Vehicle Design and Evaluation — Development of a Scalable Fuel Cell System Optimization Model with Improved Dynamic Behavior for Fuel Cell-Powered Vehicles

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Project Description

Fundamental understanding of fuel cell vehicles and fuel cell power generation systems requires a scalable, dynamic fuel cell system model. The objective of this project is to develop a useful fuel cell system model that will help to analyze and understand different fuel cell system configurations and the dynamic effects of the fuel cell system on the fuel cell vehicles and help in our study toward a high performance fuel cell vehicles. And contribute to general training and education of students and young researchers at the same time.

The project is based on the fuel cell optimization and fuel cell vehicle models released by the Fuel Cell Vehicle Modeling Program (FCVMP), UC Davis during winter, 2001.

Research and Development Activities

- ❑ Develop a scalable fuel cell system optimization model in Matlab-Simulink. The model can automatically size and scale the compressor and water and thermal management system, and generate optimal operation condition for fuel cell vehicle models.
- ❑ Improve fuel cell vehicle models including the dynamic air supply system and scalable energy storage system. The speed of the compressor and the charging/discharging of the air supply manifold and exhaust manifold will be modeled.
- ❑ Optimize fuel cell hybrid control strategies and evaluate performance of fuel cell vehicles

Project Milestones

- ❑ Scalable fuel cell system optimization model
- ❑ Fuel cell model with dynamic air supply system
- ❑ Improved fuel cell vehicle models

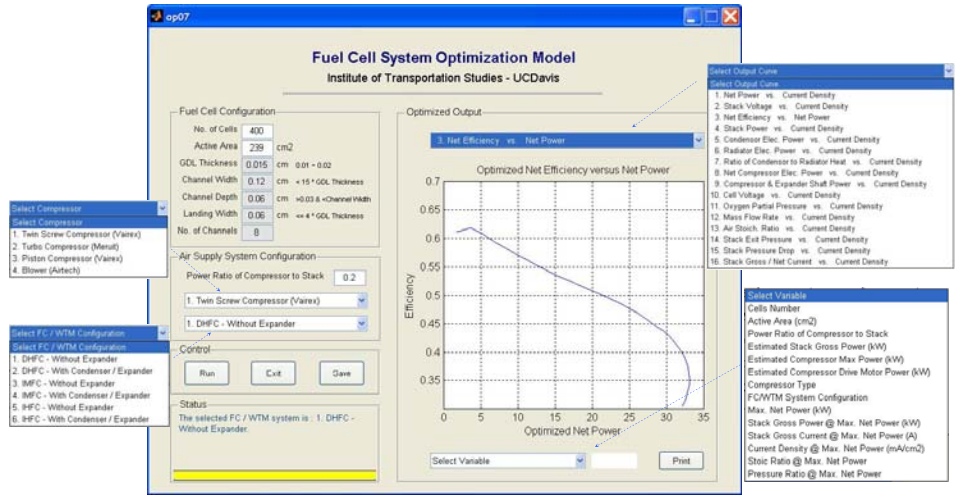
Collaboration Goals / Interests

Our fuel cell optimization model and fuel cell vehicle models are based on the dated (1995) fuel cell MEA experimental data. We plan on updating our cell model to reflect recent advantages in MEA technology to yield current fuel cell performance with the help of sponsors.

Scalable Fuel Cell Optimization Model

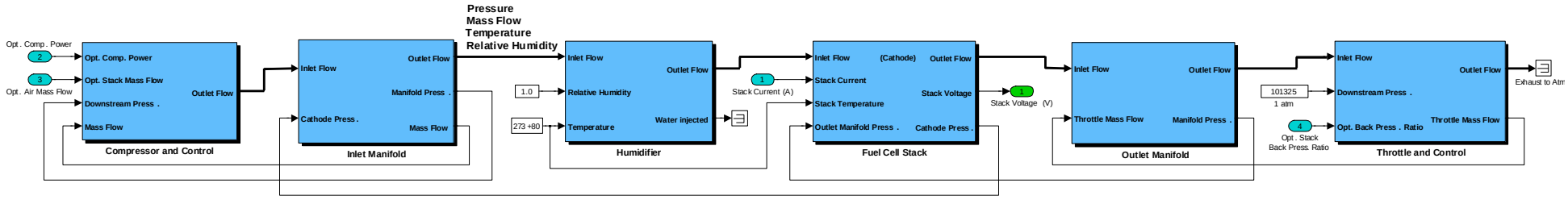
- ❑ Size and scale the fuel cells by the active area and number of the cells.
- ❑ Automatically search the maximum power operating point of the selected compressor and scale the performance maps of the compressor according to the ratio of the compressor power to the fuel cell gross power.
- ❑ Scale the optimal water and thermal management data by power.
- ❑ All data related to the fuel cell system can be defined and optimized in the optimization model and can be transferred to the UCD fuel cell vehicle models.
- ❑ Compare different air supply systems and generate their optimal operating conditions.
- ❑ Help direct and improve the design of auxiliary components, such as compressors.

GUI of the Fuel Cell System Optimization Model



Dynamic Model of Fuel Cell Air Supply System

The dynamic air supply system model was developed to ensure the proper air mass flow and pressure over the entire operating range, which is important for performance and but also to avoid fuel cell damage due to reactant starvation and unequal pressure. The compressor speed and the opening angle of the back pressure valve are controlled to ensure the fuel cell system operating around optimal operation points (obtained from the fuel cell system optimization model).



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