Fraunhofer ISE

Press Release

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Hydrogen Generation Fast and Easy

Fraunhofer ISE Develops Fully Automated Pyrolysis System

Pyrolysis is a simple and cost-effective procedure to gain high-concentration hydrogen from fuels. A product gas having a hydrogen content of over 80 vol.-% is formed, which makes it extremely suitable for use in fuel cells. Pyrolysis presents itself as a good alternative to the usual reforming processes. The advantages are a less expensive catalyzer without precious metals, a simpler construction and the lack of process water. As a result, further components and process steps can be avoided, e.g. a water pump, an evaporator and the complex water purification procedure. Researchers at Fraunhofer ISE have focused on the potential of the pyrolysis procedure and have developed a fully automated system. This system can be used with many gaseous and liquid fuels, such as natural gas, biogas or diesel. A model of this pyrolysis system can be viewed at the Hannover Trade Fair from 4-8 April in Hall 27 C60.

In the pyrolysis process, carbon, as well as hydrogen, is produced. The carbon deposits on the catalyst and must be regularly burned off. To produce a continuous flow of hydrogen during the pyrolysis process, therefore, two reactors are required. These are operated alternately. The system developed at Fraunhofer ISE automatically switches between the two reactors. Because of the low carbon monoxide concentration (< 1 vol.-%), the product gas can be directly fed into the high temperature PEM or SOFC fuel cell system and converted to electricity without undergoing any additional gas purification steps. Tests at Fraunhofer ISE show no significant differences in power density for a HTPEM fuel cell operating with pyrolysis gas as compared to an operation with pure hydrogen.

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The central component of the pyrolysis system is the reactor with catalyst. “The operating conditions are continually changing and high temperatures of over 950 °C are reached during carbon burn-off. These severe conditions put stringent requirements on the catalyst. Up to now, no commercially available catalyst exists that is suitable for a pyrolysis system,” explains Robert Szolak, the scientist responsible for developments in the area of pyrolysis and reformer systems at Fraunhofer ISE.

For the catalysts developed at Fraunhofer ISE, no expensive precious metals are used. The long-term reliable and thermally stable catalysts enable longer periods of non-operation without incurring losses. Other tests at Fraunhofer ISE showed that the developed catalyst can be operated with various fuels, e.g. propane, methane, biogas and diesel. Thus, the catalyst is well suited for many areas of application, for example, as an on-board power supply or battery charger for recreational applications, as an uninterruptible power supply (UPS), as a portable, off-grid power supply and also for stationary applications in the area of combined heat and power (CHP) generation.

In a reduced version of their developed pyrolysis system, the researchers in Freiburg have decreased material costs by up to 60 % compared to conventional reformer systems. In this case, the pyrolysis system consists of only one reactor which produces hydrogen over a certain period of time. When coupled to a fuel cell, the complete system can be used, for example, to charge a battery. When charging is completed, the pyrolysis reactor then switches to the regeneration mode. In this reduced version, several procedural components are not implemented, and the controls are much simpler as compared to a system with two reactors.

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Model of pyrolysis system with two reactors. The ball valves are set so that pyrolysis takes place in only one reactor at a time, while the other reactor regenerates. The switching is controlled in such a way to produce a high concentration of hydrogen and a low concentration of carbon monoxide. ©Fraunhofer ISE

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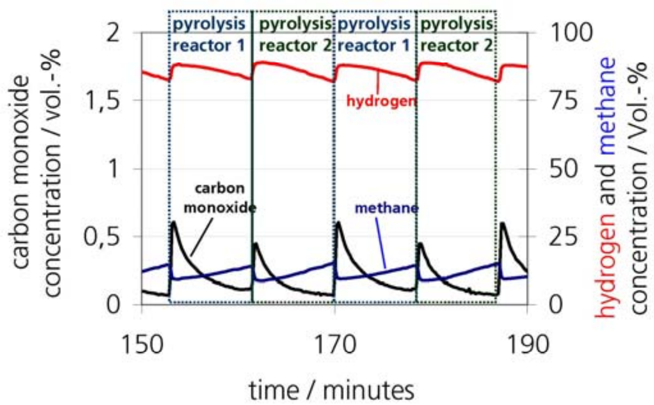

Gas composition during the propane pyrolysis from reactor 1 and 2. At changeover, the hydrogen concentration (far right axis) is also greater than 80 vol.-%.
The carbon monoxide concentration (left axis) is always lower than 0.6 vol.-%.
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