SIXTH FRAMEWORK PROGRAM NETWORK OF EXCELLENCE

Safety of Hydrogen as an Energy Carrier
Contract No SES6-CT-2004-502630

Description of INERIS-test-6 experiment and requirements for corresponding blind SBEP in the framework of the InsHyde internal project

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Contents

1 Introduction

The main objective of this work is to perform blind benchmarking of the various CFD software packages available to the HYSAFE partners, based on the new hydrogen dispersion experiments that will be performed by INERIS and which will investigate on the stratification of hydrogen and its subsequent diffusion in confined spaces.

A set of pre-test CFD calculations have already been performed by some HYSAFE partners in order to assist in the design of the abovementioned experiments on one hand and in order to select the case for a blind SBEP on the other. In total 6 different pre-test cases were considered as described in [1]. The pre-test CFD results showed that test 6 was the most prominent for a blind SBEP.

In this document the specifications regarding the proposed blind SBEP are described. The reader should also consult with [1-2] for a more complete description of the INERIS test site.

This work is part of the INSHYDE internal (to HYSAFE) project.

2 Experimental description

2.1 Geometrical description of the facility

The INERIS gallery facility, which is built inside a rock [2], has the shape of a rectangular box with a small slope in the length and width directions, as described in [1]. The roof of the facility is horizontal. The facility average dimensions are summarized in table 1.

Figure 1 shows the facility as an ideal box, for which the average dimensions of table 1 have been used. Figure 1 also shows the coordinate system, the location of the openings at the front side face, the location of the source as well as the location of the concentration sensors.

Width (m)	3.780
Length (m)	7.200
Height (m)	2.880
Ground area (m^2)	27.216
Effective volume (m^3)	78.382

Table 1: Experimental facility's average dimensions

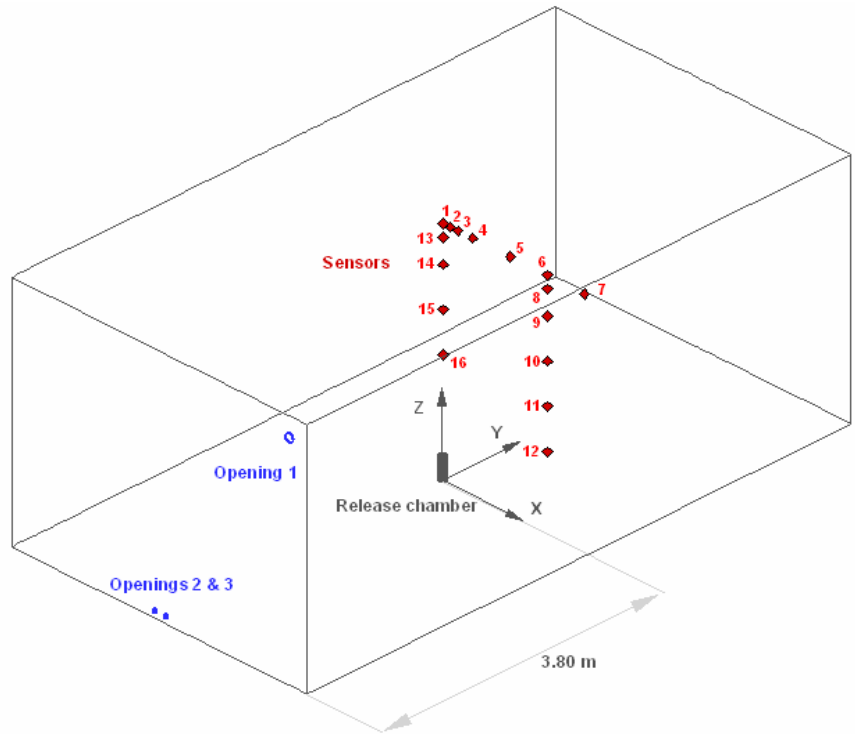

Figure 1: Experimental facility. Shown are the openings at the front side, the source and the concentration sensors.

The following figures give the front side view, Figure 2, and the length side view, Figure 3, of the experimental facility. The roughness size on the left, right and bottom faces of the facility is between 5 mm and 10 mm.

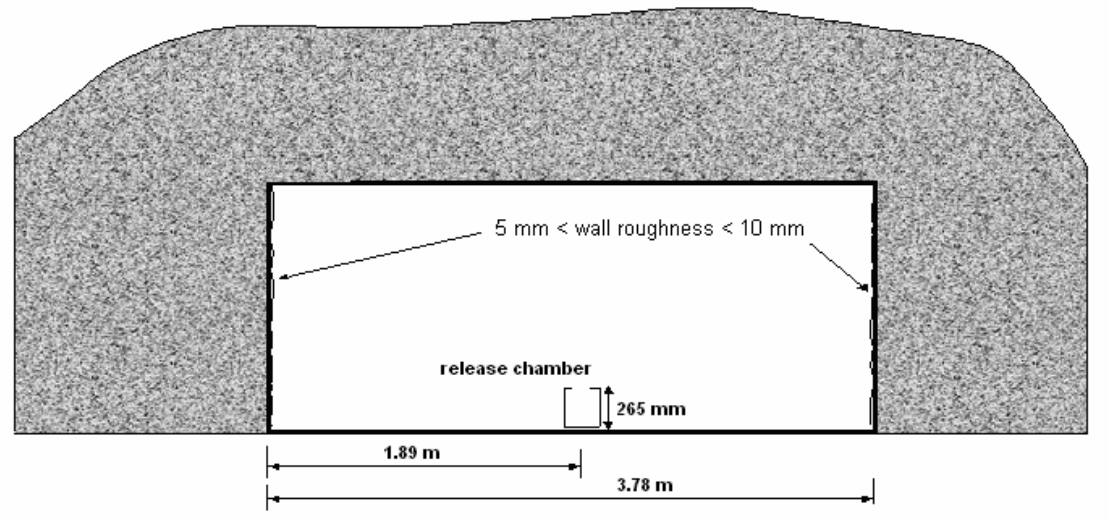

Figure 2: The facility's front side view (plane y = 0)

