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Brief Review Paper : Comparative Research – Methodology Research Paper

Study of Bio-Fuel using Plastic Waste by Pyrolysis Process

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Abstract: This thorough analysis examines a variety of new approaches to plastic waste management, with a focus on pyrolysis processes and the overriding objective of producing sustainable biofuels and value-added goods. The research looks into co-pyrolysis scenarios including waste plastic and biomass, date seeds, medical waste, and other plastic-biomass combinations. These studies highlight the dual goals of increasing biofuel output while minimizing environmental effect. The investigation includes catalytic processes, thermal cracking, and the use of natural zeolite as an effective catalyst to improve pyrolysis efficiency. Process refinement, catalyst invention, and machine learning applications suited to plastic waste pyrolysis are all problems for researchers. The possibility of converting plastic trash into high-quality plastic oil and biofuels is being considered in light of its environmental implications and contribution to alternative energy imperatives. Furthermore, an assessment of several technologies, such as supercritical gasification and microwave-assisted pyrolysis, provides insights into their industrial practicality and possible significance in addressing the worldwide plastic waste dilemma. This synthesis includes a diverse investigation of pyrolysis applications, emphasizing the necessity and difficulty of establishing long-term solutions to global plastic waste management.
Keywords: Bio-Fuel, Environment, SO2, CO2, Plastic Oil.

1. Introduction

Fossil fuels made from petroleum are currently the main energy sources used in everyday life. The massive consumption of petroleum fuels is depleting these energy sources and creating environmental issues due to the increased pollution emissions from burning these fuels (SO_2 and CO_2). Many more issues, such as waste disposal, are brought about by the depletion of these energy sources and need to be addressed right once. The problem of waste treatment has emerged as a result of the fast development in the use of plastic material because of their affordability, high resilience, and practicality. The continued use of fossil fuels has caused in serious environmental issues, such as greenhouse gas emissions, global warming, and climate change. Because of this, there is an increasing interest in alternative energy sources, which is the production of biofuels and bioenergy from lignocellulosic biomass.

Pyrolysis has generated a lot of interest because of its economical and environmental benefits. By heating biomass without oxygen, a thermochemical process known as biomass pyrolysis can create bio-oil. The continued use of fossil fuels has caused in serious environmental issues, such as greenhouse gas emissions, global warming, and climate change. Because of this, there is an increasing interest in alternative energy sources, which is the production of biofuels and bioenergy from lignocellulosic biomass. Pyrolysis has generated a lot of interest because of its economical and environmental benefits.

By heating biomass without oxygen, a thermochemical process known as biomass pyrolysis can create bio-oil. Due to their large speed advantage over biological processes such as fermentation and anaerobic digestion, these thermal techniques are becoming more and more popular. The ability to generate energy from waste materials that are resistant to microbial decomposition, like plastics, is another benefit of thermochemical technology. Pyrolysis is the most effective and promising of many thermal conversion methods. Because of its high fuel-to-feed ratio energy output, it is a very appealing choice for the energy conversion of biomass.

2. Literature Review

Benjamin Bernard Uzoejinwa et al. (2018) investigated the co-pyrolysis of waste plastic and biomass to produce high-grade biofuel. It covers the advantages, workings, and parameters of this method to increase energy security and decrease dependency on fossil fuels.

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Abrar Inayat et al. (2022) investigated the process of pyrolyzing date seeds and plastic trash to create items with additional value. The work was done on the pyrolysis of date seeds and plastic trash to produce goods with additional value.

N.K. Ndiaye et al. (2023) discussed the process of pyrolyzing waste plastic to create substitute fuel, which might support sustainable energy and more environmentally friendly waste management. It compared two techniques: thermal pyrolysis and catalytic pyrolysis.

Swathi Mukundan et al. (2022) discussed the efficient conversion of Prosopis juliflora biomass into high-quality bio-oil through catalytic hydrothermal liquefaction. It involves systematically substituting hydrogen-rich plastic waste (polypropylene) and using alumina-supported metal oxide catalysts.

