WEDNESDAY, AUGUST 24, 2005, A.M.

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

HYDROGEN USE
Sponsor(s): Materials Science and Engineering Section, The Metallurgical Society of CIM
Room: Imperial Ballroom 5
Chairmen: D. GHOSH, NRC Institute for Fuel Cell Innovation, Canada
T. K. BOSE, Université du Quèbec á Trois-Rivières, Canada

PAPER 33B.1 — 10:20 (KEYNOTE)
THE PATHWAYS FOR TRANSITION TO HYDROGEN ECONOMY.
T.K. BOSE, Université du Quèbec á Trois-Rivières, Canada

According to the Intergovernmental Panel on Climate Change (IPCC), the average global temperature has risen over the last century. If this trend continues over the next century, the IPCC projects a significant increase in temperature and a rise in sea level. The changes in climate could adversely impact human health, agriculture, water resources and ecosystems. Most national and international agencies have concluded that our use of carbon-rich fuel is responsible for global warming through the greenhouse effect. In the future, the situation may get worse if the increased need for energy in countries like China, India and Brazil is fulfilled by burning fossil fuel. However, from Delhi to Buenos Aires, compressed natural gas (CNG) is slowly finding a niche in urban transportation. Advanced natural gas-fuelled vehicles have the potential to reduce carbon monoxide and reactive hydrocarbon emissions substantially compared to gasoline vehicles. Further environmental benefits can be realized by using a blend of natural gas and hydrogen. Such an approach will help create an infrastructure for an eventual transition to hydrogen.

PAPER 33B.2 — 10:40
700 BAR HYDROGEN CYLINDER DESIGN, TESTING AND CERTIFICATION.
M. DUNCAN, Dynetek Industries Ltd., Canada

Lightweight, high-pressure cylinders for compressed hydrogen storage are essential components for fuel cell vehicles. Storage volume and mass are two key considerations. Current on-board hydrogen storage systems are based on a maximum pressure of 350 bar. While 350 bar systems are excellent solutions for many applications, some situations required higher storage densities due to space restrictions. As a result significant research and development work has been expended by cylinder manufacturers, systems providers, testing agencies and automotive manufacturers to develop 700 bar systems to reduce storage volume. Dynetek Industries Ltd has proactively developed a range of 700 bar storage cylinders based on a seamless aluminum liner over wrapped with a carbon fiber composite. This paper presents the challenges and processes involved in the design, testing and certification of the Dynetek Industries Ltd 700 bar cylinder.

The paper also provides reasoning for further volume and mass optimization of compressed hydrogen cylinders by incorporating realistic cylinder usage parameters into standards. In particular the overly conservative fill life requirement for cylinders will be examined.

PAPER 33B.3 — 11:00
MOS HYDROGEN SENSOR ARRAY FOR 2D GAS DISTRIBUTION MAPPING.
C. HU, X. QU and J. WU, NRC Institute for Fuel Cell Innovation, Canada
G. CHAPMAN, Simon Fraser University, Canada

A MOS capacitor hydrogen sensor array is reported for hydrogen gas distribution mapping. Si(100) was used as substrate for film deposition. After silicon oxide growing on the silicon surface with dry thermal oxidation, palladium film was sputtered on silicon oxide as hydrogen-sensitive gate material in MOS structure. The 3x3 sensor array was patterned on silicon substrate and packaged in one chip. Sensors' response was test with impedance analyzer. The sensors in array were calibrated in the hydrogen concentration range from 10ppm to 10000ppm. The 2D hydrogen concentration distribution was obtained with the calibrated sensor array.

PAPER 33B.4 — 11:20
RENEWABLE HYDROGEN PRODUCTION – SOLAR HYDROGEN GENERATION.
J. BAKOS, Giffels Associates Ltd., Ingenium Group Inc., Canada
H. K. MIYAMOTO, Clean 16 Environmental Technologies Corp., Canada

Solar Hydrogen Energy Corporation (SHEC Labs) recently constructed a pilot-plant to demonstrate a Dry Fuel Hydrogen Generation System that is powered primarily by sunlight focusing-mirrors. The pilot-plant consists of: a

Solar Mirror Array and Advanced Solar Concentrator and Shutter System; and two thermo-catalytic reactors to convert Methane, Carbon Dioxide, and Water into Hydrogen.

Results from the pilot study show that Solar Hydrogen generation is feasible and cost-competitive with traditional Hydrogen production. More than 95% of Hydrogen commercially produced today is by the Steam Methane Reformation (SMR) of natural gas, a process that liberates Carbon Dioxide to the atmosphere. The SMR process provides a net energy loss of 30 to 35% when converting from Methane to Hydrogen. Solar Hydrogen production provides a 14% net energy gain when converting Methane into Hydrogen since the energy used to drive the process is from the sun. The environmental benefits of generating Hydrogen using renewable energy include significant greenhouse gas and criteria air contaminant reductions

PAPER 33B.5 — 11:40

THE SINGLE TRAIN ULTRA REFORMER – AN INTEGRATED CATALYTIC DESIGN APPROACH TO PEMFC-QUALITY HYDROGEN PRODUCTION.

P.C. HULTEBURG, A-K. JANNASCH, M. PERSSON, A-K. HJELM and F.A. SILVERSAND, Catator AB, Sweden

In this article, an integrated catalytic reactor design approach to produce PEMFC-quality hydrogen is evaluated. The design is based on a high level of heat exchanging performed internally, highly active noble metal catalysts and a woven wire mesh catalyst support system. It consists of an integrated steam reformer and a catalytic burner section, a water gas shift section and a preferential carbon monoxide oxidation section. The reactor design is described and experiments performed to evaluate the two reactors built are reported. The two reactors have a maximum output of 3 Nm and 10 Nm^3 hydrogen/h respectively. In the larger unit, a total of six fuels, three gaseous (methane, natural gas and liquid propane gas) and three liquid (naphtha, ethanol and methanol), were evaluated. The larger unit was also used to investigate how variations of parameters such as steam-to-carbon ratio in the steam reforming part of the system and the relation between oxygen and carbon monoxide in the preferential carbon monoxide oxidation affect the reactor performance. The smaller unit was used, after implementing automatic control, to run a system life time test for 480 h. The reformer system performed according to specifications on almost every aspect.