DYNAMIC MODELING
PROTON EXCHANGE MEMBRANE FUEL CELL

OVERVIEW

Current/Completed Plug Power activities list

- Testing of natural gas SU-1
- Display of natural gas SU-1 (plexi-glass panels)
- Testing of natural gas GenSys-5
- Use of GenCore to test reformate quality effects using a novel cyclic autothermal reformer from GE
- Use of GenCore to investigate effects of fuel quality and dynamic changes in fuel composition and flow on performance
- Dynamic simulation of the GenSys and GenCore systems
- Support of sales team when asked (show operating units, discuss technology, objective perspective)
- Worked as partner to garner SCAQMD funding for fuel cell testing

GenCore system is sensitive to diluents

- As built design includes exhaust gas recirculation and a vent flow for removing small amounts of fuel contaminants

UCI System Modifications:

Anode exhaust gas recirculation (EGR) system eliminated

- Dead-headed anode was transformed to an anode with a straight-through flow path
  - Mechanism for venting only 0.05% impurities not sufficient
  - Leads to a buildup of impurities in the anode
- Humidification was added to simulated fuel stream to compensate for removal of EGR
- Functionality of the modified GenCore Fuel Cell system was tested
  - H_2 operation repeated to determine baseline operability with modifications
  - Diluents (CO_2, CO, CH_4) added to H_2 stream as “proof of concept” of straight-through anode
  - Flow rates were determined based on 33-50% utilization for all operating condition

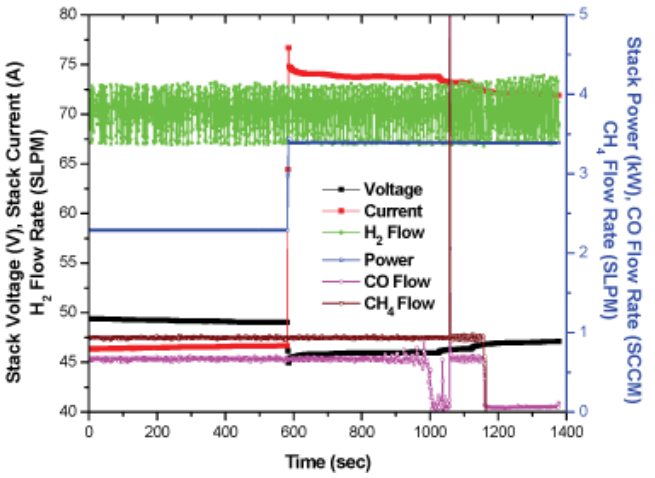
GenCore Testing with ACR

Typical reformate compositions produced by ACR approach:		
	Low	**High**
Hydrogen	70%	100%
CO2	25%	30%
C0	0 ppm	10 ppm
CH4	0%	2.40%

Reformate composition of initial tests:

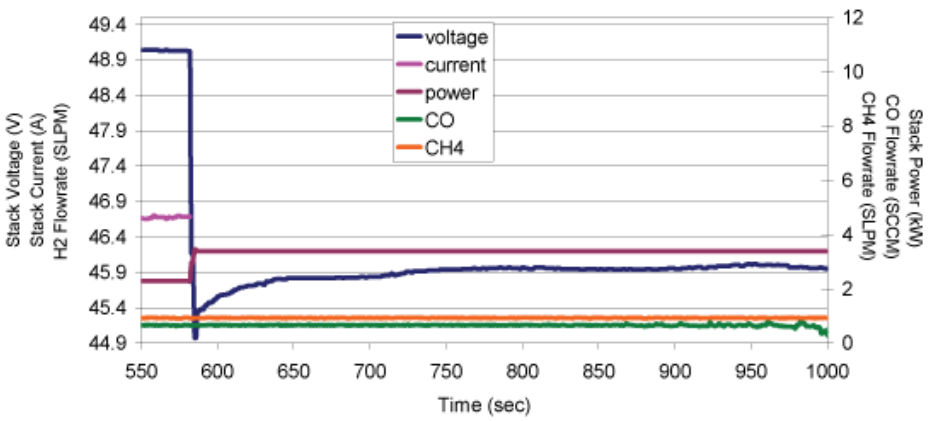
	%	**Flow**
Hydrogen	74%	70 slpm
CO	10 ppm	0.65 sccm
CH4	1%	0.937 slpm
CO2	balance	

