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CATALYTIC CRACKING OF POLYPROPYLENE WASTE USING Al-SBA-15

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A Thesis Submitted in Partial Fulfillment of the Requirements
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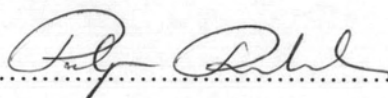
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อริสรา ชัยภูมิมาศ : การแตกย่อยเชิงเร่งปฏิกิริยาของขยะพอลิโพรพิลีนด้วยอะลูมิเนียม-เอสบีเอ-15 (CATALYTIC CRACKING OF POLYPROPYLENE WASTE USING Al-SBA-15) อ.ที่ปรึกษา: ดร. ดวงกมล นันทศรี, อ.ที่ปรึกษาร่วม: ดร.อริษา ฉายสุวรรณ, 116 หน้า

ได้สังเคราะห์เอสบีเอ-15 ซึ่งเป็นซิลิกาที่มีรูพรุนขนาดกลางด้วยวิธีไฮโดรเทอร์มัลในตัวกลางที่เป็นกรดสูง (พีเอชน้อยกว่า 1) และการใช้โพรบล็อคโคพอลิเมอร์ชนิดพอลิเอทิลีนออกไซด์₂₀-พอลิโพรพิลีนออกไซด์₇₀-พอลิเอทิลีนออกไซด์₂₀ หรือ PEO₂₀PPO₇₀PEO₂₀ เป็นสารชี้นำโครงสร้าง องค์ประกอบของเจลคือ 1.00 TEOS : 1.65 × 10⁻² PEO₂₀PPO₇₀PEO₂₀ : 6.95 HCl : 140 H₂O ได้สังเคราะห์ตัวเร่งปฏิกิริยาอะลูมิเนียม-เอสบีเอ-15 ที่มีค่าอัตราส่วนโดยโมลของซิลิกอนต่ออะลูมิเนียมต่างๆ โดยการทำปฏิกิริยาเอสบีเอ-15 กับสารละลายโซเดียมอะลูมิเนตเป็นเวลา 12 ชั่วโมง ได้สำรวจหาภาวะที่เหมาะสมในการแลกเปลี่ยนไอออนโซเดียมของอะลูมิเนียม-เอสบีเอ-15 ด้วยโปรตอน สามารถปรับสภาพอะลูมิเนียม-เอสบีเอ-15 ได้ด้วยสารละลายแอมโมเนียมคลอไรด์ที่มีความเข้มข้น 0.01 โมลาร์ หรือ กรดไนตริกที่มีความเข้มข้น 0.01 โมลาร์ ที่อุณหภูมิซึ่งเป็นจุดเดือดภายใต้รัฟลักซ์เป็นเวลา 24 ชั่วโมง ได้ตรวจสอบลักษณะเฉพาะของตัวเร่งปฏิกิริยาที่สังเคราะห์ได้ด้วยเทคนิคการเลี้ยวเบนของรังสีเอ็กซ์ การคายรังสีจากอะตอมโดยใช้พลาสมาเหนี่ยวนำ อะลูมิเนียมนิวเคลียร์แมกเนติกเรโซแนนซ์สำหรับสถานะของแข็ง การดูดซับไนโตรเจน และกล้องจุลทรรศน์อิเล็กตรอนแบบส่องกราด ได้ทดสอบความว่องไวของตัวเร่งปฏิกิริยาอะลูมิเนียม-เอสบีเอ-15 ที่ยังไม่ปรับสภาพและที่ปรับสภาพแล้วในการแตกย่อยของขยะชนิดพอลิโพรพิลีนที่ความดันบรรยากาศ ภาวะที่เหมาะสมสำหรับการแตกย่อยของพอลิโพรพิลีนคืออุณหภูมิ 380 องศาเซลเซียส 10% โดยน้ำหนักของตัวเร่งปฏิกิริยา ตัวเร่งปฏิกิริยาไฮโดรเจน-อะลูมิเนียม-เอสบีเอ-15 ที่มีอัตราส่วนโดยโมลของซิลิกอนต่ออะลูมิเนียมในช่วง 10-100 ทั้งหมดมีค่าการเปลี่ยนพอลิโพรพิลีนมากกว่าร้อยละ 96 ปริมาณผลิตภัณฑ์ส่วนที่เป็นของเหลวมีปริมาณในช่วงร้อยละ 67-73 ซึ่งมีช่วงจุดเดือดช่วงเดียวกับของแก๊สโซลีนมาตรฐาน ตัวเร่งปฏิกิริยาอะลูมิเนียม-เอสบีเอ-15 ที่ใช้แล้วสามารถนำกลับมาปรับสภาพเหมือนใหม่ได้ด้วยการเผาที่อุณหภูมิ 550 องศาเซลเซียส เป็นเวลา 5 ชั่วโมง และตัวเร่งปฏิกิริยาที่ปรับสภาพเหมือนใหม่แล้วมีความว่องไวคล้ายกัน และให้ผลิตภัณฑ์ที่มีองค์ประกอบใกล้เคียงกับที่ได้จากตัวเร่งปฏิกิริยาที่ยังไม่ได้ใช้งาน

