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Thermogravimetric study and kinetic analysis of fungal pretreated corn stover using the distributed activation energy model

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HIGHLIGHTS

- ▶ Fungal pretreatment can accelerate thermal degradation and slightly affect the shapes of TG and DTG curves.
- ▶ The temperature corresponding to maximum weight loss rate shows a lateral shift to higher temperature with the heating rate.
- ▶ The activation energies of coculture-pretreated corn stover were lower than that of monoculture pretreated.

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ABSTRACT

Non-isothermal thermogravimetry/derivative thermogravimetry (TG/DTG) measurements are used to determine pyrolytic characteristics and kinetics of lignocellulose. TG/DTG experiments at different heating rates with corn stover pretreated with monocultures of *Irpex lacteus* CD2 and *Auricularia polytricha* AP and their cocultures were conducted. Heating rates had little effect on the pyrolysis process, but the peak of weight loss rate in the DTG curves shifted towards higher temperature with heating rate. The maximum weight loss of biopretreated samples was 1.25-fold higher than that of the control at the three heating rates, and the maximum weight loss rate of the co-culture pretreated samples was intermediate between that of the two mono-cultures. The activation energies of the co-culture pretreated samples were 16–72 kJ mol^{-1} lower than that of the mono-culture at the conversion rate range from 10% to 60%. This suggests that co-culture pretreatment can decrease activation energy and accelerate pyrolysis reaction thus reducing energy consumption.

1. Introduction

Agricultural residues are promising energy feedstocks for biofuel productions via biochemical or thermochemical conversion (Demirbas and Balat, 2006). Thermochemical conversion includes combustion, liquefaction, pyrolysis, and gasification (Cantrell et al., 2008). Pyrolysis is the basic thermochemical process for converting biomass to a more useful fuel at high temperature in the absence of an oxidizing agent (air/oxygen). With the addition of heat and catalysts, the biomass breaks down to condensable vapors, non-condensable gasses (pyrolysis gas), and charcoal. All products are combustible. The condensable vapors form a liquid known as bio-oil, pyrolysis oil or crude oil, which contains a large number of oxygenated organic compounds with a wide range of molecular weights and a small amount (<1%) (Diebold, 2002; Demirbas, 2009).

Thermogravimetric analysis (TGA) is one of the commonly used techniques to study thermal events during pyrolysis of biomass and other fuels (Aboulkas and El Harfi, 2009). TGA is usually used as a means of determining pyrolytic characteristics and kinetic parameters (Williams and Ahmad, 2000; Zhao et al., 2010). TGA measures the amount and rate of change in the weight of a tested material as a function of temperature or time in a controlled atmosphere, such as nitrogen atmosphere or air. Measurements are used primarily to determine the composition of materials and to predict their thermal stability at temperatures up to 1000 °C. The technique can characterize materials that exhibit weight loss or gain during the heating process due to: decomposition, oxidation, or dehydration. The various weight loss processes determined during the TGA reflect the physical and chemical structural changes during the conversion. Differential thermogravimetry (DTG) curve highlights the various TG processes more clearly (Huang et al., 1996). Kinetic analyses have become a crucial point in thermal analysis, in which the main purpose is to determine the mechanism(s) of decomposition and to calculate the parameters of the Arrhenius equation (Noisong et al., 2009). Numerous kinetic

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