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Chapter 4.3 - Metal hydride hydrogen storage: A systems perspective

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Abstract

Metal hydrides are considered a promising candidate for hydrogen storage. Compared to gaseous and liquid storage of hydrogen, the metal hydride (MH) route is less energy intensive and safer. Hydrogen at a pressure of up to around 100 bar is injected into a bed of powdered alloy and reacts with the alloy to form a metal hydride accompanied by heat release. Hydrogen gas thus, gets stored in a solid state. If the hydrogen has to be withdrawn from the bed some energy needs to be supplied from outside to break the metallic bonds and decompose the hydride. The metal hydride formation reaction is exothermic whereas the reverse reaction is endothermic. If the MH bed is analyzed from a design point of view, it can be observed that other than the stresses due to the design pressure and expansion/contraction of the alloy lattice, heat transfer forms the cornerstone of the MH hydrogen storage tank (MHHST) design. Heat transfer within and to/from the MH bed is the key factor that impacts the performance of the MHHST. Therefore, the design of MHHST revolves around the enhancement of heat transfer within the MH bed via a variety of heat transfer techniques. The issues associated with heat transport within the MH bed are especially aggravated because the alloy has to be used in powdered form for increased reaction surface area, however, at the same time this leads to reduced thermal conductivity in most cases as low as 1 W/mK.

The design of MHHSTs over a period of time has witnessed great variety. Especially after the advent of simulation techniques, many complicated configurations have also been explored. Investigations have been carried out on the inclusion of internal and external fins, longitudinal and transverse; coiled tubes, multiple embedded cooling tubes, expanded natural graphite and metal composites, phase change materials, etc. which augment the heat transport in the MH bed. Researchers have also optimized the dimensions and numbers of these enhancements.

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