# Hydrogen Fuel Cell Electrical System Performance Final Research Project Report







SAC Undergraduate Research Program 08/30/2016

# Participants

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### Background

- We are working to build a hydrogen fuel cell vehicle for Shell Eco Marathon
- Shell Eco Marathon?
  - Design, build, test, and drive a highly energy efficient vehicle
  - Students from the Americas (North, Central, and South)
- We've received the help from:
  - SAC Faculty
  - Industry Contacts
  - Texas State University



#### **Purpose and Objectives**

- Learn how to setup and operate the Hydrogen Fuel Cell Stack (HFCS)
- Better understand how the HFCS performs under different circumstances
  - Varied gas level pressures to HFCS
  - Different loads and output power levels for the HFCS
- Find how we can optimize the HFCS for fuel efficiency
- Incorporate our findings for the Shell Eco Marathon



# **Project Timeline**

- Week 1
  - Learned about + made layout diagram for HFCS components
- Week 2
  - Made Electrical Diagram + built supporting structure from component layout
- Week 3
  - Research Hydrogen Gas Safety and Electrical Safety
- o Week 4
  - Tested the Electric Motor (we had planned on using)
- Week 5
  - Finding Flow Meter and Compression Fittings + Reviewed Safety

# Project Timeline (continued)

- Week 6
  - Search for Compression Fittings
- Week 7
  - Search for Compression Fittings + Attended Digital Story Workshop
- Week 8
  - Practice run the HFCS + Search for Pressure Gauge
- Week 9
  - HFCS testing!
- Week 10
  - Worked on Final Research Report, Poster, PowerPoint, and Video

# **Materials**

- Hydrogen Gas Tank
- Pressure Regulator
- Pressure Gauge
- Flow Meter
- H-1000XP Hydrogen Fuel Cell Stack
- Hydrogen Fuel Cell Controller
- LCD Screen
- Load Resistors
- Hydrogen Leak Sensor



#### Method





# Methods

- Performed tests on the HFCS to optimize fuel efficiency
  - Varied the hydrogen gas pressure supplied to the HFCS
  - Varied the load on the HFCS (different configurations and number of resistors)
- Increased gas pressure by intervals of 0.25 psi
- Power = Voltage\*Current
- Output power levels: 86, 125, 164, 214, 401, 553, 867 watts
- Fuel Efficiency = Power Output / Fuel Consumption Rate
- We performed testing at a lab and with a ventilation hood



#### Results



# Conclusion

- A smaller load resistance resulted in higher power outputs and decreased fuel efficiency in most cases
- Fuel efficiency at high output power levels didn't vary much from low to high gas pressures
  - High gas pressures had little to no effect on efficiency at the high power output levels (214, 401, 553, 867 W)
  - High gas pressures caused efficiency to generally decline at the low power output levels (87, 125, 164W)
- Higher fuel efficiencies occurred when the input gas pressure and power output were low for the HFCS
- Low fuel efficiencies occurred when the power output was high

#### Lessons Learned

- Communication, teamwork, attendance, and a positive attitude is key
- Make flexible timeline with room for errors/unforeseen circumstances (they will happen!)
- Have a backup plan for when something can go wrong
- Be safe and careful when dealing with hazards (know you stuff)
- Solve one problem at a time and then move on to the next one
- Research can be fun!!!

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# Thank You



# Questions?

