Exothermic reactions during low-temperature pyrolysis of plant biomass

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Biomass includes wood and agricultural waste, peat, and various types of human waste. Torrefaction (low-temperature pyrolysis) is used to improve the consumer properties of biomass and involves heating the feedstock in an inert environment to a temperature typically ranging from 250–300 °C. Torrefaction increases the energy density and grindability of the biomass, while reducing its hygroscopicity and susceptibility to decay. Biomass torrefaction can be accompanied by significant heat release due to exothermic reactions. Control of process temperature is crucial to obtain a product with the desired properties. This study analyzed the behavior of plant biomass during low-temperature pyrolysis using analytical equipment and a laboratory fixed-bed reactor. Samples of waste from the forestry and agricultural industries (pine sawdust and sunflower husk) were used in the experiments. DSC analysis (SDT-Q600, TA Instruments) revealed the temperature ranges of exothermic processes of thermal decomposition of the materials. The lab-scale study was conducted using a thermally insulated reactor with indirect (through the wall) heating and thermocouples located at various cross-sections. Experiments revealed the presence of zones in the material layer with temperatures significantly exceeding the reactor wall temperature during the thermal processing of sunflower husks. The obtained experimental data will be useful in designing a technology for producing biofuels based on the process of biomass torrefaction. This work was supported by the Ministry of Science and Higher Education of the Russian Federation (State Assignment No. 075-00270-26-00).