Simulated Reformate as Fuel

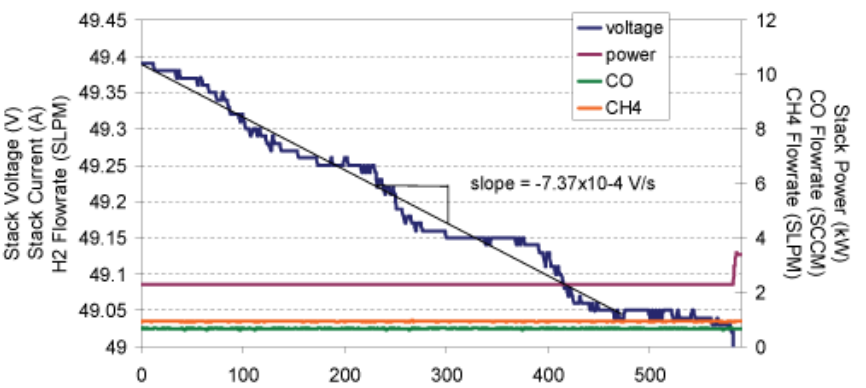


GenCore Performance with Straight-Through Anode

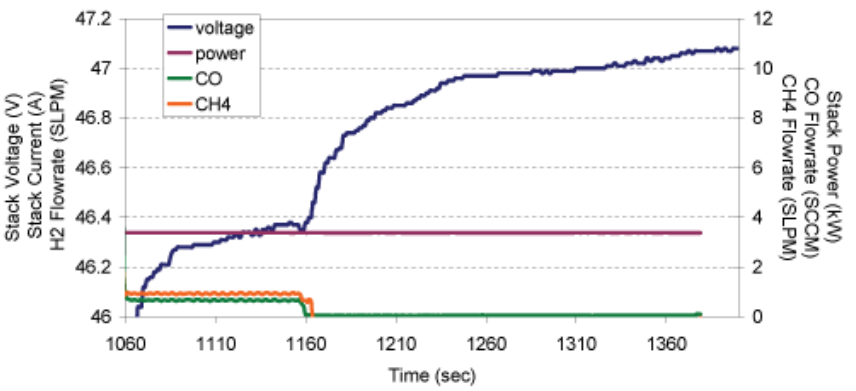
Step Change of Power From 2.3kW to 3.4kW



