Influence of Biomass Chemical Properties on Torrefaction Characteristics

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ABSTRACT

Different biomass types may differ with respect to torrefaction characteristics, and an improved understanding and ability to predict the torrefaction performance is, therefore, desired. In this study, the influence of the chemical properties (lignocellulose composition and alkali content) on the torrefaction behavior with respect to mass loss and grindability is investigated by simultaneous thermal analysis (STA) and by using a combined torrefaction and grinding reactor. The torrefaction behavior of six raw biomass samples and selected pretreated samples (washed and impregnated with KCl and K_2CO_3) has been studied. The investigated biomasses have reasonably similar carbohydrate compositions (hemicelluloses 18–25 wt % db; cellulose 38–48 wt % db; lignin 17–29 wt % db) with the exception of spruce bark, which is lower in hemicellulose content (12.9 wt % db) and cellulose content (24 wt % db), and higher in lignin content (36.8 wt % db). An increasing biomass potassium (K) content decreases the temperature of maximal conversion for both raw and alkali-impregnated biomass samples, thus decreasing the solid product yield at 270 and 300 °C. This was especially pronounced when the biomass potassium content increased from 0 to 0.2 wt %. However, the higher lignin content in bark causes a higher solid yield than what would be expected from the alkali content, illustrating that both potassium content and lignocellulose composition affect the solid yield obtained by torrefaction. The grindability of the torrefied products was evaluated by determining the d_{50} value of the particle size distribution of the biomass before and after torrefaction in the combined torrefaction and mill reactor. A significant decrease in d_{50} value was observed when the alkali content increased from 0 to 0.2 wt % db, whereas no additional effect is seen for higher potassium contents.

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