

**ACTIVITY OF LOW-TEMPERATURE WATER-GAS SHIFT OVER
GOLD-CERIA (Au/CeO₂) CATALYSTS**

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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

2007

502011

Thesis Title: Activity of Low-Temperature Water-Gas Shift over Gold-Ceria (Au/CeO₂) Catalysts
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Accepted by the Petroleum and Petrochemical College, Chulalongkorn University, in partial fulfilment of the requirements for the Degree of Master of Science.

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ABSTRACT

4873020063: Petroleum Technology Program

Todsachid Vithayanupong: Activity of Low-Temperature Water-Gas Shift over Au/CeO₂ Catalysts

Thesis Advisors: Asst. Prof. Apanee Luengnaruemitchai, Asst. Prof. Sirirat Jitkarnka, 79 pp.

Keywords: Water-Gas Shift / Gold Catalysts / Hydrogen / Fuel Cell

In this research, the catalytic activity of Au/CeO₂ catalysts for the low-temperature water-gas shift reaction (LT-WGS) was studied on both lab-scale and bench-scale experiments. A series of Au/CeO₂ catalysts was prepared by deposition-precipitation method. The effects of space velocity, H₂ pretreatment, type of CeO₂ support, H₂O/CO ratio, and H₂ mixing in the reactant on the catalytic performance were investigated over a wide temperature range 100-350°C under atmospheric pressure. The catalytic activity of Au/CeO₂ catalysts was also compared to that of a commercial CuO/ZnO/Al₂O₃ catalyst. It was found that 2%Au/CeO₂ (high surface area) pretreated with H₂ manifested the best activity; however, its activity was much lower than the commercial catalyst. The influence of H₂ on the activity of Au/CeO₂ in the LTWGS was also studied. It was found that the presence of H₂ in the feed significantly decreased the activity of the catalyst. The stability of 2% Au/CeO₂ was also investigated. The CO conversion was decreased ~10% after 500 minutes. In addition, both the 2%Au/CeO₂ and the commercial catalysts were tested in a WGS reactor with a fuel processor, utilizing natural gas as a feed. Finally, the Au/CeO₂ catalysts were characterized by XRD, TPR, TEM, and BET.

บทคัดย่อ

ทศชิต วิทยานุกงศ์: ความว่องไวในการทำปฏิกิริยาวอเตอร์แก๊สชิฟต์ที่อุณหภูมิต่ำของตัวเร่งปฏิกิริยาทองคำบนตัวรองรับซีเรียออกไซด์ (Au/CeO₂)

(Activity of Low-Temperature Water-Gas Shift over Gold-Ceria (Au/CeO₂) Catalyst) อ. ที่ปรึกษา: ผศ. ดร. อาภาณี เหลืองนฤมิตชัย และ ผศ. ดร. ศิริรัตน์ จิตรการคำ, 79 หน้า

