

**INDIUM-CONTAINING ZSM-5 CATALYST FOR METHYLATION OF
BENZENE: EFFECT OF TREATMENT AND REACTION CONDITIONS**



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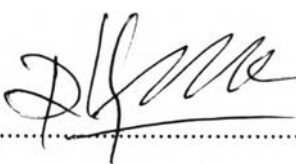
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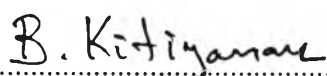
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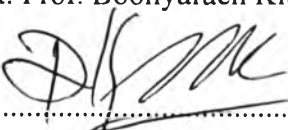
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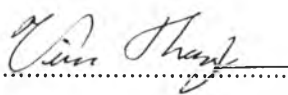
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ABSTRACT

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Toluene production through the reaction between benzene and methane has been studied by many research groups. Thermodynamic limitation is the main obstruction to achieve high conversion and yield. Since methane is highly stable, the activation process of direct benzene methylation requires suitable active catalyst and reaction conditions. In this research, indium loaded ZSM-5 was prepared by solid-state ion exchange technique using different treatment atmospheres (e.g. nitrogen, oxygen and hydrogen). The reaction was performed in a continuous flow reactor using methane and benzene as a raw materials carried by nitrogen and oxygen with different molar ratio. The reaction temperature, indium to aluminum ratio of catalysts, space velocity and methane to benzene feed ratio were also varied. It was found that benzene conversion was in the range of 0 to 10.4 % while toluene selectivity was in the range of 36 % to 100%.

บทคัดย่อ

นายไตรสิกข์ ศรีสายัณห์ : ตัวเร่งปฏิกิริยาอินเดียมบน ZSM-5 สำหรับปฏิกิริยาเมทิลเลชัน ของเบนซีน : การศึกษาผลของการปรับปรุงคุณภาพและสภาวะในการเกิดปฏิกิริยา (Indium-Containing ZSM-5 Catalyst for Methylation of Benzene: Effect of Treatment and Reaction Conditions) อ. ที่ปรึกษา : ผศ. ดร. บุญยรัชต์ กิตยานันท์ 87 หน้า

การผลิตโทลูอินจากสารตั้งต้นคือเบนซีนกับมีเทนได้มีการศึกษามาก่อนแล้ว อุปสรรคสำคัญที่ขัดขวางการบรรลุถึงเป้าหมาย คือสัดส่วนการเปลี่ยนของสารตั้งต้นไปเป็นผลิตภัณฑ์สูงเพียงพอ มาจากข้อจำกัดทางด้านเทอร์โมไดนามิกส์ เนื่องจากหนึ่งในสารตั้งต้นคือมีเทนมีความเสถียรต่อการเกิดปฏิกิริยาสูงมาก การจะเร่งให้มันเกิดปฏิกิริยากับเบนซีนโดยตรงจำเป็นต้องใช้ตัวเร่งปฏิกิริยาที่มีความว่องไวสูงรวมถึงใช้สภาวะการทำปฏิกิริยาอย่างเหมาะสม ในการทดลองนี้ได้ใช้ ZSM-5 ที่เติมอินเดียมเป็นตัวเร่งปฏิกิริยา เตรียมด้วยเทคนิค solid-state ion exchange โดยใช้สภาวะบรรยากาศในการเตรียมที่แตกต่างกัน ได้แก่ ในบรรยากาศของแก๊สไนโตรเจน แก๊สออกซิเจน และแก๊สไฮโดรเจน สำหรับขั้นตอนการทดสอบปฏิกิริยา จะนำแก๊สมีเทนและไอของเบนซีนเข้าสู่เตาปฏิกรณ์อย่างต่อเนื่อง โดยมีแก๊สไนโตรเจนกับออกซิเจนในสัดส่วนที่แตกต่างกันเป็นตัวพาเบนซีน นอกจากนี้แล้ว ในการทดลองยังมีการหาสภาวะที่เหมาะสมของตัวแปรต่างๆ อันได้แก่ อุณหภูมิในการทำปฏิกิริยา สัดส่วนของอินเดียมต่ออลูมิเนียมในตัวเร่งปฏิกิริยา ความเร็วในการไหลของสารตั้งต้น รวมถึงสัดส่วนระหว่างมีเทนกับเบนซีนที่ใช้ จากผลการทดลองพบว่า สัดส่วนการเปลี่ยนของเบนซีนไปเป็นผลิตภัณฑ์ที่พบ อยู่ในช่วงตั้งแต่ 0 ถึง 10.4 % ขณะที่สัดส่วนการเกิดไปเป็นโทลูอินอยู่ในช่วง 36 ถึง 100 %

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