Gang Li et al. (2023) investigated the co-pyrolysis of distiller's grains (DG) and waste polypropylene plastic (PP) to enhance biofuel production. Co-pyrolysis exhibited distinct effects, including a slower rate of weight loss, wider temperature range, and different activation energies compared to individual pyrolysis of DG and PP.

Bingchao Zhao et al. (2022) discussed the pyrolysis and transesterification processes for producing biodiesel from plastic waste. While the biodiesel mixes showed considerably lower power and efficiency, they significantly reduced carbon monoxide emissions.

Guangcan Su et al. (2023) investigated convert medical waste into valuable fuel through pyrolysis. Utilizing medical protective clothing (MPC) alongside oil palm wastes (OPWs) and catalysts improves bio-oil quality.

M.M. Harussani et al. (2022) discussed a sharp increase in the production of PPE based on polypropylene, which led to a notable buildup of plastic waste. To solve this, scientists have concentrated on pyrolysis, a procedure that turns polypropylene (PP) plastic into solid char and liquid oil that resemble fuel.

Krishnaraj Janarthanan et al. (2022) investigated the thermal cracking method for extracting fuel from waste plastics through the pyrolysis process at a range of temperatures in an oxygen-free environment, yielding approximately 78% liquid fuel at 370°C, with a calorific value of 38.53 MJ/kg.

Apip Amrullah et al. (2022) discussed the co-pyrolysis of food waste and plastic to produce bio-oil and bio-char. Optimal conditions were 350°C, yielding 66% bio-oil and 40% bio-char. The process promoted carboxylic acid and hydrocarbon formation, with higher plastic waste ratios increasing carboxylic acid content.

M S Hossain et al. (2016) investigated co-pyrolysis of solid tire waste and rice husk to produce biofuels and chemicals. The process was affected by the tire waste percentage in the blend and reactor temperature.

Jamin Escalante et al. (2022) discussed the importance of thermogravimetric analysis (TGA) in evaluating the pyrolysis of various waste biomass sources, offering insights into thermal characteristics and the potential for sustainable bioenergy, while also discussing the benefits and limitations of TGA in this context.

Farinaz Ebrahimian et al. (2023) investigated the environmental effects of several biorefinery techniques for turning organic municipal solid waste into biofuels.

Shashank Pal et al. (2023) investigated growing population and fossil fuel depletion drive the need for alternative energy. Chemical recycling of plastic waste via pyrolysis produces high-grade plastic oil (PO). Using plastic oil in an engine reduces efficiency by 6.90% compared to diesel.

S.M.R. Mirkarimi et al. (2022) discussed an emphasis on creating a pyrolysis oil that is comparable to diesel fuel. In addition to comparing the physico-chemical characteristics of waste plastic oil with traditional diesel fuels, it evaluates the effects of different parameters on the yield of liquid products and looks at the emissions and engine performance of diesel engines.

Jie Li et al. (2023) emphasized the difficulties in process optimization and catalyst development for the manufacturing of high-quality liquid fuel. Additionally, it promotes data expansion, improved interpretability of the model, and investigation of novel machine learning applications for catalyst design and process optimization in plastic waste pyrolysis.

Hendrawati et al. (2023) discussed converting plastic waste into fuel oil using natural zeolite as a catalyst. The optimum conditions included 7% and 3% catalyst ratios, resulting in 69.69% and 65.60% liquid fraction yields, respectively, showcasing the effective use of natural zeolite in simplifying the pyrolysis process.

Zhiwei Wang et al. (2021) discussed how abundant solid biomass and waste plastics can be combined for co-pyrolysis to increase the yield of fuels and value-added products.

Chiun Chao Seah et al. (2023) emphasized a thermochemical process called pyrolysis shows promise in turning the plastic wastes into biofuels; pyrolyzing plastic and biomass together improves the

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quantity and quality of the resulting biofuel.

