LICENSING OPPORTUNITY: NON-CRYOGENIC HYDROGEN STORAGE AT LOW-PRESSURE

DESCRIPTION

Problem

Stationary hydrogen-powered fuel cells are emerging as a solution for delivering clean and flexible power. Renewable energy-powered electrolysis can generate hydrogen for the fuel cells, but use may require multiple days' worth of stored hydrogen to smooth renewable-energy variability. Storage is also needed in cases where hydrogen is used as a backup power system, with a necessary target storage duration of 96 hours to meet the requirements set by the United States National Fire Protection Association. This presents a challenge, as compressed gas or cryogenic hydrogen storage is operationally expensive and inefficient at large scales for these storage durations, and salt caverns proposed for storage are not widely available and require pipelines to make them suitable for significantly larger applications. As such, much work has been conducted to identify material-based solutions for large-scale hydrogen storage that operate at lower pressures and noncryogenic temperatures. Additionally, in most low-temperature hydrogen storage conditions, hydrogen is naturally lost from storage tanks in the form of "boil-off." These boil-off events are costly, and materials that can effectively capture boil-off hydrogen are of great need.

Invention

NIST has developed a new metal-organic framework (MOF) that can be utilized for stationary hydrogen storage for long-duration energy supply. It has fast delivery rates, displays significant uptake at non-cryogenic temperatures, and does not require high pressure. Additionally, given the MOF's adsorption profile of hydrogen (and its isotopes) with temperature, it is an ideal candidate for hydrogen boil-off capture.

BENEFITS

Potential Commercial Applications

Large-scale stationary storage of hydrogen at moderate temperatures and pressures. Large-scale hydrogen storage is relevant to the transportation industry, stationary grid and emergency electrical power systems, any industry seeking use of hydrogen fuel cells, or any industry seeking a scalable hydrogen storage reservoir. Capture of "boil-off" hydrogen is relevant to any industry looking to mitigate hydrogen loss during storage.

Contact: licensing@nist.gov

NIST TECHNOLOGY PARTNERSHIPS OFFICE

NIST Technology Partnerships Office
National Institute of Standards and Technology
100 Bureau Drive, Gaithersburg, MD 20899-2200

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Competitive Advantage

The MOF hydrogen storage system has very practical attributes sought for industrially utilized materials, and which allow for significant energy savings:

- Dense and robust against moisture or oxygen gas.
- Low manufacturing cost — derived from cheap commodity chemicals, the new MOF is one of the simplest and lowest-cost known, with costs around US$1-2/kg.
- Low-pressure storage — the MOF-based system enables high energy storage density at pressures as low as 0 bar, significantly lower than the high pressures used in commonly used hydrogen cylinders.
- Ambient-temperature storage — safe storage at ambient temperature is possible, as the MOF exhibits high excess and total H2 adsorptive properties at non-cryogenic temperatures.
- Safe, long-term storage conditions — As the MOF-based system does not require highly pressurized hydrogen or cryogenic temperatures, it does not require complex and costly safety protocols, features that in turn enable long-term storage.

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