

**การผลิตถ่านกัมมันต์จากยางรถยนต์ใช้แล้วโดยการกระตุ้นด้วยไอน้ำร้อนขวดขิง  
และคาร์บอนไดออกไซด์ในเครื่องปฏิกรณ์แบบเบดนิ่ง**

**นางสาวธนพร ล้อทอง**



**สถาบันวิทยบริการ**

**จุฬาลงกรณ์มหาวิทยาลัย**

**วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต**

**สาขาวิชาปิโตรเคมีและวิทยาศาสตร์พอลิเมอร์**

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**PRODUCTION OF ACTIVATED CARBON FROM USED TIRES BY  
SUPERHEATED STEAM AND CARBON DIOXIDE ACTIVATION  
IN A FIXED BED REACTOR**

**Miss Thanapon Lortong**

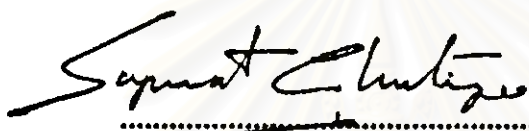
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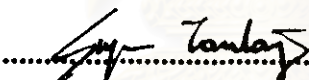
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DIOXIDE ACTIVATION IN A FIXED BED REACTOR  
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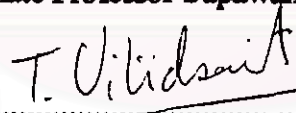
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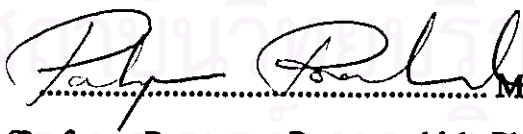
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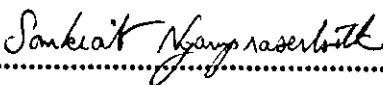
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งานวิจัยนี้เป็นการศึกษาการผลิตถ่านกัมมันต์จากยางรถยนต์ใช้แล้ว โดยกระบวนการผลิตที่ประกอบด้วย  
ด้วยการคาร์บอนไนซ์ แล้วกระตุ้นด้วยไอน้ำร้อนขวดยั้งและคาร์บอนไดออกไซด์ในเครื่องปฏิกรณ์แบบเบดนิ่งเส้น  
ผ่านศูนย์กลาง 100 มิลลิเมตร คาร์บอนไนซ์ยางรถยนต์ใช้แล้วที่อุณหภูมิ 350°C เป็นเวลา 60 นาที ด้วยอัตราการ  
ไหลของอากาศ 0.52 n/min ถ่านชาร์ที่ได้มีร้อยละผลิตภัณฑ์ 41.40 %, ปริมาณคาร์บอนคงตัว 62.67 %, ปริมาณ  
เถ้า 15.30 % และปริมาณสารระเหย 22.13 % จากนั้นนำถ่านชาร์ที่ได้ไปกระตุ้นด้วยไอน้ำร้อนขวดยั้งและ  
คาร์บอนไดออกไซด์ ภาวะที่เหมาะสมในการกระตุ้น คือ ถ่านชาร์ขนาด 0.60-1.18 มิลลิเมตร ที่อุณหภูมิ 900°C เป็น  
เวลา 45 นาที ใช้อัตราการไหลของอากาศ 0.27 n/min, อัตราการไหลของคาร์บอนไดออกไซด์ 2.0 n/min และไอน้ำ  
ร้อนขวดยั้ง พบว่าถ่านกัมมันต์ที่ได้มีร้อยละผลิตภัณฑ์ 27.99 %, ความหนาแน่นเชิงปริมาตร 0.3590 g/cm<sup>3</sup>,  
ปริมาณเถ้า 21.05 %, ค่าการดูดซับไอโอดีน 698.79 mg/g, ค่าการดูดซับเมทิลีนบลู 247.08 mg/g, พื้นที่ผิวรูพรุน  
658.75 m<sup>2</sup>/g, พื้นที่ผิวรูพรุนชนิดไมโครพอร์ 424.27 m<sup>2</sup>/g, พื้นที่ผิวภายนอก 234.48 m<sup>2</sup>/g และเส้นผ่านศูนย์กลาง  
รูพรุนเฉลี่ย 22.24 อังสตรอม

