Hydrogen future: Safety assessment of hydrogen facilities

Hydrogen is increasingly being used as a transport fuel in Fuel Cell Electrical Vehicles (FCEVs) thanks to its environmentally friendly nature and increasing availability from water electrolysis or steam reforming.

Several projects have already been undertaken both within the UK and worldwide to provide infrastructure to support the operation of FCEVs. UK ventures, spanning London to Aberdeen, include support for hydrogen fuelled buses, vans, cars and waste disposal vehicles.

Regulatory requirements

The UK regulatory requirements for hydrogen producing or dispensing facilities depend on the quantity of flammable fluids onsite, with any facility handling less than 5 tonnes of hydrogen falling under the Planning (Hazardous Substances) Regulations. Above this threshold, the Control of Major Accident Hazards (COMAH) regulations apply.

Currently, standards relating to the specific design and safe operation of hydrogen facilities are few and far between. However, a limited amount of guidance is available, such as British Compressed Gas Association (BCGA) Code of Practice 41.

Hazard identification & assessment

For a facility of any size, a key requirement, both operationally and legally, is to identify and assess the associated hazards. For this, methods such as HAZIDs, HAZOPs and DSEAR assessments can be used to analyse various aspects of a site's design and operation.

Hazard Identification (HAZID) studies allow a broad assessment of the hazards associated with the operations of the site, whilst Hazard and Operability (HAZOP) studies provide an in-depth and systematic assessment of the design and operation of the process and plant.

DSEAR (Dangerous Substances and Explosive Atmospheres Regulations) assessments review the measures in place to control dangerous substances on site and prevent the generation and ignition of flammable gases.

Due to the high pressure at which hydrogen is usually stored and dispensed, the consequences of potential releases can be widespread and severe, so characterising the consequences is crucial.

CFD modelling

CFD modelling can provide useful insights into the potential consequences of gas releases, including dispersion, fires and explosions. Experimental work to validate such modelling has focused primarily on hydrocarbon releases in recent years. The advancement of fuel cell technology is now bringing similar interest in hydrogen, with projects such as SUSANA (SUpport to SAfety ANAlysis of Hydrogen and Fuel Cell Technologies) aiming to support and develop all aspects of using CFD modelling for hydrogen.

Key considerations

Whilst hazard identification and assessment studies may employ similar methods to other industries that handle flammable fluids, there are some key considerations which are specific to hydrogen:

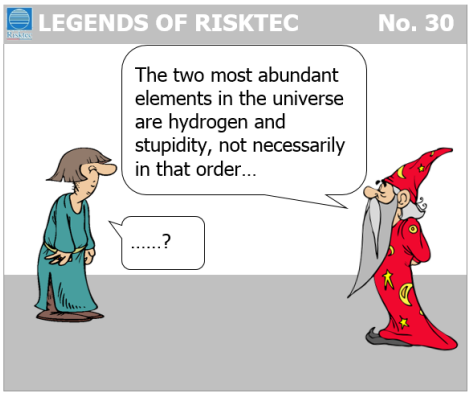
- Hydrogen leaks more readily from seals and joints due to its small molecular size, requiring the use of specialist equipment rated for hydrogen use.
- The lack of odour or taste of hydrogen makes its release far harder to detect than other gases.
- Hydrogen will usually disperse rapidly and directly upwards due to the low molecular weight of the gas, which must be considered in the design of any enclosed areas and positioning of hydrogen detectors.
- Hydrogen gas is highly flammable with a flammable range of between 4 and 75% concentration in air.
- Hydrogen, when ignited, burns with a flame that is invisible to the human eye, making a fire hard to identify.

Emergency response

The specific nature of hydrogen must also be considered when defining an emergency response plan. The plan must detail the actions to be taken in an emergency scenario not only for site staff, but also attending emergency services and any members of the public.

Conclusion

Although there may still be a lack of specific standards for the design and operation of hydrogen facilities, assessment of the key hazards and development of site documentation can be carried out using similar methods to other hazardous industries, augmented by hydrogen-specific safety assessment.



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