Hydrogen Fires

WHITE PAPER

1. Abstract

Hydrogen is an important gas, which for many decades has been widely used in industry. Apart from industry, which mainly uses Gray Hydrogen, governments have encouraged the production of clean, Green Hydrogen for energy use. Hydrogen is a highly combustible gas with specific risks. In this White Paper, these risks, and the role of Flame Detectors to mitigate these risks, are discussed.

2. Hydrogen applications

Gray Hydrogen has been used in the process industry for a long time, however, production is not without its downsides, because CO_2, which is a Greenhouse gas, is released during the process, however, with the use of electrolysers, clean, Green Hydrogen can be produced.

2.1 Gray Hydrogen

Gray Hydrogen is currently used for refining of oil and the production of fertilizers, food, (e.g., vegetable oil shortening), plastics, glass, pharmaceuticals, and semiconductors, etc.

Currently, the most common form of Hydrogen that is produced worldwide is Gray Hydrogen. Gray Hydrogen is produced by a process called Steam Methane Reforming (SMR). SMR uses high-pressure steam, (H_2O), which reacts with natural gas, (CH_4), resulting in Hydrogen, (H_2), and the Greenhouse gas, CO_2.

2.2 Green Hydrogen

Green Hydrogen is produced using sustainable electricity. The most common process uses electrolysis, in which water, (H_2O), is split into Hydrogen, (H_2), and oxygen, (O_2), using Green electricity. Green Hydrogen, therefore, can make an important contribution for energy transition by CO_2 reduction in the above-mentioned industries. Also, Hydrogen could replace the fuel in traditional industries that are currently heavily coal dependent, such as electricity generation and steel manufacturing. Currently, Hydrogen powered vehicles are in development as an alternative to fossil fuel powered ones. Electricity generation by wind farms and solar generation is forecast to increase sharply and Hydrogen can be an alternative fuel for power generation when wind and solar farms are not able to provide enough electricity due to weather conditions.

With the growing use of Green Hydrogen in both industrial and commercial markets and with governments increasing incentives to move to cleaner fuels, there is the creation of a new worldwide supply chain, which offers many possibilities in the future.

3. The risks of Hydrogen

Because Hydrogen is a highly flammable gas, it must be handled carefully during production, transport, and use. With a Lower Explosive Limit, (LEL), of 4 % and an Upper Explosive Limit, (UEL) of 75 %, Hydrogen can form explosive gas mixtures in a wide range of concentrations. Hydrogen is the lightest gas known and as the light and small H_2 gas molecules diffuse rapidly, they can easily escape through valves and flanges, caused by leaking seals. In transport applications, Hydrogen is used under pressures up to 700 bar and these high pressures create additional risks. Hydrogen poses special threats to people and property, as it is odorless and colorless, and a typical risk of Hydrogen fires is that they are invisible. Only in the dark can a Hydrogen fire be seen as a bluish flame.

For mitigating the risk of Hydrogen leaks and fires, we advise a combination of Gas Detectors, Ultrasonic Gas Leak Monitors and Flame Detectors. Ultrasonic Gas Leak Detectors respond to Hydrogen high pressure leaks. Gas Detectors should be used to detect diffused gas plumes. Both should respond before the Hydrogen ignites and provide a timely alarm to stop the leakage. If, however, the Hydrogen, after the start of the leakage immediately catches fire, the Flame Detector should be used as

measure of last resort to detect the fire. In this paper we will focus on the flame detection part.

4. Flame Detection suitable for monitoring Hydrogen Fires

A Hydrogen flame does not emit CO_2, therefore, IR type Flame Detectors which specifically detect the CO_2 band at 4.3 micron and not the 2.7-micron H_2O band, are not suitable for detecting Hydrogen fires. UV/IR Flame Detectors, with a “water band” IR sensor at 2.7 micron are suitable for detecting Hydrogen fires. The UV/IR-210/1CZ from Sense-WARE uses an IR 2.7-micron water band sensor, combined with a solar blind UV-sensor, and therefore can detect Hydrogen fires. The UV/IR-210/1CZ is also virtually immune to unwanted alarm sources, such as arc welding, lightning, and sunlight.

Sense-WARE commissioned the Southwest Research Institute (SWRI) to do independent third-party testing of the UV/IR-210/1CZ UV/IR Flame Detector to determine the sensitivity to Hydrogen fires. The results can be found in the closing paragraph of this White Paper.

5. References

a. Standard ISO/TS 19880-1:2016 Gaseous Hydrogen — Fuelling stations — Part 1: General requirements
b. Website of the EU https://energy.ec.europa.eu/topics/energy-systems-integration/Hydrogen_en
c. US Department of Energy National Clean Hydrogen Strategy and Roadmap Draft - September 2022

6. Approvals for the UV/IR-210/1CZ Flame Detector

- EN54-10 Performance, Class 2
- ATEX, IEC Hazardous Area
  II 3G Ex nA IIC T4 Gc,
  II 3D EX tc IIIC T71ºC Dc
- FM3260 Performance, (see Manual)
- FM3611 Hazardous Area Non-Incendive: Class I, II, III, Div 2, Groups A,B,C,D,F,G

7. Third Party Testing of the UV/IR-210/1CZ Flame Detector

SWRI (Southwest Research Institute, USA)

- Model UV/IR-210/1CZ – H_2 Fire Plume Size 75 x 25 cm (Height x Diameter). Maximum detection distance - 9 m.