REACTOR DESIGN FOR BIODIESEL PRODUCTION

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INTRODUCTION

The growth of renewable energy in the power sector over the last five years has been remarkable, while significantly less progress has occurred in heating, cooling, and transport [1]. Biodiesel is an alternative fuel to diesel engines that can replace or reduce the use of petroleum diesel. Biodiesel is a renewable and clean-burning fuel made from waste vegetable oils, animal fats, recycled restaurant grease, inedible vegetable oil, or microalgae. The chemical conversion of the oil into its corresponding fatty esters is called transesterification. Transesterification is generally the catalytic reaction of triglyceride in oil with methanol to form fatty acid methyl ester (FAME) and glycerol (Figure 6.1). The main purpose of transesterification is to reduce oil viscosity for diesel engines. Refined biodiesel produces fewer toxic pollutants and greenhouse gases than petroleum diesel.

The transesterification is reversible; therefore, excess methanol is used to shift the equilibrium to the product side. Acidic or basic catalysts are used to improve the rate and yield of the reaction. The development of heterogeneous solid catalysts is progressed for catalyst recovery and regeneration [2]-[3]. Reaction inhibition by impurities such as free fatty acids (FFA) existing in the feedstock oil must be considered. It is necessary

to improve the separation process of methanol, crude glycerol, and the residual inorganic components from the biodiesel fuel after the reaction. Therefore, much research on biodiesel production has been reported recently in terms of not only the enhancement of the transesterification rate but also the effective purification of the crude FAME. This review focuses on the reactors for biodiesel synthesis.

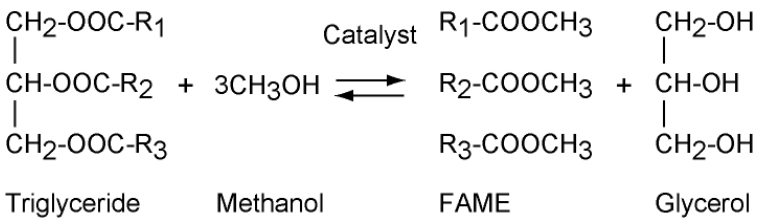

Figure 6.1 Transesterification of triglyceride

BATCH REACTOR

In laboratory-scale or commercial processes, batch stirred-tank reactors are commonly used to synthesise biodiesel. In the batch process, the excessive addition of methanol to triglyceride improves reaction yields. Of the many reports on biodiesel synthesis, the molar ratio of methanol to triglyceride is operated from 4:1 to 20:1, with the most common being 6:1. The reaction temperature is approximately 60°C to prevent the volatilisation of methanol. Most of the catalysts used are NaOH or KOH, and the weight fraction of the catalyst to oil is 0.3 wt% to 1.5 wt%. This is because the reaction rate in acid catalysts is much slower than that of alkali catalysts. Numerous kinds of research have reported on optimising operating conditions such as water content, FFA content, catalyst, and reaction temperature for transesterification of triglycerides from many types of fats and oils in a batch reactor [4]-[7]. Understanding chemical reaction kinetics is essential to selecting the best type of reactor for biodiesel production. However, there are not so many research reports [8]-[14] that examine the reaction rate.

Guan et al. [10] investigated the transesterification rate of sunflower oil in a single-phase homogenised by a variety of co-solvent: dimethyl ether, diethyl ether, tertiary-butyl methyl ether, and tetrahydrofuran at room temperature. They found that the reaction rate was influenced by the type