PARAMETRIC STUDIES ON A METAL HYDRIDE THERMAL STORAGE SYSTEM

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Abstract

Metal hydride based thermal energy storage systems are efficient, environment friendly and offer wide range of operating temperatures. In addition, these have the ability to deliver heat at nearly constant temperatures, which can be controlled by the supply pressure of hydrogen.

This paper discusses the performance of a metal hydride thermal storage system based on heat and mass transfer characteristics of the reactor. An analysis of the coupled heat and mass transfer in the hydride bed is carried out for predicting the influence of operating parameters such as hydrogen supply and discharge pressures, absorption (heat release) temperatures, and bed parameters such as effective thermal conductivity, thickness and overall heat transfer coefficient. Nickel doped MgH_2-Mg, which can store heat up to about 690 K, is chosen for the present analysis.

The system performance is defined by thermal energy storage coefficient, which is a measure of the efficiency of heat storage, and exergy loss, which is a measure of the energy degradation. At any given heat release temperature, thermal energy storage coefficient is found to increase with supply pressure. Thermal energy storage coefficient initially decreases marginally and later decreases drastically with increase in heat release temperature. This indicates that an optimum heat release temperature exists for a given supply pressure. Higher thermal energy storage coefficients are observed at low heat release temperatures. However, exergy loss is found to be minimum at higher heat release temperatures. Varying the supply pressure could heat release rate and temperature. Thin hydride beds offer lower cycle times and corresponding higher specific heat storages. Increases in overall heat transfer coefficient and bed thermal conductivity improve the system performance up to a certain limit only. Heat release time has a considerable influence on system performance, particularly when the supply pressure is low and heat release temperature is high.

Key words: Thermal storage, Metal hydrides, Coupled heat and mass transfer

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