

Simulation

Fuel cell research and development efforts at Hawaii Natural Energy Institute (HNEI) encompass both modeling activities and extensive laboratory studies utilizing actual hardware. Modeling work focuses on simulation, as applied to a variety of levels in support of technology advancement for fuel cells, fuel cell systems, and specific applications. Simulation tools have been developed for individual cells, stacks, complete fuel cell systems, and applications such as fuel cell vehicles (FCVSim).

- **Cells and Stacks:** In cooperation with R&D activities for proton exchange membrane fuel cell (PEMFC), cell and stack simulation tools have been developed. HNEI has developed cell simulation in both MatLab/Simulink and [Dymola/Modelica](#) ^[1] environments for PEMFC. The existing stack simulation in Matlab/Simulink is currently being upgraded with new models. The cell and stack modeling and simulation research work are used to understand the fundamental working of a PEMFC in terms of its design, operating conditions, and material use with the intent to improve overall performance. HNEI is continually evaluating and developing such tools for use in its fuel cell R&D programs. In addition, there is also a plan to develop computational fluid dynamics (CFD) simulation tools for calculating variables within a fuel cell bipolar plate flow field. Such tools could be used to calculate fluid properties/species within the plenums of fuel cell stacks, and within individual stack cells.
- **Systems:** HNEI has developed a generic simulation tool ("FCSystemSim") for the overall fuel cell system, which is then customized for a specific PEMFC application. Figure 1 shows the customized PEMFC (H₂/O₂) system for unmanned underwater vehicle (UUV) application. HNEI is currently focusing on developing simulations of fuel cell applications such as a fuel cell vehicle (FCVSim), UUV and unmanned aerial vehicle (UAV). Some of these simulations, such as the FCVSim, which are characteristically very dynamic, are converted into a real-time simulation program. This real-time simulation program is being used in HiL testing in order to develop a control or operational strategies, and/or analysis of the dynamic limitations of a system or hardware in test (e.g. PEMFC or stack) under a certain dynamic load.

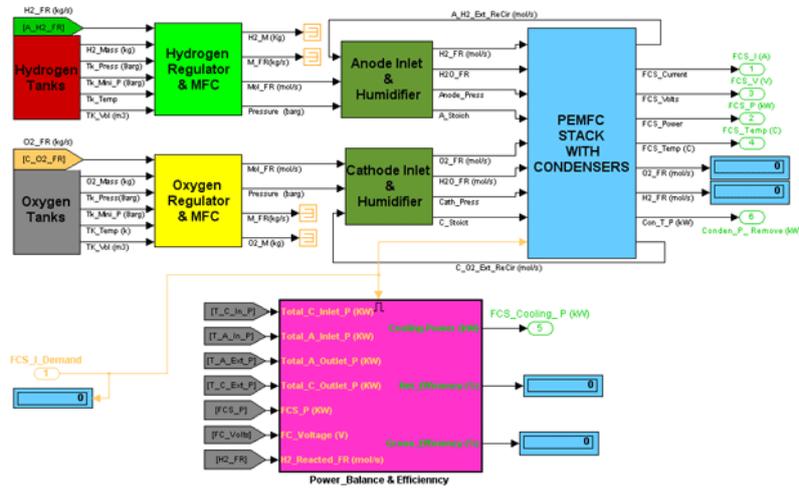


Fig. 1: Simulation tool for a PEMFC (H2/O2) System for the UUV

- Fuel Cell Vehicles:** A tool for dynamic fuel cell system simulation for the specific application of vehicles (FCVSim) has already been developed. Figure 2 shows the highest level structure of the FCVSim simulation tool. This tool will be continuously upgraded using improved dynamic models of the system components (cell, stack, compressor, dc-dc converter, etc) and will be used for the evaluation of the actual system components via real time simulation and the HiL dynamic test station. In addition, any other existing Matlab/Simulink programs for vehicle simulation will also be analyzed, modified, and utilized, as appropriate.

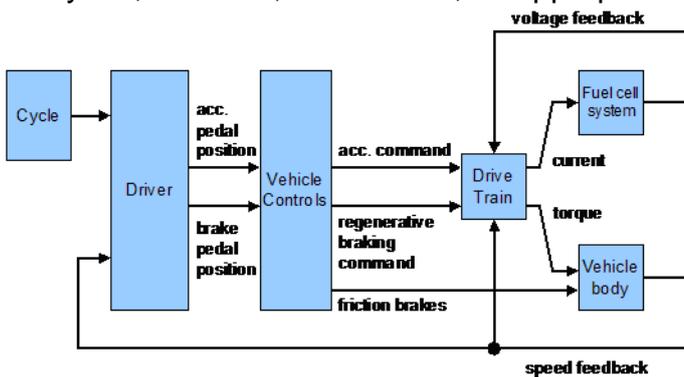


Fig. 2: Architecture of FCVSim

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Tags: [fuel cell testing](#) [2] [fuel cells](#) [3]

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Source URL: <http://www.hnei.hawaii.edu/research/fuel-cells/fuel-cell-testing/fuel-simul>

Links:

- [1] <http://web41.its.hawaii.edu/www.hnei.hawaii.edu/research-development/fuel-cells/fuel-cell-testing/fuel-simul-dymola>
- [2] <http://www.hnei.hawaii.edu/term/fuel-cell-testing>
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