

**SYNTHESIS GAS PRODUCTION FROM CO₂-CONTAINING NATURAL
GAS BY COMBINED STEAM REFORMING AND PARTIAL OXIDATION
IN MULTI-STAGE GLIDING ARC DISCHARGE SYSTEM**

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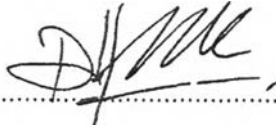
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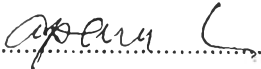

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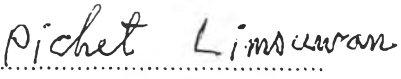
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ABSTRACT

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In this work, the reforming of CO₂-containing natural gas was conducted under the alternating current AC gliding arc discharge plasma system at ambient conditions. The results reveal that the addition of steam content of 10 mol% to the simulated natural gas was found to greatly enhance the natural gas reforming performance in terms of reactant conversions, product yields, product selectivities, and power consumptions. Next, a technique of combining steam reforming with partial oxidation of CO₂-containing natural gas in an AC gliding arc discharge was examined in order to optimize the reforming efficiency. The results show that the partial oxidation could increase both methane conversion and synthesis gas yield. The optimum oxygen feed molar ratio was found at a HCs/O₂ feed molar ratio of 2/1, providing high CH₄ and O₂ conversions with high synthesis gas selectivity and relatively low power consumptions, as compared with the other processes (sole natural gas reforming, natural gas reforming with steam, and combined natural gas reforming with partial oxidation). For the combined plasma reforming of CO₂-containing natural gas with steam and partial oxidation in multistage gliding arc discharge system was finally investigated. The series of experiments were carried out to investigate reactant conversions, product selectivities and yields, and power consumption by varying residence time, stage number of plasma reactors, feed flow rate, hydrocarbons (HCs)/O₂ feed molar ratio, and input voltage. An increase in stage number from 1 to 3 stages at a constant feed flow rate enhanced the reactant conversions, and product yields with a reduction of power consumptions.

บทคัดย่อ

กฤติยา พรใหม่ : การผลิตก๊าซสังเคราะห์จากก๊าซธรรมชาติที่มีองค์ประกอบคาร์บอนไดออกไซด์โดยกระบวนการเปลี่ยนรูปด้วยไอน้ำและการออกซิเดชันบางส่วนในระบบประกายไฟฟ้าร้อนกระแสสลับ (Synthesis Gas Production from CO₂-Containing Natural Gas by Combined Steam Reforming and Partial Oxidation in Multi-Stage Gliding Arc Discharge System) อ. ที่ปรึกษา ศ. ดร. สุเมธ ชวเดช 157 หน้า

ในงานวิจัยนี้ การเปลี่ยนรูปก๊าซธรรมชาติที่มีองค์ประกอบก๊าซคาร์บอนไดออกไซด์ได้ถูกดำเนินการโดยใช้ระบบประกายไฟฟ้าร้อนแบบกระแสสลับ ภายใต้สภาวะบรรยากาศ ผลการศึกษาเปิดเผยว่า การเติมปริมาณไอน้ำที่ 10 โมลเปอร์เซ็นต์เข้าไปในก๊าซธรรมชาติจำลองที่มีองค์ประกอบคาร์บอนไดออกไซด์พบว่า ช่วยเพิ่มประสิทธิภาพในการเปลี่ยนรูปของก๊าซธรรมชาติเป็นอย่างมาก ทั้งในรูปของการเปลี่ยนแปลงสารตั้งต้น, ผลผลิตของผลิตภัณฑ์, ค่าการเลือกเกิดของผลิตภัณฑ์, อัตราส่วนของก๊าซสังเคราะห์, และพลังงานจำเพาะที่ต้องใช้ จากนั้นได้ศึกษาเทคนิคการร่วมเปลี่ยนรูปโดยไอน้ำและการออกซิเดชันบางส่วนของก๊าซธรรมชาติที่มีองค์ประกอบของก๊าซคาร์บอนไดออกไซด์ภายใต้ระบบประกายไฟฟ้าแบบร้อน เพื่อทำให้ประสิทธิภาพของการเปลี่ยนรูปสูงสุด ที่อัตราส่วนโมลที่เติมของไฮโดรคาร์บอนต่อออกซิเจนเท่ากับ 2/1 ให้การเปลี่ยนแปลงทั้งออกซิเจนและมีเทนที่สูง การเลือกเกิดก๊าซสังเคราะห์ที่สูง และความต้องการพลังงานต่ำ เมื่อเปรียบเทียบกับกระบวนการอื่นๆ (การเปลี่ยนรูปของก๊าซธรรมชาติอย่างเดียว, การเปลี่ยนรูปของก๊าซธรรมชาติด้วยไอน้ำ, และการเปลี่ยนรูปของก๊าซธรรมชาติร่วมกับการออกซิเดชันบางส่วน) สำหรับการร่วมเปลี่ยนรูปก๊าซธรรมชาติที่มีองค์ประกอบของก๊าซคาร์บอนไดออกไซด์ โดยใช้ไอน้ำและการออกซิเดชันบางส่วนในระบบประกายไฟฟ้าร้อนแบบหลายขั้นตอนได้ถูกศึกษาเป็นลำดับสุดท้าย ชุดอนุกรมของการทดลองได้ถูกนำมาศึกษาการเปลี่ยนแปลงสารตั้งต้น, การเลือกเกิดและผลผลิตของผลิตภัณฑ์ต่างๆ, และพลังงานที่ต้องใช้ โดยการแปรเวลาอยู่ของสารตั้งต้น, จำนวนปฏิกรณ์พลาสมา, อัตราส่วนระหว่างไฮโดรคาร์บอนต่อออกซิเจน, และค่าความต่างศักย์ เมื่อเพิ่มจำนวนเครื่องปฏิกรณ์จาก 1 เครื่อง ไปเป็น 3 เครื่อง สำหรับระบบที่มีการควบคุมให้มีอัตราการไหลคงที่ปรับปรุงการเปลี่ยนแปลงของสารตั้งต้น, ผลผลิตของผลิตภัณฑ์ต่างๆ รวมทั้งการลดลงของพลังงานที่ต้องใช้

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