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THyGA

Newsletter

Testing **Hy**drogen admixture for **G**as **A**pplications

Industry News

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- **WGC 2022, Innovation award winner of the utilisation category**
- **World Hydrogen Decarbonising the Gas Grids, Barcelona, Spain**

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- **Intermediate report on the test of technologies by segment- Impact of the different H2 concentrations on safety, efficiency, emissions and correct operation**
- **Non-combustion related impact of hydrogen admixture – Tightness testing of gas distribution components in 40%H2+60%CH4**
- **Review of projects and identification of existing sensors**

Industry News:

Hydrogen continues to gain ground in European energy policy, with plans to accelerate its introduction into energy systems, and start blending it into the natural gas grid as soon as possible due to the current energy crisis. Here is some interesting news about enhancing the role of hydrogen and blending it with natural gas:

• In response to the *REPowerEU* Commission's publication following the events of the Russian invasion of Ukraine, the **European Hydrogen Backbone initiative** published a document outlining an updated, extended, and accelerated vision of the EHB, which now involves 31 energy infrastructure companies from 28 countries.

• In *California*, subsidiaries of Sempra, Southern California Gas Co. and San Diego Gas & Electric Co. presented demonstration projects to blend hydrogen into gas distribution systems on college campuses in a document filed on 8 September with the California Public Utilities Commission (CPUC). At the same time, Southwest Gas Corp. proposed a pilot project that will provide a mixture of hydrogen and natural gas to commercial customers in Truckee.

• *France* has launched an offshore platform for green hydrogen production in the port of Saint-Nazaire, along with its first offshore wind farm. Simultaneously with the launch of the hydrogen plant, which it claims is the first facility of its kind in the world, Sweden launched another 'first of its kind' facility dedicated to storing hydrogen in a rock-lined underground cavern (LRC).

• In *Slovakia*, there have been positive results from a pilot project using hydrogen in the natural gas infrastructure in the Slovak village of Blatná nad Ostrovom. The Slovak gas distributor SPP-D explained that these results show that this fuel can be safely and efficiently distributed in existing gas pipelines, with only minor modifications needed.

Events: WGC 2022, Innovation award winner of the utilisation category

The **World Gas Conference** is a global event of business leaders, experts, and policymakers from the gas industry. This year's 2022 edition, hosted by the Korean Gas Union in May in Daegum, was organised under the theme "A Sustainable Future - Powered by Gas" with more than *9500* attendees. The event provided an excellent opportunity to discuss timely industry issues as well as global agendas, both during the conference program and through special networking events.

The THyGA project was presented by Robert Judd, on behalf of the THyGA team in addition to a presentation given by Jean Schweitzer focusing on the project testing. A poster was also exhibited, highlighting key findings on each of the work packages: impacts of blendings on appliances, status of gas utilisation technologies, experimental work, standardisation and mitigation. Furthermore, the THyGA paper *"The Impact of Hydrogen Admixture into Natural Gas on Residential and Commercial Gas Appliances"* won the conference innovation award in the category of utilisation. This was an extraordinary accomplishment, that is inspiring others to pave the way for hydrogen and natural gas blends in the domestic and commercial sectors around the world.

Events: World Hydrogen Decarbonising the Gas Grids, Barcelona, Spain

'World Hydrogen Decarbonising the Gas Grids' is a conference where industry experts debate and present the most effective strategies for reshaping and implementing clean gas networks. It showcases the plans and priorities for future gas infrastructure, revealing insights from transmission and distribution companies, storage, compressor and engineering firms.

The conference gathers TSOs, DSOs, policymakers, and technology enablers from around the world to share their plans and priorities for future decarbonized gas infrastructure. The 3rd annual World Hydrogen Decarbonising the Gas Grid took place in Barcelona on 9-10 May 2022. Projects for remodelling and enabling the decarbonised gas grid were presented. Patrick Milin, on behalf of the team, presented the THyGA project in this conference.

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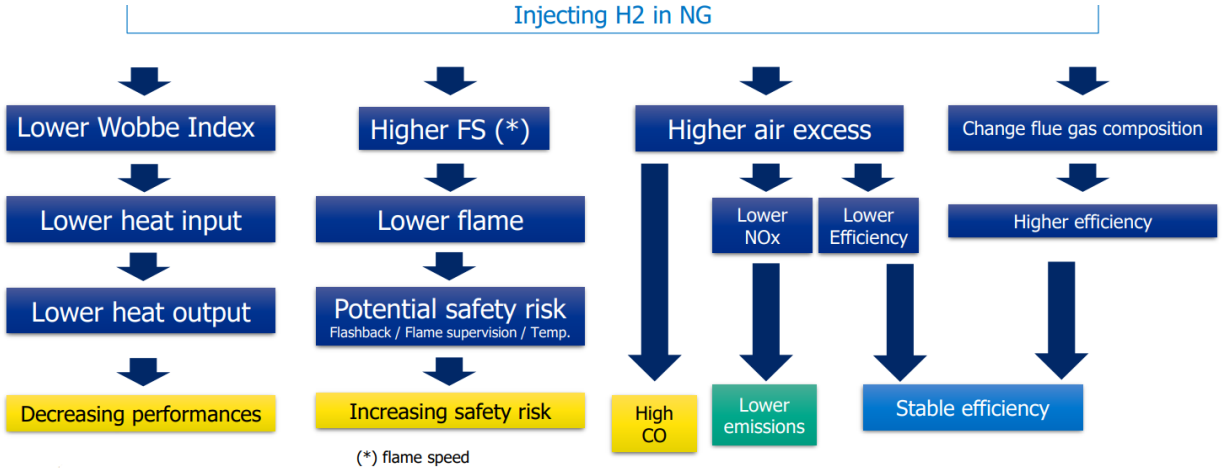
Deliverables:

