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Bloomy Solutions

For Computer-Based and Networked Measurement and Automation Users

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LabVIEW DSC Automates Fuel Cell Catalyst Research

by Robert O. Hamburger, Bloomy Controls, and Lloyd Ploense, HydrogenSource, LLC

HydrogenSource, a joint venture between United Technologies Fuel Cells Corp. (UTCFC) and Shell Oil Co., produces fuel processors and hydrogen generation systems. Currently HydrogenSource is involved in research and engineering efforts to evaluate the performance of fuel processing system (FPS) catalysts and related components. These studies employ experimental chemical reactors (Figure 1) that require the control and monitoring of large numbers of process parameters such as temperature, flow, pressure, and gas composition,

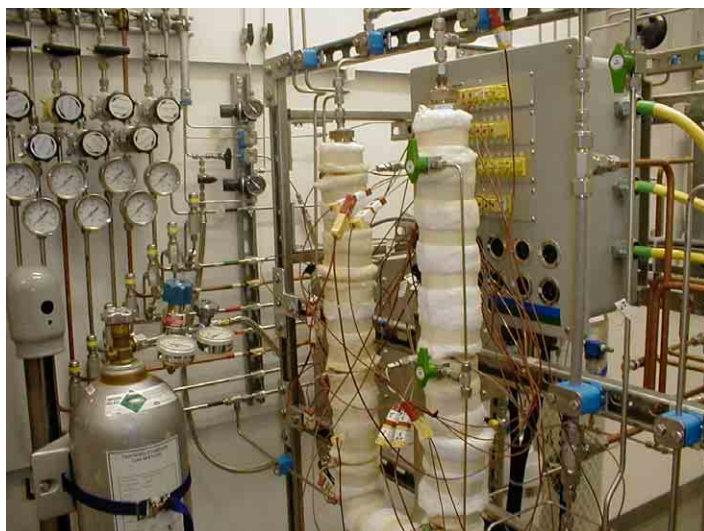


Figure 1. Experimental catalyst reactor

for periods ranging from a few minutes to several months. Previous manual monitoring methods were extremely labor-intensive, susceptible to human error, and would not provide either the quantity or quality of data required.

HydrogenSource contracted Bloomy Controls to specify, design, and implement a series of systems that would facilitate automated operation and data collection to support HydrogenSource's newly constructed FPS laboratory. The tests run in each reactor vary significantly from one experiment to another, and at the time the system was designed, all of the planned experiments were not fully defined. What was required was a system design that could accommodate a wide range of different sensors, transducers, and controls; be easily reconfigured for different experiments; and be capable of collecting large volumes of data while maintaining continuous process control.

Software

FPS catalyst experiments typically are composed of a sequence of timed steps, with process parameters either held at constant values or linearly ramped to desired settings, while data reflecting the system's performance is collected. A sophisticated recipe-driven architecture was created to give experimenters the flexibility to define and run a wide range of test protocols. The two major software components comprising this system – the Recipe Editor and Automation Engine – were written using the LabVIEW Datalogging and Supervisory Control (DSC) module.

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LabVIEW DSC Automates Fuel Cell Research (continued from page 1)

