CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
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Project Number
S1921

Project Title
Creating and Modifying a Fuel Cell System for Clean Energy

Abstract

Objectives/Goals
Fossil fuels are not a sustainable energy source and their emissions significantly degrade air quality. The greenhouse gasses they release are a leading factor in global warming. Hydrogen used in fuel cells helps contribute to a sustainable energy solution. The purpose of this project was to create a proton exchange membrane (PEM) fuel cell using readily available materials and increase its performance through structural modifications.

Methods/Materials
A membrane electrode assembly (MEA), used as the catalyst, was sandwiched between two graphite plates with channels cut to provide hydrogen and oxygen for the reaction. A multimeter was used to measure voltage and amps for each trial. The surface area of hydrogen exposed to the catalyst was varied using interchangeable plates A, B and C with surface areas of 2.6cm^2, 1.31cm^2 and 0.58cm^2 respectively. A modified McLeod gauge measured the pressure within the system and a valve was used to regulate the flow of hydrogen. Trial sets were run for each of the plates at 0.5mm Hg above atmospheric pressure and then at 4mm Hg. This data was used to calculate the power output of a hypothetical Plate D with a surface area of 26cm^2.

Results
Plates A, B and C produced 0.064W, 0.065W and 0.071W at 0.5mm Hg and 0.082W, 0.073W and 0.074W at 4mm Hg respectively. The percentage change of power from 0.5mm Hg to 4mm Hg for Plates A, B and C were 1.281%, 1.23% and 1.042% respectively, showing a greater change for larger surface areas. The graph of the percentage change in power relative to the exposed surface area for all trials revealed a linear relationship. This was used to project the percentage change of power for Plate D to be 4.06%. The power output of Plate D at 0.5mm Hg was projected to be 0.054W with the curve of best fit for the average power outputs of Plates A, B and C at 0.5mm Hg. The projected power for D was 0.219W at 4mm Hg.

Conclusions/Discussion
This project compared the power output of a PEM fuel cell to the exposed surface area of an MEA and the pressure within the fuel cell system. Trials with greater exposed surface area to hydrogen flow had greater rates of power increase with pressure in relation to the others. This indicates that pressurized systems are needed to achieve optimal performance in larger fuel cells.

Summary Statement
This project compared how the amount of hydrogen pressure and the surface area of a membrane electrode assembly (MEA) catalyst exposed to hydrogen affect the power output of a proton exchange membrane fuel cell.

Help Received
I did all my research and experiments at home with parental supervision. Experiments were conducted outside for safety with at least one parent present at all times.