

Waloryzacja odpadów i biomasy o niskich wartościach energetycznych w procesie toryfikacji

Valorization of low energy waste and biomass in the torrefaction process

Streszczenie w języku angielskim

The paper determines the influence of technological parameters of the torrefaction of low energy waste and biomass on the amount of torrefied material, its fuel properties, and the energy consumption of the process. The study investigated the impact of the 3 most important technological parameters (temperature, process duration, pressure) on 7 waste materials (waste wood, sewage sludge, biogas digestate, peloid, elephant excrement, and biodegradable polylactide and paper). The effect of the parameters has been described by mathematical models developed from the experimental data and by compiling the experimental data into tables and figures. The research was carried out in laboratory conditions. For all tested materials, the activation energy was determined using thermogravimetric analysis (TGA), also specific heat and thermal effects of changes taking place during the process were determined using differential scanning calorimetry (DSC). The tested materials were torrefied in the temperature range from 200°C to 300°C and the duration of the process from 20 minutes to 60 minutes. In addition, selected wastes were torrefied in an overpressure of up to 10,5 bar with the simultaneous measurement of energy consumption. The results showed that each of the tested materials was characterized by different fuel properties and the requirements of technological parameters ensuring the production of torrefaction with the best fuel properties. The high heating value of raw materials ranged from 11410 J·g⁻¹ to 19420 J·g⁻¹ for elephant dung and PLA, respectively. For most materials, except for PLA and sewage sludge, the use of torrefaction without overpressure allowed to increase the energy concentration in the torrefied materials by 12% (digestate 280°C and 20 min, peloid 280°C and 40 min, elephant dung 200°C and 60 min, paper 300°C and 40 min) and by 20% (waste wood 300°C and 40 min) relative to the untreated material. Moreover, the use of overpressure allowed to additionally increase the high heating value in the range from 1,7% to 7% concerning torrefied materials produced without overpressure. It has also been shown that the torrefaction process does not improve the fuel properties of PLA, and their deterioration was observed in the case of sewage sludge. Moreover, the performed mass and energy balance showed that dry waste wood, sewage sludge, digestate, and paper can be processed in an energy self-sufficient way in all technological conditions, while for peloid and elephant dung, the process can be energy self-sufficient only

at temperatures higher than 220°C and 240°C. However, after taking into account the actual water content in the processed materials, such as sewage sludge, digestate, and peloid, it has been shown that their use in torrefaction does not allow for energy self-sufficiency of the process, regardless of the technological parameters used. On the other hand, waste wood, elephant dung, and paper, due to their relatively low moisture content and a sufficient amount of released volatile matter and the chemical energy they contain, can be energy self-sufficient at temperatures above 240°C, 263°C, and 200°C, respectively.