

Research Article

Biodiesel Production from Castor Oil by Using Calcium Oxide Derived from Mud Clam Shell

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The catalytic potential of calcium oxide synthesized from mud clam shell as a heterogeneous catalyst for biodiesel production was studied. The mud clam shell calcium oxide was characterized using particle size analyzer, Fourier transform infrared spectroscopy, scanning electron microscopy, and BET gas sorption analyzer. The catalyst performance of mud clam shell calcium oxide was studied in the transesterification of castor oil as biodiesel. Catalyst characterization and transesterification study results of synthesized catalyst proved the efficiency of the natural derived catalyst for biodiesel production. A highest biodiesel yield of 96.7% was obtained at optimal parameters such as 1:14 oil-to-methanol molar ratio, 3% w/w catalyst concentration, 60°C reaction temperature, and 2-hour reaction time. Catalyst reusability test shows that the synthesized calcium oxide from mud clam shell is reusable up to 5 times.

1. Introduction

The depletion of fossil fuels and increasing demand of conventional energy globally had been the main concern of scientists nowadays. A continuous supply of energy is vital to support the human activities such as industrialization, transportation, and agriculture. As the conventional energy sources are limited, there is a need to generate an alternative, nonconventional energy to support the civilization.

Biodiesel is one of the promising biofuels to replace fossil fuels as a primary energy source for machineries and vehicles [1]. Biodiesel has many important technical advantages over conventional diesel, such as inherent lubricity, low toxicity, derivation from a renewable and domestic feedstock, superior flash point and biodegradability, negligible sulfur content, and lower exhaust emissions [2].

The homogeneous catalyzed transesterification of vegetable oil for biodiesel production possesses some drawbacks such as saponification of the oil, impossibility of catalyst recovery, and limitation in establishing a continuous process [3]. In contrast, the solid catalysts could easily be separated from the reaction mixture by filtration and reused [4]. Heterogeneous base catalysts eliminate the need for the neutralization of homogeneous base catalysts with acids and the removal of water in the commercial production of biodiesel, thereby lowering its production cost [5].

Among the heterogeneous catalysts, calcium oxide has derived researchers attention because it is a cheap and abundantly available in the nature as a limestone and also from sea shells in the form of calcium carbonate, $CaCO_3$.

Calcium oxide can be reused up to 3 times in transesterification reaction which made it an economic catalyst. As the calcium oxide was derived from the natural source, it is environmentally friendly and causes no harm to the ecosystem. Thus, calcium oxide was suitable to be used in large scale production of biodiesel for commercial purpose as it needs no posttreatment prior to its disposal to the environment [6].

Castor oil had its own advantages as one of the promising sources of feedstock for biodiesel production despite having high viscosity compared to other vegetable oils. Castor oil does not contain sulfur; it has greater cetane number which indicates a better quality of ignition and more oxygen content