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Recyclability Study of CaO Catalyst Derived from Chicken Manure in Transesterification of Waste Cooking Oil into Biodiesel

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Structured Abstract

Background: The use of waste cooking oil (WCO) as a feedstock for biodiesel production addresses the dual challenges of waste management and renewable energy generation. However, the limitations of homogeneous catalysts, such as high costs and environmental concerns, necessitate the exploration of heterogeneous catalysts. This study investigates the recyclability and efficiency of calcium oxide (CaO) derived from chicken manure in the transesterification of WCO. The research aims to evaluate the catalytic performance across multiple cycles and its impact on biodiesel yield.

Methods: Chicken manure was calcined at 900°C to produce CaO. The catalyst was characterized using techniques such as X-ray Diffraction (XRD), Thermogravimetric Analysis (TGA), Scanning Electron Microscopy with Energy Dispersive X-ray Spectroscopy (SEM-EDX), Brunauer-Emmett-Teller (BET) analysis, and Fourier Transform Infrared (FTIR) spectroscopy. The WCO underwent esterification followed by transesterification with the CaO catalyst at a methanol-to-oil molar ratio of 15:1, 65°C, and a stirring rate of 6000 rpm for 4 hours. Catalyst recyclability was assessed over four cycles, with biodiesel yield determined using GC-FID analysis.

Results: This study revealed that the CaO catalyst demonstrated high thermal stability, mesoporosity, and well-defined crystalline phases. Biodiesel yield increased from 72.23% in the first cycle to a peak of 93.56% in the third cycle, before slightly declining to 89.19% in the fourth cycle due to minor calcium leaching and surface carbonation. SEM-EDX confirmed the catalyst's structural integrity, while FTIR analysis revealed consistent CaO activity across cycles. These results highlight the strong recyclability and efficiency of the CaO catalyst derived from chicken manure.

Conclusion: The study confirms the viability of using chicken manure-derived CaO as a sustainable and recyclable catalyst for biodiesel production. Its consistent performance across multiple cycles makes it a promising alternative to conventional catalysts. Future work should focus on optimizing catalyst preparation methods and exploring additional applications to enhance the overall sustainability of biodiesel production.

Keywords: Biodiesel, CaO, Chicken Manure, Catalyst Recyclability, Waste Cooking Oil

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