Hydrogen as an energy carrier: transport in methane mixtures

Hydrogen Fuel Risks Part 2

EU TWG for Seveso Inspections and OECD Working Party on Chemical Accidents

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ISPRA - Italian National Institute for Environmental Protection and Research

Program and themes

1. The Central Committee for the technical safety of the energy transition and for the management of risks related to climate change
2. The hydrogen in methane mixtures: topics to explore
3. Conclusions and Further Developments

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Istituto Superiore per la Protezione e la Ricerca Ambientale

Sistema Nazionale per la Protezione dell'Ambiente

European Commission

1. The Central Committee for the technical safety of the energy transition and for the management of risks related to climate change

Purpose and skills

Technical, consultative, and proactive body on technical safety issues concerning systems and plants powered by hydrogen, including fuel cells, liquefied natural gas and electrochemical energy storage, innovative electricity production systems, and solutions adopted to combat the risk related to climate change and energy saving

- Identifies criteria and guidelines for the evaluation of technical safety standards, also considering the evolution of risks of systems and plants
- Proposes and coordinates studies, research, projects, and experiments in cooperation with other administrations, institutes, bodies, and companies

Composition of the committee

The Committee is established at the Ministry of the Interior

- *National Fire Brigade*
- *Civil Protection Department*
- *Department of Public Security*
- *Ministry of Environment*
- *Ministry of Infrastructure and Transport*
- *Ministry of Industry*
- *Ministry of Welfare*
- *Ministry of University and Research*
- *Agency for new technologies, energy, and sustainable development (ENEA)*
- *National Institute for Environmental Protection and Research (ISPRA)*
- *National Research Council (CNR)*

The activities of the Working Groups within the Committee

- The transport of hydrogen in methane mixtures: updating of the sector's technical regulations and safety evaluations of the blending
  - Blending between hydrogen and methane is a practice that allows the two energy carriers to be mixed, with appropriate percentages, to obtain a mixture of gases, suitable for reducing polluting emissions and supporting the energy transition
- Methodologies for risk analysis and fire safety measures to be adopted for the design and construction of Battery Energy Storage Systems (BESS)
- Fire regulations on the parking of vehicles powered by alternative fuels (LNG, hydrogen, batteries, etc.)

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2. The hydrogen in methane mixtures: topics to explore

The activities of the Central Committee in the hydrogen sector

- ✓ Updating of the Italian technical regulation with the introduction of hydrogen/methane mixtures, after exceeding the limit of 2% of hydrogen which is currently permitted to be introduced into methane pipelines
- ✓ Sharing of studies and experiments to ascertain the resilient capabilities of the materials to be used against the embrittlement of steel
- ✓ Updating the safety distances and methods of execution of pipeline crossings with roads, rivers, etc.
- ✓ Discussion of distribution and transport issues, up to the user meter
- ✓ Verifying the alignment of the new content with national standards (i.e. EN, ISO, etc.)
- ✓ Results of studies on domestic and industrial heating systems powered by hydrogen/methane blending

Compendium of regulations relating to transport and distribution

- Gas Transportation
- Gas Distribution
- Pipelines with maximum operating pressure greater than 5 bar
- Fire safety of loading and unloading operations of "tanker vehicles" transporting natural gas with a density not exceeding 0.8
- Crossings and parallels of pipelines and canals conveying liquids and gases with railways and other transport lines
- Chemical-physical characteristics and gas content

Proposal for a single regulatory text scheme

- Title I - Technical rule for the design, construction, testing, operation and surveillance of natural gas transport works and systems with density not exceeding 0.8
  - *1. General provisions. 2. Design criteria 3. Materials. 4. Construction on site. 5. Exercise. 6. Inspection and maintenance. 7. Installations inside industrial users.*
- Title II - Technical rule for the design, construction, testing, operation and surveillance of works and distribution systems and direct natural gas lines with density not exceeding 0.8
  - *1. Distribution pipelines. 2. Pipelines serving industrial users. 3. Pressure reduction systems. 4. Technical appendices (Pipes with maximum operating pressure greater than 5 bar)*
- Title III – Loading and unloading operations of "tank vehicles"
- Title IV - Technical standards for crossings and parallelism of pipelines and canals conveying liquids and gases with railways and other transport lines

