

VII.I.7 Fuel Cell Testing at Argonne National Laboratory

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Start Date: Facility commissioned 1999

Projected End Date: Project continuation and direction determined annually by DOE

Objectives

- To provide DOE with an independent, unbiased assessment of DOE contract deliverables
- To benchmark performance of state-of-the-art fuel cell technology

Technical Barriers

This project addresses the following technical barriers from the Fuel Cells section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- B. Cost
- F. Fuel Cell Power System Integration

Introduction

The objective of this task is to test and evaluate fuel cells, stacks, balance-of-plant components, and complete system hardware developed under DOE sponsorship, as well as state-of-the-art test articles obtained from other commercial developers, and document their performance relative to DOE's technical targets, which are summarized in Table 1, below [1]. The data obtained are provided to DOE and the component or system vendor. Any further dissemination or public release of the data is carried out by the DOE or the vendor at its discretion and as appropriate.

Approach

- Use technical guides and standards (published or draft) for the testing:
 - ASME PTC50-2000: Fuel Cell Power Systems Performance,
 - SAE J2578: Recommended Practices for General Fuel Cell Vehicle Safety, and
 - J2616: Performance Test Procedures for the Fuel Processor Subsystem of Automotive Fuel Cell System.
- Conduct all experiments in NEC Class I Div. 2B facility. Facility safety systems are designed with a reactive philosophy. The facility will react to two concentrations of hydrogen (continuous ventilation takes care of small leaks):
 - 20% of lower flammability limit (LFL): testing suspended and fuel supply is turned off, and
 - 40% of LFL: same as above plus fire department notified, enhanced ventilation started up and power removed from non-critical instruments.
- For fuel cells, stacks, and systems, characterize the performance of the deliverable in terms of polarization curves, with constant power at 25% and 100% of rated power.

- For balance-of-plant components, determine performance maps under simulated system operating conditions.
- For systems and components, obtain energy efficiency at 25% and at 100% of rated power and power density/specific power at the rated power.
- For fuel cell stacks, assess performance variations from cell to cell (or among groups of cells) as a function of load and other operating parameters.
- Re-evaluate stack performance after the cycling period and then repeat the cycling profile
- Continue this test protocol for the desired test period, desired number of cycles, or a maximum acceptable performance degradation, whichever occurs first
- Survivability
 - Benchmark stack performance as delivered
 - Cool stack/system down to target temperature and soak for at least 8 hours
 - Increase temperature to normal operating point and re-evaluate stack performance

Accomplishments

- Evaluated 85-kW commercial, state-of-the-art stack, 50-kW developmental full system, cathode air blower, and reformer air blower. Provided test data and reports to DOE and to the respective vendors.

Future Directions

- Cold-start-up performance testing and fuel use during warm-up
 - Cold Start #1 (less realistic, but cheaper to implement)
 - Cool stack/system down to target temperature and soak for at least 8 hours
 - Remove cooling system and start stack (allow it to heat itself and surroundings)
- Cold Start #2 (more realistic, but expensive to implement)
 - Cool stack/system down to target temperature and soak for at least 8 hours
 - Start system while still maintaining the cold ambient temperature
 - Measure start-up energy
- Durability
 - Develop a meaningful start-up/shut-down/cycling profile for durability tests and coordinate with DOE to prepare 2007 cycling profile
 - Benchmark initial stack performance as delivered
 - Load stack according to the developed cycling profile repeatedly for a pre-specified period of time

Table 1. Technical Targets for Direct Hydrogen Fuel Cell Stack [1]

Characteristics	Units	2005	2010	2015
Stack Efficiency @ 25% of rated power	%	65	65	65
Stack Efficiency @ rated power	%	55	55	55
Stack Power Density	W/L	1500	2000	2000
Stack Specific Power	W/kg	1500	2000	2000
Cost	\$/kWe	65	30	20
Transient response (time from 10% to 90% of rated power)	Sec	2	1	1
Cold start-up time to maximum power @ -20°C ambient temperature	Sec	60	30	30
	Sec	30	15	15
Precious Metal Loading	g/kW	2.7	0.3	0.2
Durability with thermal cycling	Hours	2000	5000	5000
Survivability	°C	-30	-40	-40

References

1. See <http://www.eere.energy.gov/hydrogenandfuelcells/mypp/> for latest values of technical targets.