R & D facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Energy Systems Dynamics

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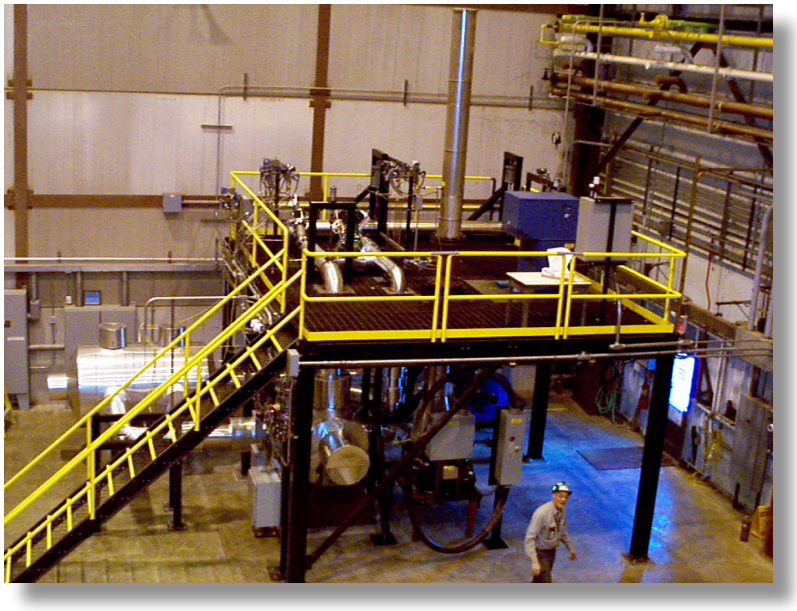
Hybrid Performance Project

Research programs initiated by the U.S. Department of Energy (DOE) to achieve increased efficiency and reduced emissions are expected to result in the development of power generation technologies that are clean and use far less fuel to produce the same power as technologies used today. This highly efficient technology would extend our natural resources and reduce the dependence of the United States on foreign sources of oil and other energy feedstocks. No single technology is capable of meeting the aggressive efficiency targets proposed by DOE programs such as FutureGen. The only technology identified with the promise of meeting such a challenge is a combination of a high temperature fuel cell and a gas turbine. This hybrid technology has been studied extensively through the use of numerical models and a limited number of demonstration projects. The Hybrid Performance Project (Hyper) was initiated by the Office of Research and Development at DOE's National Energy Technology Laboratory (NETL) to examine fundamental issues related to the integration of the two distinct technologies. Plainly put, the goal of the Hyper project is to determine how to make high temperature fuel cell turbine hybrids work.

Capabilities

Developing an understanding of dynamic issues related to the coupling of fuel cell and gas turbine technologies is critical to the design of commercial equipment and responsive control of the hybrid system. The initial phase of the Hyper project involved system analysis and detailed dynamic modeling of fuel cell turbine



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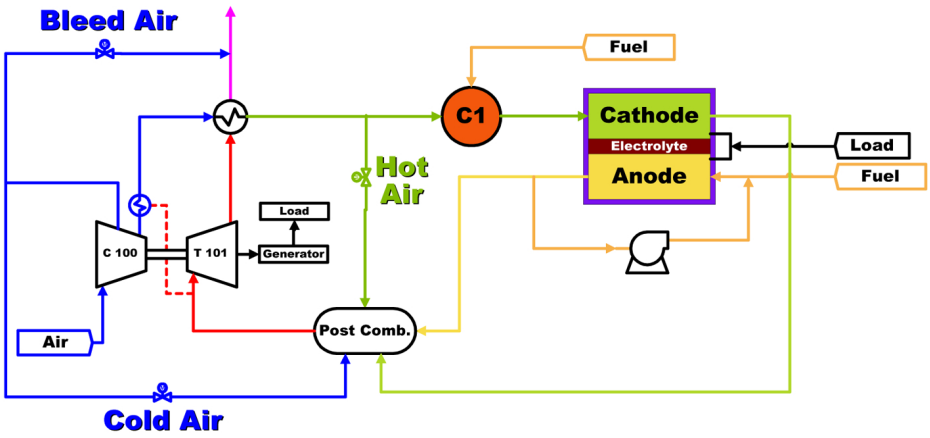
hybrid technology. NETL maintains a leadership position in this type of numerical simulation. As technical issues and potential benefits of the technology were identified, the need for hardware became apparent. An experimental test facility was designed and built at NETL's Morgantown site as a resource to researchers and industrial developers of hybrid systems. The facility is the only one of its kind anywhere in the world.

The experimental facility simulates a fuel cell through a combination of hardware and software. This hardware (pressure vessels, piping, and a burner) is coupled to heat exchangers and a turbine in order to evaluate the dynamics of a fully integrated system. Because the fuel cell is simulated, a variety of fuel cell types and geometries can be tested without risk to such an expensive component of the system. Development of controls for hybrids sometimes requires extended operation of the system at unstable conditions. In determining the operating boundaries of the system, preliminary tests would have resulted in the destruction of many fuel cells. A diagram of the type of simulated hybrid system is shown in the following figure.



The test facility was designed to isolate and independently instrument each component of the system and is capable of simulations for systems up to 1MW. Recently, a variable load bank was added to the facility to control turbine speed independently from the fuel input. This allows researchers to conduct a wider range of fuel cell transient simulations and to impose a load profile on the turbine in the system. The addition of a dSpace simulator has expanded the capabilities of the fuel cell simulation to include spatial resolution of fuel cell components in real time. In the last year, several control strategies have been successfully demonstrated, and development of a controller is underway through a collaboration with a local university.

Opportunities

The Hyper experimental facility and modeling results are available for public research collaboration with universities, industry, and other research institutions. In addition to planned NETL studies, the Hyper facility is intended to provide a test platform for novel sense and control strategies that may emerge from university or small business research projects. Collaboration with academic, non-profit, or commercial research groups can be arranged under a variety of cooperative programs, such as a Cooperative Research and Development Agreement, and student or visiting scholar programs.