

The Production of Biodiesel with Heterogeneous Catalysts

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The problem of finding economically viable and environmentally friendly renewable energy sources is a pressing matter. Not only is the world faced with a finite supply of fossil-fuels, but concern is growing over the possibility of climate change caused by greenhouse gas emissions. Biodiesel, a liquid fuel derived from plant or animal oils, represents a renewable energy source that could contribute to the solution of both problems; it can be continually produced as long as we are able to grow plants and it can be made in such a way as to release no net addition of greenhouse gases to the environment [3]. However, technical challenges must be overcome before biodiesel can contribute significantly to the world's energy supply; with current technology biodiesel production is profitable only under special circumstances. One such technical challenge is the problem of finding a way to make the reaction faster and more energy efficient. The research project presented in the following report seeks to address this problem by studying the production of biodiesel using heterogeneous catalysts and microwave reaction systems. Heterogeneous catalysts can make biodiesel more energy efficient, and therefore less expensive, by eliminating the need for expensive purification processes that separate the catalyst from reaction products typical in the use of homogeneous catalysts [4]. Microwave reaction systems both speed up biodiesel production and make it more energy efficient by accelerating the rate of reaction while decreasing energy losses involved in heating the reaction mixture [5].

The production of Biodiesel by the transesterification of vegetable oils or algae is one of the most rapidly increasing sources of Green-Diesel. It is the most energy efficient process for the production of transport fuels from renewable resources based on the use of waste oils. The process can be further improved if heterogeneous catalysts are developed to replace the homogeneous bases employed in the current and soon-to-be implemented Biodiesel plants. We have found that several heterogeneous catalysts are effective and are recyclable for transesterification of waste oils. The use of microwave energy for the modest heating of the reactor provides reaction rates that comparable to the commercial processes but obviate subsequent catalyst neutralization or removal processes. The reactor engineering of Biodiesel production by transesterification is indeed a complex interfacial process as the primary reactants (methanol and oil) and the products (fatty acid methyl esters, FAMES, and glycerine) have limited mutual solubility. Interphase transport coupled with catalysis (a three+ phase system) make this an intriguing reactor engineering process.

Several studies have examined the catalytic activity of calcium methoxide [1-3]. Using conventional heating mechanisms for the transesterification reaction, each study found methyl ester yields greater than 90% after about 2.5 hrs of reaction at 65C [1-3]. Wan et al. studied the activity of sodium aluminate in the transesterification of soybean oil using conventional heating; they found yields up to 89.9% after 30 min of

reaction at 64C [6]. With the use of microwave heating, the reactions are complete in less than 15 minutes for the same temperature and reaction mixture. This paper will discuss the influence of microwave heating on the heterogeneous kinetics of transesterification to produce BioDiesel and the associated microwave catalytic reactor engineering.

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