Numerical modeling of torrefaction reactor with heating gas recirculation

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One of the principal ecological problems in the implementation of torrefaction technology in reactor with direct heating of biomass feedstock by flue gas is efficient utilization of vapor–gas mixture of heating flue gases and volatile torrefaction products. The problem is complicated by the low concentration of volatile products and a substantial amount of water vapor in the exhaust gas, which requires high energy expenditure for their utilization. The paper presents results of numerical analysis of energy-technological complex (ETC) including gas piston cogeneration power plant (GPU), torrefaction reactor with recirculation of heating gas and heat recovery boiler (HRB). The mathematical model of the torrefaction reactor [1] was supplemented by the conservation equation for the flow of volatile products and by the module, describing the recirculation loop of heat-transfer gas. On the basis of data on the composition of torrefaction volatile products [2] the temperature dependences of heat capacities for them and their combustion products as well as the corresponding combustion heat values were calculated. Calculations of the reactor without recirculation and with recirculation of the heating gas in torrefaction zone at a different frequency of torrefied biomass discharge were held. It is shown that in recirculation modes the concentration of volatile products at the reactor outlet is increased by almost an order. Also GPU power, required for providing given reactor productivity, is reduced several times and the consumption of natural gas, needed for post-combustion of volatile products in HRB, is reduced by an order, significantly increasing the energy efficiency of all ETC.