Voltage Drop With CO Level Set to 10ppm
Power=2.3kW



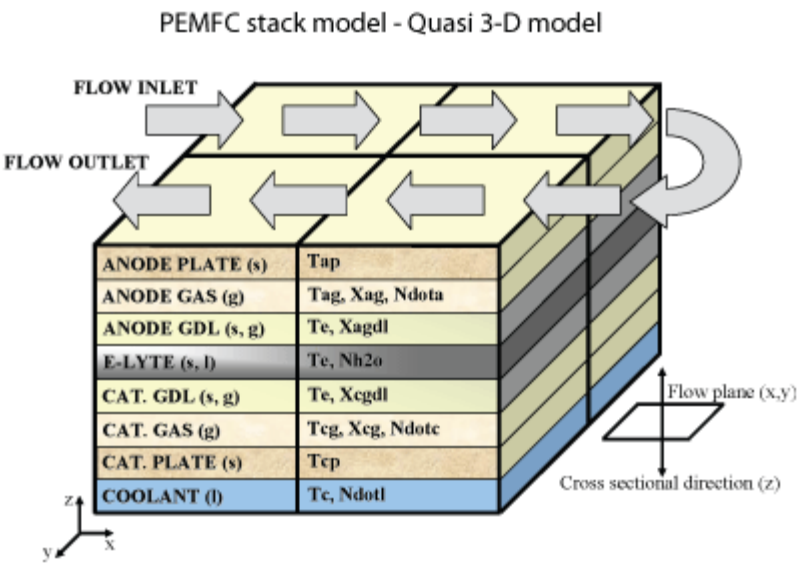
Voltage Increase Without CO
Power=3.4kW

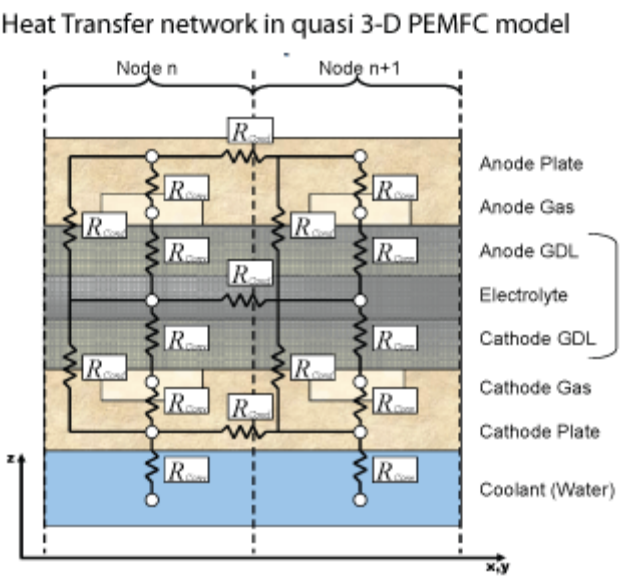


Summary – GenCore Testing with ACR

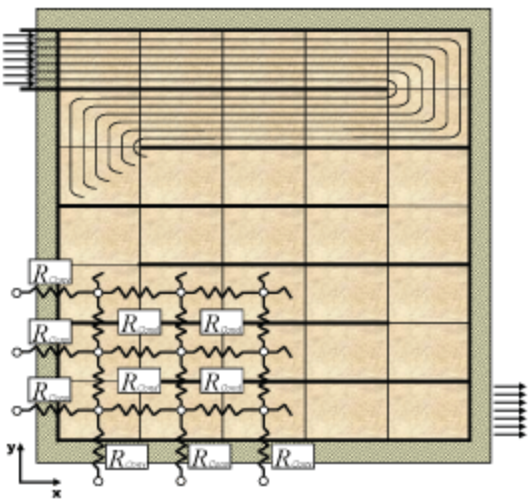
- Unmodified GenCore Fuel Cell system cannot be operated on a fuel with an impurity level over the design limit (99.95% H2)
- Modified GenCore Fuel Cell system with straight-through anode can be operated on reformate fuels
- CO Poisoning effect on fuel cell anode is still a vital issue to be addressed and investigated
    - But measured performance with 10 ppm < [CO] < 100ppm showed no long-term degraded performance
- Integration of GenCore Fuel Cell system with the GEGR ACR system was a success (although reformer never met desired fuel specifications)

