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Modeling and simulation of lead-acid batteries

Modeling and Simulation (M&S) allow scientists and engineers to design and manufacture engineering products that are too complicated to be designed by simple engineering approach. Nowadays the use of M&S within engineering is well recognized and has already helped to reduce costs, increase the quality of products and give more physical insight. Design parameters study using simulations is generally cheaper and safer than conducting experiments with a prototype. Although the use of M&S does not eliminate the need for the experiment for most cases but everybody agrees that M&S not only reduce the cost and the time of the final products but also optimize and in addition reduce the number of experiments needed to finalize the product under design. Among different energy resources, batteries are considered as the main sources of energy especially in electric vehicle industries. Due to complexity of batteries modeling and simulation is a useful tool to optimize and analyze its behavior and better understanding of its physical phenomena. Lead-acid batteries are used for a vast number of purposes due to lower price, deep cycling and high rate discharge. In this context, the modeling and simulation of lead-acid batteries including computational fluid dynamics (CFD), equivalent circuit model (ECM) and engineering model (EM) are introduced. The use of simulation and modeling in design of Lead acid batteries are explained. The advantages and disadvantages of each approach have been explored. In addition the limitation of modeling and simulation and our expectation are discussed. The need for an experimental benchmark for future and further progress in simulation and modeling of lead acid batteries is also presented. In addition, in order to speed up the battery simulation to be used in real time system, the reduced order based on proper orthogonal decomposition will be thoroughly explained along with the produced numerical results. Since lead acid batteries involve multi-disciplines engineering field, developing engineering software would be useful in order to consider all the aspects of battery design.

Biography

Vahid Esfahanian received his BSc from the University of Illinois at Chicago, IL, USA in 1982 and his MSc and PhD from the Ohio State University, USA in 1985 and in 1991, respectively. He is currently a full Professor in the School of Mechanical Engineering and the Head of Vehicle, Fuel and Environment Research Institute (VFERI), University of Tehran, Iran. His research interests include battery simulations and hybrid vehicles.

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