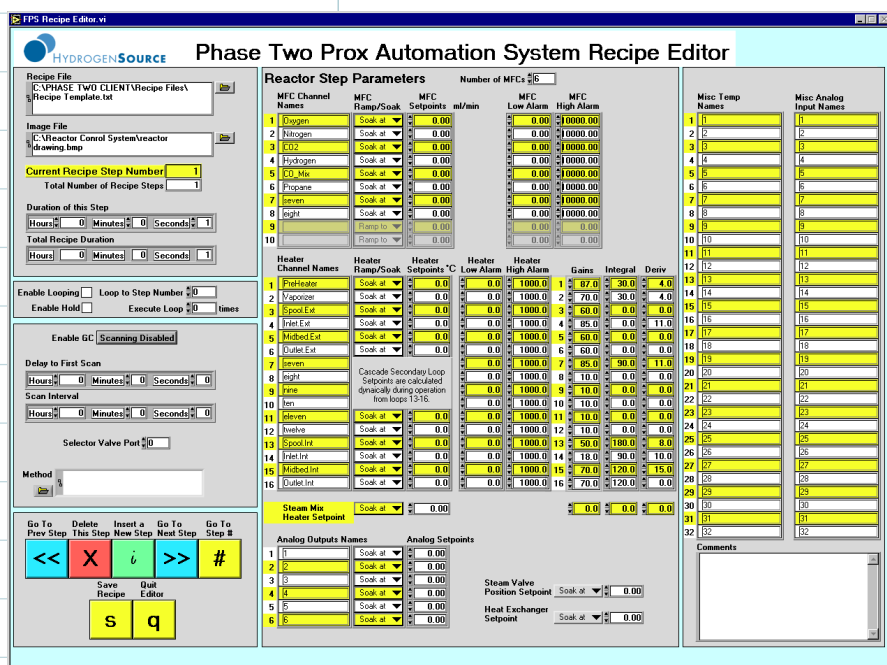


Figure 2. Recipe editor

The first component of the system is a Recipe Editor (Figure 2). Each step in an experimental test is defined by attributes including the duration of the step in seconds, set points to each controlled process parameter, definitions of high and low alarm values, and recipe sequence controls such as holding and looping. In any step, if Hold is enabled, execution of the recipe pauses at the end of the step. User input (pressing the Continue button) resumes automatic recipe sequencing. The capability for program looping allows the user to select the desired step to which to loop back, as well as the number of loop repetitions. Additionally, simple descriptive text comments for each step may be entered for documentation. Intuitive editing commands (Insert, Delete, Go To Next Step, Go To Previous Step) enable fast and easy recipe editing. The recipe is stored in a modified Windows-style.ini format – a header

section contains keys describing overall system settings (number and kind of each type of parameter, number of steps, etc.), while sections of the format [step #] each contain the detailed values for the respectively numbered recipe step.

The second major software component is the Automation Engine. This VI's front panel includes all current values of the various parameters in the system, along with descriptive recipe information previously listed. Mode Control buttons enable operation of the system – start execution of the selected recipe, pause in the current recipe step, immediately advance to next step, or abort execution of the current recipe. In addition, the Automation Engine contains a Virtual Manual Controls panel, which allows manual set point overrides, on a channel-per-channel basis, for all controlled values. This function provides the option of modifying or “tweaking” individual parameter values, independent of the current recipe, in order to fine-tune or similarly interact manually with the process. Underlying the user interface, a mixture of acquisition methods is used to make best use of the available hardware resources. A custom serial server was written to control the mass flow controllers and other analytical instrumentation, while Lookout Protocol Drivers facilitate serial Modbus RTU communication with the external PID controllers. All set point and measured parameters are logged to a Citadel database through the DSC tag engine. On the other hand, the SCXI hardware is managed through programmatic DAQ commands to accommodate both slow and fast acquisition modes. During steady-state experiments, SCXI channels are written to memory tags, while in transient tests (where sampling rates in excess of 100 Hz are needed), data is written directly to a conventional spreadsheet file. Flexible extraction tools and LabVIEW DSC's native Historical Trend Viewer allow straightforward data mining and viewing of collected data. These utilities complement the automation system's capabilities for managing and examining data.

Results

Several versions of this system have been in operation successfully at HydrogenSource for almost two years, enabling researchers to conduct complex and lengthy experiments with a minimum of user intervention. The authors estimate that these automation systems have cumulatively saved in excess of 10,000 man-hours of work that otherwise would have been expended in manual control, monitoring, and data collection efforts. ↷

To learn about the hardware configuration of this system, visit www.bloomy.com/lv_dsc_automates_fuel_cell.pdf.

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