Project Report

H2FC European Infrastructure
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Application No. 2046
Short title Characterisation of high pressure hydrogen release flammability profiles

Objectives: short, medium and long term (<250 words)

The main aims of the research are:

- To gain a better understanding of the dispersion behaviour of an unignited high-pressure hydrogen jet released close to the ground
- To gain a better understanding of the influence of the ground on ignited high-pressure hydrogen releases
- To generate experimental data with which to validate CFD modelling

Brief summary of work carried out:

Four separate test series have been performed:

- Unignited experiments of high pressure H_2 jet releases close to the ground (TEST 1)
- Ignited experiments of high pressure H_2 jet releases close to the ground (TEST 2)
- Unignited experiments of high pressure H_2 jet releases close to a ceiling (TEST 3)
- Ignited experiments of high pressure H_2 jet releases close to a ceiling (TEST 4)

For each test performed six configurations were tested with two repeats of each configuration. Two different flow conditions have been used to give similar distances to the LFL but through differing nozzle sizes and pressures. The flow conditions used were 150bar through a 1.06mm nozzle and 425bar through a 0.64mm nozzle.
For the unignited releases, hydrogen concentration was measured at 4 points per run using thermal conductivity sensors with a working range of 0 to 100% v/v hydrogen. The hydrogen sensors were moved between runs, to give up to 12 hydrogen concentration measurements per release condition. For the ignited releases, three radiometers (maximum range 110 kW/m^2) were be used to measure radiant heat flux at various distances from the jet and an IR camera to visualise the ignited jet. A single ignition location was used for each flow condition.
For the CFD modelling, fifteen unignited releases from TEST 1 and one from TEST 3 were modelled with FLACS using the flow and ambient conditions prevailing at the moment of each experiment. Free jet releases at 150 bar and 425 bar, as well as an attached jet release close to a ceiling at 425 bar were modelled without wind.

Main achievements intended for publication <250 words

It is intended to publish the results of the work as there appears to be a distinction between releases of hydrogen close to the ground and close to a ceiling surface. This has implications for the wider use of hydrogen in the automotive and energy sectors. There are also other correlations that can be deduced from the tests performed.

The experiments were carried out in highly unstable windy conditions such as time dependent directions and velocities which cannot be set accurately in the CFD tool. From a CFD aspect the wind greatly affects the concentration profile of the jets. In simulations, average wind velocity and average wind direction were used. Compared to experiments, the CFD simulations over-predicted the extent of jets in most cases. This has implications for the use of CFD tools to predict the behavior of hydrogen releases close to surfaces in the presence of highly unstable wind.

Difficulties encountered <250 words

Some difficulties were encountered with the hydrogen measurement as one sensor did not function correctly; this reduced the expected number of measurement locations down to four rather than five. Some electrical issues also affected the recording of some of radiometer measurements and some data was lost.

Further comments:

None