Investigation and Design Studies of SOFC Electrode Performance at Elevated Pressure

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The operation of the Rolls-Royce solid oxide fuel cell (SOFC) system is at pressures up to 7 atmospheres. There is limited data on the performance of electrodes under such elevated pressure conditions. Further investigations of the performance of electrodes at high pressure, and under the system prototypic gas compositions present in the Rolls-Royce design is a critical research area for Rolls-Royce in its development and commercialization of a 1MW distributed power plant, as well as for the US Dept. of Energy in its emphasis on large combined cycle centralized power stations using SOFC technology.

Pressurized testing capability has been developed for both cathode symmetric button cells and full fuel cell tubes which enables testing at fully prototypic operating conditions. Data has been produced over ranges of conditions for both cathode symmetrical button cells and full fuel cells.

Anode and cathode electrode improvement in performance on the order of 40% is evident for pressures of 6.4 Bara. Key cathode operational parameters are the partial pressure of O_2, temperature, and steam content. Anode performance also improves with pressure as both activation and mass transfer are aided. Steam on the cathode has been found to cause a longer-term loss of performance, especially at lower temperatures. Testing on full fuel cell tubes showed a clear response to the addition of steam at moderate levels. Symmetrical button cell data, however, showed that steam has no short term impact on cathode performance. The effects of pressure on degradation were harder to quantify. In general, degradation is worse at higher pressures, but testing was not conclusive.