Dynamic Model of GenSys System

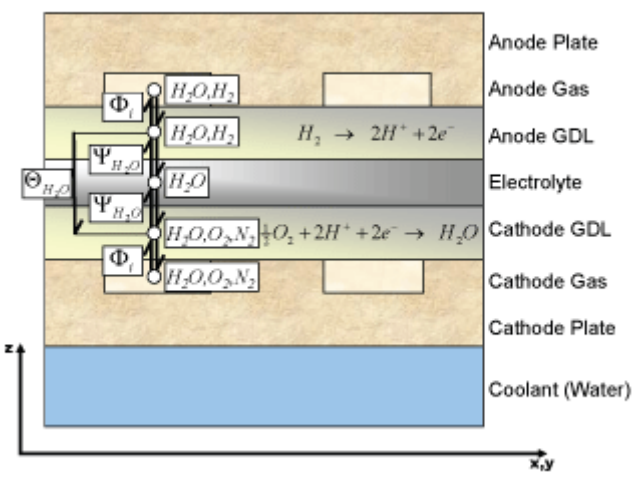




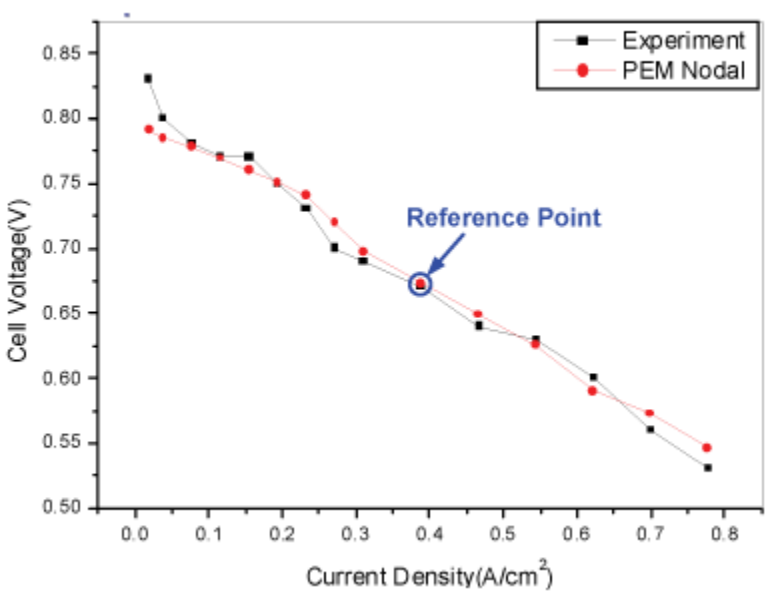
Heat Transfer Network in Quasi 3-D PEMFC model



