Compatibility assessment of non-steel metallic distribution gas grid materials with hydrogen

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Introduction

The CANDHy project was conceived to evaluate the integrity and tolerance of non-steel metallic materials present in gas distribution networks under H2/natural gas mixtures (up to 100 vol% H2), in order to enable the hydrogen injection into the natural gas grids.

Harmonised guidelines and test assets will be developed to validate technologies and materials/components that will enable the transport of hydrogen through the natural gas distribution network. These guidelines will facilitate easy integration across gas networks and guide prenormative actions in European organisations.

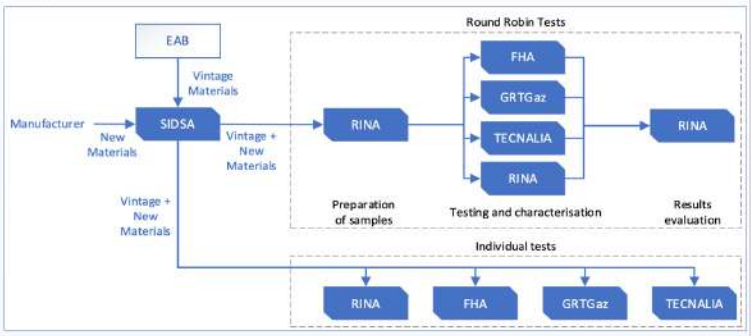

Fig.1. Testing approach

Methods

The initial phase of the project includes the inventory of non-steel metallic materials that are present in the European gas distribution grid (MOP<16 bar). This information was collected through a survey developed and shared with the most relevant stakeholders (DSOs and National Gas Associations). This analysis will allow to select the materials for the experimental campaign.

- The project also involves designing, developing, and executing an experimental campaign to assess the behavior of the most significant non-steel metallic materials, both new and vintage, considering hydrogen blends in natural gas up to 20 mol% and pure hydrogen.
- The campaign will include Round Robin testing, among the four R&D facilities involved in CANDHy, to ensure reproducibility of results. Individual testing campaigns will also be conducted to analyze a wide range of non-steel metallic materials.
- Additionally, a semi-empirical model will be developed to elucidate the mechanisms of hydrogen embrittlement in non-steel metallic materials and the project will propose pre-normative guideline for evaluating materials under hydrogen service conditions.

Results

A total of 29 European countries have been analysed, representing an overall pipeline length of 2,471,198 km of the natural gas distribution network. From this length, only 2% (representing 49,406 km) were found to be made of non-steel metallic materials such as ductile cast iron, gray cast iron and copper, see figure 2.

Components of the natural gas distribution grid are also made of non-steel metallic materials as the pipeline but also of aluminium, brass, lead, zamak and bronze.

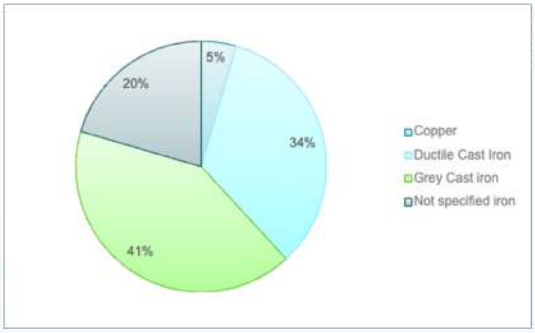

Fig 2. Graph representing what non-steel metallic materials pipeline are made of in Europe

Fig 3. Rising load machine for testing in 100%H2 and H2+CH4 blends, in Tecnalia's H2TestLab facility

Fig 4. HIGGS platform at FHA facilities

Conclusion

Following the analysis of the existing natural gas distribution grid, non-steel metallic materials were identified. Vintage as well as new materials will be selected for the experimental campaign subject to material availability.

References

- [1] ISO 11114-4: "Transportable gas cylinders – Compatibility of cylinder and valve materials with gas contents. Part 4: Test methods for selecting steels resistant to hydrogen embrittlement", International Organization for Standardization, 2017.
- [2] ASME B31.12: "Hydrogen Piping and Pipelines", The American Society of Mechanical Engineers, 2023.

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Clean Hydrogen Partnership

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