Janarthanan Krishnaraj et al. (2022) emphasized the pyrolysis process of thermal cracking to extract fuel from waste plastics, with a particular emphasis on temperatures between 370°C and 380°C.

Omojola Awogbemi et al. (2023) discussed the strategies for converting vast amounts of waste plastic into biofuels and value-added products to achieve affordable and clean energy goals.

Aizatul Hikmah Zulkafli et al. (2023) empathized the effects of various plastic types as co-reactants and discovered that their addition increased the yield and quality of bio-oil while decreasing the formation of coke and undesired oxygenated compounds, demonstrating the potential for the production of environmentally friendly chemicals and fuel.

Mohammed B. Al Rayaan et al. (2021) investigated the various technologies, including supercritical gasification, plasma gasification, and microwave-assisted pyrolysis, emphasizing their advantages and disadvantages, especially with regard to their viability as industrial processes.

3. Result and Discussion

Co-pyrolysis for Enhanced Biofuel Production: Studies by Uzoejinwa et al. (2018) and Li et al. (2023) highlight the efficacy of co-pyrolysis, demonstrating increased biofuel production when combining waste plastic with biomass or distiller's grains.

Diverse Feedstock Utilization: Investigations by Inayat et al. (2022) and Hossain et al. (2016) showcase the versatility of pyrolysis by exploring unconventional feedstocks such as date seeds and solid tire waste, indicating the potential to manage diverse waste streams.

Comparative Analysis of Pyrolysis Techniques: Ndiaye et al. (2023) provide valuable insights into waste plastic pyrolysis by comparing thermal and catalytic techniques, offering a comprehensive understanding of the advantages and disadvantages associated with each method.

Catalytic Enhancement: Mukundan et al. (2022) and Su et al. (2023) demonstrate the role of catalysts in improving bio-oil quality, with a focus on substituting hydrogen-rich plastic waste and utilizing catalysts for medical waste conversion.

Environmental Implications: Studies like Escalante et al. (2022) and Pal et al. (2023) discuss the environmental effects and alternative applications of plastic waste pyrolysis, including the production of high-grade plastic oil and its impact on engine efficiency.

Challenges and Optimization: Li et al. (2023) and Hendrawati et al. (2023) emphasize the challenges in optimizing the pyrolysis process, calling for advancements in data expansion, interpretability of models, and machine learning applications to enhance efficiency and sustainability.

This coordinated work emphasise the multifaceted character of plastic waste pyrolysis, providing a range of methodologies, feedstocks, and applications. The research contributes to a better understanding of the promise and constraints of using pyrolysis for sustainable biofuel generation and waste management.

4. Conclusion

The extensive literature analysis on plastic waste pyrolysis highlights the growing overview of new ways to solving environmental concerns, energy security, and sustainable resource utilisation. Researchers have investigated various feedstocks, such as biomass, date seeds, and medical waste, demonstrating the adaptability of pyrolysis for waste valorization. Co-pyrolysis technologies, such as combining waste plastics with biomass or other organic materials, have developed as viable methods of increasing biofuel production while reducing dependency on fossil fuels. Catalytic procedures, particularly those incorporating new materials such as alumina-supported metal oxides or natural zeolite, have the potential to significantly improve pyrolysis efficiency and product quality. The co-pyrolysis of distiller's grains and polypropylene plastic, as well as the conversion of medical waste into biofuel, highlight pyrolysis's many waste management applications. Furthermore, the inquiry topic's multidisciplinary nature is demonstrated by the exploration of environmental implications, efficiency challenges, and the function of machine learning in the advancement of pyrolysis processes. While chemical recycling of plastic waste via pyrolysis yields high-quality plastic oil, it is critical to solve related issues such as decreased engine performance The findings highlight the significance of continued research in improving processes, developing sustainable technology, and paving the road for a circular economy that solves environmental and energy challenges.

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