DESIGN AND ANALYSIS OF GAS FLOW FIELD FOR PROTON EXCHANGE MEMBRANE FUEL CELL

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DOCTOR OF ENGINEERING
IN ENERGY ENGINEERING

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A THESIS SUBMITTED TO THE GRADUATE SCHOOL IN
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ABSTRACT

The main objective of this work is to numerically and experimentally investigate the effect of parameter design of flow field channel in proton exchange membrane fuel cell and to compare performance with old fuel cell. In this study, simulation of the flow inside a serpentine flow field pattern in any parameter is affected using numerical modeling technique. Examination of relationship between dimension of channel, channel length, radius curve and inlet manifold with pressure drop, velocity distribution and polarization curve and improve proton exchange membrane fuel cell performance based on the flow field. The PEMFC model was studied in velocity and pressure drop distributions in flow channels and gas consumption in electro-chemical. The assessment of all flow fields was obtained and used as a fundamental knowledge on designing a new flow field. New flow field of fuel cell models designed and modeled numerical, 2 ways multi-serpentine flow field.

The result of gas distribution within the 2 ways multi-serpentine with header flow field was similar to the multi-serpentine flow field. However, this flow field delivered higher velocity and pressure drop. The prototype of the 2 ways multi-serpentine with header polar plates were built and tested. The performance of the 2 ways multi-serpentine with header was compared with the 4 serpentine polar plates and 6 serpentine polar plates. The results show that the 2 ways multi-serpentine with header polar plates provided power density is 621.9 mW/cm^2. The new fuel cell has performance of cell better than 6 serpentine channel flow field about 10.03% and 4 serpentine channel flow field about 14.91 % in power density. The maximum efficiency of the fuel cell occurred at the temperature of 70 °C and flow rate of 500 cm^3/min.

ชื่อเรื่องวิทยานิพนธ์	การออกแบบ และวิเคราะห์สนามการไหลของก๊าซสำหรับเซลล์เชื้อเพลิง ชนิด เมมเบรนแลกเปลี่ยนโปรตอน
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บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาถึงผลกระทบของตัวแปรในการออกแบบช่องการไหลของก๊าซ และเปรียบเทียบประสิทธิภาพการทำงานของเซลล์เชื้อเพลิงชนิดเมมเบรนแลกเปลี่ยนโปรตอน โดยอาศัยแบบจำลองเชิงตัวเลข และการทดสอบเซลล์ ในการศึกษาแบบจำลองเชิงตัวเลขของผลกระทบจากการไหล จะศึกษาจาดสนามการไหลแบบขดไปขดมา เพื่อศึกษาความสัมพันธ์ระหว่าง ขนาดของช่องการไหล ความยาวของช่องการไหล รัศมีความโค้ง และ ช่องทางเข้ารวมของสนามการไหล เพื่อศึกษาถึง การกระจายตัวของความดันตกคร่อม การกระจายตัวของความเร็ว และ กราฟโพลาไรเซชั่น เพื่อพัฒนาประสิทธิภาพการทำงานของเซลล์เชื้อเพลิงจากสนามการไหล แบบจำลองเซลล์เชื้อเพลิงชนิดเมมเบรนแลกเปลี่ยนโปรตอนจะศึกษา การกระจายตัวของความดันตกคร่อม การกระจายตัวของความเร็ว และ ปริมาณการใช้ก๊าซจากปฏิกิริยาจากนั้นได้นำผลการศึกษาที่ได้เป็นข้อมูลในการออกแบบ และพัฒนาช่องทางเดินก๊าซ ด้วยแบบจำลองเชิงตัวเลขขึ้นเอง คือ สนามการไหล 2 ways multi-serpentine

ผลการศึกษา พบว่าช่องทางเดินก๊าซแบบ the 2 ways multi-serpentine กับช่องทางเข้ารวมที่มีความคล้ายกับ สนามการไหลแบบขดไปขดมาหลายช่อง จะมีการกระจายตัวของความเร็วและความดันที่สูง ดังนั้นจึงได้สร้างต้นแบบเซลล์เชื้อเพลิงของช่องทางเดินก๊าซ แบบ the 2 ways multi-serpentine แล้วทดสอบประสิทธิภาพเทียบกับเซลล์เชื้อเพลิงที่ใช้อยู่เดิม ที่มีช่องการไหลแบบ 4 ช่องสนามการไหลแบบขดไปขดมา และ 6 ช่องสนามการไหลแบบขดไปขดมา ผลการเปรียบเทียบ เซลล์เชื้อเพลิงที่ได้ออกแบบในงานวิจัยนี้ ให้กำลังไฟฟ้าสูงสุด 621.9 mWatt/cm^2 ซึ่งสูงกว่าเซลล์เชื้อเพลิงที่ใช้อยู่เดิมคือ 6 ช่องสนามการไหลแบบขดไปขดมา ประมาณ 10.03% และ 4 ช่องสนามการไหลแบบขดไปขดมา ประมาณ 14.91% และพบว่าสภาวะการทำงานที่ทำให้ได้ประสิทธิภาพดีที่สุดของเซลล์เชื้อเพลิงที่ได้ออกแบบในงานวิจัยนี้ คือที่อุณหภูมิ 70 $^{\circ}$C และอัตราการไหลของก๊าซที่ 500 cm^3/min

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