

**MODIFICATION OF CARBON SURFACE BY OXIDATION AND
AMMONIA TREATMENT FOR CO₂ ADSORPTION**

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ABSTRACT

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Solid adsorption process is now considered as a potential technique to adsorb CO₂ from the flue gas emitted via large industrial plants. Activated carbon was commonly studied as an adsorbent for CO₂ capture since it provides potential properties such as high surface area, large pore volume, and low cost. The ability to adsorb CO₂ onto the carbon sorbent depends on two main properties; that are, pore structure and surface chemistry. In this work, commercial coconut-based activated carbon (AC), benzene-derived carbon nano spheres (CB), and pyridine-derived carbon nano spheres (CP) were applied as the CO₂ adsorbents. The CB and CP carbons were carbonized and then activated with CO₂ to obtain activated CB (ACB) and activated CP (ACP), respectively. To modify the surface chemistry, activated carbons (AC, ACB and ACP) were treated by various surface treatment approaches including HNO₃ oxidation, amination without HNO₃ pre-oxidation, and amination with HNO₃ pre-oxidation. The amount of CO₂ uptake achieved by the modified carbons was more than the amount obtained by the raw activated carbons. The treatment caused change in the surface chemistry of activated carbon, while there was no significant change in porous property. These results indicated that surface functional groups were successfully incorporated onto the carbon surface and helped increase the CO₂ adsorption capacity. The amination with pre-oxidized method gave the highest CO₂ capacity of 1.76, 1.39, and 1.28 mmol/g (at 1 atm and 40 °C) for AC, ACB, and ACP, respectively.

บทคัดย่อ

นันทิยา ทองวิจิตร: การปรับเปลี่ยนพื้นผิวของคาร์บอนโดยการออกซิเดชันและการเติมหมู่เอมีนสำหรับการดูดซับก๊าซคาร์บอนไดออกไซด์ (Modification of Carbon Surface by Oxidation and Amination for CO₂ Adsorption) อ. ที่ปรึกษา: ดร. อุทัยพร สุริยประภาดิลก 126 หน้า

กระบวนการดูดซับด้วยของแข็งในปัจจุบันนี้ถือว่าเป็นเทคนิคที่มีศักยภาพที่ใช้ในการดูดซับก๊าซคาร์บอนไดออกไซด์จากก๊าซไอเสียที่ปล่อยออกมาจากโรงงานอุตสาหกรรมขนาดใหญ่ ถ่านกัมมันต์เป็นหนึ่งในวัสดุที่ถูกนำมาศึกษากันอย่างแพร่หลายสำหรับใช้ในการเป็นตัวดูดซับก๊าซคาร์บอนไดออกไซด์ เนื่องจากมีคุณสมบัติที่มีศักยภาพ เช่น มีพื้นที่ผิวสูง มีปริมาตรรูพรุนสูง และราคาถูก ความสามารถในการดูดซับก๊าซคาร์บอนไดออกไซด์ลงบนคาร์บอนขึ้นอยู่กับ 2 ปัจจัยหลัก ได้แก่ ลักษณะทางกายภาพและทางเคมีของพื้นผิว ในงานวิจัยนี้ถ่านกัมมันต์เชิงพาณิชย์ที่ได้จากกะลามะพร้าว คาร์บอนทรงกลมขนาดนาโนที่เตรียมจากเบนซีน และคาร์บอนทรงกลมขนาดนาโนที่เตรียมจากพีดรีน ถูกนำมาประยุกต์ใช้สำหรับเป็นตัวดูดซับก๊าซคาร์บอนไดออกไซด์ ถ่านกัมมันต์ของคาร์บอนทรงกลมขนาดนาโนถูกเตรียมโดยกระบวนการเผาถ่านและการเพิ่มอำนาจการดูดซับโดยใช้ก๊าซคาร์บอนไดออกไซด์ ถ่านกัมมันต์ได้ถูกนำมาปรับเปลี่ยนลักษณะทางเคมีของพื้นผิวโดยวิธีการที่แตกต่างกัน ได้แก่ การออกซิเดชันด้วยกรดไนตริก การเติมหมู่เอมีน และการออกซิเดชันด้วยกรดไนตริกก่อนการเติมหมู่เอมีน จากผลการทดลองพบว่าคาร์บอนที่ได้รับการปรับเปลี่ยนทางพื้นผิวสามารถที่จะดูดซับก๊าซคาร์บอนไดออกไซด์ได้ในปริมาณที่มากกว่าตัวที่ไม่ผ่านการปรับเปลี่ยน วิธีการที่ใช้ในการปรับเปลี่ยนต่างๆ ทำให้เกิดการเปลี่ยนแปลงในทางเคมีของพื้นผิวของถ่านกัมมันต์ ในขณะที่ลักษณะทางกายภาพของพื้นผิวไม่มีการเปลี่ยนแปลงที่เห็นได้อย่างชัดเจน ผลการศึกษานี้ชี้ให้เห็นว่าหมู่ฟังก์ชันได้ถูกเติมลงไปบนพื้นผิวของคาร์บอนและช่วยในการเพิ่มความสามารถในการดูดซับก๊าซคาร์บอนไดออกไซด์ การปรับปรุงโดยวิธีการออกซิเดชันด้วยกรดไนตริกก่อนการเติมหมู่เอมีนให้ค่าการดูดซับก๊าซคาร์บอนไดออกไซด์สูงสุดได้แก่ 1.76 มิลลิโมลต่อกรัม สำหรับถ่านกัมมันต์ที่ได้จากกะลามะพร้าว 1.39 มิลลิโมลต่อกรัม สำหรับถ่านกัมมันต์ที่เตรียมจากเบนซีน และ 1.28 มิลลิโมลต่อกรัม สำหรับถ่านกัมมันต์ที่เตรียมจากพีดรีน (ตัวอย่างทั้งหมดวัดที่อุณหภูมิ 40 องศาเซลเซียส และความดัน 1 บรรยากาศ)

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