

# **Anurag Bajpayee, Mechanical Engineering**

Year in School: Senior

Hometown: Columbia, MO

Faculty Mentor: Dr. Gary Solbrekken, Mechanical & Aerospace Engineering

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## **Analytical model for space constrained optimization of proton exchange membrane fuel cells**

Hydrogen fuel cells are currently being looked at as one of the energy conversion devices of the future. Of the different fuel cell varieties Proton Exchange Membrane (PEM) technology, is the most promising given its high efficiency and power density, and is the focus of this work. Fuel cells are most commonly thought to be a power source replacement for internal combustion engines of land based vehicles. However, consumers have demonstrated a willingness to pay a premium for portable energy, such as dry cell batteries. It is therefore positioned that there would be a significant market for a fuel cell designed to operated in space constrained devices such as cell phones, notebook computers and space probes. Further advantages of a small scale fuel cell are that they do not create toxic waste and can be instantly recharged. It is desirable to optimize the fuel cell design using spatial constraints. An energy balance based analytical model has been developed to estimate fuel cell performance. The model is used to explore parametric design trends of material properties for the electrodes, the catalyst, the membrane and the fuel. Various physical parameters are also investigated by varying the water content of the membrane, the hydration state of the reactive gases, the stoichiometric ratios of the fuel and the distribution pattern and density of the catalyst on the gas diffusion layers. Finally, the system geometry is optimized.