MICROSCALE GLUCOSE REFORMING FOR RENEWABLE HYDROGEN

Kirsten M. Norman[a], Deidre Hirschfeld[a], David Ingersoll[b], and Daniel H. Doughty[b]

[a]New Mexico Tech, 801 Leroy Place, Socorro, NM 87801, USA
[b]Sandia National Laboratory, P.O. Box 5800, Albuquerque, NM 87185, USA

Micro-scale aqueous steam reforming of glucose is suggested as a novel method of H_2 production for micro fuel cells. Compact fuel cell systems are a viable alternative to batteries as a portable electrical power source. Compared with conventional lithium batteries, hydrocarbon powered fuel cells are more compact and boast a higher energy density[1]. Micro reactor advantages over bench top scale counter parts include decreased surface:volume ratios and increased thermal conduction and mass transfer rates. While direct biomass pyrolysis or gasification measures are being pursued on the manufacturing scale, aqueous steam reforming is best suited for micro scale reforming due to simplicity of the design and minimal waste handling issues. In addition, hydrocarbons steam reforming has the highest theoretical efficiency and H_2 selectivity.

Biomass is an attractive source of H_2 because it is renewable and carbon cycle neutral. Although numerous hydrocarbons are potentially useful as fuel, glucose and ethanol have been demonstrated to be excellent candidates for biomass derived hydrogen. Steam reforming of glucose over Pt/Al_2O_3 has a reported H_2 selectivity of 60%[2]. Hydrogen from ethanol steam reforming over Al_2O_3 supported Ni/La_2O_3 has a selectivity of 95%[3]. Factors including hydrogen selectivity and manufacturing energy and material costs determine the preferred fuel. Glucose is manufactured from corn starch using dry milling followed by acid or enzyme catalyzed hydrolysis. Ethanol is produced by further fermentation of simple sugars like glucose. Enzymatic hydrolysis of cellulosic biomass (crop residues, municipal waste, corn stalks, and “energy crops” such as grass and fast growing trees, etc.) yields simple sugars that can undergo catalyzed steam reforming to extract hydrogen. Fuel from cellulosic biomass costs 60% more than corn starch[4]. While ethanol reforming has greater hydrogen selectivity, glucose is a preferable fuel given lower processing requirements. A review of the processing and economics of hydrogen production from glucose is presented. It is not known how miniaturization of steam reforming will affect H_2 selectivity. While bench scale reactor systems are based on a tubular reactor, our design utilizes a micro reactor with 100 μm channels. Differences in reactor performance will be examined.

[1] Daymo *et al.*, Microchannel Fuel Porcessing for Man Portable Power, presented at AlChE 2000 Spring National Meeting, Altanta, GA, 2000.

[2] R. R. Davda and J. A. Dumesic, Renewable hydrogen by aqueous-phase reforming of glucose, *Chem. Commun*, pp. 36 - 37, 2004.

[3] A. N. Fatsikostas, D. I. Kondarides and X. E. Verykios, Steam reforming of biomass-derived ethanol for the production of hydrogen for fuel cell applications, *Chem. Commun.* pp. 851-852, 2001.

[4] McAloon *et al.*, Determining the Cost of Producing Ethanol from Corn Starch and Lignocellulosic Feedstocks, U.S. Department of Agriculture and National Renewable Energy Laboratory, Golden, CO, Report NREL/TP-580-28893, October 2000.