



Design and Development of an Electrolysis Stack to Generate Green Hydrogen Using Solar Power

H.K.D.C.H. Kularathna¹, M.P.S.I. Ranaweera¹, W.A.D. Rangana¹, W.P. Madhusankha¹, Y.S.K. De Silva^{1}*

¹ Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, University of Ruhuna, Sri Lanka

**Corresponding author: sanath@mme.ruh.ac.lk*

The transition toward renewable energy systems has intensified interest in green hydrogen as a clean and sustainable energy carrier. Conventional hydrogen production methods contribute approximately 830 million tons of CO₂ emissions annually, necessitating alternative zero-emission solutions. Sri Lanka's national target of achieving 70% renewable energy by 2030, supported by 1,358 MW of planned solar capacity, highlights a critical need for effective energy storage to mitigate solar intermittency. This study presents the design, fabrication, and experimental validation of a cost-effective solar-powered alkaline electrolysis stack, with the primary technical contribution being the development of an optimized bipolar stack configuration with improved sealing and system integration suitable for decentralized hydrogen production. An iterative design methodology was adopted, progressing from single-cell prototype testing to a six-cell bipolar stack configuration. Design-driven safety enhancements and material optimization significantly improved system reliability and performance. The final electrolysis stack achieved a hydrogen production rate of 85.856 cm³/min at 12 V, with a total power consumption of 36 W. The system demonstrated an electrolysis efficiency of 51%, defined as the effectiveness with which electrical energy supplied to the electrolyzer is converted into chemical energy stored in the form of hydrogen, and an energy efficiency of 59%. Successful integration with a photovoltaic power supply, battery storage, and real-time monitoring validated stable operation under variable solar conditions. The developed electrolysis stack demonstrates strong potential for off-grid energy storage and decentralized renewable energy applications in regions with high solar availability.

Keywords: Alkaline electrolysis, Green hydrogen production, Solar-powered electrolyzer, Bipolar electrolysis stack, Renewable energy storage