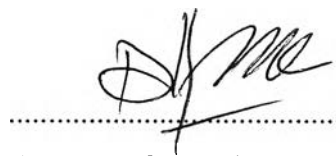
CATALYTIC CONVERSION OF ETHANOL INTO LIGHT OLEFINS USING SAPO-34 CATALYST IN A COMMERCIAL PLANT AND A PRE-FEASIBILITY STUDY

Apirat Chaitanarit

A Thesis Submitted in Partial Fulfilment of the Requirements
for the Degree of Master of Science
The Petroleum and Petrochemical College, Chulalongkorn University
in Academic Partnership with
The University of Michigan, The University of Oklahoma,
Case Western Reserve University, and Institut Français du Pétrole
2012

Thesis Title:	Catalytic Conversion of Ethanol into Light Olefins Using SAPO-34 Catalyst in a Commercial Plant and a Pre-fesibility Study
By:	Apirat Chaitanarit
Program:	Petrochemical Technology
Thesis Advisors:	Assoc. Prof. Sirirat Jitkarnka
	Mr. Chatapong Wungtanagorn

Accepted by The Petroleum and Petrochemical College, Chulalongkorn University, in partial fulfilment of the requirements for the Degree of Master of Science.

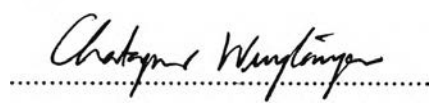


..... College Dean

(Asst. Prof. Pomthong Malakul)

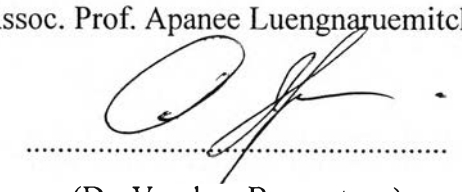
Thesis Committee:

(Assoc. Prof. Sirirat Jitkarnka)



(Mr. Chatapong Wungtanagorn)

(Assoc. Prof. Apanee Luengnaruemitchai)



(Dr. Vorakan Burapatana)

ABSTRACT

5371002063: Petrochemical Technology Program
Apirat Chaitanarit: Catalytic Conversion of Ethanol into Light Olefins using SAPO-34 Catalyst in a Commercial Plant and a Pre-feasibility Study.
Thesis Advisors: Assoc. Prof. Sirirat Jitkarnka, and Mr. Chatapong Wungtanagorn 88 pp.
Keywords: Dehydration/ Ethanol/ Bio-ethanol/ Ethylene/ Propylene/ Light Olefins/ SAPO-34/ Silicoaluminophosphate/ Operating Conditions/ Temperature/ LHSV/ Feasibility/ Economic/ IRR

Light olefins (both ethylene and propylene) are important intermediates widely used in the petrochemical industry. With the shortage of natural resource and the growing demand for light olefins, the production of light olefins from renewable resources such as bio-ethanol has received wide attention. In this work, light olefins production from bio-ethanol was investigated using a silicoaluminophosphate zeolite (SAPO-34) catalyst through the catalytic dehydration process. The effects of operating conditions were studied in terms of catalytic activity. The reaction temperature, liquid hourly space velocity (LHSV), and time on stream (ToS) were varied in the range of 350 ^{o}C to 500 ^{o}C, 0.2 h^{-1} to 1.0 h^{-1}, and 45 minutes to 180 minutes, respectively. The results revealed that the reaction temperature, LHSV, and ToS had the influences on catalytic activity. The reaction temperature of 400 ^{o}C and the LHSV of 0.5 h^{-1} were found to be the suitable conditions for a high production of propylene. The reaction temperature and the LHSV also affected to the coke formation on the catalyst. The amount of coke increased with the increase of reaction temperature and the decrease of LHSV. Moreover, the pre-feasibility of the bio-ethanol to light olefins plant was studied as well. It was found that the bio-ethanol to light olefins plant modified from Chematur was not commercially viable due to the high raw material price and high total capital cost. Moreover, the sensitivity analysis revealed that ethanol price and the product prices were the sensitive parameters mainly affecting to the feasibility of this project.

