Biomass and Plastic Waste Valorisation: Pyrolysis in a Spouted Bed Reactor

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The escalating accumulation of biomass and plastic waste poses a significant and urgent environmental dilemma, necessitating the development of advanced and sustainable waste management strategies. Among the various solutions, pyrolysis is a highly efficient thermochemical conversion process which emerges as a promising technology, capable of transforming these complex waste streams into high-value products including bio-oil, syngas, and biochar. This process not only facilitates resource recovery but also contributes to mitigating the environmental impact of plastic and biomass waste, thereby advancing circular economy objectives [1].

This study investigates the pyrolysis of agricultural biomass and plastic waste using a spouted bed reactor, highly advantageous thanks to its efficient heat and mass transfer rates and capability of handling irregular and large particles [2]. Experimental and simulation activities are performed and combined to achieve an optimized solution in terms of products yields. Experimental activities involve pyrolysis reactions using steam as fluidization agent, with various feedstock combinations, ranging from pure agricultural residues to mixtures containing varying amounts of plastic waste. In addition, simulation activities using Aspen Plus permit us to compare experimental results with predicted outputs, helping to identify discrepancies, and refine both the model and experimental device and operation. Sensitivity analysis using the validated model is used to identify the optimal pyrolysis temperature for maximizing bio-oil yield considering the feedstock composition and reactor parameters, including residence time.

This study demonstrates the potential of co-pyrolyzing biomass and plastic as an efficient waste valorization method, offering a sustainable approach for plastic waste management while recovering valuable products. The findings provide a foundation for optimizing pyrolysis systems for large-scale waste-to-energy applications.

Keywords: *pyrolysis, biomass, plastic, spouted bed reactors, ASPEN Plus*

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[2] Energies 2024, 17, 1046; doi.org/10.3390/en17051046

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