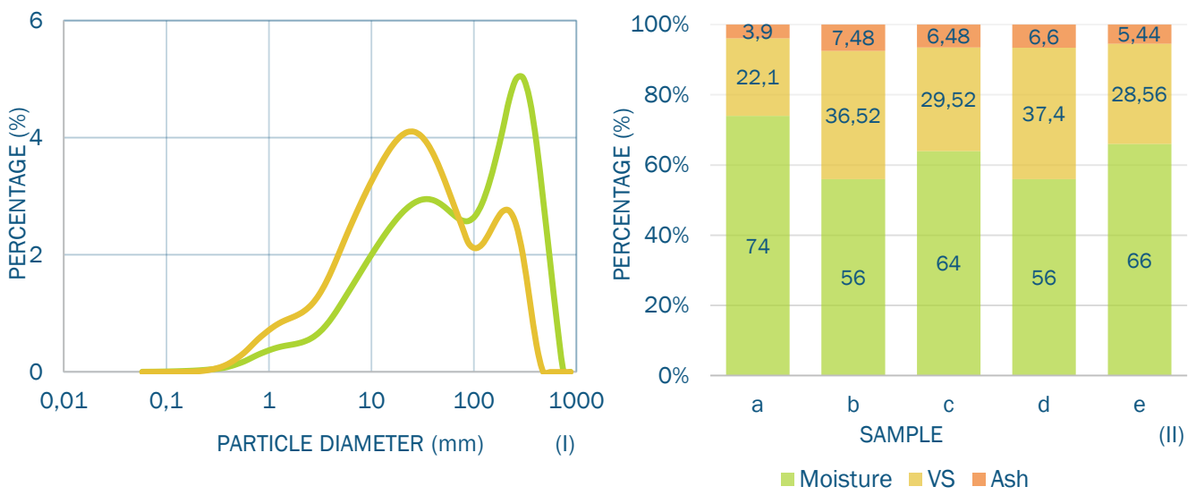

Figure 1. (I) Particle size distribution at the inlet (green line) and outlet (yellow line) of the microsieve. (II) Moisture content, volatile solids and ash content of five PSS samples.

The high VS content of PSS is reflected to the calorific value of PSS. The Higher Heating Value (HHV) of PSS has been measured as 23±0.7 MJ/kg, which is significantly higher compared to the HHV of other types of municipal biosolids and of other combustible materials (Table 1).

Table 1. Higher Heating Values of various combustible solid materials.

Type of fuel	HHV (MJ/kg)
Secondary biosolids	13.0
Lignite (Brown coal)	14.0
Wood	16.2
Primary biosolids	16.5
PSS	**23**
Charcoal	29.6
Coal	32.8

The present study aims in investigating the performance of a real scale integrated system, which is currently under installation at the WWTP of Rethymnon, Greece (*Figure 2*).

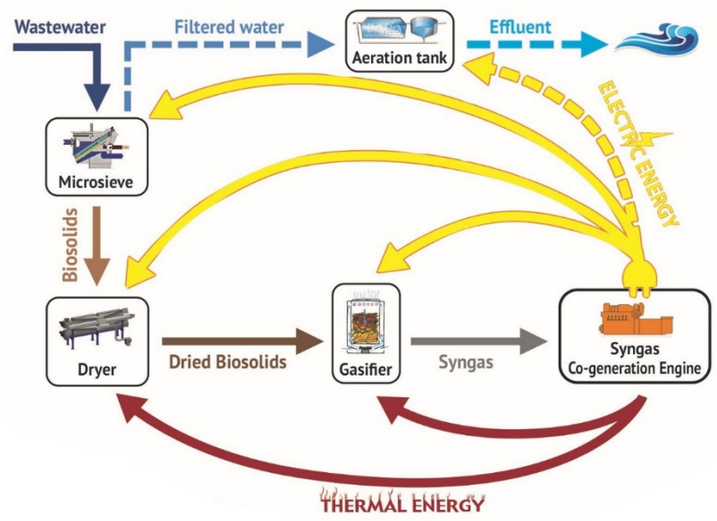

Figure 2. Mass and energy flows at the integrated plant.

The system will have hydraulic capacity of 5000 m^3/d, which is about 1/3 of the inlet flowrate of the above WWTP. All produced PSS, about 1 ton/d, will undergo further drying to 85% solids and gasification for the production of syngas. It is expected that the syngas production will be between 1800-2400 Nm^3/d. An internal combustion engine will be used for syngas combustion and for the production of thermal and electrical energy (*Figure 3*).

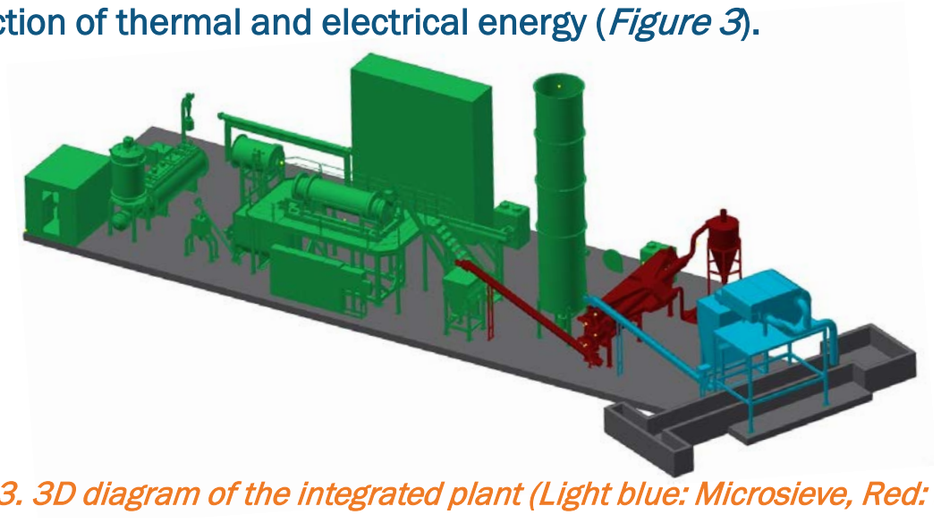

Figure 3. 3D diagram of the integrated plant (Light blue: Microsieve, Red: Dryer, Green: Gasifier and co-generation engine).

The thermal energy will be conveyed to the dryer for the drying of the PSS, while the electric energy will partially cover the electrical needs of the WWTP. The net electric energy depends on the size of the plant, as the larger the plant, the smaller the fraction of the requirement for internal electric energy consumption.

However, apart from energy production and the management of biosolids, the process has a positive effect to the performance of the WWTP, due to the reduction of the solids (and thus BOD) loading.

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