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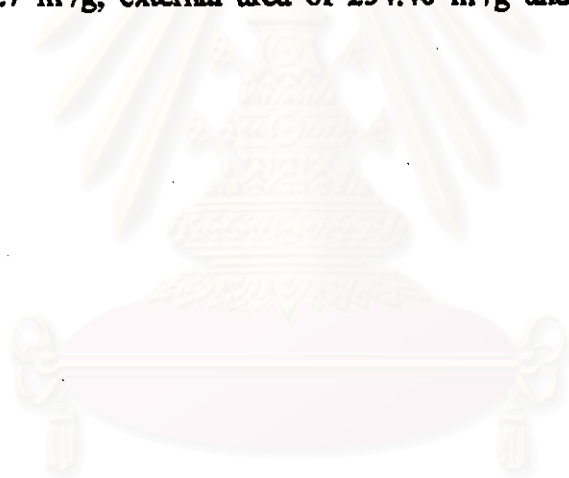
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ลายมือชื่ออาจารย์ที่ปรึกษา .....  
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ACTIVATION IN A FIXED BED REACTOR. THESIS ADVISOR : ASSIST. PROF.  
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This research was the study of the production of activated carbon from used tires by the processes of carbonization and activation with superheated steam and carbon dioxide in a fixed bed reactor with the diameter of 100 mm. The used tires were carbonized at 350°C for 60 min with the air flow rate of 0.52 nl/min. The characteristics of the resulted chars were yield of 41.40 %, fixed carbon of 62.57 %, ash of 15.30 % and volatile matter of 22.13 %. Then, the chars were activated with superheated steam and carbon dioxide. The optimum condition for activation was 0.60-1.18 mm of the chars size at 900°C for 45 min with air at a flow rate of 0.27 nl/min, carbon dioxide at a flow rate of 2.0 nl/min and superheated steam. The resulted activated carbon obtained yield of 27.99 %, bulk density of 0.3590 g/cm<sup>3</sup>, ash of 21.05 %, iodine number of 598.79 mg/g, methylene blue number of 247.08 mg/g, B.E.T. surface area of 658.75 m<sup>2</sup>/g, micropore area of 424.27 m<sup>2</sup>/g, external area of 234.48 m<sup>2</sup>/g and average pore diameter of 22.24 Å.



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ภาควิชา.....  
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ปีการศึกษา.....

ลายมือชื่อนิสิต.....  
ลายมือชื่ออาจารย์ที่ปรึกษา.....  
ลายมือชื่ออาจารย์ที่ปรึกษาร่วม.....



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## ABBREVIATIONS

T	:	Temperature (°C)
t	:	Time (min)
% Y	:	% Yield
% M	:	% Moisture
% VM	:	% Volatile matter
% FC	:	% Fixed carbon
BD	:	Bulk density (g/cm <sup>3</sup> )
IA	:	Iodine number (mg/g)
MB	:	Methylene blue number (mg/g)
S <sub>B.E.T.</sub>	:	B.E.T. surface area (m <sup>2</sup> /g)
S <sub>micro</sub>	:	Micropore area (m <sup>2</sup> /g)
S <sub>external</sub>	:	External surface area (m <sup>2</sup> /g)
S <sub>Langmuir</sub>	:	Langmuir surface area (m <sup>2</sup> /g)
V <sub>total</sub>	:	Total pore volume (cm <sup>3</sup> /g)
V <sub>micro</sub>	:	Micropore volume (cm <sup>3</sup> /g)
V <sub>non-micro</sub>	:	Non-micropore volume (cm <sup>3</sup> /g)

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จุฬาลงกรณ์มหาวิทยาลัย