DEVELOPMENT OF HETEROGENEOUS CATALYST FOR BIODIESEL PRODUCTION

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ABSTRACT

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Biodiesel has been considered as an important alternative energy for diesel engines. Most of biodiesel is produced via transesterification of vegetable oils and alcohols using a homogeneous basic catalyst to accelerate reaction. KOH seems to be the promising catalyst which is used in a commercial industry; however, its properties, such as regeneration and deduction, have been unsolved problems in the present process. To overcome these drawbacks, heterogeneous catalysts have been proposed by some researchers to substitute homogeneous catalysts. In this work, the practically commercial materials which were often selected to use as a support (Al_2O_3, NaY and mordenite zeolite, and bentonite clay) that was loaded by KOH with vary loading by impregnation method finding an optimum condition which gave the highest biodiesel yield or fatty acid methyl ester content (FAME) in a batch and packed-bed reactors. A catalyst with 15 wt% KOH/NaY, 20 wt% KOH/mordenite and 20 wt% KOH/bentonite clay was found to be the optimum catalyst, which gave the highest basic properties and the best catalytic activity. The reusability of these spent catalysts was observed under consecutive runs. The minimum leaching of K on support was suggested to have high ability to reuse in the process. The result found that the amount of leached potassium of the KOH/Al_2O_3 was higher compared to that of the KOH loaded on NaY and mordenite zeolite. The packed-bed reactor exhibited higher possibility to regenerate catalyst than the batch reactor. However, the deactivation of this catalyst still occurred due to causing from glycerol molecules which blocked the basic site on the catalyst surface.

บทคัดย่อ

พิสิฐพงษ์ อินทรพงษ์ : การพัฒนาตัวเร่งปฏิกิริยาแบบวิวิธพันธ์สำหรับการผลิตน้ำมันไบโอดีเซล (Development of Heterogeneous Catalyst for Biodiesel Production)
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น้ำมันไบโอดีเซลเป็นพลังงานทดแทนที่สำคัญมากสำหรับเครื่องยนต์ประเภทดีเซล น้ำมันไบโอดีเซลที่ผลิตได้ส่วนมากเกิดผ่านปฏิกิริยาทรานส์เอสเทอริฟิเคชันของน้ำมันจากพืชและแอลกอฮอล์โดยใช้ตัวเร่งปฏิกิริยาเอกพันธุ์ประเภทเบสเป็นตัวเร่ง โพแทสเซียมไฮดรอกไซด์เป็นตัวเร่งปฏิกิริยาที่สำคัญสำหรับอุตสาหกรรมการผลิตไบโอดีเซล อย่างไรก็ตามคุณสมบัติของตัวเร่งปฏิกิริยาเอกพันธ์อย่างเช่น การนำตัวเร่งปฏิกิริยากลับมาใช้ใหม่หรือการกำจัดตัวเร่งปฏิกิริยาออกจากไบโอดีเซลยังคงก่อให้เกิดปัญหาอยู่กระบวนการปัจจุบัน เพื่อแก้ปัญหาเหล่านี้นักวิจัยบางส่วนได้เสนอการใช้ตัวเร่งปฏิกิริยาแบบวิวิธพันธ์มาทดแทนตัวเร่งปฏิกิริยาแบบเดิม งานวิจัยฉบับนี้นำโพแทสเซียมไฮดรอกไซด์ใส่ลงบนตัวรองรับ อย่างเช่น อลูมินา โซเดียมวายและมอร์ดิไนต์ ซีโอไลต์ และ เคลย์ ด้วยวิธีการแบบอิมเพรคเนชันโดยการเปลี่ยนแปลงความเข้มข้นของโพแทสเซียมไฮดรอกไซด์ เพื่อหาสภาวะที่เหมาะสมที่จะทำให้ผลผลิตเป็นไบโอดีเซลที่สูงที่สุดในเครื่องปฏิกรณ์แบบถังกวนและแบบท่อ จากผลการทดลองพบว่าปริมาณโพแทสเซียมที่เหมาะสมสำหรับการใส่บนตัวรองรับโซเดียมวาย มอร์ดิไนต์ซีโอไลต์ และ เคลย์ คือ 15 20 และ 20 เปอร์เซ็นต์โดยน้ำหนักตามลำดับ ซึ่งทำให้ตัวเร่งปฏิกิริยามีคุณสมบัติเป็นเบสที่สูงที่สุดและมีความสามารถที่ดีที่สุดสำหรับผลิตน้ำมันไบโอดีเซล นอกจากนี้ยังได้มีการทดสอบความสามารถในการนำกลับมาใช้ใหม่ของตัวเร่งปฏิกิริยาดังกล่าว โดยสรุปได้ว่าปริมาณของโพแทสเซียมที่หลุดออกจากตัวรองรับที่น้อยที่สุด ส่งผลให้ตัวเร่งปฏิกิริยามีความสามารถในการนำกลับมาใช้ใหม่ได้ จากผลการทดลองที่ได้พบว่า โพแทสเซียมบนตัวรองรับอลูมินามีปริมาณของโพแทสเซียมที่หลุดออกจากตัวรองรับมากกว่าบนตัวรองรับ โซเดียมวาย มอร์ดิไนต์ซีโอไลต์ และเคลย์ ซึ่งส่งผลให้ประสิทธิภาพในการนำกลับมาใช้ในกระบวนการผลิตไบโอดีเซลลดลง นอกจากนี้กระบวนการผลิตไบโอดีเซลในเครื่องปฏิกรณ์แบบท่อยังสามารถช่วยส่งเสริมความสามารถในการนำกลับมาใช้ของตัวเร่งปฏิกิริยามากกว่าการผลิตไบโอดีเซลในเครื่องปฏิกรณ์แบบถัง แต่อย่างไรก็ตามการเสื่อมสภาพของตัวเร่งปฏิกิริยามีสาเหตุมาจากกลีเซอรอล ซึ่งสารตังกล่าวเกิดขึ้นในกระบวนการผลิตและขัดขวางการเร่งปฏิกิริยาเพราะกลีเซอรอลจะเกาะอยู่ที่พื้นผิวของตัวเร่งปฏิกิริยานั่นเอง

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