Contribution ID: **295** Type: **Oral**

Optimizing Hydrogen Production through SOEC-PeLUIt 40 Coupling: A Sustainable Approach to Clean Energy Generation

The urgent need for clean, sustainable energy solutions is crucial for tackling environmental concerns and securing energy resources. Hydrogen, a versatile and high-energy-density fuel, holds promise across multiple sectors. Yet, its widespread adoption relies on efficient, cost-effective production methods. In recent years, electrolysis has garnered significant attention as a sustainable means of hydrogen production. Solid Oxide Electrolysis Cell (SOEC) technology, operating at high temperatures, presents a promising avenue for enhanced efficiency and integration with high-temperature heat sources. One such source, the High-Temperature Gas-Cooled Reactor (HTGR), known for its safety and efficiency, offers potential for cogeneration applications. Indonesia is currently developing a small modular nuclear reactor named PeLUIt-40. This reactor is based on High-Temperature Gas-Cooled Reactor (HTGR) technology with a capacity of 40 MW. In addition to electricity generation, PeLUIt-40 can be coupled for hydrogen production in anticipation of achieving net zero emissions by the year 2060.This paper investigates the feasibility and capacity of hydrogen production through the coupling of SOEC technology with PeLUIt-40. Leveraging the high-temperature heat output of the reactor, this coupled system presents a synergistic approach to hydrogen production, maximizing energy efficiency while minimizing environmental impact. The Cycle Tempo computer code is employed to model and simulate the entire process. In a scenario where the PeLUIt-40 turbine bleed outlet temperature stands at 312.88℃, featuring a steam mass flow rate of 0.828 kg/s, a pressure level of 6.0 bar, and an enthalpy of 3088.85 kJ/kg, the outcome yields a hydrogen production rate of 215 kg/h, equivalent to 1.8 tons annually. In summary, this study presents an innovative approach to hydrogen production, utilizing waste heat from the PeLUIt-40 turbine. It demonstrates the viability of employing SOECs to transform surplus thermal energy into clean hydrogen, thus contributing to the advancement of environmentally friendly energy technologies.

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Track Classification: Topical Group A: SMR Design, Technology and Fuel Cycle: Track 5: Non-Electric Applications for SMR