The effect of a key parameters on the performance of the heat and mass transfer of $MmNi_{4.6}Al_{0.4}$

Y. Kerboua Ziari[(1)], A. Babou [(1,2)]

(1) *Laboratory of Thermodynamics and Energy Systems, Faculty of Physics, University of Science and Technology Houari Boumediene, BP 32 El – Alia, Algiers, Algeria*

(2) Unité de Recherche Appliquée en Energies Renouvelables, URAER, Centre de Développement des Energies Renouvelables, CDER, 47133, Ghardaïa, Algeria

1. Introduction – The aim of this work is to study numerically the heat and mass transfer in the metal hydride reactor equipped with PCM able to store the heat released during the absorption process in order to restore it again during the desorption process. The influence of different operating parameters such us, hydrogen supply pressure, thermal conductivity, melting latent heat and PCM mass on the charging rate were rigorously investigated. The numerical results show that the charging rate is mainly influenced by hydrogen supply pressure thermal conductivity and melting latent heat of the PCM. It was also found that the improvement of the thermal conductivity by inserting aluminum foam in the PCM enhances the thermal conductivity and favorites the heat and mass transfer in the MHT-PCM system and significantly decreases the charging time. The metal hydride reactor considered in the present study is shown in Fig. 1. It consists of a metal hydride powder packed in a cylinder, surrounded by a phase change material.

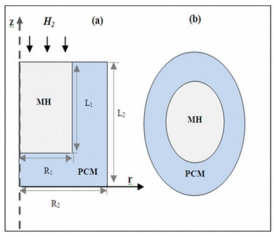

Fig 1 Schematic view of metal hydride reactor equipped with PCM

2. Mathematical model - The metal hydride hydrogen storage model is governed by the conservation of mass, momentum, and thermal energy [1]. For a phase change process, energy conservation can be expressed in terms of total volumetric enthalpy and temperature [2].

3. Results and Discussion – The effect of: Charging pressure, thermal conductivity, melting latent heat and PCM mass on the hydrogen absorption process was carried out. The Fig. 2 presents the time evolution of the temperature in the metal hydride bed and in the PCM domain. Initially as shown in this figure, the temperature of metal hydride bed increases very rapidly due to the heat released from the reaction between hydrogen and metal hydride during the absorption process, and then decreases gradually until the metal hydride bed is fully saturated. The heat of reaction released during this reaction is stored by the PCM domain as sensible heat, and the bed temperature reaches the thermal equilibrium with the PCM.

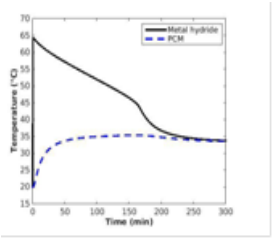

Fig 2 Time evolution of the average temperature of the hydride bed and the PCM.

4. Conclusion - A two-dimensional model was developed to investigate the coupled heat and mass transfer during the absorption process in hydrogen storage tank equipped with change phase material, PCM. The influence of different operating parameters such us, hydrogen supply pressure, thermal conductivity, melting latent heat and PCM mass on the absorption process has been simulated. The important obtained numerical results showed that: 1. The time of full charging was considerably reduced with a higher charging pressure. 2. The improvement of the thermal conductivity by adding aluminum foam to the PCM medium increases the reaction rate and significantly reduces the time of charging. 3. The augmentation of the melting latent heat of PCM enhances the hydrogen storage capacity. 4. The adequate mass of the PCM for the metal hydride reactor is important for the optimal MHT-PCM system.

5. References

[1] Jemni A, Ben Nasrallah S. Study of two-dimensional heat and mass transfer during adsorption in a metal-hydrogen reactor. Int J Hydrogen Energy 1995; 20(1):43–52.

[2] Voller VR, Prakash C. A fixed grid numerical modeling methodology for convection-diffusion mushy region phase change problems. Int J Heat Mass Transf 1987;30:1709e19.