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Performance Analysis of a Metal Hydride Based Heat Transformer

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Abstract

A thermal model for predicting the performance of a single-stage metal hydride based heat transformer (MHHT) is presented. The pair of metal hydrides chosen for the present study is $LaNi_{4.7}Al_{0.3}$ and $LaNi_5$.The performance of the system is predicted by solving the combined energy and mass (heat and hydrogen) transfer equations during absorption and desorption of hydrogen to/from the hydride bed in cylindrical coordinates. Numerical results are compared with the experimental data reported in the literature, and a good agreement is found between them. The effects of operating temperatures such as heat source (T_M), heat output (T_H) and heat rejection (T_L) temperatures on the system performances in terms of coefficient of performance (COP_{HT}), specific heating power (SHP) and second law efficiency (η_E) are investigated. For the given range of operating parameters, there exist the optimum values of bed thickness and bed effective thermal conductivity. The COP_{HT} and SHP are found to increase with heat source temperature and however, both are found to decrease with heat output temperature. At the operating conditions of T_H = 423, T_M = 383 K and T_L = 303 K, the COP_{HT} and SHP of the MHHT are found to be 0.415 and 46 W/kg of alloy, respectively. Higher T_L yields better η_E while its value is found to be lower at higher T_M.