บทคัดย่อ

อภิรัฐ ชัยธนฤทธิ์ : การเปลี่ยนเอทานอลเป็นโอลิฟินส์เบาในโรงงานเชิงพาณิชย์โดยใช้ตัวเร่งปฏิกิริยาเอสเอพีโอสามสิบสี่และการศึกษาความเป็นไปได้เบื้องต้น (Catalytic Conversion of Ethanol into Light Olefins using SAPO-34 Catalyst in a Commercial Plant and a Pre-feasibility Study) อ. ที่ปรึกษา : รศ. ดร. ศิริรัตน์ จิตการค้า และ นายฉัตรฐาพงศ์ วังธนากร 88 หน้า

โอเลฟินส์เบา (เอทธิลีนและโพรพิลีน) เป็นสารตัวกลางที่สำคัญที่ใช้กันอย่างแพร่หลายในอุตสาหกรรมปิโตรเคมี เนื่องด้วยทรัพยากรธรรมชาติมีจำกัดและความต้องการของโอเลฟินส์เบาที่เพิ่มมากขึ้น การผลิตโอเลฟินส์เบาจากแหล่งทางเลือกอื่นๆ เช่น จากเอทานอลชีวภาพกำลังเป็นที่ได้รับความสนใจในขณะนี้ ในงานวิจัยนี้เป็นการศึกษาการผลิตโอเลฟินส์เบาจากเอทานอลโดยใช้ตัวเร่งปฏิกิริยาซีโอไลต์ชนิดซิลิโคอลูมิโนฟอสเฟต (เอสเอพีโอสามสิบสี่) ผ่านกระบวนการดีไฮเดรชั่น โดยศึกษาผลของอุณหภูมิ ความเร็วในการไหล และเวลาที่ทำปฏิกิริยาในช่วงของ 350 ถึง 500 องศาเซลเซียส, 0.2 ถึง 1.0 ต่อชั่วโมง และ 45 ถึง 180 นาทีตามลำดับ จากการศึกษาพบว่าทั้งอุณหภูมิ ความเร็วในการไหล และเวลาที่ทำปฏิกิริยาต่างมีอิทธิพลต่อความสามารถเชิงเร่งของตัวเร่งปฏิกิริยา เงื่อนไขที่เหมาะสำหรับการผลิตให้ได้โพรพิลีนปริมาณสูงคือที่อุณหภูมิ 400 องศาเซลเซียส และความเร็วในการไหล 0.5 ต่อชั่วโมง นอกจากนั้นอุณหภูมิและความเร็วดังกล่าวยังคงส่งผลกระทบต่อการเกิดโค้กบนตัวเร่งปฏิกิริยา ปริมาณของโค้กเพิ่มขึ้นเมื่ออุณหภูมิสูงขึ้นและความเร็วในการไหลต่ำลง นอกจากนี้ยังมีการศึกษาความเป็นไปได้เบื้องต้นของโรงงานผลิตเชิงพาณิชย์สำหรับผลิตโอเลฟินส์เบาจากเอทานอลอีกด้วย โดยโรงงานผลิตในเชิงพาณิชย์นั้นถูกออกแบบเพิ่มเติมจากเทคโนโลยีของเคมมาชัว จากการประเมินพบว่าโครงการนี้ไม่มีความเป็นไปได้ในเชิงพาณิชย์เนื่องจากราคาวัตถุดิบที่สูงและมูลค่าการลงทุนสูง นอกจากนี้การวิเคราะห์ความอ่อนไหวของตัวแปรพบว่าการผันแปรของราคาเอทานอลและราคาผลิตภัณฑ์เป็นตัวแปรสำคัญที่ส่งผลต่อความเป็นไปได้ของโครงการนี้

ACKNOWLEDGEMENTS

This work could not be accomplished without the assistances and supports from the following people and organizations.

First and foremost, I am deeply thankful to my advisor, Assoc. Prof. Sirirat Jitkarnka, for a great opportunity for me to do this work, valuable guidance, advantageous recommendations, and the heedfulness throughout this thesis work.

Secondly, I would like to thank my co-advisor, Mr. Chatapong Wungtanagorn, for beneficial recommendations. I also would like to thank Thaioil Public Company Limited for research fund, and also thank Sapthip Company Limited for bio-ethanol used in this work.

Next, I would like to extend my gratitude to the thesis committee, Assoc. Prof. Apanee Luengnaruemitchai and Dr. Vorakan Burapatana for their valuable comments and suggestions.

Unforgettably, I would like to thank all my friends and Ph.D. students for their understanding, moral support, and helpful assistance at all time.

My gratitude also extends to all of The Petroleum and Petrochemical staff members for many useful technical supports.

I am grateful for the scholarship and funding of the thesis work provided by the Petroleum and Petrochemical College, and by the Center of Excellence on Petrochemical and Materials Technology, Thailand.

Lastly, I am deeply appreciated to my family for their love, great support, and worth encouragement.

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