Palm Oil Shell Pyrolysis: Temperature Effect, Kinetics, and Thermodynamics Study

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Abstract

Palm oil shell (POS) is a solid waste from the oil palm industry and can cause environmental problems. This waste could convert into high-quality products such as biochar, bio-oil, and biogas that follow reaction mechanisms and kinetics parameters. This study aims to characterize palm oil shells and biochar, determine the optimum temperature of oil palm shell pyrolysis to produce biochar as briquettes and obtain kinetics and thermodynamic parameters. Palm oil shells were cleaned, sifted to a size of 0.4-2 mm, and dried at 105 ºC for 24 h. The pyrolysis was operated by 200 g of POS in a pyrolysis reactor and kept at 350 ºC, 375 ºC, and 400 ºC for 1 h. The bio-oil mass was recorded every 5 min, starting from the first drop after the temperature of pyrolysis reached. The optimum temperature for charcoal briquettes was 375 ^{o}C. The liquid and solid products were increased by increasing temperature, and gas products were decreased. The kinetics parameters of activation energy (E) and pre-exponential factor (A) were 20.7808 kJ mol-1 and 0.0821 min-1, respectively. Palm oil shell pyrolysis requires a lot of heat which is indicated by a positive enthalpy change (ΔH) of 15.3934 kJ mole-1. The non-spontaneous reaction on pyrolysis was proved by a positive Gibbs free energy change (ΔG) of 179.2998 kJ mole-1. Those parameters allow the process to be operated in optimal conditions, increasing the efficiency in future studies.

Keywords:

Pyrolysis; palm oil shells; biochar; kinetics; thermodynamics.