ABSTRACT

The limited supply of fossil fuels and increasing greenhouse gas emissions pose challenges for the transition to cleaner energy. Indonesia produced 1.3 gigatons of CO2 in 2022, making it one of the world's largest contributors of CO2. Proton Exchange Membrane *Fuel cell*s (PEMFCs) are a promising technology because they can generate electricity with lower emissions through an electrochemical reaction between hydrogen and oxygen. This research aims to develop a hydrogen and oxygen *flow* control system to improve the efficiency and performance of PEMFCs. The system will use a single PEMFC stack, making it suitable only for laboratory-scale applications. This research will design a control system capable of automatically adjusting gas *flow* based on changes in electrical load. Previous research has shown that control systems in *fuel cell*s generally use the PID method to regulate the *flow* of hydrogen and oxygen gases. This study develops a new approach by integrating fuzzy control, enabling the system to adapt more quickly to load changes and optimize its response to voltage drops. The system integrates an INA219 sensor to detect voltage and current, as well as a pneumatic valve connected to a servo to regulate the *flow* of hydrogen and oxygen from the *electrolyzer*.The results of testing the *flow* rate control system with fuzzy logic show that the designed control system is capable of maintaining *fuel cell* voltage stability, where the system is able to respond to voltage drops to a critical level of 0.45 V and successfully return it to a normal operating level of around 0.6 V. The primary success parameter was achieved through validation that increasing the input voltage of the *electrolyzer*, such as from 3.3 V to 4.9 V, directly increases gas production, which significantly increases the *fuel cell* output voltage from 0.008 V to 0.928 V.

Keywords: fuel cell, electrolyzer, flow rate control, fuzzy logic