International Journal of Hydrogen Energy
Volume 48, Issue 66, 1 August 2023, Pages 25869-25883

Machine learning-assisted tri-objective optimization inspired by grey wolf behavior of an enhanced SOFC-based system for power and freshwater production

Tao Hai [a b c], As'ad Alizadeh [d], Masood Ashraf Ali [e], Hayder A. Dhahad [f], Vishal Goyal [g], Ahmed Sayed Mohammed Metwally [h], Mirzat Ullah [i]

https://doi.org/10.1016/j.ijhydene.2023.03.196

Abstract

In recent years paying attention to the generation of clean and sustainable power and fresh water along with having lower cost and emission has increased. In the present research, a novel scheme for generating efficient power using the flame-assisted fuel cell is introduced, which has higher efficiency than ordinary fuel cells due to increased hydrogen concentration in the flame-rich combustion chamber. The waste heat is then introduced to a multi-effect desalination unit through a heat recovery steam generation unit to generate fresh, drinkable water. In order to make the system have higher efficiency, lower cost, and lower emission, the machine learning techniques are applied to optimize the operational conditions of the system, and find out the best solution point based on the cutting-edge algorithm of the grey wolf. Also, a complete techno-economic analysis and a parametric study are necessary to figure out the best solution point based on the TOPSIS method. The results indicate that the maximum value of exergy efficiency and drinkable water generation is 67.5% and 3.4kg/s, respectively, while the minimum energy cost is 90.1 $/MWh. Moreover, results show that for the second optimization scenario considering the drinkable water production, energy cost, and pollution index as the objectives, the net produced power, energy efficiency, exergy efficiency, and water mass flowrate improve by around 1059kW, 5.1%, 1.3%, and 1.6kg/s than the design condition. Besides, energy cost and emission index are reduced by about 22 $/MWh and 51.9kg/MWh, respectively.