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Technologue: H2 Go - "The fuel of the future" may not always be

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by Frank Markus

I swore off further coverage of fuel-cell vehicles until my first test drive of a production prototype, quipping that "hydrogen is the fuel of the future-and always will be." The darned stuff is simply too difficult to distribute, dispense, and store. Carrying enough fuel on board to deliver the kind of range customers expect these days requires pricey, bulky, (somewhat scary) tanks; compressing or liquefying it consumes too much energy.

Then I heard about Power+Energy's plan to power a fuel cell with conventional gas, diesel, or E85. Hold on, you're thinking, didn't Chrysler try that in 1999? Yep. The Commander concept carried what looked like a scale-model refinery under the hood, which involved partial oxidation, steam reformation, and myriad other chemical processes to crack the hydrogen out of gasoline, but enough carbon monoxide remained in the hydrogen stream to poison the proton-exchange-membrane fuel cell, so the idea was abandoned.

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(*Art by: Nigel Buchanan*)

Power+Energy is in the business of providing equipment that purifies the usually "dirty" hydrogen generated as a byproduct of petroleum refining from several thousand parts-per-million level of CO and other gook to less than one-part-per-billion required for manufacturing LEDs and other electronics. To do this, the company developed a palladium membrane that behaves like an ultra-fine-mesh screen through which only hydrogen atoms-the smallest in the universe-can pass. (It's really a chemical process whereby the alloy absorbs hydrogen ions, and a pressure differential across the membrane forces them through.)

Here's the kicker: Using seed money from the department of defense (which is keen to obtain hydrogen fuel cells that run on the conventional fuels currently used on the battlefield), Power+Energy has modified the process to "purify" the hydrogen out of vaporized gasoline, diesel, biofuels, ethanol, or E85. Operating at the same high temperature (600 C/1100F) as the Commander's mini-refinery, this new system combines multiple steps into one extremely compact one. The fuel is mixed with steam, vaporized, superheated and reformed into H2, CH4, CO2, H2O, and CO. More steam then converts the CO to CO2. All this takes place at the nano-level near the palladium-alloy membrane, and the small unit quickly achieves operating temperature (by burning some of the fuel). The reformer also is said to react relatively quickly to changing power demand, though it's generally understood that all fuel-cell vehicles will be battery-electric hybrids, relying on the battery for instantaneous response.

Ah, but can we afford the palladium? In volume production, the precious-metal content of the reformer should be little or no more than what goes into the catalytic converter of an equivalent gasoline-powered vehicle, so palladium price/supply issues shouldn't stymie this technology, and the price of the gas-tank and reformer should come in below that of a 5000-10,000psi hydrogen-storage tank with none of the safety concerns.

A gallon of diesel fuel produces about 1 kg of hydrogen, gasoline yields roughly 900 g, and the reformer extracts about 90 percent of the heating value of the original liquid fuel as hydrogen. Running it through a state-of-the-art fuel cell with 46-percent efficiency will effectively double the fuel efficiency of a similar size/weight gasoline car, cutting CO2 emissions in half and generating no NOX.

Power+Energy is on target to demonstrate a 5kW ethanol-powered fuel-cell auxiliary power unit to the U.S. Navy in mid-2008 and anticipates strong consumer demand for similar units to power refrigerated trailers and driver comfort items on big-rig trucks when parked overnight. The development leap from large, essentially stationary ship-based reformers to small, car-based ones capable of withstanding the temperature and operational extremes of today's automotive environment isn't trivial-except by comparison with the task of distributing and storing purified hydrogen.

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About Power+Energy

Power & Energy, Inc. is headquartered in Pennsylvania, USA. Established in 1993, the company's mission is to enable the hydrogen economy and promote energy efficiency through the application of micro-channel technologies. The company provides a full range of micro-channel hydrogen purifiers to ultra-high purity users across the U.S., Asia and Europe.

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