The studies on the transportation of hydrogen by pipeline

- Collect the main evidence presented in the literature relating to the transport and distribution of hydrogen on pipelines, as a pure substance or in the form of a mixture
- Starting from a collection of statistical data relating to hydrogen pipelines, we address the main evidence relating to the frequency of release events in hydrogen plants and the mechanisms by which hydrogen can cause weakening effects on steel
  - *1. Events on hydrogen pipelines*
  - *1.1 Evidence relating to the frequency of release in hydrogen plants*
  - *1.2 Ignition probability of hydrogen and natural gas-hydrogen mixtures*
  - *2. Hydrogen-steel interaction*

Technical reference sources

- «Admissible hydrogen concentrations in natural gas systems», Klaus Altfeld and Dave Pinchbeck. Reprint: gas for energy 03 / 2013. ISSN 2192-158X. DIV Deutscher Industrieverlag GmbH
- "Gas infrastructure - Consequences of hydrogen in the gas infrastructure and identification of related standardization need in the scope of CEN/TC 234". TECHNICAL REPORT. FINAL DRAFT FprCEN/TR 17797
- "Review of Release Behavior of Hydrogen & Natural Gas Blends from Pipelines", Austin R. Baird, Austin M. Glover, Brian D. Ehrhart. SANDIA REPORT- SAND2021-9802. Printed August 2021

Hydrogen as an energy carrier for residential use

- In Italy, the civil sector represents 41% of gas end uses. The other uses are the thermoelectric sector 33%, industry 20.5%, transport 1.5%
- Technology available and certified
- Various projects carried out abroad that prove the safety of using hydrogen (equivalent to methane), considering the entire supply chain: production of green H2, storage, transport, distribution, end uses
- It is desirable to be able to carry out field tests to acquire the experience necessary for all operators, simplifying the procedures for starting experiments and defining test protocols with mixtures of natural gas and hydrogen with increasing percentages

3. Conclusions and developments

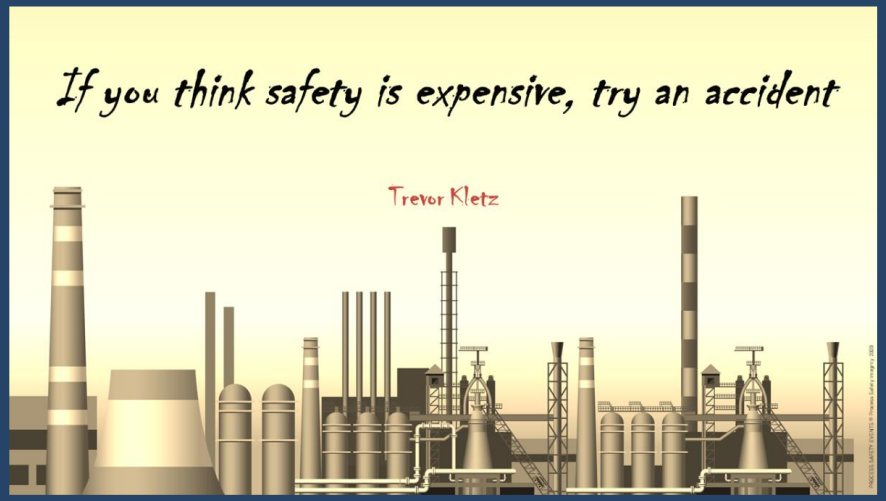
Hydrogen concentrations in natural gas: State-of-the-art

- Technical standard UNI EN 16276:2018 "*Gas infrastructure - Gas quality - Group H*"
  - ✓ Suitability up to 10% vol. hydrogen
  - ✓ The safety parameters (flammability limits, ignition energy, flame speed) are marginally influenced
- Experimental campaigns for the evaluation of the effect of H2-NG mixtures on the transport infrastructure
  - Use of H2 at 5% vol., in some sections of a pressure reduction plant on the national NG network
  - Use of H2 at 5% vol., in some sections of the national NG network (supply for the pressure reduction cabin and two utilities)

Further investigations

- Identification of models for risk assessment and analysis relating to pipeline transportation of H2-NG mixtures (probability of release and triggering in case of loss of containment)
  - Uncertainties on the chemical-physical and combustion properties
  - Disagreement on emerging risk scenarios after a loss of containment
- Identification and design of experimental tests related to hydrogen transport
  - A maximum hydrogen content of no more than 10% vol. should not alter the risk scenarios defined for the transport of natural gas

Acknowledgment: Eros Mannino, CNVVF



Thanks for the attention!

Questions…???...

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