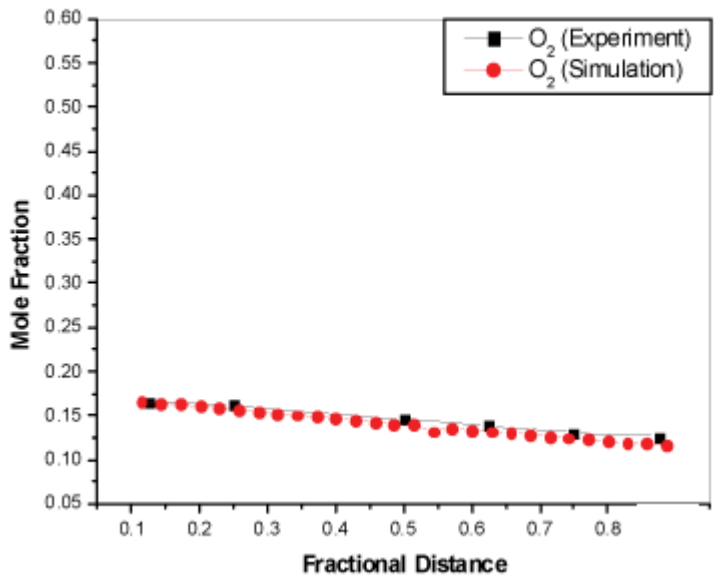
Water Dynamics – Quasi 3-D PEMFC model



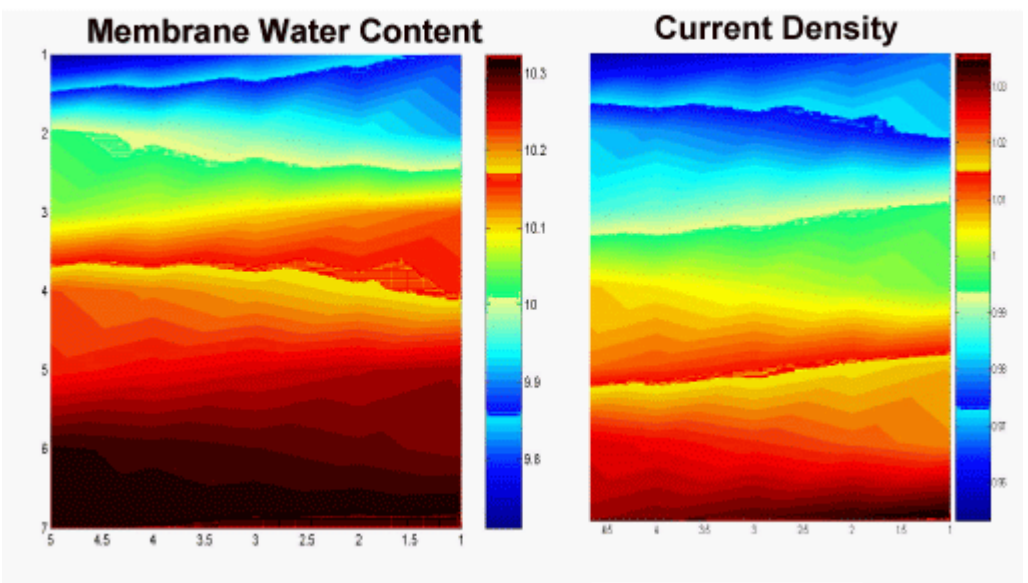
Model comparison to Seoul National Univ. PEMFC data



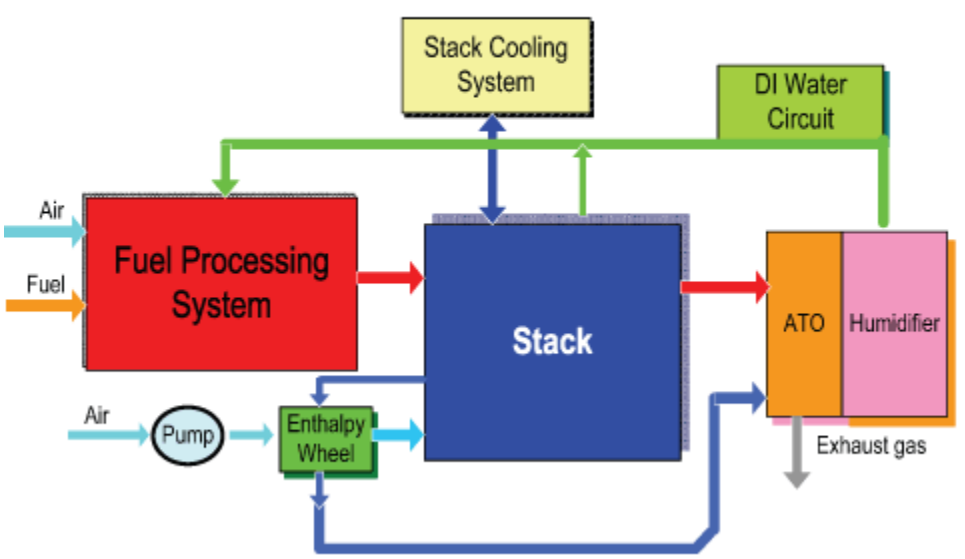
Model comparison to Seoul National Univ. PEMFC data



