National Center for Hydrogen Technology® High-Pressure Water Reforming Hydrogen Technology

INTRODUCTION

The Energy & Environmental Research Center's (EERC's) National Center for Hydrogen Technology® (NCHT®) is leading the way to develop the hydrogen fueling station of the future and provide major manufacturing opportunities for hydrogen-reforming and -dispensing systems in the Grand Forks region.

COMMERCIAL NEED

Hydrogen is an environmentally clean source of energy for end users, particularly in transportation applications, with no release of pollutants such as particulate matter or greenhouse gases at the point of end use. However, a major hurdle on the path to implementing a hydrogen economy is the supposed large investment required for new infrastructure. According to a U.S. Department of Energy (DOE) 2006 estimate, transportation and storage of hydrogen make up $4 to $6 of the cost of hydrogen on a gallon-of-gasoline equivalency (gge) basis. Thus a means to cost-effectively reduce hydrogen infrastructure costs is necessary.

HPWR HYDROGEN TECHNOLOGY

The EERC has developed a high-pressure water reforming (HPWR) hydrogen process for converting conventional liquid fuels such as ethanol, methanol, and gasoline to hydrogen. This HPWR hydrogen process effectively eliminates the need for, and prohibitive costs associated with, hydrogen transportation, compression, and storage (see Figure 1). This process is at the core of an on-demand hydrogen refueling strategy targeted at the retail transportation sector. The EERC's HPWR process uses conventional liquid fuels at the fueling station in order to fully utilize the existing refueling infrastructure. This means that the prohibitive infrastructure costs of nationwide hydrogen transportation and storage will be eliminated so that hydrogen refueling will be accessible and affordable. Furthermore, safety is enhanced by the elimination of high-volume storage and transportation. The process works as follows. Conventional liquid fuels are transported to the refueling station and stored in regular underground tanks. Then the liquid fuel is pumped to the reformer, located on the canopy above the dispensers. The reformer converts the liquid fuel to hydrogen. Impurities such as

Source: U.S. Department of Energy, Hydrogen Program, FY2006 Annual Progress Report

Figure 1. Cost-effective process to convert fuels to hydrogen.

Table 1. Conversion Rates for Various Feedstocks

Feedstock	Temperature, °C	Pressure, psi	Conversion, %	Reformate Molar Composition, %				
				H_2	CO_2	CO	CH_4	C_xH_y
S-8	590	4960	88	55	22	0.7	17.0	3.8
Methanol	380	4890	100	73	25	0.5	0.9	0.1
Ethanol	470	5360	95	51	23	0.6	19.0	5.0
Glycerin	540	4840	93	60	31	1.1	5.8	0.7

CO_2 are separated as coproduct streams. Once the impurities are removed, the hydrogen is then stored in small surge tanks until needed in the dispenser. Hydrogen is then readily available for customers to dispense into their vehicles. One of the most beneficial aspects of the EERC's HPWR technology is that it can utilize a variety of feedstocks to produce hydrogen. Conversion rates vary depending on the feedstock used and are being optimized to reach the maximum conversion rate of 75% (see Table 1, front page).

ADDITIONAL INDUSTRIAL APPLICATIONS

In addition to commercial applications in transportation, the HPWR system can also be used for industrial production of hydrogen. Many plants use small to medium volumes of hydrogen for semiconductor manufacturing, materials processing, generator cooling, chemical production, and other applications. Hydrogen is highly valued for its extremely low density, high thermal conductivity, and powerful chemical-reducing properties. Until recently, small-volume users had few supply options other than storing compressed or liquefied hydrogen. Technological advances now allow users to generate high-purity hydrogen on-site, economically as needed.

Figure 2. Possible hydrogen refueling system.

MANUFACTURING OPPORTUNITY

A system will be designed, fabricated, tested, demonstrated, and ready for manufacture. The EERC is looking for additional partners to commercialize the system for widespread use. Shell Hydrogen has emerged as the industry leader in building hydrogen refueling stations. Shell has expressed an interest in the EERC's HPWR process as a means of providing on-demand refueling for Shell customers. Shell's latest hydrogen refueling station designs incorporate the dispenser in the same isle as the gasoline dispensers. All other on-site hydrogen infrastructure is located on the roof of the canopy that shades and protects the dispensers (see Figure 2).

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