

**HIGH-THROUGHPUT PRIMARY SCREENINGS OF METHANE
CATALYTIC COMBUSTION BY A MULTI-FLOW REACTOR**

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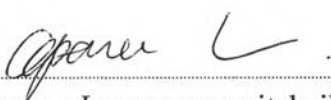
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ABSTRACT

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Catalytic combustion of natural gas has been considered as an ongoing challenge to achieve ultra low emissions, and improve turbine efficiency over the past decade. The best catalyst suggested was Pd/ γ -Al₂O₃, however, its lights-off temperature and time-on-stream properties are still challenging to be enhanced as well as cost reduction on noble metal usage. In this study, palladium (Pd), platinum (Pt), and lanthanum (La) were employed and also co-loaded in bi- and tri-element system supported on γ -Al₂O₃ washcoated ceramic monolith. Multi-flow reactor equipped with gas chromatograph (GC) based on the concept of high throughput screening was employed to screen both conversion and selectivity of all catalysts. Two parameters affecting combustion activity, which are the calcination steps related to the alumina phase and loading amount, were prior studied to determine an appropriate conditions used for generating other catalysts for further experiments. The combustion activity results indicated that the catalyst should be prepared by pre-calcinating washcoated monolith at 500°C for 3 hrs before being impregnated with 5%wt of total loading. After that, it should be re-calcined at 900°C for 3 hrs before being used. The substitution of Pd by Pt, while maintaining 5% total loading, was observed to improve the combustion activity, however, its combustion activity was slightly decreased when Pt was further substituted by La. Nevertheless, the use of Pd and Pt in equivalent amount with three times of La dilution (Pd:Pt:La = 1:1:3) was suggested to be the best formula not only due to its high combustion activity at even low temperatures, but also the reduction of noble metal usage.

บทคัดย่อ

ณัฐกร ไกรกุล : การทดสอบความสามารถของตัวเร่งปฏิกิริยาการเผาไหม้ของมีเทนวิธีทดสอบแบบไฮทรูพุทด้วยเครื่องปฏิกรณ์แบบหลายท่อไหล (High-Throughput Primary Screenings of Methane Catalytic Combustion by a Multi-flow Reactor) อ. ที่ปรึกษา: ดร. ศิริรัตน์ จิตการคำ ดร. อาภาณี เหลืองนฤมิตชัย และ ศ.ดร. แคนเน็ล อีรีสาสโก 93 หน้า ISBN 974-9651-30-8

การเผาไหม้โดยใช้ตัวเร่งปฏิกิริยาของก๊าซธรรมชาติถูกพิจารณาว่าเป็นทางเลือกที่สามารถลดปริมาณสารมลพิษที่ถูกปล่อยออกสู่บรรยากาศและช่วยเพิ่มประสิทธิภาพของกังหันความร้อนตลอดทศวรรษที่ผ่านมา ตัวเร่งปฏิกิริยาที่ถูกพบว่าดีที่สุดคือพาลลาเดียมบนตัวรองรับแกมมา-อะลูมินา อย่างไรก็ตาม อุณหภูมิไลท์-ออฟ (lights-off temperature) และ สมบัติไทม์-ออน-สตรีม (time-on-stream properties) ของตัวเร่งปฏิกิริยาดังกล่าวยังคงเป็นสิ่งท้าทายที่จะปรับปรุงให้ดีขึ้น เช่นเดียวกับการลดปริมาณการใช้โลหะมีตระกูลในการเร่งปฏิกิริยา ตัวเร่งปฏิกิริยาในงานวิจัยนี้ได้แก่ พาลลาเดียม แพลทินัม แลนทานัม ที่เป็นตัวเร่งปฏิกิริยาแบบองค์ประกอบเดียว และตัวเร่งปฏิกิริยาผสมในระบบสองและสามองค์ประกอบบนตัวรองรับแกมมา-อะลูมินา ตัวเร่งปฏิกิริยาทั้งหมดถูกทดสอบทั้งความสามารถในการเกิดปฏิกิริยาและความเลือกเฉพาะในการเกิดปฏิกิริยาโดยเครื่องปฏิกรณ์แบบหลายท่อไหลตามหลักการแบบไฮทรูพุท ตัวแปรสองชนิดที่มีผลต่อความสามารถในการเร่งปฏิกิริยา ได้แก่ ขั้นตอนการเผาตัวเร่งปฏิกิริยาด้วยอุณหภูมิซึ่งสัมพันธ์กับเฟสของอะลูมินา และ ปริมาณการใช้โลหะ ถูกศึกษาเพื่อหาสถานะที่เหมาะสมสำหรับเตรียมตัวเร่งปฏิกิริยาดังกล่าวต่อไป ผลการศึกษาเบื้องต้นชี้ว่า ควรเตรียมตัวเร่งปฏิกิริยาโดยนำโมโนลิทที่ถูกเคลือบแล้วไปเผาที่ 500°C เป็นเวลา 3 ชม. ก่อนนำมาทำให้ชุ่มด้วยสารละลายของโลหะให้ได้น้ำหนักรวมของโลหะเป็น 5% โดยน้ำหนัก จากนั้นนำไปเผาอีกครั้งที่ 900°C เป็นเวลา 3 ชม. ก่อนนำไปใช้งานจึงจะได้ผลดีที่สุด ในการทดสอบสารเร่งปฏิกิริยาแบบหลายองค์ประกอบ การใช้แพลทินัมแทนที่พาลลาเดียมโดย คงน้ำหนักรวมของโลหะเป็น 5% ทำให้ความสามารถในการเร่งปฏิกิริยาเผาไหม้ของตัวเร่งปฏิกิริยาสูงขึ้น อย่างไรก็ตาม ความสามารถดังกล่าวจะลดลงเล็กน้อยเมื่อโลหะแพลทินัมถูกแทนที่ด้วยแลนทานัมอีกครั้งหนึ่ง จากการทดลองพบว่า การใช้พาลลาเดียมและแพลทินัมด้วยน้ำหนักที่เท่ากันและเจือจางด้วยแลนทานัมสามเท่า (พาลลาเดียม:แพลทินัม:แลนทานัม = 1:1:3) เป็นอัตราส่วนที่เหมาะสมที่สุด ทั้งจากความสามารถในการเร่งปฏิกิริยาการเผาไหม้ที่สูง และการลดปริมาณการใช้โลหะมีตระกูลด้วยแลนทานัม

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