












Exergy and environmental analysis of SOFC-based system including reformers and heat recovery approaches to establish hydrogen-rich streams with least exergy loss

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Abstract

Building total CO₂ emissions must decline by more than 95% from 2020 to 2050. Statistical studies affirm that 84% of the fuel cell applications in the world are attributed to the residential market and are limited to the range of 0.5–5 kW. In this study, defining a building-based fuel cell, the first and second law of thermodynamics were approved for the hybrid system consisting of SOFC enhanced with an internal reformer and microturbine. In addition, an external reformer along with two heat recovery systems are integrated to change methane to hydrogen. Based on the exergy balance equation, 37 The installation of heat recoveries was very effective in hybrid system irreversibility reduction so they were able to reduce exergy losses by 38%. The most irreversibility was related to chemical reactions that occurred in the external reformer (share of 37.3%) and combustion chamber (share of 32%) while the share of the fuel cell was only 10.7%. The calculations of the second law showed that the hybrid system with heat recovery can convert 57.6% of the input exergy into useful work. The environmental analysis revealed that establishing a hybrid system with a higher temperature is more effective than that with higher pressure. The CO₂ emissions of the hybrid system at the lowest and highest temperature were 1.946 kg/kW and 0.81 kg/kW.