Hardware-in-Loop

The Hawaii Natural Energy Institute (HNEI) Fuel Cell (FC) Hardware-in-Loop (HiL) dynamic test stand has been developed and is in operation evaluating proton exchange membrane fuel cells (PEMFCs) under dynamic application conditions. HiL methodology is well established in the automotive industry, where the technique is applied to develop and debug control algorithms for automotive drive systems. Similarly, HNEI?s FC HiL process shown in figure 1 is capable of the following:

- Evaluating a fuel cell or stack within the context of a fuel cell system design, an application (e.g., a fuel cell vehicle), and for a typical load pattern (e.g., a standard drive cycle).
- Developing optimal control strategies and algorithms for a fuel cell system and its associate components using a real-time simulation for a desired fuel cell application (FCV, UUV, UAV, CHP) under dynamic load profile.
- Decoupling of parameters, combined with high-end instrumentation allows distinguishing of impacts, allocation of weak spots, and performance degradation and ageing effects of the cell or stack.
- Evaluate both the performance and durability of a specific fuel cell or stack design (geometry, materials, flow fields, etc.) under dynamic test conditions that mimic the actual conditions that a cell or stack will experience when placed in a realistic environment.

Figure 1 below shows the FC HiL concept as applied to the HNEI dynamic test stand. This concept allows the actual experimental behavior of the fuel cell under test to be incorporated into the real-time simulation and the performance of the fuel cell for the simulated application and demand to be realistically determined.
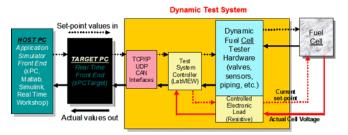

Fig. 1: HNEI Fuel Cell Hardware-in-Loop Concept

The original software and data communication provided by the test system vendor, and typically used in static fuel cell testing, were incapable of providing the dynamic response required for our FC HiL dynamic tester. To insure the correct dynamic testing of a fuel cell, the test stand controller response time should not be a limitation. Hence, the controller configuration was revised and redesigned based on improving performance and speed. Figure 2 shows the configuration of the new controller architecture which has a response time of <= 100 milliseconds (msec).

Fig. 2: New controller/communication Configuration

HNEI?s FC HiL dynamic test stand is being used as a valuable diagnostic tool for testing PEMFCs under conditions relevant to a particular dynamic application. Figure 3 shows how the FC HiL dynamic test stand can be applied as a PEMFC diagnostic tool.
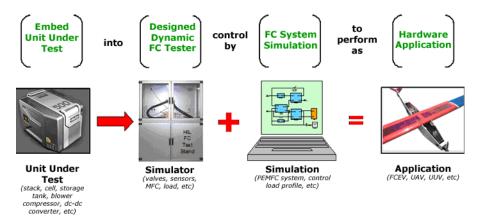

Fig. 3: HNEI?s FC HiL Test Stand as a diagnostic tool

The FC HiL system offers a great opportunity to characterize a PEMFC single cell or stack, develop control strategies and evaluate system components with high flexibility and cost efficiency.

Last Updated: Saturday, July 03, 2010

Hawaii Natural Energy Institute ? 1680 East West Road, POST 109 ? Honolulu, HI 96822 ? Ph: (808) 956-8890 ? Fax: (808) 956-2336 ? Email:Contact ?