

The escalating global concern over plastic waste management has driven a surge of interest in sustainable and efficient recycling methods. Among these, pyrolysis and gasification have emerged as promising technologies to transform plastic waste into valuable products and energy sources. This comprehensive literature review critically assesses and compares the two recycling processes, shedding light on their compatibility with circular economy principles as guided by ISO 14000 and ISO 13000 series.

Plastics play a pivotal role in establishing a circular economy and achieving a climate-neutral society. Their durability, resource and energy utilization efficiency, and recyclability contribute to product circularity and make plastics instrumental in delivering sustainable solutions for various applications, including electric cars, wind power stations, and energy-efficient homes.

The primary objective of this report is to provide a comprehensive literature review comparing pyrolysis and gasification as prominent plastic waste recycling techniques for polyolefins and high-value chemical production. The study analyzes key factors influencing the performance and viability of each method and emphasizes the need to transition from the traditional linear "take-make-dispose" model to a more sustainable and regenerative system.

This report delves into a wide array of research studies, academic papers, and industry reports to explore the advantages, limitations, and challenges associated with pyrolysis and gasification processes. It introduces the fundamentals of both techniques, detailing their mechanisms, operating conditions, and product yields. Furthermore, the report highlights the significance of energy efficiency, mass balance, and carbon footprint analysis in assessing the environmental impact of these recycling methods.

In conclusion, this comprehensive review determines that recycling through gasification is the optimal route for the project's aims. Gasification's self-sufficiency, harnessing process-generated heat to drive reactions, leads to a lower carbon footprint compared to pyrolysis. Moreover, gasification demonstrates greater simplicity and clarity in its end product (syngas), offering potential for transformation into mixed alcohol products through catalytic synthesis processes.

While pyrolysis proves effective for energy recovery, its alignment with closed-loop circular economy principles necessitates a balanced approach to integrate energy recovery with circular economy strategies for sustainable waste management.

For polyolefins and high-value chemical production, gasification appears more promising than one-step pyrolysis, particularly for its potential to produce key petrochemicals. Nonetheless, the combination of pyrolysis and steam/catalysis reforming shows potential advantages, urging further research to optimize and advance its effectiveness.

This literature review serves as a benchmark for policymakers, researchers, and industries striving to develop sustainable plastic waste management strategies. By facilitating informed decision-making, this study contributes to the broader goal of achieving an efficient and circular economy for plastics.