tech briefs

Westinghouse Savannah River Company

Hydrogen Storage Device

at a glance

- Stores in an inherently safe solid form
- Storage density equivalent to liquid hydrogen
- Minimal insulation, no evaporative loss
- Controllable H2 discharge up to 300 psi
- Customizable pressure/temperature
- U.S. Patents 6,015,041, 6,267,229, 6,432,379
- European Patent EP 0 891 294
- Canadian patent pending

for more information

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Providing tomorrow's energy source

This patented technology uses metal hydrides to absorb, store, and desorb hydrogen. The metal hydride storage system is safe, compact, reliable, and efficient. This system can store and discharge hydrogen at user-defined flow rates and pressures up to 300 psi with a storage density equivalent to liquid hydrogen and an estimated minimum lifetime of 2000 charge/discharge cycles. System capacity can be enlarged as desired by manifolding multiple modules together. Performance at higher pressures is achievable with design modifications.

A national priority

In his 2003 State of the Union address, President Bush announced a $1.2 billion hydrogen fuel initiative to reverse the United States' growing dependence on foreign oil by developing the technology for commercially viable hydrogen-powered fuel cells to power cars, trucks, homes, and businesses with no pollution or greenhouse gases. The United States imports 55 percent of the oil it consumes. That is expected to grow to 68 percent by 2025. Two-thirds of the 20 million barrels Americans use each day is used for transportation. Vehicles are also a significant source of air pollution in America's cities.

An attractive alternative

Hydrogen has the highest energy content per unit of weight of any known fuel. When burned in an engine, hydrogen produces effectively zero emissions. When powering a fuel cell, its only waste is water.

Hydrogen can be produced from abundant domestic resources including natural gas, coal, biomass, and even water.

Current hydrogen storage methods are inadequate

Current methods of storing hydrogen include compression and liquefaction. Both have major safety and handling issues. Compression requires high operating pressure, and liquefaction requires extremely low operating temperatures. Both methods consume a lot of energy during the charging process.

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Hydrogen Storage Device

Metal hydride storage has advantages

With this metal hydride storage system, hydrogen is stored in an inherently safe solid form, which minimizes user requirements for handling explosive gases. The system greatly reduces the liability for carrying large quantities of hydrogen and for storing hydrogen in highly populated areas. Hydrogen storage containers can be easily transported using the existing truck, rail, and ship transport infrastructure.

Easy charge/discharge mechanism

The metal hydride storage system is a device that will store and release hydrogen gas safely by the control of operating temperature. The system consists of a specially engineered tubular assembly containing metal hydride particles.The particles are charged with hydrogen from an outside source at ambient temperature (below 100˚C) and pressure (100-300 psi), generating heat, which is dissipated by water passed through the assembly. To release the stored hydrogen, the particles are heated by water passed through the assembly.

Known issues resolved

Metal hydrides have been known to have poor heat transfer, which slows the intake and release of hydrogen. The use of aluminum foam in this new system to hold the metal hydride particles enhances heat transfer during charge and discharge. The expansion and contraction of hydrides can stress the storage container and cause the hydrides to compact. The use of aluminum foam allows the particles to expand and contract without stress and compaction. Separator plates compartmentalize the system, preventing clumping of the hydride particles. A porous metal filter runs the length of the assembly to minimize the potential for clogging.

Performance parameters can be optimized

Adjustments to the hydride powder composition can control the following system performance parameters:

- temperature/pressure operating point
- cost
- hydrogen storage density (% by weight)
- service lifetime (number of charge/discharge cycles)

Engineering design can control the following system performance parameters:

- charge/discharge times
- cost (to a lesser extent than hydride powder composition)
- device weight
- ease of hydride replacement
- shape of device
- percent of hydrogen release in event of device rupture

Demonstrations confirm viability

The hydrogen storage device was installed and operational on a hybrid hydrogen/electric bus (H2Fuel Bus) in Augusta, Georgia. The device was tested for more than 25 cycles and driven over 1,000 miles.

In another demonstration with academic and industrial partners, the hydrogen storage device was used to power an industrial fuel cell vehicle called the Gator™. The vehicle demonstrated a 50 percent improvement in fuel-to-wheel efficiency when compared to similar internal combustion engine vehicles and 100 percent improvement in range when compared to battery-electric vehicles.

Partnering opportunity

U.S. Patents 6,015,041, 6,267,229, and 6,432,379 have been issued on this invention. European Patent EP 0 891 294 also has been granted. A Canadian patent is pending.

Westinghouse Savannah River Company (WSRC) invites interested companies with proven capabilities in this area of expertise to develop commercial applications for this storage device under a cooperative research and development agreement or a licensing agreement. Interested companies will be requested to submit a business plan setting forth company qualifications, strategies, activities, and milestones for commercializing this invention. Qualifications should include past experience at bringing similar products to market, product design and development capabilities, reasonable schedule for product launch, sufficient manufacturing capacity, established distribution networks, and evidence of sufficient financial resources for product development and launch.

Technology transfer

WSRC is the managing contractor of the Savannah River Site for the U.S. Department of Energy. WSRC scientists and engineers develop technologies designed to improve environmental quality, support international nonproliferation, dispose of legacy wastes, and provide clean energy sources.

WSRC is responsible for transferring technologies to the private sector so that these technologies may have the collateral benefit of enhancing U.S. economic competitiveness.

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technology transfer

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