HYP SA OUR SAFETY STORY

ABSTRACT

Australian Gas Infrastructure Group's (AGIG's) vision is to be the leading gas infrastructure business in Australia, this means delivering for our customers, being a good employer and being sustainably cost efficient. Establishing and developing a hydrogen industry is a key pathway for us to achieve our vision.

In South Australia, AGIG is pioneering the introduction of hydrogen into its existing gas distribution networks through the Hydrogen Park South Australia (HyP SA) project. With safety our top priority, we would like to give an overview of the safety considerations of our site, our network methodology and the development of new safety procedures and culture regarding the production, handling and reticulation of a 5% hydrogen blend.

We will cover three themes, each having a safety story that is specific to the Australian context and to the project's success:

- The Production Plant and Site
  Project site safety, known hazards and risk mitigation, electrical protection, safety procedures, lighting and security. Hydrogen storage filling and transportation.
- The Network
  Securing the network for an isolated safe demonstration footprint. Gas network and hydrogen safety considerations, why 5%? Emergency procedures and crew training. New safety regulations blended networks. How does hydrogen perform in a blended gas with respect to leaks? How safe is the existing network and what sensors and controls are we using.
- The Home
  Introducing blended gas to existing homes. Appliance safety and failure mode analysis. Community engagement and education on a 5% renewable hydrogen gas blend and use in the home.

We aim to give a comprehensive overview of delivering a safe demonstration network for the HyP SA project in terms of the three main ecosystems that the hydrogen will be present, our learnings so far and the development of the safety methodologies that will be applied in the industry in the future.

1.0 PROJECT OVERVIEW

Momentum around hydrogen in Australia is building. 2018 saw extensive activity with respect to understanding the hydrogen opportunity, funding to accelerate the industry and project proposals. Located at the Tonsley innovation district, HyP SA is an Australian first project with respect to its type and scale.

HyP SA is an $11.4 million dollar project, enabled by $4.9 million in funding from the South Australian Government. It comprises a 1.25MW PEM electrolyser owned and operated by AGIG, which will enable several technologies to be demonstrated as a complete large scale system.

Hydrogen will be produced from renewable electricity and will be utilised for:

1. Blending into AGIG's South Australian gas network for partially decarbonising the gas supply within the area of influence, initially the segregated demonstration network.
2. Compression into tube-trailers for transporting to industrial users and other pure hydrogen applications in the future.
3. Mobility (buses/trucks/cars) via tube-trailer supply to refuelling stations.

We will also investigate the interaction of the electrolyser with the electricity network.

First hydrogen production is expected by mid-2020. During the development stage of the project, we are obtaining an understanding of the safety protocols relating to hydrogen production, distribution and end use in an Australian context.

The injection of hydrogen into our distribution network will be the first time such activity has occurred at this scale in Australia. Importantly, this approach is consistent with a paper developed by Australia's Chief Scientist for the Council of Australian Governments Energy Council which notes that:

"Progressively adding small amounts of hydrogen to domestic gas networks would be one way to gradually build local demand and begin driving down production costs as manufacturing scales up. Starting with 2% by volume and gradually moving to 10% over a period of years would be achievable with no impact on distribution infrastructure or appliances, and a low impact on prices." [1]

1.0 THE PRODUCTION PLANT AND SITE

Although moving at pace, in Australia, the electrolyser (and hydrogen industry more generally) is less progressed than that internationally. As a result the project team has experienced, but overcome, challenges in deploying HyP SA with respect to the plant equipment, layout and local expertise.

1.1 Plant Equipment

A key component of HyP SA is the electrolyser which splits water (H_2O) into hydrogen (H_2) and oxygen (O). There are currently no commercial scale Australian suppliers of electrolysers and the technology and local market are developing.

As a result of the infancy of the Australian electrolyser industry (and hydrogen industry more generally), there are challenges in the application of this technology under the current standards and climactic conditions.

Given the limited Australian market to date, electrolyser vendors have limited experience with ensuring their equipment complies with the requirements of key Australian Standards (AS), such as AS 3000, AS60079, AS 1210 & AS4343.

Local Australian climactic conditions are also quite different to those found in the homelands of many electrolyser manufacturers. Installation in Australian environments can extend the design envelope of existing electrolyser plant and consideration should be paid by electrolyser suppliers to how plant can be engineered to safely operate in Australian conditions to avoid the need for onerous climate control of electrolyser housings.

1.2 Plant Layout

Small-scale hydrogen production facilities via electrolysis in Australia are few and far between. Local regulations and standards do not yet specifically cater for small-to-medium scale hydrogen production plants, which can prove to be a challenge for the practical development of a facility.

