WEDNESDAY, AUGUST 24, 2005, A.M.

SESSION 33A: INTERNATIONAL SYMPOSIUM ON FUEL CELL AND HYDROGEN TECHNOLOGIES

SOFC OTHER

Sponsor(s): Materials Science and Engineering Section, The Metallurgical Society of CIM
Room: Imperial Ballroom 5
Chairmen: R. MARIC and D. GHOSH, NRC Institute for Fuel Cell Innovation, Canada

PAPER 33A.1 — 8:20 (KEYNOTE)

ADVANCED ELECTROCHEMICAL SYSTEMS FOR CLEAN AND EFFICIENT POWER GENERATION.

P. SINGH, L. PEDERSON and G. McVAY, Pacific Northwest National Laboratory, Richland WA

Advanced high temperature electrochemical systems such as fuel cells, electrolyzers and ionic transport membranes are currently being developed for a wide variety of energy conversion, storage and gas cleanup applications. These systems offer high electrical efficiency, multi fuel capability, modular construction, no/negligible emissions (SOx, NOx, VOC, particulate matters) with capability to sequester green house gas emissions (GHG). Electrochemical processes and electrode reactions will be discussed. Cell and stack component materials and fabrication processes will be presented. Bulk, surface and interface degradation processes responsible for cell and stack performance degradation will be examined.

PAPER 33A.2 — 8:40

STUDY ON THE ON-CELL TEMPERATURE DISTRIBUTION IN A REFORMING SOFC STACK.

W. DONG and S. THOMPSON, Versa Power Systems, Canada

Natural gas direct-internal-reforming (DIR) in a SOFC stack is a technical strategy for the purpose of improving stack efficiency and thermal management. However, it was recognized that on-cell DIR may cause short-term cell damage due to a certain thermal shock, and long-term cell degradation due to an accelerated anode microstructure change, such as metal dusting and grain size change, etc., though the detailed mechanisms are not so clear yet.

In order to investigate the on-cell temperature distribution under a high DIR condition, both the computer simulation approach and the experimental testing approach have been developed. In this work, comprehensive in-house DIR and SOFC models were developed and employed for the CFD based 3D computer simulation. The current SOFC module has been corrected in terms of taking into account both the on-cell electrical leaking effect and the stack stage structural resistance. Meanwhile, an instrumented testing single-cell jig with multi-thermocouples has been built, and a series of experimental tests have been performed for different reforming rates. The numerical results based on the baseline single-cell jig are in very good agreement with the testing results.

PAPER 33A.3 — 9:00

FEASIBILITY ANALYSIS OF METHANOL FUELED SOFC SYSTEMS FOR REMOTE DISTRIBUTED POWER APPLICATIONS.

M. STAITE, P. MARCAZZAN, D. GHOSH, J. STANNARD and C. CHONG-PING, NRC Institute for Fuel Cell Innovation, Canada

This paper analyzed the conversion of a 5kW natural gas SOFC power generator system to be fuelled by methanol. The analyses included laboratory methanol fuel processing experimentation, methanol reformate SOFC cell testing, and SOFC system mass and energy balance modelling. Experimentation indicated theoretical reformate compositions can be achieved for high temperature methanol steam reforming. A 6% open circuit voltage decrease and a 10% peak power current density decrease between cell operation on humidified hydrogen and methanol reformate was observed. SOFC system mass and energy balance modelling indicated that a natural gas SOFC system can be converted to operate on methanol fuel with minimal efficiency impacts, however the systems' thermal integration can be impacted.

PAPER 33A.4 — 9:20

INVESTIGATION OF Y-DOPED $BaCeO_3$ AS ELECTROLYTE IN PROPANE FUELED PROTON CONDUCTING SOLID OXIDE FUEL CELL.

Y. FENG, J.L. LUO, A.R. SANGER and K.T. CHUANG, University of Alberta, Canada

Perovskite structured oxide 15% Y-doped $BaCeO_3$ (BCY15) has been evaluated for use as proton conducting electrolyte in SOFC with propane as the fuel and Pt as both electrodes. Under the fuel cell conditions, BCY15 exhibited high proton conductivity and good cell performances. Propylene was detected as product at the anode outlet, and the product distribution suggests that propane dehydrogenation underwent competition with cracking to lighter hydrocarbons. Stability during cell performance tests showed that there was no obvious degradation for BCY15 electrolyte during operation of C_3H_8-O_2 fuel cell.

PAPER 33A.5 — 9:40

PERFORMANCE IMPROVEMENT OF AN AUTO-THERMAL GASOLINE REFORMER.

C. CANERS, C. MCINTYRE, B. PEPPLEY, C. THURGOOD, Fuel Cell Research Centre, Queen's University, Canada

S. HARRISON and P. OOSTHUZEN, Queen's University, Canada

One of the main uses of fossil fuels is in the transportation sector, leading to environmental consequences such as climate change. In order to move towards a more sustainable energy infrastructure, a transition must begin from fossil fuels to renewable fuels, derived from e.g. biomass. One means of facilitating this transition is to develop reforming technology that can extract hydrogen from a suitable fuel that is either fossil fuel or renewable in origin. The hydrogen would be feed to a 'fuel cell' engine that would power the car, truck or bus.

One reforming technology that is attractive for automotive applications is autothermal reforming (ATR). Autothermal reforming is the combination of steam reforming and partial oxidation, whereby a portion of the fuel is combusted using a sub-stoichiometric amount of air, and the resulting thermal energy drives the more desirable steam reforming reaction. ATR is attractive for fast start-up, rapid load following and ease of control. ATR also has the benefit of smaller volume and fewer peripheral requirements as compared to other reforming technologies.

Recently, a bench-scale gasoline autothermal reformer (ATR) was constructed and tested. This ATR employs a novel design, consisting of three concentric annuli in order to promote heat transfer from the partial oxidation reaction to the steam reforming reaction.

Concurrently, a CFD based model (FLUENT) of the ATR that considers the geometric complexity of the reformer was validated. In spite of the use of simplified kinetics, the model predicted well the observed trends in temperature and overall performance. This paper will discuss the use of the model to improve the design of the ATR. The impact of various system parameters upon performance will be investigated along with alterations in the geometry of the ATR. The various tradeoffs in performance and system volume/size will be highlighted in the context of a fuel cell power system.

COFFEE BREAK — 10:00 – 10:20