Accurate Detection of Impurities in Hydrogen Fuel at Lower Cost (IN-08-072)

Advancing the science of fuel cells for advanced technology vehicles

The Invention

Scientists at Argonne National Laboratory have developed two alternative strategies for detecting impurities in the hydrogen used in fuel cells. Both yield highly accurate results and use simpler, less costly equipment.

As the United States gradually establishes a refueling infrastructure for fuel cell vehicles, lawmakers will adopt standards for impurities in the hydrogen used in these vehicles. Impurities can cause fuel cell performance degradation and catalyst poisoning. Such standards require that hydrogen producers, vendors and regulators be able to detect impurities and certify that they are present only at very low concentrations. Currently, detecting such trace levels requires highly sensitive, costly equipment.

In the first strategy, Argonne researchers took advantage of the high pressure of hydrogen at the dispenser nozzle. By removing the hydrogen through a special membrane, scientists can isolate the remaining impurities at a higher concentration. Once concentrated, the impurities are easily detected using less costly, potentially portable sensors (Figure 1).

Argonne's second strategy uses an enrichment device that employs a pressure-swing adsorption cycle (Figure 2). In this device, the sample gas is passed through a bed of sorbents at high pressure so that the impurities are adsorbed on the sorbent surface. Releasing the pressure in the sorbent chamber then releases the impurities into the gas phase to elevate their concentrations in that space. The enrichment factor for each gas species depends on the sorbent and the gas species used in the pressure-swing enrichment device; it typically exceeds one order of magnitude.

Argonne's concepts are novel and provide inexpensive solutions to a significant problem. Although other organizations are working on similar concepts, Argonne is the first to publish the results of research into this technology.
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Benefits
- Facilitates the analysis of trace impurities in high-pressure hydrogen streams
- Replaces costly analytical equipment with inexpensive, easy-to-operate sensor devices that are potentially portable
- Allows rapid, repeated analyses to assure quality

Applications and Industries
- Analysis of hydrogen quality at distributed hydrogen refueling stations
- Analysis of hydrogen quality at central hydrogen production plants, such as oil or chemical refining plants
- Analysis of trace species in high-pressure hydrogen samples at refueling stations or in the laboratory

Developmental Stage
Both devices have been demonstrated in the laboratory.

Availability
Ready for field testing at refueling stations where high-pressure hydrogen is available.
The devices can be specially tailored for potential users, including hydrogen producers, state regulators or vendors providing analytical services, and can be used to monitor single or multiple species for process quality assurance.

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