3.5 Intermediate report on the test of technologies by segment- Impact of the different H2 concentrations on safety, efficiency, emissions and correct operation

First version of the document that presents the THyGA short-term tests' results, aiming at observing how appliances react in the short term (few minutes to few hours) on different H2NG admixtures. The evaluation covers the following parameters: *(1) safety, (2) energy efficiency, (3) combustion/emissions, and (4) operational aspects (correct functioning).* During the tests, the varying parameters were:

- The percentage of hydrogen (H2 %)
- The H2 rate of change (ROC)
- The composition of the natural gas (NG)
- The addition of H2 with constant pressure and with increasing pressure to keep the heat input constant
- Pressure changes
- Whether or not an adjustment is necessary



Overview of results

Provisional results of the first tests indicate mixed outcomes, the most important impact that may hinder the easy development of hydrogen is on **safety**. Atmospheric burners are more sensitive to flashback with the addition of H2 in natural gas. Premix burners can cope with higher % of H2, but appliances that are "adjustable at constant air-gas ratio", typically premix, present potentially higher risk (CO emissions). **The impact on emissions from appliances is generally positive**, there is a decrease in measured emissions. The impact on appliance performances is very **modest**.

(1) Results on Safety

The atmospheric technologies tested so far have been able to cope with 30% of H2. The principal reason for issues for the premix appliances is the adjustment (code "AD_G"). If we consider this can be solved, most appliances will have no problem anymore and can burn up gas with at least 40% H2.

(2) Results on Efficiency

Hydrogen injection does not impact strongly on efficiency. For boilers, there is no general trend. The potential changes in efficiency for a boiler are due to several factors and could counteract each other. There are different conclusions on the topics in literature about the impact of hydrogen on efficiency. However, the effect is generally small and difficult to measure.

(3) Results on Emissions

In principle, H2 injection will result in higher air excess and lower flame temperature (decrease) resulting in lower NOx (decrease). For CO, things are slightly more complicated as CO is following a "U curve" and slight changes on air excess will not impact CO emissions until a certain point where CO can increase dramatically.

(4) Results on Operational aspects

Impact of hydrogen on the heat input: H2 impacts the Wobbe and calorific value of the gas and this will result in a decrease of the heat input. However, in practice the flow of gas may just increase and will so be compensating some of the decrease in energy brought to the appliance. The main consequences: For cooking, it will increase the heating time. For hot water, production it will reduce the amount of produced hot water, potentially bringing discomfort. For heating appliances like boilers, it should not be a problem as those are in general oversized.

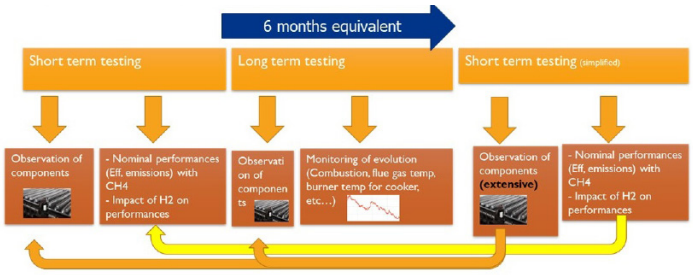
Next Steps

These first results are interesting in themselves, but they also allow the project to improve the existing test protocol and fine-tune it for the remaining tests. At the end of August, around 65 appliances are tested, and thematic reports (per type of appliances) are being worked on by the project partners.

Deliverables:

3.6 Intermediate report on the progress of the long-term tests

One of this project main objectives is to observe possible alterations of the devices in the long term with a given H2NG mixture. The idea with the long-term tests is to simulate a real situation in order to speed up the testing time; several indicators will also be continuously monitored to identify possible alterations. The long-term tests are planned to last 30 weeks for a total of 2520 hours of operation with a 30% H2 admixture in the natural gas on 5 boilers and 2 cooking hobs. The operating hours will be a mix of nominal and minimal load durations with breaks (no systematic runs during weekends and holidays). The project decided to r**ealize short-term tests before and after the long-term test to have a complete vision of the impact** of the hydrogen presence on functionalities and components, this deliverable provides an overview of the implemented test protocol.



