

Scalable, Portable Hydrogen Generation (#3824, 3899, 6239)

A method and apparatus for generating hydrogen from hydrocarbon fuels at high power density and adaptive throughput

Georgia Tech inventors have developed a method and apparatus for generating hydrogen from hydrocarbon fuels at high power density and adaptive throughput with a very low (CO) concentration (<10 ppm), thus eliminating the need for separate CO-cleanup units. The technology combines the processes of fuel reforming, water gas shift, compression, and hydrogen separation into a single, scalable unit. It is ideal for use with proton exchange membrane (PEM) fuel cells and power plants operating between 1 W and 100 kW. A unique aspect of the innovation is its piston and cylinder assembly that operates in a four-stroke cycle to generate hydrogen at a highly selective and scalable manner. The reactors offer precisely controlled volume, pressure, temperature, and reaction time. Precision actuators move reactants and products in and out of the chamber at the appropriate times. The walls of the reactor and/or actuator may be selectively permeable to one or more of the reaction products, resulting in product purification as well as shifting of reaction equilibrium in a favorable direction. Each reactor unit is optimized for performing a specific reaction or multiple reactions and/or separation steps. Scale-up to required power is achieved by parallel operation of multiple identical units.

Benefits/Advantages

- **Controlled operation:** achieves maximum conversion of fuel to hydrogen and CO₂
- **Optimal sizing:** performs at most favorable operating conditions to optimize output
- **Rapid scale-up:** allows reactors to be stacked for increased processing capacity
- **Seamless integration:** combines multiple reactions in a single operating unit

Potential Commercial Applications

- Portable power generation
- Automotive applications
- Distributed power generation and chemical production
- Point-of-use energy generation

Background/Context for This Invention

Hydrogen is the energy source of choice for fuel cells, for power generation, and have many other industrial uses. Methanol reformers can produce hydrogen and carbon dioxide (CO₂) via a chemical reaction between methanol and water in the form of steam; however, the conventional large-scale, continuous-flow

reactors are not readily adaptable to portable or smaller scale distributed power applications due to poor down-scalability and inability to accommodate dynamically variable throughput demand. In addition, the current technology does not allow to produce a concentrated CO₂ stream, which is essential for carbon capture and sequestration.

[See other hydrogen fuel-related technologies by Dr. Fedorov.](#) To see his entire portfolio of available technologies, [click here](#).

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More Information

U.S. Patent Issued - [7,981,171](#)

U.S. Patent Issued - [9,403,143](#)

Publications

[Four-Stroke Engine Cycle Produces Hydrogen from Methane and Captures CO₂](#), Georgia Tech News Center, February 16, 2017

For more information about this technology, please visit:

<https://licensing.research.gatech.edu/technology/scalable-portable-hydrogen-generation>

Images:

The automated sequential delivery of multiple fluids. A varying number of delay gates imprinted in the branches are shown in the figure.

COVID-19 and flu saliva test on paper: (A) The automatic sequential delivery of multiple reagents required for virus test; (B) Water pouring into the device triggers the virus assay, allowing the presence of SARS-CoV-2 and influenza A & B viruses to be visually identified by the color changes in the corresponding detection spot

