NEWSLETTER

***C**ompatibility **A**ssessment of **N**on-steel metallic **D**istribution gas grid materials with **Hy**drogen*

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CANDHy

In this Issue

INTRODUCTION

The CANDHy project started with the WP2 “Review of the state-of-the-art of the grid material and existing standards”, where the main objectives were to perform a comprehensive review of:

- The European gas distribution grids;
- The standards and codes on testing regarding material compatibility with hydrogen;
- Hydrogen embrittlement mechanisms.

PROJECT MOTIVATION

Most projects assessing safe hydrogen compatibility with natural gas distribution grids have performed experiments to study the leakage ratio, emission potential and explosion severity of vintage components.

However, long-term material integrity assessment replicating distribution grid operating conditions in testing platforms is still necessary.

The work was divided into four tasks:

1. Task 2.1: Refining inventory of non-steel metallic materials used in the natural gas distribution grid.
2. Task 2.2: Review of standards and codes on testing and qualification for materials compatibility with hydrogen gas.
3. Task 2.3: Collecting information from past and ongoing projects and research literature on the testing and evaluation of metallic materials compatibility in hydrogen gas.
4. Task 2.4: Literature review on hydrogen embrittlement phenomena.

Clean Hydrogen Partnership

The project is supported by the Clean Hydrogen Partnership and its members.

Task 2.1 - Refining inventory of non-steel metallic materials used in the natural gas distribution grid

In Task 2.1, the materials present in the current natural gas distribution network of EU countries including Ukraine and the UK were analysed, and non-steel metallic materials were determined.

A total of 29 countries were surveyed and provided information on pipe materials, but also on the accessories and the auxiliary elements present in the network, the odorant, the nominal diameter, the thickness and the installation time of the pipes and the welding materials.

The non-steel metallic materials present in the distribution networks consists of ductile cast iron, gray cast iron, copper, brass, aluminium, lead, zamak and bronze. The pipe materials were found to be cast iron and copper, with thicknesses between 2 and 17 mm, while the components were made from all the above materials.

Task 2.2 - Review of standards and codes on testing and qualification for materials compatibility with hydrogen gas

The main objective of the Task 2.2 was to perform a state-of-the-art review of the standards and codes on testing and qualification for metallic materials compatibility with hydrogen gas. Firstly, general standards, codes and guidelines on material requirements related to the delivery of 100% hydrogen or hydrogen/natural gas mixtures in low-pressure distribution grids were collected and reviewed.

Secondly, the testing methods and characterization techniques proposed in the standards, and relevant to determine the H2 suitability, were analysed.

The review focused on the applicability and complexity of the existing procedures for non-steel metallic materials and components in the distribution gas grid. Limitations and gaps on key properties and factors for the validation and qualification of materials or components were identified. The hydrogen readiness, including EU infrastructure and assessment of defects, has been analysed. The area of future needs as well as the need for new standards, essential to the future gas distribution systems, were evaluated. The current standards cover steel materials and further information is needed for non-steel metallic materials and distribution network components. The most common tests to evaluate the behaviour of materials were found to be KIH, Fracture toughness, SSR, FCGR, fatigue life, disk rupture and C-ring tests.

Task 2.3 - Collecting information from past and ongoing projects and research literature on the testing and evaluation of metallic materials compatibility in hydrogen gas

In task 2.3, information was gathered from previous and ongoing projects/activities and research literature/documents on the testing and evaluation of the compatibility of metallic materials with hydrogen gas.

The focus was on the testing of non-steel metallic materials to identify the procedures applied and materials previously tested to not overlapping with other ongoing activities. Literature research on testing and evaluation of metallic materials compatibility in hydrogen gas was also carried out in order to identify gaps, missing information and established non-steel metallic materials whose behaviour in hydrogen service is unknown.

The applicability, availability and complexity of the existing tests and qualification procedures as well as the need for new standards and component characterization techniques were evaluated. Screening tests were found to be the most common tests to evaluate the behaviour of materials in hydrogen and mainly tensile and SSR tests were performed on non-steel metallic materials. Therefore, fracture and fatigue tests providing data on crack initiation and growth quasi-static or cyclic loading would be necessary to completely understand the effect of hydrogen gas.

Task 2.4 - Literature review on hydrogen embrittlement phenomena

As part of Task 2.4, a full review of the hydrogen dissociation, solubility and diffusion in non-steel metallic materials was performed. In this task, gaseous hydrogen dissociation and adsorption on metals, electrochemical hydrogen evolution and hydrogen diffusion were briefly described, with the main mechanism of hydrogen embrittlement. The analysis focused on hydrogen diffusion and embrittlement on cast iron, copper, and lead materials. Existing literature generally suggests that these materials exhibit no significant effects when exposed to high-pressure gaseous hydrogen at room temperature. However, some detrimental effects can be observed during hydrogen electrochemical charging or exposure to high-temperature H2 environments.

All information is currently being used for the development of testing protocols in hydrogen environment at a pressure of 16 bar to derive the properties of, vintage and new, ductile and gray cast iron, and brass materials chosen by CANDHy.

PROJECT PARTNERS

The CANDHy project is being carried out by eight (8) partners from four (4) European Countries representing non-profit research association, technological centres, transmission and distribution gas system operators, universities and services companies.

VALUABLE INSIGHTS

- **Duration:** 36 months
- **Kick-off:** September 2023
- **End:** August 2026
- **Coordinator:** FHa
- **Funding Institution:** Clean Hydrogen Partnership
- **Focus:** Non-steel metallic distribution gas grid materials

CONSORTIUM MEETING

The latest CANDHy in-person meeting was hosted on 17-18 September 2024 by GRTGaz in Alfortville, Paris (France).

On that occasion, project members shared the latest updates with the consortium, followed by a visit to GRTGaz facilities.

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