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Performance analysis of sodium alanate hydride reactor with different nanofluids

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HIGHLIGHTS

- Developed and validated mathematical model of sodium alanate based hydride reactor.
- Used nanofluid as a heat exchange fluid.
- Presented performance for $\text{Al}_2\text{O}_3/\text{HTF}$, CuO/HTF and MgO/HTF Nanofluids.
- Absorption time is improved by 14% for given conditions.
- Reported up to 10% enhancement in the heat exchange rate for CuO/HTF nanofluid.

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ABSTRACT

The thermal management of the hydride based hydrogen storage reactor is the key factor to realize the complete storing potential of hydrides. In this regards a hydride reactor filled with sodium alanate in multiple tubes is numerically analyzed for absorption process. Based on various governing equations, a mathematical model of hydride reactor is developed and validated with the help of ANSYS Fluent. The hydride reactor uses mainly water or oil for heat exchange during hydrogen sorption. In the present study conventional heat transfer fluid (HTF) is replaced with the nanofluid since it has a greater heat exchange properties. The CuO/HTF , $\text{Al}_2\text{O}_3/\text{HTF}$ and MgO/HTF nanofluids are selected based on previous studies and results of numerical experiment are recorded. The outcomes are attained for various parameters such as material and concentration of nanoparticles, supply pressure of hydrogen and inlet temperature of heat exchange fluid. The CuO/HTF nanofluid with concentration of 5 vol% exhibited better rate of absorption in comparison with other vol% concentrations and other selected nanofluids. It shows improvement in hydrogen absorption time up to 14% under selected conditions. Additionally, it is observed that CuO/HTF nanofluid with 5 vol% concentration is thermodynamically superior to other selected nanofluids; as a result it enhances the rate of the heat exchange up to 10% for hydride reactor. It is realized that the performance of CuO/HTF nanofluid with 5 vol% concentration is superior among picked nanofluids. Therefore for the hydride reactor the use the nanofluid is advantageous.

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