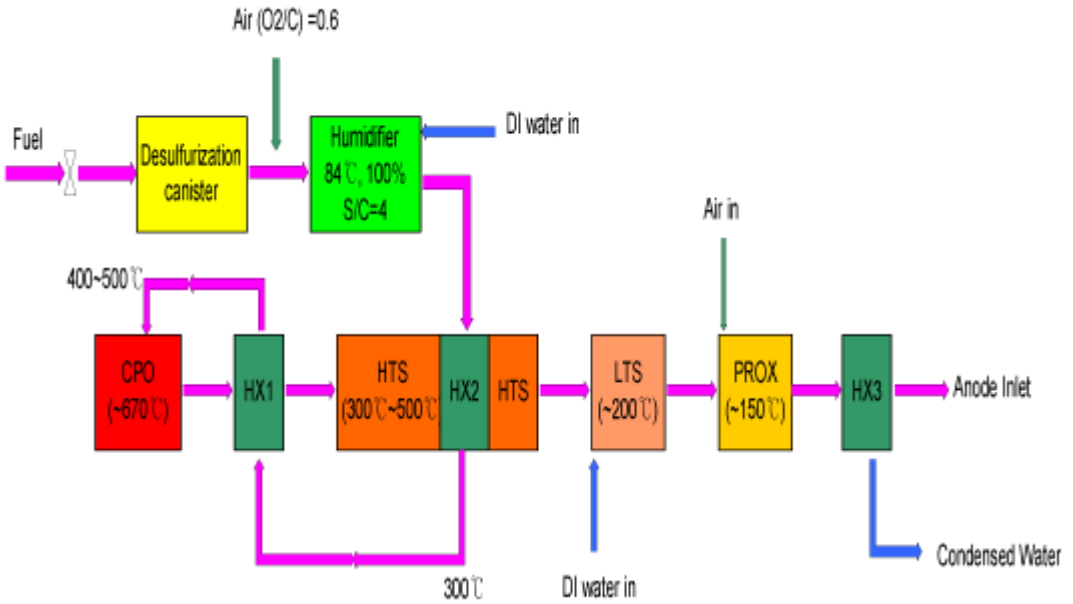
Quasi 3-D PEMFC model results



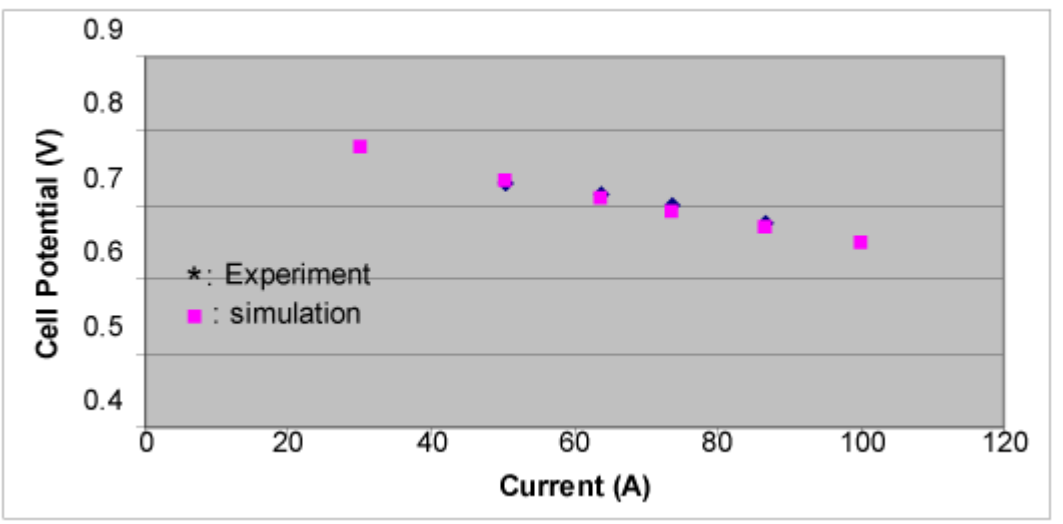
Plug Power GenSys-5 PEMFC System Model



