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Thermochemical conversion modelling of multilayer packaging waste using Aspen Plus®

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Paper based multilayer packaging (PMP) is difficult to recycle due to its heterogeneous composition. Cellulosic fibers, with high recycling value, are recovered from the waste by hydro-pulping, whereas the remaining solid residues are mostly landfilled or incinerated. Pyrolysis is a thermochemical technique that can reduce this waste while producing valuable chemicals and energy. This study focuses on the reactor modelling of pyrolysis and combustion using Aspen Plus®. Global chemical kinetics were obtained from PMP's individual components and their mixture, adopting both model-free approaches (Friedman method and model-based compensation effect). Experimental data for kinetic modelling were collected utilizing a thermogravimetric analyzer for multiple heating rates (5, 10, 15, and 20 ^{o}C/min), under controlled nitrogen and air atmospheres. In the subsequent stage, the PMP's solid residue was thermally processed at bench scale to obtain the solid, liquid, and gas yields. Thereafter, robust pyrolysis and combustion models on Aspen Plus® for the PMP waste, using the process parameters acquired from the antecedent stages, were developed. Using the physicochemical properties, including the proximate & ultimate analyses, and heating values, the unconventional solids were defined to represent PMP mixture. A steady-state simulation of the waste thermochemical valorization was developed using Aspen Plus® V14. The process flow sheet comprised of four primary stages: hydro-pulping, drying, thermochemical decomposition and solid-gas separation. The detailed kinetic models and schemes were used to establish a robust feasibility analysis of PMP's pyrolysis against combustion.

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