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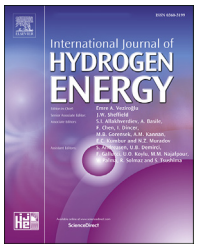

Enhancement of heat and mass transfer characteristics of metal hydride reactor for hydrogen storage using various nanofluids

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HIGHLIGHTS

- Developed and validated numerical model of metal hydride reactor for hydrogen storage.
- Selected various nanofluids for heat and mass transfer enhancement.
- Presented performance for Al_2O_3/H_2O, CuO/H_2O and MgO/H_2O nanofluid.
- Reported 10% improvement in the heat transfer rate for CuO/H_2O nanofluid.
- Absorption time is lowered by 9.5% for given conditions.

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ABSTRACT

The execution of metal hydride reactor (MHR) for storage of hydrogen is greatly affected by thermal effects occurred throughout the sorption of hydrogen. In this paper, based on different governing equations, a numerical model of MHR filled by $MmNi_{4.6}Al_{0.4}$ is formed using ANSYS Fluent for hydrogen absorption process. The validation of model is done by relating its simulation outcomes with published experimental results and found a good agreement with a deviation of less than 5%; hence present model accuracy is considered to be more than 95%. For extraction or supply of heat, water or oil is extensively used in MHR during the absorption or the desorption process so as to improve the competency of the system. Since nanofluid (mixture of base fluid and nanoparticles) has a higher heat transfer characteristics, in this paper the nanofluid is used in place of the conventional heat transfer fluid in MHR. Further the numerical model of MHR is modified with nanofluid as heat extraction fluid and results are presented. The Al_2O_3/H_2O, CuO/H_2O and MgO/H_2O nanofluids are selected and simulations are carried out. The results are obtained for different parameters like nanoparticle material, hydrogen concentration, supply pressure and cooling fluid temperature. It is seen that 5 vol% CuO/H_2O nanofluid is thermally superior to Al_2O_3/H_2O and MgO/H_2O nanofluid. The heat transfer rate improves by the increment in the supply pressure of hydrogen as well as decrement in temperature of nanofluid. The CuO/H_2O nanofluid increases the heat transfer rate of MHR up to 10% and the hydrogen absorption time is improved by 9.5%. Thus it is advantageous to use the nanofluid as a heat transfer cooling fluid for the MHR to store hydrogen.

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