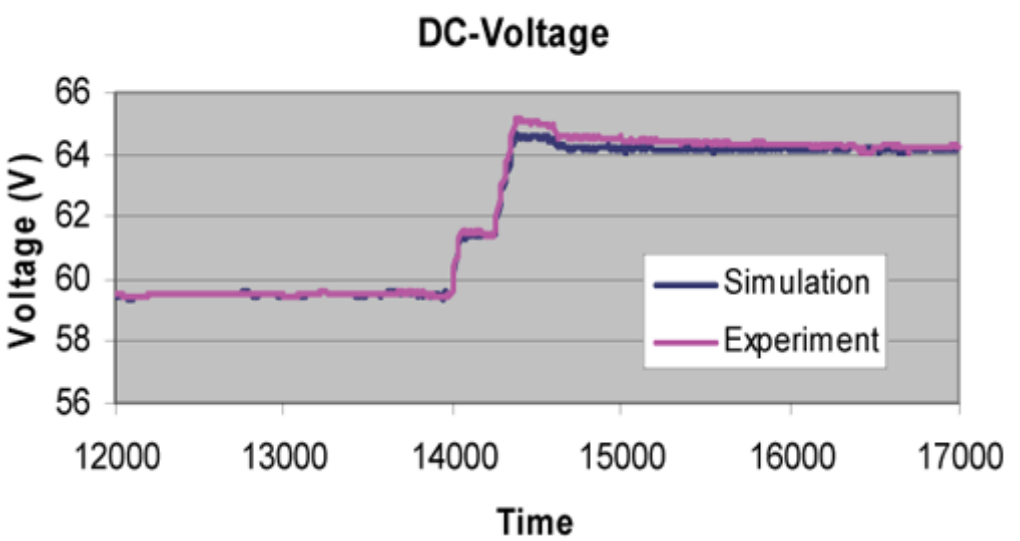
Plug Power GenSys-5 PEMFC System Model



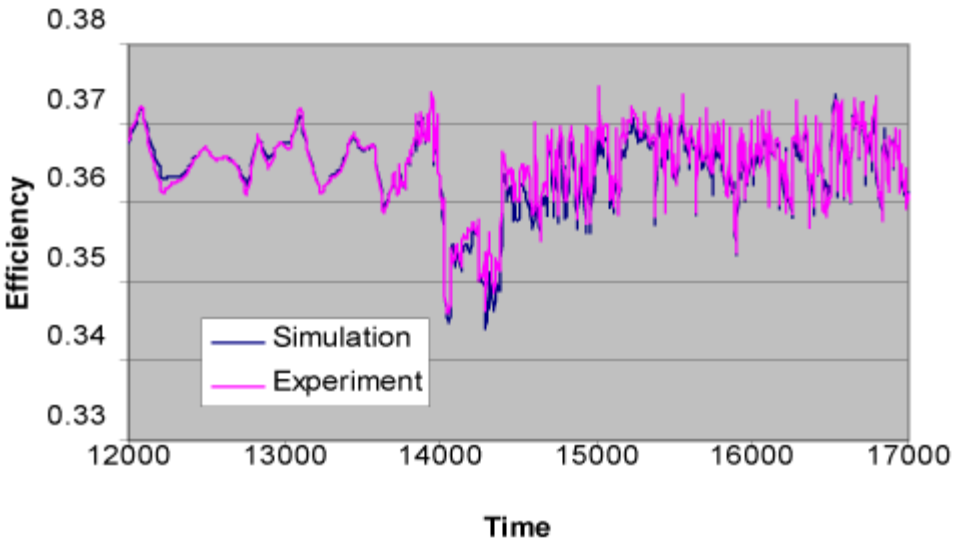
Plug Power GenSys-5 PEMFC System Model – data comparison



