

**PRODUCTION OF AROMATICS FROM SYNGAS USING Fe-BASED
FISCHER-TROPSCH AND Pt/KL OR HZSM5 AROMATIZATION
CATALYSTS**



Kodagoda G.H. Kodagoda

A Thesis Submitted in Partial Fulfillment 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
2011

I 28375385

Thesis Title: Production of Aromatics from Syngas Using Fe-based Fischer-Tropsch and Pt/KL or HZSM5 Aromatization Catalysts

By: Kodagoda G.H. Kodagoda

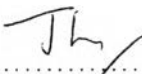
Program: Petroleum Technology

Thesis Advisors: Asst. Prof. Siriporn Jongpatiwut
Assoc. Prof. Thirasak Rirksomboon
Prof. Somchai Osuwan
Prof. Daniel E. Resasco

Accepted by the Petroleum and Petrochemicals College, Chulalongkorn University, in partial fulfillment of the requirements for the Degree of Master of Science.



..... College Dean
(Asst. Prof. Pomthong Malakul)

Thesis Committee:

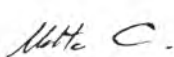

.....
(Asst. Prof. Siriporn Jongpatiwut)


.....
(Assoc. Prof. Thirasak Rirksomboon)


.....
(Prof. Somchai Osuwan)


.....
(Prof. Daniel E. Resasco)


.....
(Asst. Prof. Boonyarach Kitiyanan)


.....
(Assoc. Prof. Metta Chareonpanich)

ABSTRACT

5273026063: Petroleum Technology Program

Kodagoda G.H. Kodagoda: Production of Aromatics from Syngas
Using Fe-based Fischer-Tropsch and Pt/KL or HZSM5
Aromatization Catalysts.

Thesis Advisors: Asst. Prof. Siriporn Jongpatiwut, Assoc. Prof.
Thirasak Rirksomboon, Prof. Somchai Osuwan, and Prof. Daniel E.
Resasco 69 pp.

Keywords: Syngas/ Fischer-Tropsch synthesis/ Aromatization/ Pt/ FeCoK/
HZSM5/ KL zeolite/ Hybrid catalysts

Aromatics are significant and essentially an important fraction of feedstock for the petrochemical industry, which have been mainly produced from fossil fuels for several decades. With the emerging concept of green economies all over the world, the biological origin for aromatic production seems to have a high potential in the future, which provides sustainability to petrochemical industry. Fe-based catalysts are well known for converting syngas, which can be produced from biomass, to linear hydrocarbons via Fischer-Tropsch synthesis. Pt/KL and HZSM5 catalysts are proven for their aromatization activity. The purpose of this study is to investigate the combined effects of Fe-based Fischer-Tropsch catalysts such as Fe/KL or FeCoK with Pt/KL or HZSM5 aromatization catalysts on converting syngas to aromatics. It was observed that at a given temperature, precipitated FeCoK produced heavier products than Fe/KL. In addition, the Fe/KL catalyst physically mixed with Pt/KL zeolite catalyst showed a better aromatic selectivity than the co-impregnated catalyst with the same active metal contents but decreased its selectivity drastically due to the deactivation of Pt sites by CO. In another test conducted to study the combined effects of HZSM5 and FeCoK, it was observed that increasing HZSM5 in the hybrid catalyst shows the best performance at the HZSM5 to FeCoK ratio of 2 giving 4.7% aromatics yield.

บทคัดย่อ

โคคะ โคะเคอะ กามะเก ฮารินเคอะ โคะคะ โคะเคอะ: การผลิตสารอะโรเมติกส์จากซินแก๊ส โดยการใช้ตัวเร่งปฏิกิริยาที่มีเหล็กเป็นองค์ประกอบสำหรับปฏิกิริยาฟิสเซอร์โทรป และ ตัวเร่งปฏิกิริยาแพลทินัมบนซีโอไลต์แอล หรือ ซีโอไลต์ซีเอสเอ็มไฟว์ (Production of Aromatics from Syngas Using Fe-based Fischer-Tropsch and Pt/KL or HZSM5 Aromatization Catalysts) อ. ที่ปรึกษา: ผศ.ดร. ศิริพร จงผาดิวุฒิ รศ. ดร. ชีรศักดิ์ ฤกษ์สมบูรณ์ ศ. ดร. สมชาย โอสุวรรณ และ ศ. ดร. แดเนียล อี รีซัสโก 69 หน้า

