STUDY OF PYROLYSIS FOR BIOCHAR PRODUCTION FROM BIOMASS FEEDSTOCKS USING A SIMPLIFIED ASPEN PLUS MODEL

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The importance of implementing greenhouse gas removal (GGR) technologies such as biochar application in soil for CO2 sequestration is becoming a necessity in achieving UK's net zero target[1]. In establishing the biochar as a GGR technology, it is crucial to have a thorough understanding on the production technology and the generating outputs from the process in order to assess its life cycle. In this work, we studied the reaction kinetics of the pyrolysis process to foresee the yields and the properties of the produced biochar along with a cost evaluation. The Aspen Plus simulation tool was used to develop a steady-state model to predict the pyrolysis products including the yield and characterization of biochar and the composition of the vapor phase. The cost evaluation is supported by the Aspen process economic analyzer (APEA) and industrial data. The proximate and ultimate analyses of the feedstocks were applied as input parameters to the model along with the feedstock price details. The simulation was carried out at 400-1000˚C and at 1 atm pressure. The model predicted reasonable outcomes for the produced biochar yields in line with the experimental outcomes of pyrolyzing biomass feedstocks from previous literature. Biochar yields in the range of 17-37% were obtained for biomass feedstocks in the considered pyrolysis temperature range, which was validated with previous studies on biomass feedstocks such as woody biomass, wheat straw, corn stover, bagasse and rice straw. The key merit of this model is the ability to predict the quality of the produced biochar by outputting the proximate and ultimate characteristics of the biochar. With the obtaining detailed ultimate analysis outcomes of biochar from the model, the stability of biochar can be demonstrated considering the accepted biochar stability indicators of atomic O/C and H/C ratios[2,3]. The outcome from the model assists in evaluating the carbon sequestration potential and the economic viability of the biochar production process from different feedstocks. The developed simplified pyrolysis model will be helpful in identifying the potential yield and the characteristics of the produced biochar for biomass feedstocks under the specific reaction conditions which ultimately guides in selecting the appropriate feedstocks for producing stable biochar through pyrolysis considering the environmental and economic concerns.

Reference:

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