Perception or reality: how does the safety concern of Hydrogen compare with other fuels?

There is significant debate within society about the use of Hydrogen as a future fuel to meet decarbonisation targets. Most discussion relates to green versus blue Hydrogen and how industry can develop a truly sustainable form of energy. While discussions are dominated by the environmental aspects of producing, storing, and using Hydrogen it is important not to lose sight of safety.

To some, Hydrogen creates the perception of danger and large explosions, no doubt through historical events such as the Hindenburg disaster. Is Hydrogen particularly unsafe? Is it appropriate as a fuel used by the general population? The answer of course is that "it depends".

The environmental benefits of Hydrogen are largely dependent upon the detail. For instance, if Hydrogen has been manufactured by reforming methane and then compressed using grid electricity made from burning coal then no environmental benefit is derived. Should renewable electricity be used to generate Hydrogen from water and then further used in compression, then there are potential environmental benefits. Similarly, the risk is dependent upon the context of how it is made and used along with its storage. Risk itself is best understood not by looking at Hydrogen in isolation but establishing how it compares to competing technologies such as Natural Gas or Petroleum.

From a technical perspective, Hydrogen is neither substantially more nor less "dangerous" than many other competing fuels. It is just different, and it is these differences which need to be understood so that effective safeguards can be implemented. Those who have worked with Hydrogen can point to the extremely low ignition energy required to ignite it in comparison with other fuels. This has minimal impact on the risk when you recognise that most of the typical ignition sources can ignite Petroleum or Natural Gas anyway. Hydrogen could also be considered "more risky" due to its wide flammable range, typically high storage pressures and containment issues due to its ability to easily find leak paths. Although true, Hydrogen also has great buoyancy and can ventilate away easily if the location of use is designed correctly. Competing fuels, such as Natural Gas or Petroleum, would generate flammable clouds which could persist for longer periods while Petroleum would create low level vapours. The wider flammable range of Hydrogen also doesn't necessarily mean that there is greater risk. Hazard ranges from a flammability perspective are driven by the lower explosive limit (LEL) rather than the flammable range. In this respect, Hydrogen is similar to competing fuels such as Natural Gas, while Petroleum actually has a lower LEL. Again, this is not about better or worse, just a different problem which requires a different solution.

From a risk perspective, the likely dominating factor in the move towards Hydrogen fuels in non-industrial settings is the end users. This can be understood on two levels: perceived risk, and actual risk. The public are likely to perceive the risk of Hydrogen as larger than it is, given the unfamiliarity in comparison with known, existing technologies. This high perceived risk is a good thing. Currently, incidents within the Hydrogen industry are infrequent, no doubt due to accumulated experience and competence of the industry and its people. However, familiarity can breed contempt and there are trade-offs between experience and complacency. The challenge when using Hydrogen as a future fuel is to transfer the knowledge and competence to the users, during which a higher perceived risk by the public is undoubtedly a good thing.

As society moves towards a more extensive use of Hydrogen as a fuel, considerations are needed to ensure risks are reduced to appropriate levels. From a safety perspective we should ask ourselves:

- How does the introduction of pressurised Hydrogen impact upon hazard ranges for the facility/installation?
- Is the ventilation suitable in design and sufficient in capacity to prevent an accumulation of Hydrogen gas?
- Do we have an optimal layout to minimise risks at the design stage?
- Is equipment suitably rated for Hydrogen service from an ignition risk perspective?
- To what degree do specific issues such as Hydrogen embrittlement, fatigue and the ease of Hydrogen leakage affect the risk profile?
- What additional competencies will be required both within industry and the general population to safely use Hydrogen?

Author – Kris Ellenthorpe, Principal Consultant, SLR
kellenthorpe@slrconsulting.com