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HIGH-TEMPERATURE FUEL CELL HEAT UTILIZATION FOR COLD STORAGE IN AIR CONDITIONING SYSTEM

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Abstract – During the day, temperatures rise causing a gap between air conditioning systems demand and energy availability. Renewable energy sources such as photovoltaic cells are a promising option for powering these systems. However, due to the thermal inertia of buildings, there still occurs a temporal misalignment between peak cooling demand and energy supply, highlighting the need for efficient energy storage systems. This study investigates advanced strategies for integrating high-temperature fuel cells (HTFC) into air conditioning systems, with a focus on cold storage applications. Two main approaches are analysed. The first involves storing electrical energy by producing hydrogen or syngas through electrolysis, converting it in HTFCs, and using the generated electricity and heat to power chillers. The second approach explores storing cold in a zeolite sorption reactor, which utilizes waste heat from the fuel cells. The study analyses the influence of storage parameters, including working gas volume and sorbent bed size on overall system efficiency, responsiveness to dynamically changing cooling demand, as well as the applicability in a humid continental climate (Warsaw, Poland). Hybrid approaches that combine electrical energy storage with sorption-based cold storage may offer superior performance by balancing peak demand coverage with renewable energy availability. The findings provide insights into the design of renewable energy-powered air conditioning systems that utilize HTFCs, contributing to the development of sustainable cooling technologies.

Keywords – *Electrolysis; sorption reactor; syngas; thermal energy storage; zeolites*

