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A sustainable recycling technology for aluminium and energy recovery from metallised food packaging plastics waste using pyrolysis-mechanical-chemical treatment

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This work presents a sustainable recycling technology for converting the organic fraction of waste metallic food packaging plastic (MFPW) into paraffin wax and gas products using a small pyrolysis plant (Fig. (1)). In order to close the loop of the developed technology, mechanical pretreatment followed by chemical leaching process was used to separate aluminum against carbon powder fraction what helps to achieve the principle of zero-waste technologies with high economic and environmental benefits. The pyrolysis experiments were performed at constant heating rate (25°C/min) and different pyrolysis temperatures (500, 600, and 700°C). While the leach process was carried out using hydrochloric acid, thus recovering Al fraction in the form of salt and char in form of carbon Black. The chemical structure, composition and morphology of the recovered products and compounds were examined using FTIR, XRD, ICP, GC, SEM, etc. The developed strategy was successed to convert MFPWs at 600°C into paraffin wax (19.5%), biogas (63%), and Al/char (17.8%) beside decreasing carbon footprint by −984 kg CO2-eq/t of MFPWs with profitably estimated at 610 $/ton.

Recent Publications

1. Yousef, S., Eimontas, J., Zakarauskas, K., & Striūgas, N. (2021). Microcrystalline paraffin wax, biogas, carbon particles and aluminum recovery from metallised food packaging plastics using pyrolysis, mechanical and chemical treatments. Journal of Cleaner Production. https://doi.org/10.1016/j.jclepro.2021.125878
2. Yousef, S., Eimontas, J., Striugas, N., & Abdelnaby, M. A. (2021). Catalytic pyrolysis kinetic behavior and TG-FTIR-GC–MS analysis of metallised food packaging plastics with different concentrations of ZSM-5 Zeolite catalyst. Polymers. https://doi.org/10.3390/polym12081763
3. Yousef, S., Eimontas, J., Subadra, S. P., & Striūgas, N. (2021). Functionalization of char derived from pyrolysis of metallised food packaging plastics waste and its application as a filler in fiberglass/epoxy composites. Process Safety and Environmental Protection. https://doi.org/10.1016/j.psep.2021.01.009
4. Yousef, S., Eimontas, J., Striūgas, N., Zakarauskas, K., Praspaliauskas, M., & Abdelnaby, M. A. (2020). Pyrolysis kinetic behavior and TG-FTIR-GC–MS analysis of metallised food packaging plastics. Fuel. https://doi.org/10.1016/j.fuel.2020.118737
5. Yousef, S., Eimontas, J., Striugas, N., & Abdelnaby, M. A. (2020). Modeling of metalized food packaging plastics pyrolysis kinetics using an independent parallel reactions kinetic model. Polymers. https://doi.org/10.3390/polym12081763

Biography

Samy Yousef has completed his Ph.D. in mechanical engineering, Cairo University, Egypt. After that, he obtained postdoctoral studies from Messina University, Italy, and University of Technology, Lithuania (two years). Since 2018, He is Associate Professor, senior researcher at Faculty of Mechanical Engineering and Design, Kaunas University of Technology. He has published more than 58 papers (Scopus) in reputed journals with total impact factor >200 and H index (18). During the last four years, Dr. Yousef has achieved several promising results in materials recovery from different wastes such as WEEE, food packaging plastics, solar cells, textile, glass fibre reinforced polymer composites, and banknote waste, etc. then reprocessing of extracting metals into high added value products and adapting laboratory technology for industrial scale and Circular Economy principles. Also, he participated in developing many sustainable energy conversion strategies for textile waste, clothes dryer, plastic waste, end-of-life cotton banknotes into energy products using pyrolysis technology.