

**INVESTIGATION OF METHANE HYDRATE FORMATION AND
DISSOCIATION KINETICS WITH THE PRESENCE OF PROMOTERS
FOR GAS STORAGE APPLICATION**

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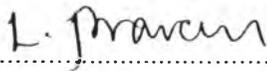

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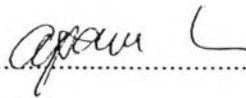

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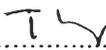

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ABSTRACT

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Keywords: Methane/ Gas hydrate/ Hydrate formation/ Hydrate dissociation/ Kinetics/ Promoter/ Activated carbon/ Tetrahydrofuran/ Surfactant

Gas hydrate is of interest for the process to store and transport gas. However, the slow kinetics and the storage capacity remained the obstruction. In this study, the hydrate promoters, including activated carbon, tetrahydrofuran (THF) and sodium dodecyl sulfate (SDS), were investigated for methane hydrate formation and dissociation kinetics. The experiments were conducted in a quiescent condition in a batch reactor at the desired experimental conditions. The results showed that all promoters significantly enhanced the kinetics of methane hydrate formation compared to pure water. In other words, the addition of porous media could increase the contact area between gas and liquid, SDS reduced the interfacial tension of the liquid phase, while THF shifted the methane hydrate phase equilibrium to higher temperature and lower pressure. A small particle size of activated carbon showed the fastest induction time; however, the highest gas consumption was observed with a large particle size. In contrast, a small particle size showed the fastest hydrate dissociation. Moreover, the surface treatment of activated carbon resulted in the increase in the gas consumption. In the system of THF, at the same concentration, increasing the experimental temperature led to the decrease in the kinetics of hydrate formation but the increase in the gas consumption; however, it was not stable at high temperature. The higher THF concentration exhibited a faster induction time than that of the lower concentration. Mixed THF-SDS showed the synergetic effects on the methane hydrate formation kinetics.

บทคัดย่อ

อัยฎวูธ เสียงไส : การศึกษากลไกการเกิดและสลายตัวของมีเทนไฮเดรตที่มีการเติมตัวเร่งสำหรับการกักเก็บแก๊ส (Investigation of Methane Hydrate Formation and Dissociation Kinetics with the Presence of Promoters for Gas Storage Application) : รศ. ดร. ปราโมช รั้งสรรค้วจิตร ดร.สันติ กุลประทีปญญา ผศ. ดร. ปราวีณ ลินกา และ ผศ. ดร. บุญยรัชต์ กิตติยานันท์ 172 หน้า

เทคโนโลยีแก๊สไฮเดรตนั้นได้รับความสนใจอย่างมาก สามารถใช้กักเก็บแก๊สธรรมชาติและการขนส่ง โดยสามารถการกักเก็บได้ในปริมาณสูงถึง 170 ลูกบาศก์เมตรต่อ 1 ลูกบาศก์เมตรของแก๊สไฮเดรตที่ความดันและอุณหภูมิมาตรฐาน อีกทั้งยังมีความปลอดภัยสูง อย่างไรก็ตามกระบวนการการเกิดแก๊สไฮเดรตนั้นต้องใช้เวลาและต้องอยู่ในสภาวะที่ความดันสูง อุณหภูมิต่ำ ในการศึกษาวิจัยมุ่งเน้นไปที่ตัวเร่งการเกิดแก๊สไฮเดรตได้แก่ ถ่านกัมมันต์ โซเดียมโคเดซิลซัลเฟต และเตตระไฮโดรฟูแรน เพื่อศึกษากลไกการเกิดและสลายตัวของมีเทนไฮเดรต การทดลองจะถูกศึกษาในสภาวะที่ไม่มีกระบวนการ ผลการทดลองแสดงให้เห็นอย่างมีนัยสำคัญว่าการใส่ถ่านกัมมันต์ โซเดียมโคเดซิลซัลเฟต และเตตระไฮโดรฟูแรนนั้นสามารถเร่งการเกิดมีเทนไฮเดรตให้เร็วขึ้นได้เมื่อเปรียบเทียบกับระบบที่มีเฉพาะน้ำ กล่าวคือถ่านกัมมันต์นั้นเพิ่มพื้นที่สัมผัสระหว่างแก๊สและน้ำ จึงช่วยลดเวลาการเกิดมีเทนไฮเดรตได้โดยเฉพาะถ่านกัมมันต์ที่มีขนาดเล็ก นอกจากนี้ยังพบว่า ขนาดของถ่านกัมมันต์ที่ใหญ่ขึ้นนั้นจะช่วยเพิ่มปริมาณการกักเก็บแก๊สมีเทนด้วยแต่จะสลายตัวได้ช้ากว่าถ่านกัมมันต์ที่มีขนาดเล็ก โซเดียมโคเดซิลซัลเฟตสามารถลดแรงตึงผิวของน้ำทำให้แก๊สสามารถละลายในน้ำได้มากขึ้น โดยที่ความเข้มข้นสูงขึ้นการละลายของแก๊สมีเทนในน้ำจะมากขึ้นจนกระทั่งจุดวิกฤติความเข้มข้นของไมเซล และเตตระไฮโดรฟูแรนจะส่งผลกระทบต่ออุณหพลศาสตร์ของระบบ กล่าวคือเตตระไฮโดรฟูแรนสามารถเลื่อนจุดสมดุลของระบบไปที่อุณหภูมิสูงขึ้นและความดันต่ำลง ส่งผลให้แก๊สไฮเดรตสามารถเกิดได้ง่ายขึ้น ถึงแม้มีเทนไฮเดรตจะเกิดได้ที่อุณหภูมิสูงในระบบที่มีเตตระไฮโดรฟูแรน แต่ความเสถียรของมีเทนไฮเดรตนั้นจะลดลงเมื่อเทียบกับมีเทนไฮเดรตที่อุณหภูมิต่ำ นอกจากนี้การผสมกันระหว่างโซเดียมโคเดซิลซัลเฟตและเตตระไฮโดรฟูแรนที่ความเข้มข้นต่ำ สามารถทำให้เกิดมีเทนไฮเดรตที่เร็วขึ้นเมื่อเทียบกับระบบที่มีโซเดียมโคเดซิลซัลเฟต หรือเตตระไฮโดรฟูแรนที่ความเข้มข้นต่ำเพียงอย่างเดียว นอกจากนี้ยังเพิ่มปริมาณการกักเก็บแก๊สมีเทนในรูปแบบของแก๊สไฮเดรตด้วย

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