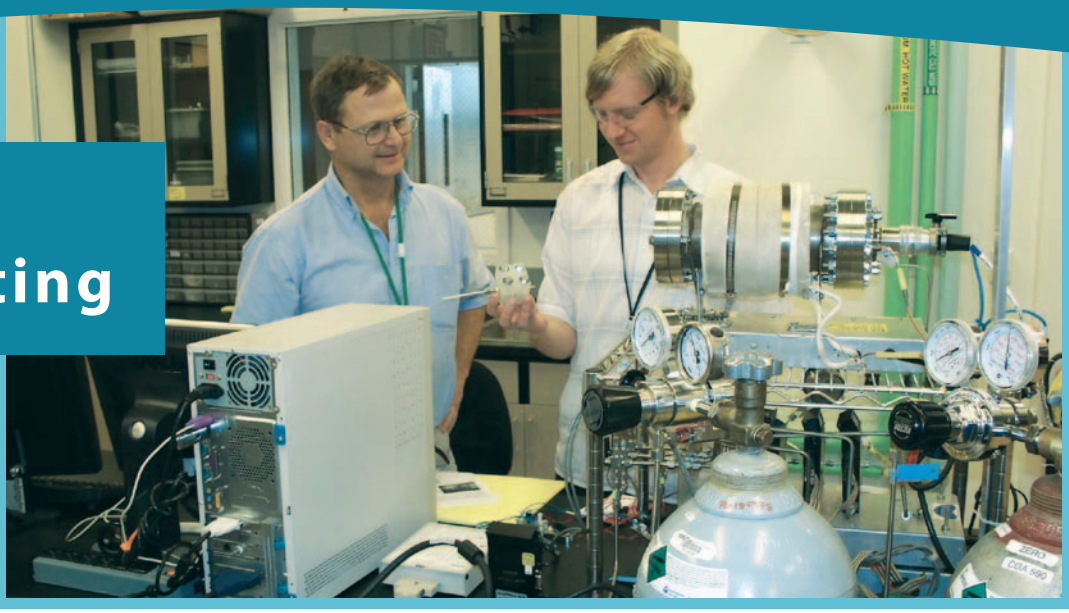
Hydrogen Sensor Testing



NREL researchers William Buttner and Matthew Post setting up a test for a commercially available hydrogen sensor. Because hydrogen is colorless and odorless, sensors are key safety elements of fueling stations and other hydrogen facilities. Pix 15977.

Highlights

Because hydrogen is colorless and odorless, sensors will be key safety equipment for safe fueling stations and other hydrogen facilities. Sensors can be used to detect releases, automatically shut down systems, activate alarms, and notify emergency responders.

A number of companies are making sensors, but they are using several different technologies, experience is limited, and they need to meet certification standards.

NREL researchers are using a new hydrogen sensor laboratory to test the various sensors available against DOE performance targets and work with manufacturers to meet performance targets.

Hydrogen is no more dangerous than current transportation fuels, but it is different. One key difference is that hydrogen is colorless and odorless and its flames are virtually invisible in daylight. Hydrogen detectors will therefore be a key part of safe design for hydrogen fueling stations and other hydrogen facilities. How do we ensure that those detectors are reliable and do everything they need to do?

Many pieces will need to be put in place for hydrogen fuel cell vehicles to become a major part of our transportation structure. Among those pieces, dependable detectors are needed to keep concern about safety from being a missing nail in the horseshoe. A number of companies are producing hydrogen sensors, but they rely on several different technologies, most are relatively new products, and they need to meet emerging certification standards. National Renewable Energy Laboratory (NREL) scientists are using a new hydrogen sensor laboratory to test the various sensors available, check their performance against U.S. Department of Energy (DOE) targets for sensor performance, and work with manufacturers to meet performance targets.

Hydrogen has been used extensively for many years in industrial applications, with an excellent safety record. With growing fuel cell uses such as powering forklifts and providing back-up power for cell-phone towers—and particularly the anticipated emergence of fuel cell vehicles—hydrogen is increasingly being used in locations that are publicly accessible. This requires more foolproof safety measures than are typically used in more controlled industrial applications. Sensors are a key part of such enhanced safety systems. They can detect releases of hydrogen and shut down systems automatically, activate alarms, or send information to emergency responders. Thus, effective and dependable sensors will play a vital role in safe general public use of hydrogen and NREL testing can help ensure their availability.

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Performance Measures

Each sensor technology has particular strengths and weaknesses and each needs to be tested against various concerns and requirements, both generally, and for the various specific applications and settings in which they might be used. Some general concerns with sensor performance include:

- Whether they will give false positive readings
- How they will react to exposure to moisture
- How they will react to exposure to temperature extremes
- How reliable they will be over time
- What maintenance they will require.

In addition, the DOE has set several specific performance targets for sensors:

- Measurement range coverage of 0.1%–10.0% concentration
- Operation in temperatures of -30°C to 80°C
- Response time less than 1 second
- Accuracy within 5% of full scale
- Function in an ambient air gas environment within a 10%–98% relative humidity range
- Lifetime greater than 10 years
- Resistance to hydrocarbon and other interference.

Current Sensors and Planned Test Lab Capability

Sensors can be generally categorized into six basic types: electrochemical, palladium and palladium alloy film, metal oxide, pellistor, thermal conductivity, and optical/acoustic devices.

Staff in the NREL Hydrogen Sensor Test Laboratory will be able to test a wide range of viable sensor types. Researchers will examine any new sensor technologies to evaluate whether these should also be tested. All sensors will be tested using the manufacturers' performance specifications and with procedures consistent with recognized national and international test methods. In addition, researchers will use the lab to monitor long-term sensor performance to help define maintenance requirements. The data generated are intended to help sensor manufacturers improve the performance of their products and reduce testing expenses. Data will remain confidential in a manner to ensure that all business information is protected.

NREL is collaborating in this work with the JRC (Joint Research Centre) Institute for Energy, located in Petten, the Netherlands, which is doing similar work in Europe and the Illinois Institute of Technology (IIT), which has also done considerable work in the area. NREL also works closely with hydrogen safety codes and standards development organizations including Underwriters Laboratories and others, to see that hydrogen sensors can meet certification performance requirements.

Progress to Date

As of October, 2008, the laboratory is up and running and a scientist and sensor expert from IIT has now joined the NREL staff. More than a dozen sensors—covering the six current technologies—have been acquired with additional acquisitions planned. Testing has started and a quality assurance process is being performed to verify the testing procedures. Already, the first test results are being shared with the sensors' manufacturers. Permanent equipment for an advanced NREL test facility has been ordered and should be largely in operation by October 2009. The primary pieces of equipment are specially designed test chambers to accommodate the multiple sensor types, environmental control systems, gas analysis equipment, and data acquisition and control devices for consistent, repeatable test conditions.

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