CATALYST DEVELOPMENT FOR METHANE REFORMING WITH CO_2

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ABSTRACT

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The reforming of methane with CO_2 produces synthesis gas with high CO/H_2 ratio, which is suitable to produce higher hydrocarbons and oxygenated compounds by Fischer-Tropsch synthesis. In this study, the sol-gel technique, which has several advantages over conventional technique, was applied to prepare 5% Ni/Al_2O_3 catalyst and alumina support. The performance of 5% sol-gel catalyst on CH_4 reforming with CO_2 was compared to that of 5% impregnation catalysts supported on commercial alumina and on sol-gel alumina. It was found that all three catalysts deactivated with time on stream, because of carbon deposition on the catalysts resulting in total loss of catalytic activity. In addition, the reverse water gas shift reaction, the side reaction, uses H_2 to produce CO. Therefore, CO selectivity is higher than H_2 selectivity. Temperature programmed oxidation (TPO) on thermogravimetric analyzer (TGA) was used to determine the amount of carbon on the three prepared catalysts used for 20 hours. It was found that the carbon deposition on the catalyst can be oxidized at high temperatures in the range of 670-700 °C and % carbon on Ni/sol-gel Al_2O_3 is 17.61%, whereas that on sol-gel Ni/Al_2O_3 is 25.15% and on Ni/commercial Al_2O_3 is 17.89%.

บทคัดย่อ

กฤษฎิ์ พันธ์บูรณานนท์ : การพัฒนาตัวเร่งปฏิกริยาการรีฟอร์มก๊าซมีเทนด้วยก๊าซคาร์บอนไดออกไซด์ (Catalyst Development for Methane Reforming with CO_2) อ. ที่ปรึกษา : ศ.ดร. เออโดแกน กูลารี (Prof. Erdogan Gulari) รศ. กัญจนา บุณยเกียรติ และ ดร. ธีรศักดิ์ ฤกษ์สมบูรณ์ 51 หน้า ISBN 974-331-897-6

การรีฟอร์มก๊าซคาร์บอนไดออกไซด์ (CO_2) ด้วยก๊าซมีเทน (CH_4) เพื่อผลิตก๊าซสังเคราะห์ (synthesis gas) ที่มีสัดส่วนของก๊าซไฮโดรเจน (H_2) ต่อก๊าซคาร์บอนมอนอกไซด์ต่ำเหมาะสมกับการผลิตไฮโดรคาร์บอนโมเลกุลใหญ่โดยปฏิกิริยาฟิชเชอร์ทรอป (Fischer-Tropsch) งานวิจัยนี้ใช้ 5% Ni/Al_2O_3 เป็นตัวเร่งปฏิกิริยา เตรียมโดยวิธีโซลเจล (sol-gel technique) และวิธีอิมเพรกเนชั่น (impregnation technique) บนอลูมินาที่ใช้ใน อุตสาหกรรมและอลูมินาที่เตรียมโดยวิธีโซลเจล จากการศึกษาพบว่าตัวเร่งปฏิกริยาเสียความว่องไวเนื่องจากการเกาะตัวของคาร์บอนบนตัวเร่งปฏิกริยา นอกจากนี้ปฏิกริยารีเวอร์ส วอเตอร์ก๊าซ ชิฟท์ (reverse water gas shift reaction) มีผลให้ ค่าการเลือกของคาร์บอนมอนอกไซด์ (CO selectivity) สูงกว่าค่าการเลือกของไฮโดรเจน (H_2 selectivity) ส่วนการหาปริมาณคาร์บอนที่เกาะตัวบนตัวเร่งปฏิกิริยากระทำในเครื่องวิเคราะห์ทางความร้อนชนิดโปรแกรมอุณหภูมิได้ภายใต้บรรยากาศที่มีก๊าซออกซิเจน (temperature programmed oxidation on thermogravimetric analyzer) พบว่า คาร์บอนสามารถทำปฏิกริยากับก๊าซออกซิเจนเป็น ก๊าซคาร์บอนไดออกไซด์ (CO_2) ในช่วงอุณหภูมิ 670-700 ^{o}C และปริมาณคาร์บอนบน sol-gel Ni/Al_2O_3, Ni/commercial Al_2O_3 และ Ni/sol-gel Al_2O_3 เป็น 25.15%, 17.89% และ 17.61% ตามลำดับ

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