On Homogeneous Basic Catalysts Process of Biodiesel Production

YANG Shih-chieh, LEE Maw-tien
(Department of Applied Chemistry, National Chiayi University, Chiayi City, Taiwan 600)

Abstract: For the homogeneous process, basic catalysts are most used for its low methanol/oil ratio and high reaction rate in comparison with that of heterogeneous catalyst process. However with the phase separation of alcohol and oil, reaction rate is limited. Because methanol could not dissolve in soybean oil, tetrahydrofuran (THF) and nonionic surfactant (PANNOX5) was used to form a single phase system to improve the reaction rate. Effects of impellers speed was also detected for the batch process. In order to increase the mixing effect, two static mixers in series were used. Reaction rate and yield of the reaction were discussed according to the experimental results.

Key words: biodiesel; transesterification; cosolvent
CLC number: TE624.5 Document code: A Article ID: 0529-6579 (2007) S1-0260-02

1 Introduction

Biodiesel derived from triglycerides by transesterification with methanol has attracted considerable attention during the past decade as a renewable, biodegradable, nontoxic fuel and low air pollution (Sheehan[1]). Amount of studies have been conducted and several review papers have been published, such as Hideki Fukuda[2]. To reduce the interface resistance of mass transfer, cosolvent method[3] and a phase transfer catalyst were tested. The composition of methanol, glycerol and methyl ester in the feed was critical in affecting the reaction. In this study methanol/glycerol=6 was used. Effects of rotation speed of mixer, cosolvent were conducted and discussed for reaction taken in a stirred tank reactor (batch process). Finally a tube reactor (continuous process) was used for comparison.

2 Experiments

American National Standard D6584—00 was chosen for samples analysis. For batch process, the reaction was conducted in a 500 mL three neck bottle with a 5 cm stirrer. Dissolving 1 g of NaOH in 28 mL dehydrous methanol and mixing with 100 g of soybean. The reactor was kept at 60 ℃ and samples were taken for the required reaction time. For the continuous process, the reaction occurred in the tube reactor. The reactor was made of 180 cm, 0.5" diameter stainless steel. Temperature was kept at 60℃ and the flow rate was 4 mL/min. Samples were taken at different positions of the tube. Reaction times of this process were calculated by dividing the lengths of the sampling positions by flow rate.

3 Results and discussions

As shown in fig.1, mass transfer resistance is not important if the stirring rate is greater than 150 r/min. It is clearly that system with THF has greater conversion and ester yield (fig.2). It is believed that cosolvent can reduce the interface mass transfer resistance.

The higher the pressure is, the greater the conversion is. However, the increase is small (fig.4).

Figure 5 gives the evidence that phase transfer catalyst PANNOX has positive effect on conversion and yield for the reaction.

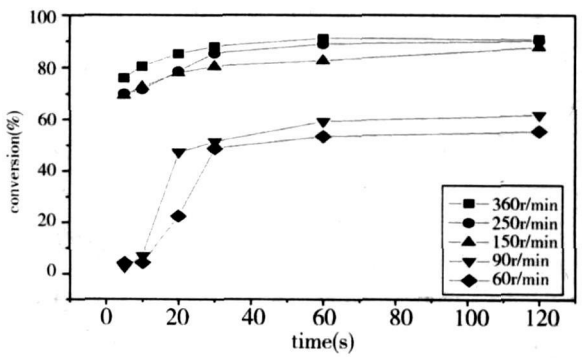

Fig.1 Effects of stirring rate on the conversion of reaction

①收稿日期: 2007-01-10
作者简介: 杨世杰 (1983年生), 男, 研究生; 通讯联系人: 李茂田; E-mail: mtlee@mail.ncyu.edu.tw

