215a The Power Performance Curve for Engineering Analysis of Fuel Cells

Jay B. Benziger, I. G. Kevrekidis, M. B. Satterfield, W.H.J. Hogarth, and J.P. Nehlsen

The power delivered by a fuel cell to an external load is controlled by the impedance of the external load. The Power Performance Curve is a new metric that relates the power delivered to the external load to its impedance. The power delivered is zero for both an open circuit and a short circuit (infinite and zero external impedance) and is a maximum when the external load impedance matches the internal resistance of the fuel cell. Fuel efficiency is 50% at maximum power output. Higher fuel efficiency is achieved when the load impedance is much greater than the internal resistance of the electrolyte. A simple equivalent circuit for the fuel cell consisting of a battery, diode and resistor captures the essential characteristics of a fuel cell as part of an electrical circuit and can be used to analyze of the response to changes in load. Simple circuit analysis can be employed to elucidate the power output and efficiency of large area fuel cells and fuel cell stacks. Non-uniformities in large area fuel cells create internal potential differences that drive internal currents dissipating energy. Non-uniformities in fuel cell stacks can drive low power cells into an electrolytic state, eventually leading to failure. The Power Performance Curve simplifies analysis of control and operation of fuel cell systems.