Optimal design of hybrid and non-hybrid fuel cell vehicles

by

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ABSTRACT

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Fuel cells are under development as an alternative power source for automobiles, because of their clean and efficient power production. This emerging technology, however, still has many issues to be addressed for market acceptance. Several fuel cell vehicle concepts have been proposed and studied in terms of safety, robust operation, fuel economy and vehicle performance. Despite the relatively large number of models and prototypes, a model-based vehicle design capability with sufficient fidelity and efficiency is not yet available in the open literature.

In this study we develop an analysis and design optimization model for fuel cell vehicles that can be applied to both hybrid and non-hybrid vehicles by integrating a fuel cell vehicle simulator with a physics-based fuel cell model. The integration is achieved via quasi-steady fuel cell performance maps and provides the ability to modify the characteristics of fuel cell systems. Thus, a vehicle can be optimized subject to its own constraints, which include various vehicle performance metrics, safety, packaging and cost.

Optimal designs using the above modeling environment are compared in terms of fuel economy and vehicle performance. Parametric studies with respect to vehicle, fuel cell

and hybridization parameters are also presented. Even though hybrid vehicles provide increased freedom to designers, the benefit of hybridization of a fuel cell vehicle is not as big as that of a conventional one. Moreover, hybridization without proper power management control may reduce the fuel economy due to increased weight and reduced power generation. Therefore, an optimal control strategy also needs to be taken into account in the design phase of vehicle components.

To my family.

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