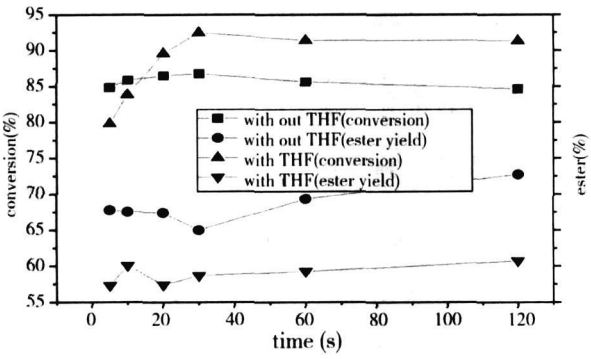

Fig. 2　Effect of THF on conversion and ester yield Stirring rate 60 rpm

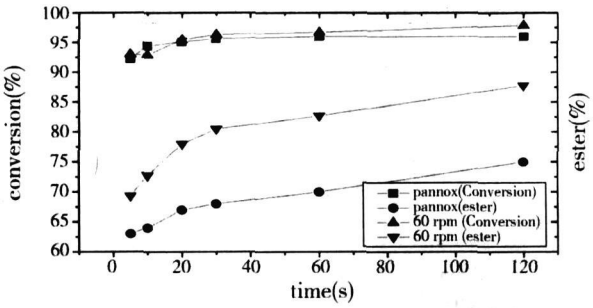

Fig. 3　Effects of PANNOX on conversion and ester yield

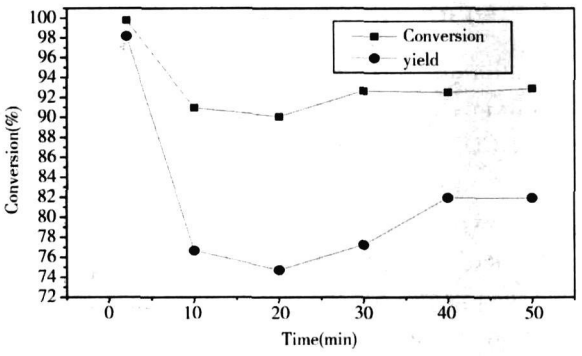

Fig. 4　Continuous process. (flow rate 4cm/min)

To improve the conversion and yield, a cascade continuous reactor was used. It is clearly as shown in figure 4, that the conversion and yield increase in this case.

4　Conclusions

Experimental study on the biodiesel production by homogeneous basic catalyst was conducted. The following conclusions are achieved.

(1) Mass transfer resistance is not important if the stirring rate is greater than 150 r/min.

(2) Cosolvent can reduce the interface mass transfer resistance.

(3) Phase transfer catalyst PANNOX has positive effect on conversion and yield for the reaction.

(4) Continuous process increases the conversion and yield.

References:

[1] Sheehan J, Camobreco V, Duffield J, Graboski M, and H. Shapouri. Life cycle inventory of biodiesel and petroleum diesel for use in an urban bus [Z]. NREL/SR—580—24089, 1998.

[2] Hideki Fukuda, Akihiko Kondo, and Hideo Noda. Biodiesel fuel production by transesterification of oils [J]. J of Bioscience and Bioengineering, 2001, 92 (5): 405—416.

[3] SCHICK M J. Nonionic surfactants [J]. Marcel Dekkers, 1967.

生质柴油碱性均匀相触媒制程研究

杨世杰，李茂田

(嘉义大学 应用化学系，台灣 嘉义 600)

摘　要：生质柴油为重要之可再生能源。本文研究改善液相触媒制程，以降低甲醇与三酸甘油酯间界面阻力，以提生反应速率。实验结果发现，在批式制程中，提高搅拌速率可提升反应速率，然因工厂实际操作恐有困难。以相转移触媒可达增加反应速率与产率效果，但需注意选用之相转移触媒不可在强碱下被破坏。使用共溶剂 THF可促进反应速率与产率，为一可行的选择。而连续制程较批式制程有较好的效率。

关键词：生质柴油；转酯化反应；共溶剂

中图分类号：TE624.5