PRESLHY

Newsletter

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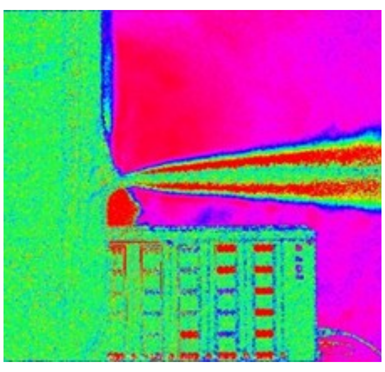
Top stories in this newsletter



DisCha experimental campaign completed

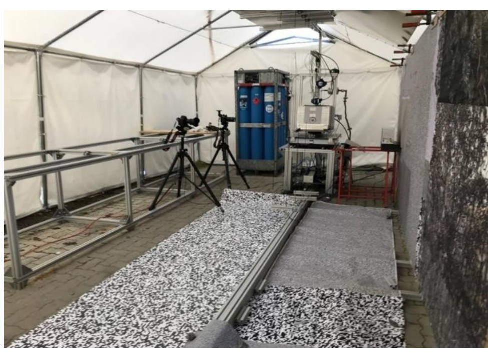
KITopenData

Debut of PRESLHY Open Data repository

Progress of experimental tests on ignition properties

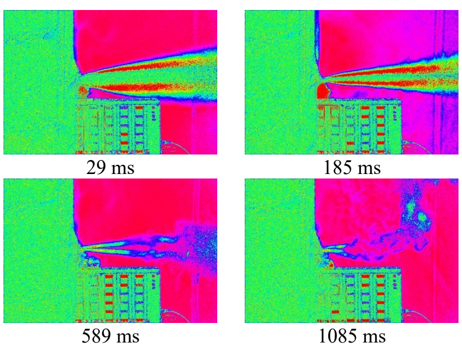
DisCha experimental campaign on cryogenic hydrogen jets successfully completed

Project partners Karlsruhe Institute of Technology (KIT) and Pro-Science (PS) performed over 200 hydrogen blowdown tests for low to high pressure (5-200 bar) releases at ambient and cryogenic temperature (80 K). The main purpose of the tests was to provide validation and reference data for:



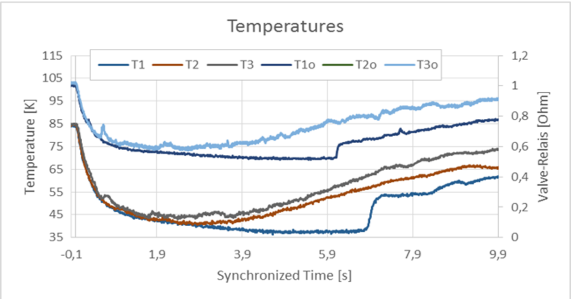
→ models defining or using a discharge coefficient
→ subsequent explosion tests, where the released gases will be ignited
→ electrostatic field excitation and associated ignition potential of high pressure hydrogen gas jets at cryogenic temperatures.

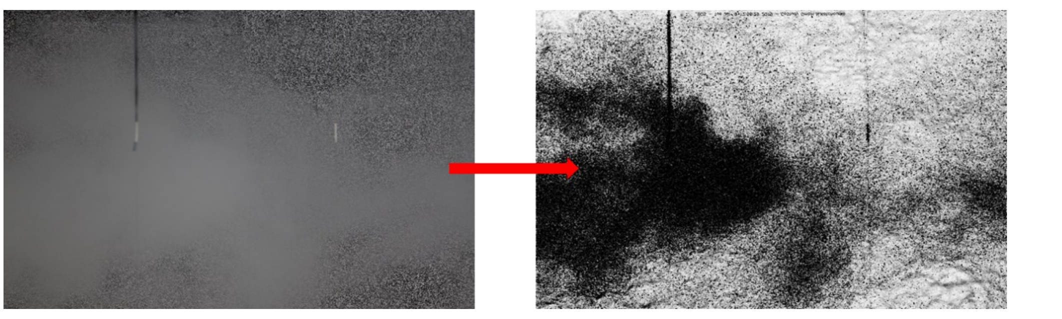
Tests showed a good reproducibility, although the experimental facility was continuously improved and extended. The final test set-up included 2 pressure sensors and 13 thermocouples, 5 hydrogen concentration probes, 2 field mills for electrostatic field strength and 3 cameras.



