Process safety considerations for

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In 2019 the Committee on Climate Change (CCC) issued a report[1] to the UK Government recommending a new emissions target for the UK: net-zero greenhouse gases by 2050. The UK Government and the devolved administrations committed to this new target as recommended by the CCC.

The switch from natural gas to Hydrogen as a fuel source is key part of the UK's plan to honour the net-zero commitment. Hydrogen has the technical potential to reduce emissions from most forms of industrial combustion, and a report commissioned by the Committee on Climate Change published last year also showed that low-carbon hydrogen has a unique role to play in reducing emissions from direct firing. HyNet is playing a key role in proving this technology, with hydrogen production due to come online by 2025. Nearly £13 million of government support[2] has been provided to develop the design of the hydrogen production and undertake industrial fuel switching trials.

From both a technical and economic point of view, the transition to Hydrogen as a fuel source is a clear part of the roadmap to net-zero. The North West Chemical Industry is in a prime position to hit the ground running. Being geographically close to innovative Hydrogen Projects, such as HyNet[3] and HyDeploy[4], puts members of Chemicals North West close to the growing expertise and skills in the Hydrogen arena.

Safe Handling of Hydrogen

Designers and operators have a duty of care for their employees, visitors and members of the public near the facilities they build and operate. Past Hydrogen explosion events have alerted the public to the potential hazards associated with Hydrogen. Care must be taken to reassure potential users of Hydrogen and neighbours of Industrial Hydrogen users that all necessary measures are being taken to ensure their safety.

It should be no surprise that the key to preventing Hydrogen accidents is no different to preventing other high hazard incidents that already exist in Industrial Chemical Facilities today. The established methods of hazard identification, risk assessment, and applying the hierarchy of controls to ensure the overall risks are at a broadly acceptable level, or as low as reasonably practicable (ALARP), are still applicable. Understanding the inherent hazards associated with Hydrogen is a good starting point to enable comprehensive risk assessment and ensure the design and operation of facilities to prevent, control or mitigate against Hydrogen hazards.

In the UK, the primary regulations that will govern the handling of Hydrogen and the associated infrastructure are DSEAR, COMAH, PER and the Carriage of Dangerous Goods Regulations all of which arise from implementation of EU Directives. There are three threshold values for Hydrogen Inventory that should be taken into account if considering the transition to Hydrogen:

1. The controlled quantity of Hydrogen for The Planning (Hazardous Substances) Regulations 2015 is 2 Tonnes.
2. Hydrogen is a named dangerous substance under COMAH regulations.
3. The threshold quantities are 5 Tonnes (lower tier) and 50 Tonnes (upper tier).

Physical Properties of Hydrogen

The inherent physical properties of Hydrogen provide guidance as to considerations in design.

- Hydrogen is colourless, odourless, and tasteless; making it difficult to detect.
- Hydrogen is non-toxic, does not support life and may act as an asphyxiant. Liquid hydrogen can produce cold boil-off gas, which can produce severe burns upon contact with the skin.
- Hydrogen is extremely flammable in air; the ignition energy is lower than methane and it burns in air with a very hot and almost invisible flame. It has a greater propensity to detonate than mixtures of air with more common flammable fuels.
- Maximum burning velocity of a hydrogen-air mixture is about eight times greater than those for natural gas.
- The low density and low viscosity makes it difficult to prevent Hydrogen leaks. If a hydrogen leak occurs in an open or well-ventilated area its diffusivity and buoyancy will help to reduce the likelihood of a flammable mixture forming in the vicinity of the leak. Hydrogen is likely to pool at high points, such as roof apexes. Hydrogen leak detection should be placed accordingly.
- The dispersion behaviour of a liquid release of hydrogen will be different from a release from gaseous storage. The gaseous hydrogen would be initially very cold, denser than air and start accumulating at low level.
- Liquid Hydrogen carries a potential for rapid phase transition (RPT) explosion.
- Spills of liquid hydrogen can result in air condensing out in and around the pool of liquid.

Figure 1: Artistic Impression of Hydrogen Flame vs. Carbon Flame