T2R2 東京科学大学 リサーチリポジトリ
Science Tokyo Research Repository

論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Enhancement of Biodiesel Production Reaction with Static Mixer
著者(和文)	PAWEETIDASUNGWORN
Author(English)	10D53423
出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第9508号, 授与年月日:2014年3月26日, 学位の種別:課程博士, 審査員:吉川　邦夫,加茂　徹,高橋　史武,時松　宏治,梶谷　史朗
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第9508号, Conferred date:2014/3/26, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

Powered by T2R2 (Science Tokyo Research Repository)

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	環境理工学創造　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of　（工学）
学生氏名： Student's Name	Sungwornpatansakul Paweetida	指導教員（主）： Academic Advisor(main)	吉川　邦夫
		指導教員（副）： Academic Advisor(sub)	高橋　史武

要旨（和文 2000 字程度）
Thesis Summary (approx.2000 Japanese Characters)

The main target of this research is to apply the static mixer to biodiesel production to enhance the reaction rate and reduce requirements for chemicals and energy in biodiesel production. The comparisons between conventional mechanical mixer and the static mixer were carried out on three different reactions. These reactions are the alkali-catalyzed tranesterification reaction, the acid-catalyzed esterification reaction, and the tranesterification reaction with heterogeneous catalyst. The evaluations of the conversion efficiency and the reaction kinetics were conducted to show the performances of each mixer. The contents of this study have been divided into six chapters as follows:

The first chapter introduces background of biodiesel and the details of the production reaction. Previous works were discussed to present the problem of the conventional processes and stated the challenges in the development of biodiesel production. These challenges lead to the utilization of the static mixer in this research and the application and advantage of this static mixer are also explained in this chapter.

In chapter 2, the comparative studies on the conventional mixer and the static mixer under the batch process were studied. Both the conventional mechanical stirrer and the static mixer were used to produce biodiesel under the alkali-catalyzed transesterification reaction and investigated the potential of reaction enhancement by the static mixer.

The results showed that the static mixer has the potential of reaction enhancement since it can obtain better mixing intensity than the conventional mixer, especially in the first stage of the reaction. In addition, two different raw materials were tested in this chapter, the pure vegetable oil and the waste cooking oil, in order to confirm that the same results can still be achieved.

Chapter 3 focused on the mechanism of enhancement or the reaction kinetics of the transesterification reaction by the static mixer was investigated in comparison with the conventional mixer. The mechanism is investigated by comparing droplet size measurement of methanol in raw oil and the reaction rate coefficient. There are three operating stages in the reaction that need to be considered, the slow initial mass transfer stage, then the fast chemical controlled stage, and the final slow equilibrium stage.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	環境理工学創造　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of	（工学）
学生氏名： Student's Name	Sungwornpatansakul Paweetida	指導教員（主）： Academic Advisor(main)	吉川　邦夫	
		指導教員（副）： Academic Advisor(sub)	高橋　史武	

要旨（英文 300 語程度）
Thesis Summary (approx.300 English Words)

The results showed that the static mixer has the potential to deliver better rigorous mixing between the raw oil and methanol, to make the dispersed droplets of methanol in the raw oil smaller and more uniform, which results in enhancement of the reaction. Also, static mixer demonstrated much larger value of the reaction rate than the mechanical mixer which means that the static mixer can accelerate the transesterification reaction significantly. However, the static mixer gave effects on the reaction only in the initial stage of the reaction.

This chapter also included the calculation of the new reaction order which is the most suitable for these experimental results and found that it is in higher order than the ones proposed by other researchers, which means that the reaction mechanism changed following the time change since the catalyst also promoted the reaction rate proportionally.

In chapter 4, another comparative study between conventional mechanical mixer and the static mixer was performed on acid-catalyzed esterification of Jatropha curcas oil. When the high free fatty acids oil such as Jatropha oil is utilized, an acid-catalyzed esterification reaction is needed to neutralize the raw material as the pre-treatment reaction. The reaction kinetics are also studied and compared between the two mixers.

The results showed that the minimum requirement of methanol and the catalyst can be reduced by using static mixer, and the kinetic studies also showed that the static mixer could enhance the forward reaction and the activation energy was slightly decreased which might be the reason of this enhancement.

Chapter 5 is focusing on a continuous production system with the use of the heterogeneous catalysts, which can reduce the production costs and energy requirement. Many researches have been focused on the replacement of the homogeneous catalysts by the heterogeneous catalysts in biodiesel production but only a few can be utilized in the commercial production.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	環境理工学創造　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of （工学）
学生氏名： Student's Name	Sungwornpatansakul Paweetida	指導教員（主）： Academic Advisor(main)	吉川　邦夫
		指導教員（副）： Academic Advisor(sub)	高橋　史武

要旨（英文 800 語程度）
Thesis Summary （approx.800 English Words ）

In this chapter, the static mixer is applied to the heterogeneous catalysts to investigate the possibility of reaction enhancement since there is the mass transfer limitation which is the same problems as the homogeneous catalysts which can be resolved by the static mixer. Two catalysts are compared in this chapter to see the performance by using different reactors and mixers. The results showed that using the high activity catalyst could help to promote the reaction enhancement with the use of the static mixer. A scale-up experiment with the usage of the activated carbon was also conducted to demonstrate the combination of the continuous tranesterification process and the static mixer.

In the last chapter 6, main achievements in this research were summarized and the future works are proposed.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).