Joint Research Centre

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Hydrogen Energy for Tomorrow

Hydrogen Safety in Storage and Transport

Why hydrogen?

Hydrogen is not a primary energy source such as coal or gas but is an energy carrier (similar to electricity) and can store and deliver energy in an widely usable form. It is one of the most promising alternative fuels for future transport applications. When produced from renewable sources it provides pollution-free transport, without carbon dioxide emissions and decreases our dependence on dwindling oil reserves. However significant development is needed before hydrogen can be exploited in the same way as conventional fossil fuels.

How does JRC-IE contribute to the safe use of hydrogen

Safety, performance and end-use efficiency must be all assured before mass public use of hydrogen is possible. This is the motivation behind the Hydrogen Safety in Storage and Transport (HySaST) project as it supports the EU drive towards clean and efficient transport technologies.

The scientists, engineers, computer modellers and technical staff of this project perform pre-normative and underpinning research for the development and improvement of performance characterisation methodologies for hydrogen storage, detection and safety. In addition they provide S&T support to Community and international standardisation and regulatory bodies in this field and act as a reference on hydrogen storage, detection and safety related activities in the Commissions Joint Technology Initiative on Fuel Cells and Hydrogen.

Dedicated state-of-the-art testing facilities include these for:

- for testing full-scale high-pressure hydrogen (and natural gas) tanks for vehicles.
- for performance characterisation of materials for solid-state hydrogen storage.
- for performance characterisation of hydrogen sensors for safety.

These facilities are supplemented by the development and application of computational tools for numerical modelling of hydrogen releases, dispersion and safety scenarios.

EU Policy Related to Hydrogen

The integrated Energy and Climate Change Package endorsed by the March 2007 Spring Council constitutes the starting point of a European Energy Technology policy reflected in the Strategic Energy Technology (SET) Plan. In the Plan, fuel cell and hydrogen technologies are earmarked as critical for enabling the EU to reach its ambitious goals of 20% renewables, 20% reduction in greenhouse gas emissions and 20% energy efficiency increase by 2020.

In May 2008, the European Council adopted a Regulation setting up the Fuel Cell & Hydrogen Joint Technology Initiative (FCH JTI) to facilitate the commercial deployment of fuel cell technologies in a strong public private partnership. The JTI, with a budget of one billion Euros during its 2008-2017 life span, is the first of the set of European Industrial Initiatives identified in the SET-Plan.

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Compressed Hydrogen Storage

Storage of gases under pressure, including hydrogen, is a rather well-known technique. However the use of hydrogen tanks in vehicles, and in particular the challenge of using very high pressures, require new safety and performance studies. The JRC-IE uses the Gas Testing Facility for carrying out tests on high pressure vehicle tanks for hydrogen (H_2) or natural gas (CH_4). Typical tests are:

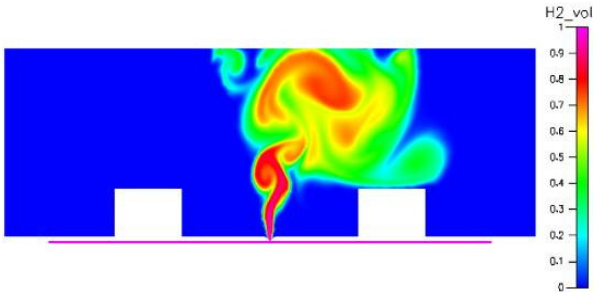
Cycling tests: Vehicle tanks are repeatedly fast-filled using real gas and emptied slowly at least 1000 times to simulate their lifetime in a road vehicle. The maximum pressure is 350 bar and the filling time is less than 3 minutes. During this cycling process, the tank is monitored for leaks and permeation rates using a gas chromatograph. The maximum pressure will be increased to 700 bar in the near future.

Permeation tests: Tanks are filled up to 700 bar and the permeation of the system is measured as a function of time. It is possible to control ambient and tank temperatures up to at least 85°C.

The testing of other high-pressure components such as valves and pipes is also possible.

Numerical Modelling

The widespread use of hydrogen requires the distribution and storage of large quantities of hydrogen. Bearing this in mind it is essential to understand the safety implications of potential accident situations. Use of Computational Fluid Dynamics tools allow release, dispersion and combustion of hydrogen to be modelled and compared with releases of other gases (e.g. natural gas) to understand and minimise the risks involved in hydrogen use.



The hydrogen sensor testing facility at JRC-IE

Hydrogen Sensors and Safety

The Sensor Testing Facility assesses the performance of hydrogen sensors under a wide range of environmental conditions. Hydrogen can not be detected by human senses making the use of suitable detection devices (sensors) necessary. Since hydrogen leaks can be hazardous if not detected quickly reliable detection systems need to be tested, and their performance validated so that they can be safely deployed wherever hydrogen is produced, stored, distributed or used.

In collaboration with international and European partners, the facility is used in inter-laboratory experimental programmes aimed at preparing guidelines for testing hydrogen sensors, assessing their performance and reliability and providing feedback on the results to sensor manufacturers and end users.

Solid State Hydrogen Storage

The Solid-state Hydrogen Storage Testing Facility is dedicated to the testing and performance assessment of potential hydrogen storage materials. The laboratory is equipped with instruments which can measure how much and how quickly materials can reversibly store hydrogen and under which conditions. Experiments cover a variety of materials and testing conditions and the research is complemented by in-house microstructural analysis studies.

In view of the large disparity in hydrogen sorption data reported in the literature, the laboratory focuses on comparing measurements made using different techniques. The activity identifies discrepancies and potential error sources, and suggests improvements in testing procedures and measurements to achieve reliable, reproducible and accurate data. The laboratory is currently involved in European and international collaborative projects for testing hydrogen storage materials. and offers its services for 'second opinion' measurements to European research centres and university groups that develop new materials, and serves as a training ground for aspiring young scientists active in this challenging field.

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