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Mathematical modelling and kinetics of thermal decomposition of corn stover using thermogravimetry (TGA-DTG) technique

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Lignocellulosic biomass could be pyrolytically converted into value-added products and one of the steps during the pyrolysis is thermal decomposition which involves multiple reactions. Therefore, mathematical modelling of thermal decomposition could provide molecular insight into thermal degradation reactions by providing accurate prediction of the phases of the multi-component reactions in particular nucleation, growth and boundary-phase reactions occurring under different working conditions. In this study, thermal decomposition behaviour of Corn Stover was explored using thermogravimetry technique (TGA-DTG) at heating rates of 20, 30, 40 and 50 °C/min under nitrogen gas flow (55 mL/min) and oxygen gas flow at 15 mL/min. The Flynn-Wall Ozawa (FWO) and Kissinger Akahira Sunose (KAS) models were used to estimate the kinetic parameters such as apparent activation energy, pre-exponential factor and order of reaction so as to be able to design the pyrolytic reactor that could be used for the biomass conversion. The hemicellulose maximum mass loss rate was at 300 °C, cellulose at 410 °C and lignin decomposition from 190 °C to 620 °C. The apparent activation energies calculated ranged from 44.39 -134.81 kJ/mol using the FWO method while the KAS method gave 87.83 - 282.41 kJ/mol. The variation of the apparent activation energy represents the four different stages occurring during the thermal decomposition process for the corn stover. The Friedman's model was used with reaction- order model to estimate the order of reaction. The predicted model fitted well with the experimental data showing that the complex degradation process followed a first-order reaction.

Topics
Biomass energy sources, **Thermogravimetric analysis**, **Mathematical modeling**, **First-order reactions**, **Pyrolysis**, **Pre-exponential factor**, **Biopolymers**, **Carbohydrates**

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