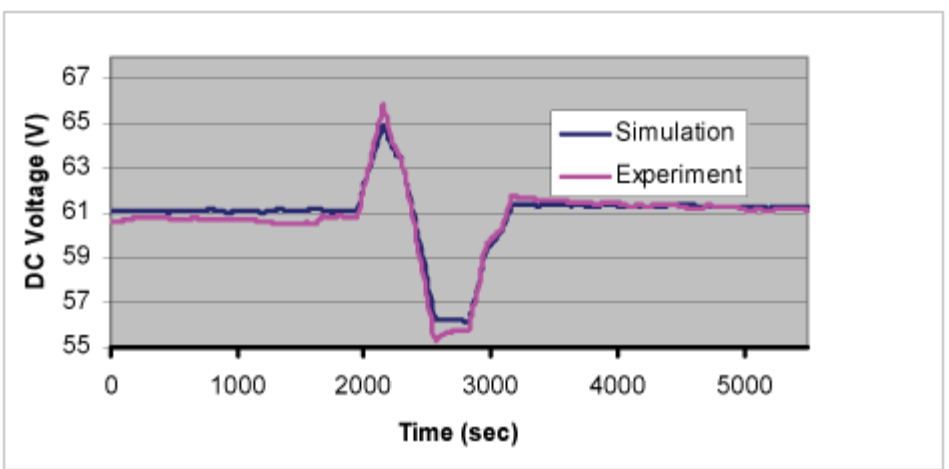
Plug Power GenSys-5 PEMFC System Model – Voltage Transient comparison



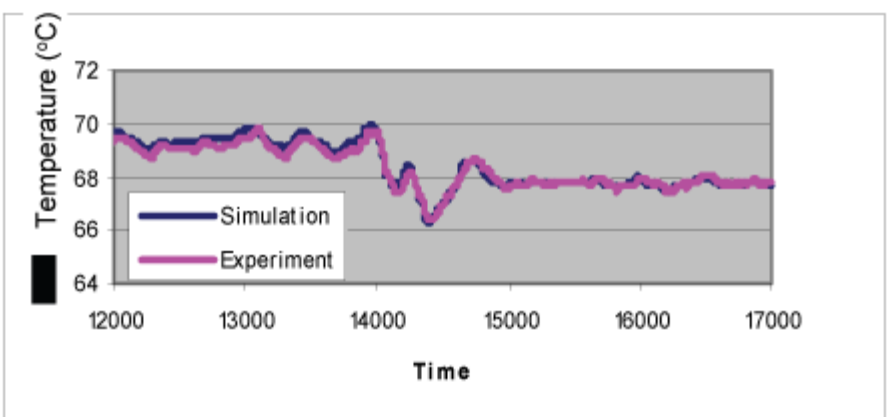
Plug Power GenSys-5 PEMFC System Model – Stack DC Efficiency comparison



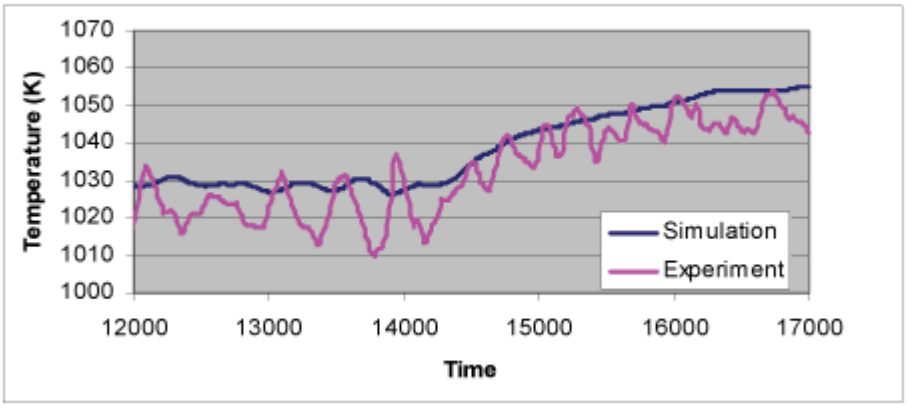
Plug Power GenSys-5 PEMFC System Model – Stack Voltage Transient comparison



Plug Power GenSys-5 PEMFC System Model – Fuel Cell Stack Coolant Temperature comparison



Plug Power GenSys-5 PEMFC System Model – CPOx Reactor
Temperature comparison



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SPONSORS

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