ในงานวิจัยนี้ศึกษาปฏิกิริยาวอเตอร์แก๊สชิฟต์ ที่อุณหภูมิต่ำ (Low Temperature water-gas shift) โดยใช้ตัวเร่งปฏิกิริยาโลหะทองคำบนตัวรองรับซีเรียออกไซด์ที่เตรียมด้วยวิธีตกตะกอนแบบ Deposition-precipitation ศึกษาในช่วงอุณหภูมิระหว่าง 100 ถึง 350 องศาเซลเซียส โดยมีตัวแปรที่ศึกษาได้แก่ ความเร็วของสารตั้งต้น, ปริมาณโลหะทองคำ, ผลของการ Pretreated ตัวเร่งปฏิกิริยาด้วยก๊าซไฮโดรเจนก่อนทำปฏิกิริยา, ชนิดของซีเรียออกไซด์, ปริมาณไอน้ำซึ่งเป็นส่วนประกอบของสารตั้งต้นในระบบ, ผลของกระทบต่อปฏิกิริยาเมื่อใส่ก๊าซไฮโดรเจนเข้าไปในสารตั้งต้น, นอกจากนี้ความว่องไวของปฏิกิริยาที่ได้จากตัวเร่งปฏิกิริยาโลหะทองคำ บนตัวรองรับซีเรียออกไซด์จะถูกเปรียบเทียบกับผลของความว่องไวของปฏิกิริยาที่ได้จากตัวเร่งปฏิกิริยาที่ใช้โลหะชนิดอื่นที่ใช้ในอุตสาหกรรม (CuO-ZnO-Al₂O₃) จากผลการศึกษาพบว่า ตัวเร่งปฏิกิริยาที่มีปริมาณโลหะทองคำร้อยละ 2 บนตัวรองรับซีเรียออกไซด์ชนิดพื้นที่ผิวมาก โดยนำไปพรีทริทด้วยไฮโดรเจนก่อนทำปฏิกิริยาให้ผลความว่องไวของปฏิกิริยาได้ดีที่สุด อย่างไรก็ตามความว่องไวของปฏิกิริยานับว่ายังต่ำกว่าเมื่อเปรียบเทียบกับตัวเร่งปฏิกิริยาที่ใช้โลหะชนิดอื่นที่ใช้ในอุตสาหกรรม ส่วนผลกระทบของต่อปฏิกิริยาเมื่อใส่ก๊าซไฮโดรเจนเข้าไปในสารตั้งต้นพบว่าความว่องไวของปฏิกิริยาลดลง ผลของกระทบต่อปฏิกิริยาเมื่อใส่ก๊าซไฮโดรเจนเข้าไปในสารตั้งต้น ในขณะที่ความทนทานของตัวเร่งปฏิกิริยาของ 2% Au/CeO₂ ได้ถูกศึกษาที่อุณหภูมิ 250 องศาเซลเซียส เป็นระยะเวลา 500 นาที จากผลการทดลองพบว่าความว่องไวของปฏิกิริยาลดลงประมาณ 10 เปอร์เซ็นต์ นอกเหนือจากการศึกษาปฏิกิริยาบนชุดทดลองขนาดเล็กในห้องวิจัยแล้ว ตัวเร่งปฏิกิริยาทั้งสองได้ถูกนำไปใช้ศึกษากับชุดทดลองต้นแบบที่ใช้ในการผลิตไฮโดรเจน โดยมีสารตั้งต้นซึ่งเป็นผลิตภัณฑ์ที่ได้จากระบบสตีมีรีฟอร์มมิ่งอีกด้วย ท้ายที่สุดตัวเร่งปฏิกิริยาทั้งหมดได้ถูกวิเคราะห์ ด้วย XRD, TPR, TEM และ BET

ACKNOWLEDGEMENTS

This work has been a very good experience. It would not have been successful without the assistance of the following individuals and organization.

This thesis work is funded by the Petroleum and Petrochemical College; and the National Excellence Center for Petroleum, Petrochemical, and Advanced Materials, Thailand.

First, I gratefully acknowledge Asst. Prof. Apanee Luengnaruemitchai, and Asst. Prof. Sirirat Jitkarnka for several enlightening suggestions, discussions, and encouragement throughout the course of my work. This thesis work would never have been completed without their consistent help.

I would also thank Assoc. Prof. Pramoch Rangsunvigit, and Assoc. Prof. Thirasak Rirkasomboon, who served as my thesis committee, for their well-intentioned suggestions and comments which are greatly acknowledged.

I would thank the Department of Alternative Energy Development and Efficiency, Minister of Energy for financial support.

I would thank Mr. Surasee Chutipanich, Thai Kaseihin Co.,Ltd. for Shiftmax 120 and 230 catalysts from Sud Chemie Co.,Ltd.

I would like to take this opportunity to thank all The Petroleum and Petrochemical College's staffs who supported me throughout my thesis work and my friends for their friendly help, cheerfulness, and good relationship.

Finally, I would like to express deep appreciation to my parents and my family for their endless support, love, and everything of my life.

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