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ARISARA CHAIPURIMAT: CATALYTIC CRACKING OF POLYPROPYLENE WASTE USING Al-SBA-15. THESIS ADVISOR: DUANGAMOL NUNTASRI, Ph.D. THESIS CO-ADVISOR: ATICHA CHAISUWAN, Ph.D., 116 pp.

Mesoporous silica SBA-15 was synthesized by hydrothermal method in strongly acidic medium ($\text{pH} < 1$) and using the tri-block copolymer, poly(ethylene oxide)₂₀ – poly(propylene oxide)₇₀ – poly(ethylene oxide)₂₀ or (PEO₂₀PPO₇₀PEO₂₀) as a structure directing agent. The gel composition was 1.00 TEOS : 1.65×10^{-2} PEO₂₀PPO₇₀PEO₂₀ : 6.95 HCl : 140 H₂O. The Al-SBA-15 catalysts with various Si/Al molar ratios were synthesized by reacting SBA-15 with a solution of sodium aluminate for 12 h. The optimum ion exchange condition of Na⁺ of Al-SBA-15 by H⁺ was investigated. H-Al-SBA-15 could be obtained by treatment with 0.01 M NH₄Cl or 0.01 M HNO₃ under reflux at boiling temperature for 24 h. The synthesized catalysts were characterized using X-ray diffraction, inductively coupled plasma-atomic emission, solid state ²⁷Al-NMR, nitrogen adsorption and scanning electron microscopic techniques. The untreated and treated H-Al-SBA-15 catalysts were tested for their catalytic activities in the cracking of polypropylene at atmospheric pressure. The optimum polypropylene cracking condition is at the reaction temperature of 380°C, 10 wt% of catalyst and under N₂ flow of 20 cm³/min. All of H-Al-SBA-15 catalysts with Si/Al molar ratios varied in the range of 10-100, exhibit the polypropylene conversion over 96%. The product obtained is mainly in liquid fraction at the yield in the range of 67-73% with the same boiling point range compared to that of standard gasoline. The spent H-Al-SBA-15 catalyst can be regenerated by calcination at 550°C for 5 h, and the regenerated catalyst exhibits similar activity and gives the product composition close to that for the fresh one.

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LIST OF ABBREVIATIONS

BET	Brunauer- Emmett-Teller
FSM-16	Folded Sheets Mesoporous Material-16
GC	Gas Chromatography
HMS	Hexagonal Mesoporous Silica
MCM-41	Mobil's Composite of Matters-41
NMR	Nuclear Magnetic Resonance
PEO ₂₀ -PPO ₇₀ -PEO ₂₀	Poly(ethylene oxide) ₂₀ -poly(propylene oxide) ₇₀ - poly(ethylene oxide) ₂₀
PP	Polypropylene
SEM	Scanning Electron Microscope
SBA-15	Santa Barbara Amorphous-15
TEOS	Tetraethyl orthosilicate
TPD	Temperature-Programmed Desorption
XRD	X-ray diffraction