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REVIEW ON PYROLYSIS, GASIFICATION AND LIQUEFACTION OF BIOMASS FOR BIOFUEL PRODUCTION

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REVIEW ON PYROLYSIS, GASIFICATION AND LIQUEFACTION OF BIOMASS FOR BIOFUEL PRODUCTION

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ABSTRACT

REVIEW ON PYROLYSIS, GASIFICATION AND LIQUEFACTION OF BIOMASS FOR BIOFUEL PRODUCTION

Rising energy demand and environmental concerns have highlighted the important of sustainable and renewable energy sources. Biofuels derived from biomass are recognized as sustainable substitutes for fossil fuel due to their carbon neutrality, potential to reduce greenhouse gas emissions, and ability to utilize various organic wastes. Biomass from agricultural forest waste and municipal solid waste (MSW) appears as attractive fuel to overcome the issues of environmental impact of organic waste accumulation. Pyrolysis, gasification and liquefaction have been widely used to convert biomass into energy-dense product such as bio-oil, syngas and biocrude due to their high conversion efficiency, flexibility, and low processing time in converting biomass to energy products. However, using biomass as a single feedstock perform a several limitations including high moisture and ash content, low higher heating value (HHV) which can compromise product quality. Recent studies have explored co-processing of biomass with other feedstocks such as plastic and coal to improves biofuel composition, enhance thermal degradation behaviour, increase product yield and energy content, and support integrated waste management strategies. However, there remains a gap in comprehensive and comparative evaluations of these three thermochemical conversion techniques under co-processing conditions particularly with respect to product yield, energy efficiency, and process optimization. This review addresses this gap by systematically comparing the performance of pyrolysis, gasification and liquefaction when applied to biomass as a single feedstock and when blending with other feedstocks influence by process parameters such as temperature, heating rate, residence time, pressure and reactor design. This review further identifies which process demonstrates the greatest potential for efficient and sustainable biofuel production under co-processing conditions Furthermore, this work provides a comprehensive understanding on how process selection, operating conditions, and feedstock ratio influence thermochemical conversion performance, offering guidance for optimizing biomass utilization and advancing sustainable energy system.

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