Technology Readiness Level: 4
Component and/or Breadboard Validation in Laboratory Environment

Eltron Research & Development

Tech Brief

Eltron's New Compact Hydrogen Generation Device

Reduces cost of hydrogen production, provides a CO_2-rich stream ready for sequestration

Eltron Research & Development is in the process of developing a new, compact hydrogen generation device. A simplified diagram showing the components of this system is shown in Figure 1. This reactor is based upon a *combination* of several Eltron technologies that can significantly improve the economics of hydrogen generation. The new technologies included in this reactor are:

- Eltron's Oxygen Transport Membrane to separate oxygen from air
- Catalytic partial oxidation of fuel at high space velocity
- Eltron's Hydrogen Transport Membrane to separate hydrogen from the fuel reformate

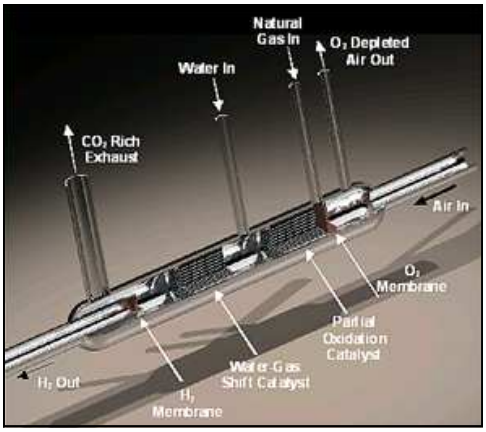

Figure 1. Conceptual diagram of Eltron's compact hydrogen generation device.

Eltron's Hydrogen Transport Membrane separates hydrogen from the CO_2 -rich stream downstream of the water-gas shift reactor and allows CO_2 sequestration.

The generation of hydrogen from methane proceeds in three modular steps from all fuels to hydrogen. First, Eltron's Oxygen Transport Membrane separates oxygen from air. Second, the fuel and oxygen is reacted to produce synthesis gas in the synthesis gas generation module. The synthesis gas is then fed to a water-gas shift reactor, where the CO is reacted with water to produce more hydrogen and CO_2. The hydrogen then must be separated from the primarily CO_2-containing stream by a hydrogen transport membrane.

Drawbacks of Current Technologies

In current industrial cases, methane, the main component of natural gas, is steam reformed as follows:

$$CH_4 + H_2O\ (g) \rightleftharpoons CO + 3\ H_2 \qquad \Delta H = +206\ \text{kJ mol}^{-1}$$

Heat required for this endothermic reaction in present commercial reactors is obtained by burning natural gas in air to form $CO_2 + H_2O$. The reaction above is called the steam methane reforming reaction. It is often performed in reformer tubes where the burning of the natural gas (or fuel gas) provides the heat to drive the thermodynamically controlled, steam methane reforming reaction.

The CO formed by steam reforming of methane can be further reacted with steam to form additional hydrogen through the water-gas shift reaction:

$$CO + H_2O \rightleftharpoons CO_2 + H_2 \qquad \Delta H = -41\ \text{kJ mol}^{-1}$$

This happens in the CO shift reactor. The exothermic water-gas shift reaction is favored by low temperatures. Inlet gas temperatures in commercial water-gas shift reactors can be as low as 310℃. Exhaust

temperatures are typically 420℃–440℃. Water-gas s hift reactors often operate above 31 bar (450 psi). Although this steam methane reforming process has been commercially performed for number of years, it is not particularly efficient. This is largely due to the endothermic nature of the steam reforming reaction and the indirect heating from the burning of fuel gas and the complexity and expense of the process as practiced.

Eltron's Technology

Eltron's solution simplifies the hydrogen generation process. As shown in Figure 1, air is fed to an oxygen transport membrane operated at 800℃–1000℃. Th e oxygen is ionically transported across the membrane, to the catalytic partial oxidation catalyst. Fuel – including methane, LPG, gasoline, or diesel – partial oxidation and synthesis gas (H_2 and CO) is produced. Liquid water is injected at this point to cool the synthesis gas mixture to about 400℃, wher e the water-gas shift reaction occurs. More hydrogen is produced through the WGS catalyst bed. After the water-gas shift catalyst, a hydrogen transport membrane is used to separate the H_2 from the CO_2 stream. Pure H_2 is produced and concentrated CO_2 is ready for sequestration.

We believe that this novel combination of technologies can significantly reduce the cost of hydrogen production and also can provide a CO_2-rich stream ready for sequestration.

Development of this new technology is under way. We are seeking commercialization and development partners.

The technologies described, and all related inventions are owned by Eltron Research & Development Inc, and protected by copyrights, trademarks, issued and pending patents, trade secrets, or other applicable intellectual property rights.

Contact Us

To discuss the possibility of entering into a business relationship with Eltron, contact the Business Development Group at business@eltronresearch.com.

To learn more about Eltron Research & Development's hydrogen technologies and the many other technologies that the company is researching and commercializing, visit www.eltronresearch.com.

Eltron Research & Development

Eltron Research & Development Inc.

Eltron Research & Development Inc. commercializes novel technologies involving advanced materials, energy, water and environmental systems.

4600 Nautilus Court South | Boulder, CO 80301 | Phone: 303.530.0263 | www.eltronresearch.com

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