HYSDEP: A SIMULATION AND DESIGN TOOL FOR ON-BOARD HYDROGEN STORAGE

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Abstract text

Many challenges have still to be overcome in order to establish a solid ground for significant market penetration of fuel cell hydrogen vehicles. The development of an effective solution for on-board hydrogen storage is one of the main technical tasks that need to be tackled [1].
The work deals with the development of a simulation platform named HySDeP (Hydrogen Storage Design Platform) to design and compare different vehicular storage options with respect to targets based upon storage and fueling efficiencies. The set targets represent performance improvements with regard to the state-of-the-art technology and are separately defined for each storage solution investigated in this work. Attention is given to solutions that involve high-pressure solid-state and gas hydrogen storage with an integrated passive cooling system. A set of libraries is implemented in the modeling platform to select among different material compositions, kinetic equations, heat exchanger configurations and to enable the tailoring of the analysis according to the user needs.
Reliable computational models are implemented to describe hydriding and dehydriding reactions as well as melting and solidification processes that occur in the metal hydride tank and novel compressed-hydrogen vessel respectively [2, 3].
For the metal hydride tank, the tubular layout in a shell and tube configuration with 2 mm inner diameter tubes is found to achieve the desired refueling time of 3 min and store a maximum of 3.1 kg of hydrogen in a 126 L tank. The dehydriding ability of this solution is proven to withstand intense discharging conditions.
For the hydrogen gas tank, a novel design that includes a phase change material in its inner volume. Heat transfer augmentation techniques (e.g. encapsulation) are found to be the reward strategy to achieve the same stored mass and fueling time of the standard technology, while enabling ambient temperature fueling and save the energy cooling demand (4.2 MJ per fueling) at the refueling station [3].

References

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	Born in Venice (Italy) in 1987. Humanities studies in Liceum Foscarini. Bachelor degree in Energy Engineering (2006-2009) at University of Padua. Master of Science in Energy and Nuclear Engineering (2009-2011) University of Padua with a master thesis on the integration of woodchips gasification, SOFC and STIG cycles carried out at DTU (Denmark). PhD (2012-2015) within the International HyFill Fast research project in "Tank designs for combined high pressure gas and solid state hydrogen storage". Team leader (6 months) at Purdue University for the project of optimal heat exchanger design for metal hydride heat pump systems. Research Assistant (Nov. 2015-Jan. 2016) at DTU. PostDoc from February 2016 at DTU. Expertise: ► Design and dynamic/steady-state modeling of complex energy systems. ► Hydrogen fueling and storage systems. ► Thermal power plants analyses and design. ► Heat transfer analyses and heat exchanger design.