In the absence of specified local standards and regulations, selection and adoption of appropriate international standards is necessary to ensure a consistent level of safety.

As local experience with such facilities increases, we expect to see steady improvements in plant layout and ergonomics, efficiency of space utilisation, and minimization of impacts on the surrounding community.

1.3 Local Expertise and Experience

For the rapid expansion of the "hydrogen economy" in Australia, the local knowledge base will need to upskill in hydrogen specific areas. A coordinated approach will need to be employed to increase knowledge and experience with hydrogen gas, its properties and effects, and hydrogen related technologies.

Due to the emerging nature of the industry (hydrogen production for energy distribution) there is currently a shortage of hydrogen specific experience in facility design.

We have approached this, along with our EPC partners, with an open dialogue and based on experiences with other projects and observations from installations in other parts of the world.

In this early phase of development, design considerations will more regularly need to be approached from a first principles basis, rather than through operating experience and learnings. For example:

- Experience with hydrogen materials compatibility, and applications to design of pressure vessels (grades of carbon and stainless steels in relation to hydrogen embrittlement)
- Designing the plant as a whole to meet the desired operating philosophy, which requires an understanding of all of the components required and how they all work together.
- Engineering an inline gas blending facility which is able to consistently maintain a hydrogen/natural gas blend ratio, as well as provide the appropriate levels of over pressure protection to the downstream gas network.

As experience in operating these types of facilities increases, the hydrogen industry in Australia will develop an understanding of what can be achieved from a plant, and ways in which components or configurations can be improved.

2.0 THE NETWORK – PREPARATION FOR A HYDROGEN BLEND DEMONSTRATION

2.1 Network Materials

It has been established through various global research and demonstration programs that materials typically used within a gas distribution network do not have compatibility issues with hydrogen / natural gas blends of 5-20%. It is known that steel materials are susceptible to hydrogen embrittlement; however, this is considered to be a negligible risk for networks with low operating pressures, due to the stress levels in steel pipes within such networks being generally less than 20% of the Specified Minimum Yield Strength (SMYS).

2.2 Network Operation

Blending of 5% hydrogen with natural gas will have a minor impact on the properties of the resultant hydrogen / natural gas blend compared to natural gas only. In general terms, flame speed, buoyancy and UEL increase slightly, and LEL, viscosity, heating value and Wobbe index slightly decrease.

A Formal Safety Assessment was carried out to assess the impact of the differing gas properties on the equipment and procedures employed to manage the gas distribution network. Areas of consideration included the frequency and detectability of leaks, odourant dilution, blend concentration control and reliability, metering impacts, network data capture, emergency response procedures and personnel training requirements.

3.0 THE HOME – BRINGING HYDROGEN/NATURAL GAS BLENDS INTO THE HOME

3.1 Gas Appliance Compatibility

During the demonstration we have set an initial blending target of 5% hydrogen by volume in natural gas. This blend ratio was determined to ensure the resultant blended gas would not fall outside the Wobbe index specification limit defined by AS4564 – Specification for General Purpose Natural Gas, given the historic range of gas compositions typically delivered to the South Australian gas network. AS4564 defines the requirements for providing a natural gas suitable for general purpose use, and provides the range of gas properties consistent with safe operation of the natural gas appliance population.

As an added reassurance measure, an extensive appliance testing program was undertaken by the Future Fuels Cooperative Research Centre to determine the compatibility and safe operation of a range of appliances with hydrogen / natural gas continuous blends of 10% by volume. The testing methods chosen for this program were conducted in the same manner as existing appliance compliance testing, which is conducted prior to appliances being approved for sale in Australia.

3.2 Community and Stakeholder Engagement

As asset owners and operators we are experienced in operating gas infrastructure safely and reliably. The blending of hydrogen in these networks presents us with new technical challenges, which can be overcome through the planned research and development. Whilst we are confident in this new hydrogen-world, to deliver on our vision and ensure we are delivering for customers it is essential that we bring them on the journey with us – they must understand the hydrogen economy and have confidence in the hydrogen/blended gas network and their appliances.

The community engagement around HyP SA was seen as one of the biggest challenges of the project. It was essential we have meaningful two-way engagement, rather than traditional one way education pieces. Over the course of 2019 we developed collateral before beginning the targeted engagement program. Our presentation will discuss the engagement approach, customer response and sentiment towards hydrogen and its safety.

REFERENCES

1. Hydrogen Strategy Group, Hydrogen for Australia's Future, A briefing paper for the COAG Energy Council, 2018, pp. 45.

SUBMISSION OF MANUSCRIPT

Please submit the manuscript (**only in PDF version**) electronically using the Conference website: **(www.ichs2019.com**) after the 1st of February 2019.