Preeyaphat Wawdee 2014: Development of Effectiveness of Fuel Cell. Master of Engineering (Chemical Engineering), Major Field: Chemical Engineering, Department of Chemical Engineering. Thesis Advisor: Associate Professor Sunun Limtrakul, D.Sc. 82 pages.

Two methods to improve performance of proton exchange membrane, PEM, fuel cell were studied. The first method focuses on the catalyst layers where the reaction takes place which is the heart and significant to cell performance. The cell performance increases with high cost platinum catalyst loading due to higher surface area for electrochemical reaction. Reduction of expensive platinum consumption is sought. The concentration of reactants decreases along the length of the flow channel due to consumption in reaction. Catalyst gradient distribution loading along with decreasing reactant concentration is proposed to minimize catalyst consumption while maximizing the cell performance. The results showed that the descending gradient catalyst loading pattern from high at the gas inlet to low at the gas outlet can improve the fuel cell performance while the ascending gradient loading cannot improve the fuel cell performance at the same average catalyst loading. Cell humidification is another important factor affecting PEM fuel cell performance. In the second method, a new cell was designed with slanted grooves on both cathode and anode flow channels to improve water management. Water out flow was measured to provide information on flooding, hydration, and back-diffusion. The results showed water amount flowout at the cathode of an anode down-slanted channel was less than that of a rectangular channel, because down-slanting of anode induced a hydration gradient which caused water generated in anode to back-diffuse into the anode. Membrane hydration and conductivity was improved, thus better performance. At high feed gas humidification, performance decreased because of water condensation which blocked the gas diffusion layer. By replacing the rectangular channel with an anode down-slanted channel, performance was improved to match that of a rectangular cell at normal humidification. However, the cathode down-slanted channel showed membrane dehydration effect from water draining away. Moreover, anode or cathode up-slanted channels induced flooding, leading to poor performance.

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