ADSORPTIVE REMOVAL OF SULFUR COMPOUNDS FROM DIESEL USING ACTIVATED CARBON AND ALUMINA MODIFIED WITH Cu (I) AND Ni (II)

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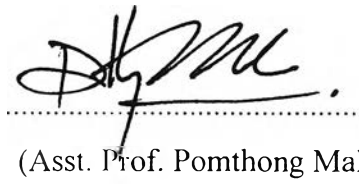

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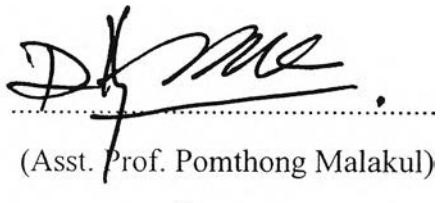

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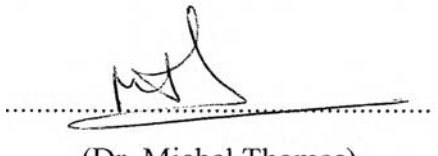

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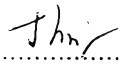

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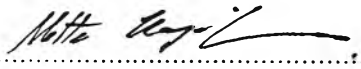

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ABSTRACT

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This research studied the adsorptive capacity and selectivity of dibenzothiophene (DBT) and 4,6-dimethyldibenzothiophene (4,6-DMDBT) in simulated diesel fuels containing polyaromatic or nitrogen compounds on activated carbon and alumina, modified with Cu^{+} and Ni^{2+} using different preparation methods. Direct impregnation by using $CuCl/CH_3CN$ was found to be unsuitable due to the stability and low solubility of Cu^{+}. Impregnation was therefore performed with an aqueous solution of $CuCl_2$ following by a reduction step of $CuCl_2$ into CuCl using H_2. For Ni^{2+}, an aqueous solution of $NiCl_2$ was used. A suitable feed flow rate and granulometry of the adsorbent was found to be 0.4 cm^3/min and 100 to 400 μm, while the optimum temperature was 60°C and 90°C for Ni^{2+} and Cu^{+} impregnated alumina, respectively. The adsorption capacity at the sulfur breakthrough followed the order non-impregnated macroporous alumina < Cu^{+}/macroporous alumina < non-impregnated mesoporous alumina < Cu^{+}/mesoporous alumina < Ni^{2+}/macroporous alumina < Ni^{2+}/mesoporous alumina < Cu^{+}/AC < non-impregnated AC. The breakthrough capacity of DBT was higher than 4,6-DMDBT for both of Ni^{2+} and Cu^{+}/mesoporous alumina. Moreover, the breakthrough capacity of DBT without polyaromatic and nitrogen compounds was higher than that with polyaromatic and nitrogen compounds.

บทคัดย่อ

ศิรภา ประทีปอมรกุล: การกำจัดสารประกอบกำมะถันจากน้ำมันดีเซลโดยใช้ถ่านกัมมันต์และอะลูมินาดัดแปลงโดยคอปเปอร์และนิกเกิลเป็นตัวดูดซับ (Adsorptive Removal of Sulfur Compounds from Diesel Using Activated Carbon and Alumina Modified with Cu(I) and Ni(II)) อ. ที่ปรึกษา : ผศ. ดร. ปมทอง มาลากุล ณ อยุธยา, ดร. โทมัส มิเชล 98 หน้า

ในงานวิจัยนี้ศึกษาประสิทธิภาพของการดูดซับและความเฉพาะเจาะจงในการดูดซับไดเบนโซไทโอฟีนและ 4,6-ไดเมททิลไดเบนโซไทโอฟีนในแบบจำลองน้ำมันดีเซลที่มีสารประกอบพอลิอะโรมาติกหรือสารประกอบไนโตรเจนปน ด้วยตัวดูดซับประเภทถ่านกัมมันต์ (Activated carbon, AC) และอะลูมินา (Alumina) ที่อิมเพรกเนชั่นด้วย Cu^{+} และ Ni^{2+} โดยใช้วิธีการเตรียมหลายวิธี จากการทดลองพบว่าการอิมเพรกเนชั่นโดยตรงโดยใช้ $CuCl/CH_3CN$ นั้นไม่เหมาะสม เนื่องจากความไม่เสถียรและความสามารถในการละลายที่ต่ำของ Cu^{+} ดังนั้นจึงใช้วิธิอิมเพรกเนชั่นที่ใช้สารละลายของ $CuCl_2$ และตามด้วยการรีดิวซ์ของ $CuCl_2$ เป็น CuCl โดยใช้ก๊าซไฮโดรเจน หรือใช้สารละลาย $NiCl_2$ สำหรับ Ni^{2+} นอกจากนี้ พบว่าความเร็วที่เหมาะสมของแบบจำลองน้ำมันดีเซลคือ 0.4 ลูกบาศก์เซนติเมตรต่อนาที โดยมีเส้นผ่านศูนย์กลางของตัวดูดซับที่เหมาะสมคือ 100-400 ไมโครเมตร และอุณหภูมิที่เหมาะสมสำหรับการดูดซับของ Ni^{2+} เท่ากับ 60 องศาเซลเซียส และสำหรับ Cu^{+} เท่ากับ 90 องศาเซลเซียส จากผลการศึกษาพบว่าความสามารถในการดูดซับของไดเบนโซไทโอฟีนเพิ่มขึ้นตามลำดับดังนี้ Macroporous alumina < Cu^{+}/Macroporous alumina < Mesoporous alumina < Cu^{+}/Mesoporous alumina< Ni^{2+}/Macroporous alumina < Ni^{2+}/Mesoporous alumina < Cu^{+}/AC < AC และพบว่า ตัวดูดซับที่อิมเพรกเนชันด้วย Ni^{2+} และ Cu^{+} นั้น มีประสิทธิภาพในการดูดซับไดเบนโซไทโอฟีนได้มากกว่า 4,6-ไดเมททิลไดเบนโซไทโอฟีน นอกจากนี้ ยังพบว่าประสิทธิภาพในการดูดซับไดเบนโซไทโอฟีนในระบบที่ไม่มีสารประกอบพอลิอะโรมาติกหรือไนโตรเจนนั้นสูงกว่าในระบบที่มีสารประกอบพอลิอะโรมาติกหรือไนโตรเจน

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