MESOPOROUS MCM-41, MCM-48, SBA-15, AND PYROLYSIS CHAR AS CATALYSTS FOR CATALYTIC PYROLYSIS OF WASTE TIRE

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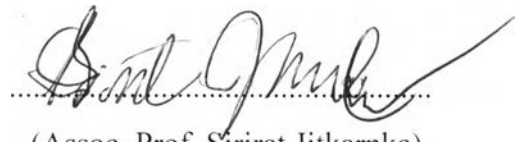

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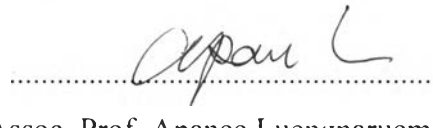

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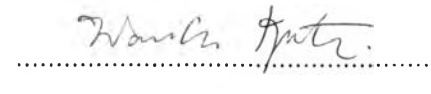

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ABSTRACT

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Due to the fact that aromatic compounds and hetero-atoms such as nitrogen are present, tire-derived oil (TDO) is not suitable for direct uses in a vehicle engine. Additionally, char remaining from pyrolysis is highly obtained, but it has only a few applications. Therefore, the objectives were to (1) design catalysts for removal of heavy compounds in TDO, (2) study the effect of pore size and pore structure of selected catalysts, (3) upgrade pyrolysis char for using as catalyst, and (4) identify N-containing compounds for better understanding in further treatment. The result indicated that aromatic compounds (size 8-16 Å by average) were mainly in gas oil and vacuum gas oil fractions. The selected catalysts, like mesoporous materials, were thus suggested to handle these compounds. Subsequently, mesoporous Al-MCM-41 (33.1 Å) and Al-SBA-15 (60.5 Å) were used to study the effect of pore size whereas mesoporous Si-MCM-41 (hexagonal structure) and Si-MCM-48 (cubic structure) were used to study the effect of pore structure. As a result, the pore size of 33.1 Å and cubic structure gave better removal of heavy compounds, petrochemical productivity, and sulfur removal. Furthermore, pyrolysis chars with and without treatment well performed on improving lighter fractions from conversion of heavy portions. Moreover, identification of nitrogenous compounds in TDO was successfully accomplished using an effective GCxGC/TOF-MS. The detected species were classified into 10 groups. Interestingly, diazabicycloheptenes is a new group, firstly detected in TDO, owing to the high performances of GCxGC/TOF-MS on separation and detection of highly-complex mixtures.

บทคัดย่อ

สุพัตรา เส้งเอียด : การใช้วัสดุที่มีรูพรุนขนาดกลางเอ็มซีเอ็ม-41, เอ็มซีเอ็ม-48, เอสบีเอ-15, และไพโรไลซิสชาร์เป็นตัวเร่งปฏิกิริยาสำหรับกระบวนการไพโรไลซิสยางหมดสภาพ (Mesoporous MCM-41, MCM-48, SBA-15, and Pyrolysis Char as Catalysts for Catalytic Pyrolysis of Waste Tire) อ. ที่ปรึกษา : รศ. ดร. ศิริรัตน์ จิตการค้า 204 หน้า

ด้วยเหตุผลที่ว่าการมีสารประกอบแอโรแมติกส์และวิวิธพันธ์อะตอม เช่น ไนโตรเจน เป็นองค์ประกอบในน้ำมัน ดังนั้นน้ำมันที่ได้จากกระบวนการไพโรไลซิสจึงยังไม่เหมาะต่อการนำไปใช้โดยตรงกับยานยนต์ ยิ่งไปกว่านั้นกระบวนการไพโรไลซิสยังสามารถผลิตชาร์ได้ในปริมาณมากแต่มีการนำไปประยุกต์ใช้น้อย ดังนั้นจุดประสงค์ของงานนี้คือเพื่อที่จะ (1) ออกแบบตัวเร่งปฏิกิริยาสำหรับการกำจัดสารไฮโดรคาร์บอนหนัก, (2) เพื่อที่จะศึกษาอิทธิพลของขนาดรูพรุนและโครงสร้างของตัวเร่งปฏิกิริยาที่ถูกเลือกมาใช้, (3) เพื่อที่จะเพิ่มคุณสมบัติของไพโรไลซิสชาร์สำหรับใช้เป็นตัวเร่งปฏิกิริยา และ (4) เพื่อที่จะระบุรูปพรรณสารประกอบไนโตรเจนเพื่อสร้างความเข้าใจที่มากขึ้นในการปรับปรุงคุณภาพต่อไป จากผลการทดลองแสดงให้เห็นว่าสารประกอบแอโรแมติกส์ (ขนาด 8-16 อังสตรอม โดยเฉลี่ย) เป็นองค์ประกอบหลักในน้ำมันเตาและน้ำมันเตาสุญญากาศ ดังนั้นตัวเร่งปฏิกิริยา เช่น วัสดุที่มีรูพรุนขนาดกลางจึงถูกแนะนำเพื่อใช้จัดการกับสารประกอบเหล่านี้ หลังจากนั้นวัสดุที่มีรูพรุนขนาดกลางอลูมินาเอ็มซีเอ็ม-41 (รูพรุน 33.1 อังสตรอม) และอลูมินาเอสบีเอ-15 (รูพรุน 60.5 อังสตรอม) จึงถูกนำมาศึกษาอิทธิพลของขนาดรูพรุน ในขณะที่ซิลิกาเอ็มซีเอ็ม-41 (โครงสร้างแบบหกเหลี่ยม) และ ซิลิกาเอ็มซีเอ็ม-48 (โครงสร้างแบบลูกบาศก์) ถูกนำมาศึกษาอิทธิพลของโครงสร้าง ผลลัพธ์ที่ได้พบว่า รูพรุนขนาด 33.1 อังสตรอม และ โครงสร้างแบบลูกบาศก์ สามารถใช้กำจัดสารไฮโดรคาร์บอนหนัก เพิ่มผลผลิตปิโตรเคมีและกำจัดซัลเฟอร์ได้ดีกว่า นอกจากนี้ไพโรไลซิสชาร์ทั้งที่บำบัดและไม่บำบัดยังมีประสิทธิภาพในการปรับปรุงสารประกอบเบาจากการเปลี่ยนแปลงของสารประกอบหลักได้เป็นอย่างดี นอกจากนี้ยังประสบความสำเร็จในการระบุรูปพรรณของสารประกอบไนโตรเจนที่มีอยู่ในน้ำมันโดยใช้ GCxGC/TOF-MS โดยสารประกอบที่ถูกตรวจจับได้ถูกแบ่งออกเป็น ๑๐ กลุ่ม สิ่งที่น่าสนใจก็คือ ไดอะซาไบไซโคลเฮปทีนส์ เป็นไนโตรเจนกลุ่มใหม่ที่สามารถตรวจวัดได้ครั้งแรกในน้ำมันที่ได้จากกระบวนการไพโรไลซิส อันเนื่องมาจากความมีประสิทธิภาพสูงของ GCxGC/TOF-MS ในการแยกและตรวจวัดสารที่มีองค์ประกอบซับซ้อนมากๆ ได้

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