The evaluation will be based on the following components: Visual evaluation of the components (mainly burner), follow up on the evolution of the measurement of data during testing (temperatures, flue gas composition, etc.), re-assessment of the appliances at the end with a simplified short-term test to check possible alteration of performances, emissions, or safety.

3.7 Non-combustion related impact of hydrogen admixture – Tightness testing of gas distribution components in 40%H2+60%CH4

Another objective of THyGA was to begin investigating the gas lines' tightness with the buildings, in link with H2NG blends. A first report (D3.4) described the experimental setting while deliverable D3.7 provides the experimental evaluation of the tightness of the components located on domestic and commercial gas lines from the gas meter to the end user appliance, in presence of a mixture 40%H2+60%CH4 at 35 mbar.
The objective of the test was to be able to conclude on being to be as close as possible to the service condition - for that reason it is being tested with a "safety margin" (so 35 mbar instead of 20 and 40% H2 instead of 20%). The components were taken from installations being used currently in Germany, Denmark, Belgium and France and tested during several minutes before carrying out tests on longer period of time and evaluate the potential influence of time. One of the conclusions highlighted in the report is the difficulty to obtain accurate results at low pressures, due in particular to the strong influence of the temperature on the pressure evolution as was observed. For further investigations, specific apparatus measuring the temperature inside the pipeline to minimise the influence with ambient and weather conditions is recommended. Furthermore**, the test should be carried out in a lab fitted with a well-controlled temperature.**

The results presented are in line with the main findings of other projects on the tightness of the gas distribution network:

- Generally, none of the leakage rates obtained on the short- and long-term tests were above the admissible leakage of the NEN 7244-7, and EN15502-1:2021 standards. Hence, once a gas line is properly installed, following NG standards, at low pressures (35 mbar) it can be expected that it will be tight in the gas blend.
- On the long-term tests, no further increase of leakage rates were observed. Hence, for these test durations, no deterioration of the joints and coupling was induced by the gas blend. Furthermore, at these low pressures, the potential permeation of gas through the material can be neglected.

In conclusion, under the tested conditions and with gas lines installed properly, leakage rates for both gas lines and appliances will be below the current admissible standard rates. There were no differences in the leakage rates of the H2NG blend and air at those low pressures. Furthermore, no component degradation or loss of tightness was seen in the lines that could withstand the pressure for longer than 200 hours of testing.

Deliverables:

5.1. Review of projects and identification of existing sensors

The main goal of THyGA's WP5 is to investigate ways to adapt residential or commercial appliances that have safety or performance issues, to different levels of H2 concentrations in natural gas. This deliverable presents some mitigation measures based on a literature study and calculations.

Gas Quality

A first mitigation measure could be to use means of reducing the Wobbe Index (WI) bandwidth of gases at entry points. In the past, mixing stations have been used to handle this problem by **mixing different qualities of gases or by introducing inert gases or high WI gases.**

Adding new gases can improve gas properties

It could also degrade them on others

*Calculations can discriminate impacts, but only tests could quantify them and validate the approach.

New Appliances

For new appliances the starting point is the study of sensors. There are already correlation-based gas sensors available in the industrial gas applications. However, they are still very expensive. For the moment, a few sensors exist in domestic appliances, but improvements are needed especially for combustion control purposes.

- *Safety sensors*: The thermocouple as a flame detector is an appliance that can run on natural gas or pure hydrogen. However, the sensor's response time is slow and may not meet current safety requirements. Alternatives include (expensive) ultraviolet sensors.
- *Mitigation of the flashback problem*: Some patents have been published.They suggest increasing the air/fuel ratio when operating conditions could produce flashbacks (ignition). However, increasing air/fuel ratio to avoid flashback may cause other problems (blow off, no or delayed ignition) if the air/fuel ratio exceeds the recommended range.

Existing Appliances

The impact of the burner design is briefly described in the report. However, re-designing a burner can be a complex work as improvements in some areas can lead to drawback in others (ex: improving flashback behaviour is usually compensated by worse blow off behaviour).

Increasing distribution pressure for H2NG could be a way to mitigate the loss of heating power for high proportion of H2. However, this solution would not work for appliances with a pressure regulator.

Grey Areas

On site adjustment will be a major problem if, in the future, the proportion of hydrogen varies on a wide range. In the labs of THyGA partners, adjustment tests are carried out with lab CO2 analysers (with a CO2 sensor). However, field adjustment is performed with combustion analysers equipped with O2 sensors. The analysers convert O2 data into CO2 data using a predefined natural gas composition. The impact of this was not measured in THyGA.

Detailed tests/analysis of this situation will be performed, with gas analysers and with a specific O2 range calculated from CO2 range given in instruction manuals. This could eventually mitigate adjustment problems. Natural draught should not be an issue on most appliances. Preliminary calculations show that increasing the proportion of H2, decreases the volume of flue gases and its density (at constant temperature).

However, increasing the proportion of H2 also increases the air excess, and thus, can also decrease flue gases temperature. As lower flue gases temperature means less natural draught, this point has to be investigated, mainly in extreme conditions, when a boiler is at the limit of a malfunction.

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Clean Hydrogen Partnership