Influence of Process Parameters on Bioenergy Production from Microwave Pyrolysis of Waste Blends: A Case Study of Industrial Sludge and Plastics

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Abstract:

Waste management poses a significant global challenge due to the escalating volume of waste generation and the inadequacy of current waste management infrastructure. Microwave pyrolysis has emerged as a promising technology for addressing this challenge by valorizing waste through thermal conversion. However, the efficacy of this process remains uncertain due to concerns regarding low bioenergy yields and high energy consumption. This study investigates the potential of microwave pyrolysis to convert plastic and industrial wastes into valuable bioenergy products, including bio-char, bio-oil, and syngas. Wastes originating from plastic and industrial sources were utilized as feedstocks for the microwave pyrolysis process. The energy content of all major products obtained was meticulously analyzed. Subsequently, a multivariable statistical analysis was employed to evaluate the bioenergy generation from the microwave co pyrolysis process. The study statistically analyzed the relationship between key parameters, such as pyrolysis temperature, feedstock ratio, and catalyst type, and their influence on bioenergy yield. The findings revealed that the utilization of catalysts, specifically HZSM5 and KOH, significantly enhances the bioenergy content within the bio-oil yield within a high-temperature range (550-650 °C). A remarkable peak bioenergy yield of approximately 92.59% was achieved, demonstrating the considerable potential of microwave pyrolysis as a viable technology for sustainable waste-to-bioenergy conversion.