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Design of Control System of Hydrogen and Oxygen Flow Rate for Proton Exchange Membrane Fuel Cell Using Fuzzy Logic Controller

Adisorn Thomya[a,]* and Yottana Khunatorn[a]

[a]*Department of Mechanical Engineering, Faculty of Engineering, Chiang Mai University, 239 Huay Kaew Road, Muang District, Chiang Mai 50200, Thailand*

Abstract

This research studies to develop design and construct a prototype of the operation control system of Proton exchange membrane fuel cell. The experimental results show that the performance of fuel cell depends on gas flow rate, temperature, humid and operating pressure. Therefore, the control system performance in the aspect of these parameters is evaluated. The control system performance was determined by comparing between control flows generated from simulations control with flow rate of a self-created, used fuzzy logic control. It was observed that the external load changes the current output proportionally to comply with the requirements; Power was control by voltage was 0.6. Enhancement during a constant load and its time strongly depends on the operational current level. This genetic fuzzy controller demonstrates improved response than manual control. This predictive control is accomplished by the use of fuzzy logic. Finally shows the prototype operation control system which easy controlled to optimization of the fuel cell performance and it can portable control system.

Keywords*: Fuzzy logic controller, Flow rate, PEMFC, Design of control, Control system.*

1. Introduction

Proton exchange membrane fuel cells (PEMFCs) transform the chemical energy into electricity. Hence, it is environment friendly energy source. Its performance and efficiency still needed to be improved, and the issues of cost, reliability and safety are needed to be considered to realize the fuel cell commerciality. In order to enhance its performance and reliability, it is necessary to learn more about the

* Corresponding author. Tel.: +66-53-944-146; fax: +66-53-944-145.
E-mail address: adisorn2@hotmail.com, ngairzai@hotmail.com,

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mechanism that causes the performance loss, such as, non-uniform concentration, current density distributions, high ionic resistance due to dry membrane, or high diffusive resistance due to the flooding on the cathode. The flow field and water/thermal management of fuel cell need optimal design to achieve high performance and reliability. The numerical modeling and dedicated experimental technique development will be the effective tools to improve the optimal design of fuel cell system. An improved approach to reduce harmonics generated in inverters employed in renewable energy systems is proposed in [4]. Fuzzy control is one of the useful control techniques for uncertain and ill-defined nonlinear systems. Control actions of a fuzzy controller are described by some linguistic rules. This property makes the control algorithm easy to understand. Heuristic fuzzy controllers incorporate the experience or knowledge into rules, which are fine-tuned based on trial and error.

Finally, a fuzzy logic based controller is designed for this purposes because of the numerous advantages it has high performance. Over the other types of controllers, The most important aspect being, the cost of the controller design and implementation. The proposed hydrogen flow controller modify control active current to the load change and setpoint current for controlling to the load.

2. ACOMPONENT AND OPERATE OF FUEL CELL

2.1 Component of PEMFC

The single PEMFC components includes of gas diffusion, catalyst layer, membrane, shown in Figure. 1.

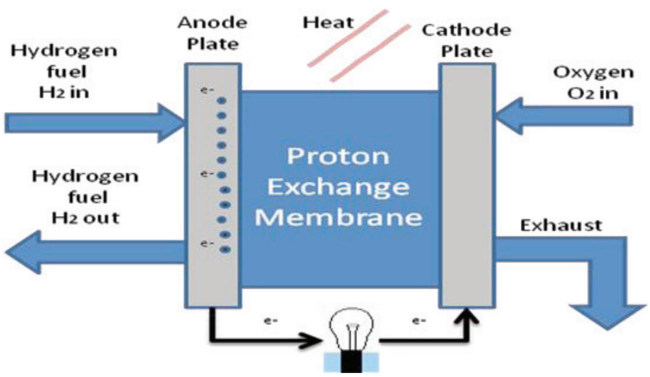

Fig. 1. Diagram of Fuel Cell Operation.

2.2 Electrochemical Reaction Process in Fuel Cell

Fuel cells are energy source from electrochemical in cell. The reactions are from hydrogen gas flow pass the catalyst layer in Anode, it is Oxidation reaction and show in eq. (1). Hydrogen ion from the reaction flow pass Electrolyte to Cathode and the reaction in the catalyst layer are Reduction, The Oxygen is reactance in the reaction and show in eq. (2). The products from the reaction are water and electrons. The current in the Cathode and Anode from electron flow pass between two sides shown in Figure. 1

$$H_2 \longrightarrow 2H^+ + 2e^- \qquad \text{Oxidation process} \qquad (1)$$

$$O_2 + 4e^- + 4H^+ \longrightarrow 2H_2O \qquad \text{Reduction process} \qquad (2)$$

2.3 Efficiency of Fuel Cell

Electrical energy is obtained from a fuel cell only when a reasonable current is drawn, but the actual cell potential is decreased from its equilibrium potential because of irreversible losses as shown in Figureure.4. Several sources contribute to irreversible losses in a practical fuel cell. The losses, which are