

Characterization of dried sewage sludge for the purpose of its energy utilization

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The excess of activated sewage sludge (EWC code 19 08 05) is produced during biological treatment of the municipal wastewater. Central WWTP of Ljubljana, capital of Slovenia, produces about 4000 tonnes dry matter of this bio-waste, which needs permanent removal. Together with cesspool content (EWC code 20 03 04) and the sewage sludge from small wastewater treatment plants (<2000 PE), which is brought in due to the implementation of mandatory public service, the excess sludge is anaerobically stabilized, and dried to of 91% dryness. This bio-waste is stable, hygenised and non-hazardous. It is in the shape of pellets with size distribution $d_{50} <3$ mm and $d_{90} <4$ mm. The pellets have a substantial calorific value which matches the quality criteria for alternative solid fuels, SRF. Yearly-average data on pellet calorific value is rather stable of 13.3 MJ/kg, with mean fluctuation of 3.9 %. Classification of pellets as an alternative solid fuel has been determined as "NCV 4; Cl 1; Hg 4-5" according to technical standard CSN EN 15359:2011.

To predict the biomass content, combustion behaviour, the mass loss of pellets and the melting point temperature of thermal residue, it is necessary to: i) conduct extensive characterization of pellets by advanced thermal analysis, ii) morphological and physical-chemical analysis, XRD and SEM-EDS analysis of thermal solid residues.

The results, which were obtained by using thermal analysis (TGA/DTA/DTG/EGA) of pellets are as follows: i) in the pyrolysis, the mass loss of the pellets is 75.7 %, and in an oxidizing atmosphere is 72.6 %, ii) the volatility of a substance (up to 450 °C) is slightly more pronounced in the pyrolysis, iii) at temperatures above 900 °C the substances show volatility only by pyrolysis - volatilization in an oxidizing atmosphere above this temperature is negligible. Collected data allow the improvement of technological processes for energy recovery of waste according to "R1" waste procedure (incineration, co-incineration) or recycling of the organic content according to "R3" waste procedure by densifying the energy content of pellets through thermal pre-treatment processes (pyrolysis). In our research of energy utilization process of pellets more attention is given to the isolation and characterization of the resulting bio-oil. Thermal residues (of bottom ash by the incineration and of bio-char by pyrolysis) with the aim to provide guidelines for their further material utilization - turning solid residues into usable products – are considered as well.

Keywords: dried sewage sludge; energy utilization; thermal analysis; incineration; pyrolysis