THyGA

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

Questions & Answers from the Webinar "Material Science – Impacts of hydrogen blends"

26th of October 2020, 10-12 am

Organisation	WP2, GWI
Host of the day and speakers	Lisa Blanchard & Laurent Briottet, CEA Johannes Schaffert, GWI Maximilien Merieux, GERG
Notes	Lisa Blanchard, CEA
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1. Hydrogen embrittlement

FHa - Vanesa Gil

Could you comment in which H2S content range is more dramatically observed?

There are many results in aqueous environments on the influence of H_2S but not many in hydrogen gas. This is something that we are trying to address. The only results we know so far are the one presented in the webinar showing an embrittlement factor multiply by 4 in the presence of 0.1% H_2S on Cr-Mo alloys.

CAMPAIGNOLLE Xavier (Storengy)

HE inhibition by O2: isn't a laboratory artefact as in the lab the steel is bright polished and in the networks already covered by oxides and calamine?

It is true that oxides reduce hydrogen sensitivity. The issue is to make sure that the oxide layer is covering the entire surface of the component and remains, meaning that it is not removed by scratches or mechanical loading. Regarding artificial layers, there are some studies on the influence of layer acting as reducing hydrogen adsorption and absorption but this is still an open question: will it work and how can we ensure that the layer will be covered the entire structure on kilometers?

Laurent Alvarez

What is the more suitable test method for fracture toughness then to determine K rising load or constant displacement? I understood from your presentation that the rising load will provide the more conservative value?

Rising load tests provide more conservative values. In the case of high strength steels (Rm > 950 MPa), both methods give similar results. However, steels with Rm < 950 MPa, a big difference can be observed between the two and the rising load will be more conservative.

CAMPAIGNOLLE Xavier (Storengy)

Does gas wetness promote or impedes carbon steels HE?

There is not a single answer to this question. As an example, on Cr-Mo alloys, water vapour promotes hydrogen embrittlement however, on C-Mg steels it reduces this susceptibility. This is dependent on the oxide layer developed at the steel surface.

Enzo Alfonsetti

Does mercaptan (odorant) promote embrittlement?

We are currently doing some study on the mercaptan influence. This is a real point, indeed, as it is sulfur based it may have some effect.

Maurizio Beghi

Answering about components in appliances: materials did not really change since many decades in gas appliance and are almost the same (steel, brass and aluminum alloys) as when town gas was distributed (high H2 %). We do not expect heavy impact for these materials at the small pressures and concentration. Mercaptans as odorants add Sulphur, but again very low ppms. To be verified the use of proper gasket for sealants. More a matter of lifetime expectancy than of performance.

Verhoog R.H. (René)

At what percentage of yield strength, you no longer have to take HE into account in connection with fracture mechanics?
There is no answer to this question as it depends on the material.

N. Mostefaoui (CETIAT)

What are the carbon steels recommended for H2 injection (e.g. 20%) in distribution gas networks?
This question relates to the one we asked during the presentation on the existence of standards for materials of gas distribution network. The answer might be difficult to answer as each European country can have different operating conditions and safety regulation. But generally, we can say that carbon steels show the biggest problem, compare to austenitic steels.

João Carlos Pereira

Regarding the HE on steel pipes evaluation, shall we set the pressure test according to the service pressure? For instance, if we are considering a service pressure of 4 bar, we should use the same pressure for a static test?
For sure, better to do the test at the operated pressure. For example: the tensile properties of a X70 carbon steel are not affected at 1 bar hydrogen pressure while for the same pressure, fracture toughness properties are strongly reduced (which does not mean they cannot be managed). Hence, the environment pressure is not the only parameter to be considered.

Driessen, Hans

What about (hydrogen-) gas air mixtures and material compatibility? I saw one sheet with 0,1% O2, but what with e.g. 10% O2?
In the case of metallic materials, we are not aware on results taking into account hydrogen and air mixture. Need some more investigation and we are developing the topic of the influence of O_2.

Regarding the presence of Zr components in the combustion chain that would be in contact with hydrogen, if they are not subjected to stresses then it should not be a problem.

2. Leakage test

Loigerot Jacques

Have you planned to standardize force to lock assemblies, I mean fitting, tubes, etc... Have you a presentation of the protocol to assembly elements?
The lines will be tested under nitrogen and helium before moving onto the gas mixture to first identify if leakage exist. But this is a real point and we discussed a lot with ENGIE and the other partners on how we could make sure our fittings are consistent with the one in service.

ALLIAT Isabelle (ENGIE SA)
In the GRHYD project, we assessed the tightness of several components from the gas distribution grid and from the gas inner network, by means of Helium. Up to 20 %vol, the leakages are quite small and below the "not worrying" level in the standard NF P45500. We concluded that H2 doesn't

change significantly the tightness of gas components and the safety is then not impacted. It was determined that a flow of 6 l.h-1 was not worrying.

Stanislav Kazda
I have one comment just for your info. We (RGC Ukraine) have already done 15 static experiments with 100% hydrogen concentration on 5 testing polygons (build from old distribution grid equipment and pipelines, PE included). Basic outcome is we lost in average 40% of pressure within 10 days (tests were provided on the mid and load pressure). The main source of leaks are fittings, joints and flanges. Now we open the same test with 50% mixture. The preliminary results seem to be very similar. We have already done first dynamic test related with combustion (next dynamic tests are coming). Metrological and material test are going to be started soon (mid of November). Just for clarification - we are focusing on materials and equipment produced in the past in Eastern Europe and Russia and compliant with GOST standards. If it is interesting for you, we are ready for knowledge sharing.

What pressure difference will be considered as a leakage: for example, in the laboratory we test domestic appliances at 20 mbar and some 0.2mmbar could be regarded as leak. What would be your criteria in the lab?
We will detect the smallest leakage we can do and then discuss with the partners what would be acceptable.

3. Comments on the need and existing standards

Jean Schweitzer
There are national standards on gas quality.

N. *MOSTEFAOUI (CETIAT)*
This will be discussed in the Standardization request for H2.

Driessen, Hans
WGs started on defined a new gas family for the H2-HG mixtures

Miklós Ferenc Fazakas
We have national standard for gas quality for more than 10 years

Jean Schweitzer
Marcogaz is presently preparing an overview with national H2 requirements.

ALLIAT Isabelle (ENGIE SA)
CEN TC234 is working on gas quality and gas infrastructures with H2.

SVGW, Bettina Bordenet

Extending regulation on, enlarge to H 234, 2024 standards available, working groups have started to do the standardization.