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DETECTION AND MEASURING OF PURE HYDROGEN AND BLENDS OF NATURAL GAS WITH HYDROGEN

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ABOUT MARCOGAZ

Founded in 1968, Marcogaz represents 29 member organisations from 20 countries. Its mission encompasses monitoring and policy advisory activities related to the European technical regulation, standardisation and certification with respect to safety and integrity of gas systems and equipment, rational use of energy as well as environment, health and safety issues. It is registered in Brussels under number BE0877 785 464.

DISCLAIMER

1. Introduction

The properties of hydrogen (H_2) are different to those of natural gas (NG). Mixtures of hydrogen and natural gas (H_2NG) have different properties than the two individual gases. This raises the question on specific safety topics regarding the existing natural gas infrastructure and end uses equipment for utilizing such mixtures. The safety topic of this paper is detection and measuring of H_2. This document gives examples of hydrogen detection systems.

2. Safety properties of natural gas and hydrogen

The safety properties of methane and hydrogen are described in the Table 1 below:

Property		CH_4	H_2
Minimum Ignition Energy (MIE)	[mJ]	0,22	0,017
Ignition temperature	[°C]	537 (CH_4) – 670 (L-gas)	560
LEL-UEL	[Vol %]	4,4 - 17	4 - 77
Molecular weight	[g/mol]	18	2
Relative density	[-]	0,55	0,07

Table 1 - Safety properties of natural gas and hydrogen

Differences between safety properties of H_2 and CH_4 are:

- The explosion limits of hydrogen are much wider than those of methane
- The specific gravity of hydrogen is much lower than air, so that pure hydrogen released with low momentum rises about 6 times faster than methane (20 m/s)
- Due to the high rate of rise, the dilution in air is faster than that of methane under these conditions (approx. 3,8 times faster)
- The required ignition energy through sparks is much lower than that of methane in a stoichiometric mixture (27%), in outdoor air installations the required ignition energy is approximately the same because it is difficult to get the mixture above 10 vol.-% there.
- Attention has to be given to prevention with respect to installations in buildings due to possible accumulation of H_2 at ceiling This probability is higher compared to CH_4.

3. Measuring principle

In literature [Add reference] some different methods of detecting hydrogen are described for example:

Measuring principle	Used in one or more MARCOGAZ companies
Open Path Raman Scattering	x
Distributed Optical Fibre	x
Ultrasonic	x

Imaging	x
Networked Spot Sensors	x
Ultraviolet (UV) absorption spectroscopy	x
Electrochemical detector	x

Table 2 – Measuring principles

Characterizations of an electrochemical detector are:

- No reaction with flammable carbon-components
- Cross sensitive with H_2S

Combined (IR + Electrochemical sensor) detection devices are commercially available. IR systems used for NG will not detect hydrogen directly.

Alarm thresholds generally used in the field:

Country	1st alarm	2nd alarm
Netherlands	10 % LEL	40 % LEL
Spain	20 % LEL	40 % LEL
Germany	20 % LEL	40 % LEL

Table 3 – Alarm threshold

4. Detection of micro flames

When hydrogen leaks, it will ignite in most cases because of the low MIE. Small leakages will result in invisible micro flames.
A small unnoticed burning leak, burning for a long period of time, can affect the integrity of the infrastructure and is a possible source of ignition. A small local leak from a typical gasket or screw connection cannot maintain a flame if the leakage rate is below 28 µg/s (= 0,33 l/h).
Micro flames can be detected with a thermal imaging camera or the burning of ignited other materials.

5. Detection tape

H_2 Visual Hydrogen Leak Detector[1] is a colour changing self-fusing silicone wrap designed to detect hydrogen gas leaks in fuel cell, transmission, storage and generation facilities. When in contact with concentrated hydrogen gas, the tape quickly changes from light grey to dark black in the event of a leak.

[1] DetecTape™: https://www.detectape.com/

6. Conclusion

Operator will have to check existing detection systems to detect NG before injecting hydrogen (H_2NG).

7. Glossary

CH_4	Methane
H_2	Hydrogen
IR	Infrared
LEL	Lower Explosion Limit
L-gas	Low calorific natural gas
MIE	Minimum Ignition Energy
NG	Natural Gas
UEL	Upper Explosion Limit
UV	Ultraviolet

8. References

- Askar et al., "Explosion Protection for Mixtures of Hydrogen and Natural Gas", 21st World Hydrogen Energy Conference, Zaragoza, Spain, 13-16.06.2016
- Zalosh, Barilo, "Wide area and distributed hydrogen sensors"; https://h2tools.org/sites/default/files/2019-08/Wide%20Area%20and%20Distributed%20Hydrogen%20Sensors.pdf

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