newsletter

Hydrogen

energy source and fuel of the future

As an alternative, renewable and environmentally friendly fuel, hydrogen is being used more and more as a source of primary energy.

Introduction

Going forward, the need to replace fossil fuels by alternative, renewable energy sources is going to become ever more urgent. Today, projects with this aim are already being promoted in cooperation with industry in many countries. One important potential energy source is hydrogen, whose everyday utility, especially in mobile, stand-alone applications, for example as a fuel for motor vehicles, including the extensive supply network and storage facilities required, is currently undergoing trials in pilot projects. Hydrogen technology opens up a wide range of opportunities, but the properties of hydrogen entail not only risks that have long been familiar from industrial applications but also new risks associated with its everyday use.

Properties

Hydrogen (H_2) is a colourless, non-toxic, non-corrosive, odourless and tasteless gas that does not pose any water-pollution hazard. Its hazard potential lies in its very high combustibility and its ability to react with oxygen and ambient air to form gas mixtures that are explosive over a wide range of mix ratios.

Amounts produced, processes

About 20bn m^3 of hydrogen are produced per year in Germany alone, production worldwide adds up to about 500bn m^3. It has been produced and used on an industrial scale for over 100 years for a wide range of applications in the chemicals industry, eg in refineries and coking plants and in the manufacture of fertilisers and plastics.

Production processes

The most commonly used production processes are:

- from natural gas and steam (steam reforming),
- from methanol and steam (autothermal reforming),
- from natural gas or heavy oil (Kvaerner process),
- through electrolysis of water into hydrogen and oxygen,
- through biological decomposition of biomass by bacteria and green algae.

Hydrogen as an energy source and fuel

Unlike fossil fuels, hydrogen is available in practically unlimited quantities in chemically bonded form (mainly in water). At present, the high energy input needed to separate the hydrogen is obtained using fossil fuels. With the aim of effectively mitigating the environmental impact and reducing reliance on fossil fuels, research today is geared toward harnessing renewable energy sources (solar and wind power, water power and biomass) to produce hydrogen.

Storing hydrogen

Storing hydrogen involves a major technical effort. On the other hand, storage is essential if use of this energy source is to be separated from its time and place of production. Hydrogen can be stored as a compressed gas in pressurised tanks or as a refrigerated liquid in vacuum-insulated tanks.
Nowadays, hydrogen can be safely stored in small quantities. Fire and crash tests with hydrogen-fuelled cars show that they are no more dangerous than vehicles with conventional fuel tanks. The fire test results were even better than those for conventionally fuelled cars.
Further possibilities are "chemical storage" in methyl cyclohexane or storage under pressure in carbon microfibres. However, these processes have not yet reached maturity for large-scale use.

In Germany, the use of hydrogen is subject to the safety regulations for combustible gases. The precautions for explosion-hazard areas (EN 60079-10) and the explosion-proofness requirements of Art 11 GSGV (Equipment Safety Act) must also be observed:

- maintenance of safe distances and definition of safety zones,
- enhanced risk assessment during engineering and operation,
- avoidance of leaks in design, maintenance and operation,
- simulation of gas distribution and combustion in the event of gas escapes,
- reliable and quick-acting gas detectors,
- emergency responses (shutdown of equipment, physical separation of plant units, eg by means of valves)
- structural design to avoid gas accumulations (pockets), reliable discharge in the event of gas escapes.

Transporting hydrogen

In addition to storage, transporting hydrogen is a further important aspect. Essentially, the same means of transportation are available as for conventional fuels:

- tanker trucks/rail tanks,
- pipelines,
- tanker ships.

Here, too, the properties of hydrogen call for more stringent requirements than for conventional fuels. Technically, local transportation by means of road and/or rail tankers would be possible, but only theoretical consideration has been given to global transportation up to now.

Power generation, fuel cells

An increasingly important method for tapping the energy content of hydrogen is the use of fuel cells, in which electric power and heat are generated.
Significantly higher efficiencies can be achieved with this technology than with conventional combustion engines.
Fuel cells are already being used to supply power and heat for buildings or as the centrepiece of heat-and-power cogeneration plants. Hydrogen technology in the form of modified combustion engines will in future be used in motor vehicles, for marine and aircraft propulsion and for power generation. Hydrogen-based power sources for small and mini-applications such as laptops, mobile communication facilities and household devices are currently in the trial phase.

Risks

The special risks associated with hydrogen technology derive from the specific properties of hydrogen, in particular its very high combustibility and its strong propensity to form explosive gases when mixed with atmospheric oxygen. Because of its extremely low boiling point and high volatility, hydrogen gas also makes stringent demands both on the materials and on the technologies used for storing and transporting it.
A raging hydrogen fire is difficult to recognise (weak blue flame). Besides, its very high combustion rate means that any fire can be expected to propagate rapidly. A hydrogen fire that has already been extinguished can quickly break out again if further gas escapes in hot surroundings.
A further risk arises from the propensity of hydrogen to heat up and ignite spontaneously on expansion, eg through leaks from tanks or pipelines but also as a result of manipulated opening of valves.
In terms of its other properties, however, hydrogen itself and its combustion product (water) pose no danger to human health or the environment.

Information for the underwriter

The state of the art is that use of hydrogen as an energy source affords good prospects for the future: it is an environmentally benign technology that produces no greenhouse gas emissions (CO_2) or other pollutants (eg fine-particle dust).
Both the production of hydrogen and the technical implementation of the associated processes are going to make exacting demands on the designers of this new technology. To be able to largely eliminate reliance on fossil fuels in the production of hydrogen, greater use will have to be made of alternative primary energy sources (eg solar, wind, hydro).

The great opportunities opened up by this new technology are also associated with new risks that are not fully known or appreciated at this time.
These result from:

- the properties of hydrogen,
- new technologies,
- broad public accessibility.

The latent explosion and fire risk may also pose a hazard to third parties. In this context, organisational, structural and technical safeguards must be implemented to minimise the risk.
The same holds true in the context of property insurance. Hydrogen is highly inflammable and belongs to the category of combustible gases.
Against this background, great importance needs to be attached to accurate risk assessment and to analysing the efficacy of the safety precautions in place.

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