A glance at the experimental results

For the cold hydrogen jets, it was observed the formation of ice crystals from air humidity at the nozzle prior to the test initialization. It is considered that crystals are then entrained in the jet under the form of particles. Tests with larger diameter and high pressure showed a strong temperature decay in the reservoir close to the hydrogen boiling point. However, it is not possible to say if hydrogen condensed because of further temperature reduction at the nozzle due to the gas acceleration. Multi-phase calculations accounting for non-equilibrium effects are needed to assess this eventuality.





Figures description. Top Left: BOS post processing of cryogenic jets. Top right: experimental facility. Bottom Left: Temperature measurements in the DisCha vessel for blow-down of 200 bar cold hydrogen (T~80K). Bottom Right: original picture and results of the black and white BOS post-processing of a photograph of the jet far field.

Presence of a white fog in the experimental tests

Ambient humidity varied in the range 35-100% in the 4 months period of the tests. Ambient humidity was considered to be the cause of a white fog observed in all the cold tests. This impaired measurements by Background Oriented Schlieren BOS methodology particularly in the far field.

Ignition and electrostatic build-up

No spontaneous ignition was observed in any of the performed tests. The generation of strong electrostatic fields was observed in the cold jets, in the order of 5 kV/m. These values, 100-1000 times higher than natural electrostatic background field, are considered to be provoked by the ice crystals formed at the nozzle. Jets at normal temperature did not generate significant electrostatic fields.
The next step will be to move on to the tests involving ignition of these hydrogen jets.

Visit our Open Data repository!

Our first research data publication has been realised with the help of KITopen! The DISCHA blowdown/release data are now available worldwide via https://doi.org/10.5445/IR/1000096833. Along with the data, it is provided a detailed description of the experimental set-up, sensors, result data structure and access.

Critical temperature of ignition by hot surface $T_{p,crit}$

Project partner INERIS conducted a set of experiments to investigate the ignition properties of a cryogenic hydrogen-air flow. A continuous injection of hydrogen, nitrogen and oxygen was provided in tube with internal diameter equal to 0.1 m and length of 2.5 m. An electrically heated coil was employed to ignite the mixture at the open end of the tube. The coil temperature was determined through an infrared camera. $T_{p,crit}$ resulted to be approximately 600 °C, which is close to the autoignition temperature (AIT). For standard hydrocarbons $T_{p,crit}$ is generally larger than AIT. Surprisingly, it was also observed that:

→ $T_{p,crit}$ does not vary with the content of hydrogen in the mixture (5-70% H_2 by vol).
→ $T_{p,crit}$ does not depend on the temperature of the mixture, which was decreased from ambient to -120 °C.
→ The influence of the flow velocity (0.5-30 m/s) on $T_{p,crit}$ was hardly noticeable for a mixture with 10% H_2 by vol.

Figures description. Top: experimental set-up. Bottom: electrically heated coil

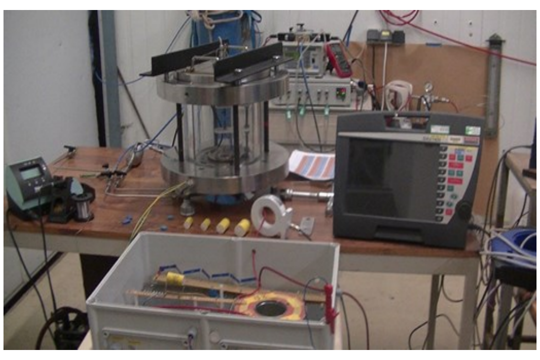


Figure: MIE experimental device

Progress on experimental campaign on hydrogen-air mixtures minimum ignition energy (MIE)

This set of experiments is aimed at determining the MIE and flame kernel propagation in hydrogen-air mixtures as function of H_2 content and temperature. The MIE device is a 7 liters transparent cylindrical chamber. Currently the spark device has been used to test propane/air and hydrogen/air mixtures at ambient temperature.
The refrigerated device is under construction to perform tests at cryogenic temperature.

Forthcoming events

→ International Conference on Hydrogen Safety 2019, Adelaide, Australia (24-26 September 2019)
→ PRESLHY 4th project meeting and workshop, Buxton, UK (6-8 November 2019)
→ FCH JU Review Days, Brussels, Belgium (19-20 November 2019)

KIT Karlsruher Institut für Technologie · HySafe International Association for Hydrogen Safety · Health & Safety Laboratory · INERIS controlling risks for sustainable development · Ulster University · Air Liquide · Pro-Science · Warwick The University of Warwick

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FCH · FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

To find more information about our research activities, please visit: www.preslhy.eu
Next edition newsletter: Issue 3, December 2019