



Slovak Society of Chemical Engineering
Institute of Chemical and Environmental Engineering
Slovak University of Technology in Bratislava

PROCEEDINGS

51st International Conference of the Slovak Society of Chemical Engineering SSCHE 2025

Hotel DRUŽBA
Jasná, Demänovská Dolina, Slovakia
May 27 - 30, 2025

Editors: Assoc. Prof. Mário Mihaľ

ISBN: 978-80-8208-158-2, EAN: 9788082081582

Published by the Faculty of Chemical and Food Technology Slovak Technical University in Bratislava in Slovak Chemistry Library for the Institute of Chemical and Environmental Engineering; Radlinského 9, 812 37 Bratislava, 2024

Khurram, A., Escudero Sanz, F., Carrier, M., Haydary, J.: Thermochemical conversion modelling of multilayer packaging waste using Aspen Plus, Editors: Mihaľ, M., In *51st International Conference of the Slovak Society of Chemical Engineering SSCHE 2025*, Jasná, Demänovská Dolina, Slovakia, 2025.

Thermochemical conversion modelling of multilayer packaging waste using Aspen Plus®

Abdul Rehman Khurram^{1,2}, F. Javier Escudero Sanz¹, Marion Carrier¹, Juma Haydary²

¹*CNRS UMR 5203, Université de Toulouse, IMT Mines Albi, Campus Jarlard, 81013 Albi CT Cedex 09, France*

²*Institute of Chemical and Environmental Engineering, Faculty of Chemical and Food Technology, Slovak University of Technology in Bratislava, Radlinského 9, 812 37 Bratislava, Slovakia*

e-mail: abdul.khurram@mines-albi.fr

Key words: Multilayer packaging waste, Pyrolysis, Combustion, Global kinetics

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 °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.

Acknowledgements: The authors acknowledge the financial support by the French state managed by the National Research Agency in the name of France 2030 to conduct the French scientific program PAC-3R (ANR-22-PERE-0004). This work has also benefited from State aid managed by the Agence Nationale de la Recherche under the Programme d'Investissements d'Avenir with the reference ANR-18-EURE-0021.