COMPETITIVE ADSORPTION OF METHANE OVER CARBON DIOXIDE ON MODIFIED ACTIVATED CARBON

Pantipa Pranudomrat

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By:	Pantipa Pranudomrat
Program:	Petrochemical Technology
Thesis Advisors:	Assoc. Prof. Pramoch Rangsunvigit
	Dr. Santi Kulprathipanja
	Asst. Prof. Boonyarach Kitiyanan

Accepted by The Petroleum and Petrochemical College, Chulalongkorn University, in partial fulfillment of the requirements for the Degree of Master of Science.

..... College Dean

(Asst. Prof. Pomthong Malakul)

Thesis Committee:

.....

(Assoc. Prof. Pramoch Rangsunvigit)

.....

(Dr. Santi Kulprathipanja)

.....

(Asst. Prof. Boonyarach Kitiyanan)

.....

(Assoc. Prof. Thirasak Rirksomboon)

.....

(Assoc. Prof. Vissanu Meeyoo)

580021

ABSTRACT

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The use of natural gas as a fuel has become an attractive alternative to gasoline and diesel fuels because of its inherent clean burning characteristics. Adsorbed natural gas (ANG), in which natural gas is adsorbed by a porous adsorbent material at a relatively lower pressure with similar methane capacity than commercially compressed natural gas (CNG), has gained much attention. Carbon-based adsorbents, like activated carbon, could provide high adsorption capacity and delivery due to its high specific surface area and high volumetric storage capacity. In this work, the adsorption capacity of methane was investigated by using coconut shell activated carbon (CSAC) as an adsorbent having high surface area (952 m^2/g) and total pore volume (0.52 cm^3/g) in a packed bed reactor at atmospheric pressure and room temperature. Equivolume mixture of methane and carbon dioxide was used. Gas adsorption was determined by GC. The adsorbent was treated by strong and weak alkali solutions to clean pores and modified with methyltriethoxysilane (MTES), which is a hydrophobic promoter. Results showed that carbon dioxide significantly affected the adsorption of methane. The breakthrough time of carbon dioxide was longer than that of methane because carbon dioxide was more selectively adsorbed on all adsorbents than that of methane. The amount of carbon dioxide adsorption decreased with the increase in the MTES amount due to the hydrophobic extent on the surface. The Langmuir isotherm was used to fit the experimental data. The relative error of predicted data was less than 20%.

บทคัดย่อ

พันธิภา ปราณอุดมรัตน์: การแข่งขันการดูดซับก๊าซมีเทนและก๊าซคาร์บอนไดออกไซด์บนถ่านกัมมันต์ที่ผ่านการปรับแต่ง (Competitive Adsorption of Methane over Carbon Dioxide on Modified Activated Carbon) อ. ที่ปรึกษา: รศ. ดร. ปราโมช รังสรรค์วิจิตร ดร. สันติ กุลประทีปัญญา และ ผศ. ดร. บุนยรัชต์ กิติยานันท์ 84 หน้า

การใช้ก๊าซธรรมชาติเป็นเชื้อเพลิงได้กลายเป็นทางเลือกที่น่าสนใจนอกเหนือจากการใช้น้ำมันเบนซินและน้ำมันดีเซล เนื่องจากมีการเผาไหม้ที่สะอาด Adsorbed Natural Gas (ANG) เป็นหนึ่งในวิธีการกักเก็บก๊าซโดยการดูดซับบนวัสดุที่มีรูพรุน โดยใช้ความดันที่ต่ำกว่าการกักเก็บก๊าซธรรมชาติโดยวิธี Compressed Natural Gas (CNG) ในการเก็บปริมาณของก๊าซมีเทนในปริมาณที่เท่ากัน ถ่านกัมมันต์เป็นหนึ่งในวัสดุที่มีรูพรุน ซึ่งมีความสามารถดูดซับสูงเนื่องจากมีพื้นที่ผิวที่เฉพาะเจาะจงและมีปริมาตรการกักเก็บสูง ในงานวิจัยนี้ศึกษาความสามารถของการดูดซับก๊าซมีเทนโดยใช้ถ่านกัมมันต์จากกะลามะพร้าวซึ่งมีพื้นที่ผิวจำเพาะ 952 ตารางเมตรต่อกรัม และปริมาตรรูพรุน 0.52 ลูกบาศก์เซนติเมตรต่อกรัม ในคอลัมน์แบบ Packed-bed ที่อุณหภูมิ 25 องศาเซลเซียส และความดัน 1 บรรยากาศ การศึกษาใช้ก๊าซมีเทนและก๊าซคาร์บอนไดออกไซด์ผสมในปริมาตรที่เท่ากัน ปริมาณของก๊าซที่ถูกดูดซับบนตัวดูดซับถูกวัดโดยใช้ GC นอกจากนี้ ในการทดลองได้นำตัวดูดซับมาผ่านการทำความสะอาดพื้นผิวโดยใช้สารละลายด่างอ่อนและด่างแก่ก่อนทำการปรับแต่งด้วยเมทิลไตรเอท็อกซีไซเลน (MTES) ซึ่งจะช่วยเพิ่มลักษณะความไม่ชอบน้ำของตัวดูดซับ ผลการทดลองแสดงให้เห็นว่าก๊าซคาร์บอนไดออกไซด์ส่งผลกระทบอย่างมีนัยสำคัญต่อการดูดซับของก๊าซมีเทน ก๊าซคาร์บอนไดออกไซด์ใช้เวลาหลุดออกจากตัวดูดซับนานกว่าก๊าซมีเทน เนื่องจากตัวดูดซับทุกตัวเลือกดูดซับก๊าซคาร์บอนไดออกไซด์มากกว่าดูดซับก๊าซมีเทน ปริมาณของก๊าซคาร์บอนไดออกไซด์ที่ถูกดูดซับลดลง เมื่อใช้ตัวดูดซับที่ผ่านการปรับแต่งด้วย MTES เนื่องจากลักษณะความไม่ชอบน้ำบนพื้นผิวของตัวดูดซับ นอกจากนี้ยังได้มีการสร้างไอโซเทอมของ Langmuir เพื่อใช้คาดการณ์ผลการทดลองการดูดซับของก๊าซมีเทนและก๊าซคาร์บอนไดออกไซด์บนถ่านกัมมันต์ จากไอโซเทอมที่คาดการณ์ได้ มีความคลาดเคลื่อนจากผลการทดลองประมาณ 20%

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