อะโรเมติกส์เป็นสารตั้งต้นที่สำคัญในอุตสาหกรรมปิโตรเคมี ปัจจุบันสารอะโรเมติกส์ผลิตได้จากวัตถุดิบที่ได้มาจากน้ำมันปิโตรเลียม ด้วยแนวความคิดใหม่ที่เกิดขึ้นทั่วโลกเกี่ยวกับเศรษฐกิจสีเขียว การผลิตสารอะโรเมติกส์จากวัตถุดิบที่ได้จากสารชีวมวลจึงมีศักยภาพสูงและสามารถสร้างความยั่งยืนให้กับอุตสาหกรรมปิโตรเคมีในอนาคต ตัวเร่งปฏิกิริยาชนิดที่มีเหล็กเป็นองค์ประกอบเป็นตัวเร่งปฏิกิริยาที่รู้จักดีในการเปลี่ยนซินแก๊สซึ่งสามารถผลิตได้จากสารชีวมวล ให้กลายเป็นสารประกอบไฮโดรคาร์บอนโซ่ตรงโดยผ่านปฏิกิริยาฟิสเซอร์โทรป ส่วนตัวเร่งปฏิกิริยาชนิด Pt/KL และ HZSM5 มีความสามารถในการเปลี่ยนไฮโดรคาร์บอนสายตรงไปเป็นสารอะโรเมติกส์ วัตถุประสงค์ของงานวิจัยนี้คือเพื่อศึกษาการใช้ตัวเร่งปฏิกิริยาฟิสเซอร์โทรป ที่มีเหล็กเป็นองค์ประกอบ เช่น Fe/KL หรือ FeCoK กับตัวเร่งปฏิกิริยา Pt/KL หรือ HZSM5 ในการเปลี่ยนซินแก๊สไปเป็นสารประกอบอะโรเมติกส์ จากผลการทดลองพบว่าที่สภาวะการเกิดปฏิกิริยาเดียวกันตัวเร่งปฏิกิริยาชนิด FeCoK ก่อให้เกิดผลิตภัณฑ์ไฮโดรคาร์บอนสายยาวกว่า ผลิตภัณฑ์ที่ได้จากตัวเร่งปฏิกิริยาชนิด Fe/KL นอกจากนี้ตัวเร่งปฏิกิริยาชนิด Fe/KL ที่ผสมด้วยวิธีทางกายภาพกับตัวเร่งปฏิกิริยา Pt/KL ทำให้เกิดสารประกอบอะโรเมติกส์ได้มากกว่าตัวเร่งปฏิกิริยาชนิด PtFe/KL ที่เตรียมโดยวิธีการฝังแบบขึ้นร่วม (co-impregnation) แต่มีการลดลงของการเลือกเกิดไปเป็นสารอะโรเมติกส์ในระยะเวลาสั้น ๆ เนื่องจากการเสื่อมสภาพของแพลทินัมโดยคาร์บอนมอนอกไซด์ อีกหนึ่งการทดสอบที่ทำในงานวิจัยนี้คือการทดสอบการใช้ตัวเร่งปฏิกิริยาชนิด HZSM5 และ FeCoK จากผลการทดลองพบว่าเมื่อมีการเพิ่มขึ้นของปริมาณ HZSM5 ตัวเร่งปฏิกิริยาชนิดไฮบริดแสดงประสิทธิภาพดีที่สุดในอัตราส่วนของ HZSM5 ต่อ FeCoK เท่ากับ 2 ซึ่งจะให้ผลผลิตของอะโรเมติกส์ถึง 4.7%

ACKNOWLEDGEMENTS

This work is successfully completed not only due to my dedication but also with the extended support by a number of people and organizations. I am glad to appreciate all who support me to drive this work to a completion.

Specifically, Asst. Prof. Siriporn Jongpatiwut, who is my advisor for this work actually extended her support beyond the advisors scope. I am glad to gratitude to Asst. Prof. Siriporn Jongpatiwut for the guidance given on research work as well as to manage the life as an expatriate and special support offered when dealing with Thai speaking people.

Assoc. Prof. Thirasak Rirkksomboon, Prof. Somchai Osuwan, and Prof. Daniel E. Resasco who acted as my co-advisors and offered their support with their professional expertise in getting this work a successful one. I take this opportunity to give my thanks to my co-advisors for the support extended. Also, special thanks to Asst. Prof. Boonyarach Kitiyanan, Assoc. Prof. Metta Chareonpanich, and advisors for acting as the thesis committee. This work is an output of my studies for Masters Degree in Petroleum Technology. I am grateful for the scholarship and funding of the thesis work provided by the Petroleum and Petrochemical College; and by the National Center of Excellence for Petroleum, Petrochemicals, and Advanced Materials, Thailand. Further, Sri Lanka Petroleum Corporation offered funding for living expenses for the period of study. In completion of this work successfully, the financial supports offered by these organizations paid a big role and I am glad to extend my appreciation to Sri Lanka Petroleum Corporation.

Further, I present my gratitude to all faculty members, research staff and other staff of the Petroleum and Petrochemical College, for the support and guidance given for better completion of the work.

Finally, in completion of this work, support and encouragement received from my wife Ms. Tharangani Samarasooriya, family members and friends should be gratefully reminded.

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ABBREVIATIONS

ASF	-	Anderson – Schulz – Flory
BET	-	Brunauer – Emmett – Teller
BP	-	British Petroleum
BTEX	-	Benzene, toluene, ethylbenzene and xylenes
CB	-	Carbiding
CP	-	Co-precipitation
EU	-	European Union
FID	-	Flame ionization detector
FT	-	Fischer-Tropsch
GHSV	-	Gas hourly space velocity
HP	-	High pressure
ID	-	Inner diameter
IWI	-	Incipient wetness impregnation
MCP	-	Methyl cyclopentane
NLDFT	-	Non local density functional theory
P	-	Pressure
PE	-	Polyethylene
PP	-	Polypropylene
PVC	-	Polyvinylchloride
SEM	-	Scanning electron microscopy
EDX	-	Energy dispersive x-ray
SF	-	Saito – Foley
SV	-	Space velocity
TCD	-	Thermal conductivity detector
TGA	-	Thermo gravimetric analysis
TOS	-	Time on stream
TPO	-	Temperature programmed oxidation
TPR	-	Temperature programmed reduction
WGS	-	Water-gas-shift