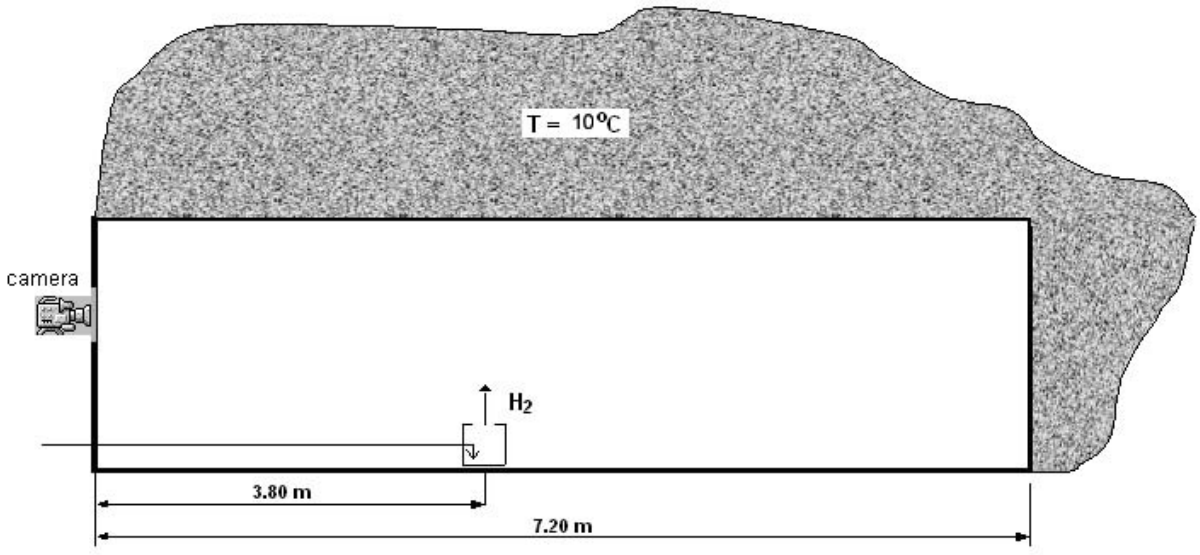

Figure 3: The facility's length side view (plane x = 0)

2.2 Experimental conditions

1.1.1 Release conditions

Hydrogen will be released through an orifice on top of a stabilization chamber (release chamber) as shown in Figure 4. The H_2 outlet orifice will be a straight hole of 3 mm thickness. Homogenization is obtained using a dispersion bed. The dimension of the dispersion bed particles will be between 10 to 15 mm (diameter) and the dispersion bed will have a height of between 30 to 40 mm. The grid at the bottom of the dispersion bed is located at half height of the chamber (132.5 mm). The internal diameter of the chamber is 120 mm and its height is 265 mm. The hydrogen flow will carry very fine droplets of ammonium chloride to allow visualization with a laser. The chamber location is shown in Figures 1 and 2.

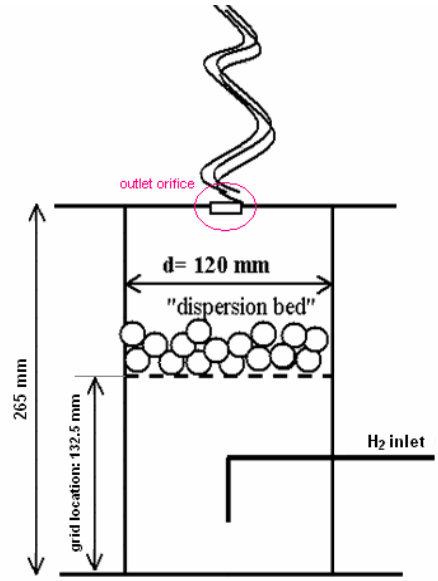

Figure 4: The stabilization chamber

Hydrogen release conditions are summarized in the following table.

Test	Release direction	Filling temperature (°C)	Release mass flow rate (mg/s)	Release duration (s)	Orifice diameter (mm)	Exit velocity (m/s)	Ventilation
6C	Vertical upwards	10	1000	240	20	38.0	Opening 1 is closed
6N	Vertical upwards	10	1000	240	20	38.0	Natural through opening 1

Table 2: Hydrogen release conditions for tests 6C and 6N (in both cases openings 2 and 3 are open)

1.1.2 Ventilation conditions

No ventilation will be provided for test 6C (C stands for confined). The increasing pressure inside the facility, due to the inlet flow rate, will be controlled through openings 2 & 3 located at the front of the facility as shown in Figures 1 and 5. Opening 1 will be sealed during the experiment (6C). Openings 2 and 3 will be completely open (no piping or cables will pass through these openings).

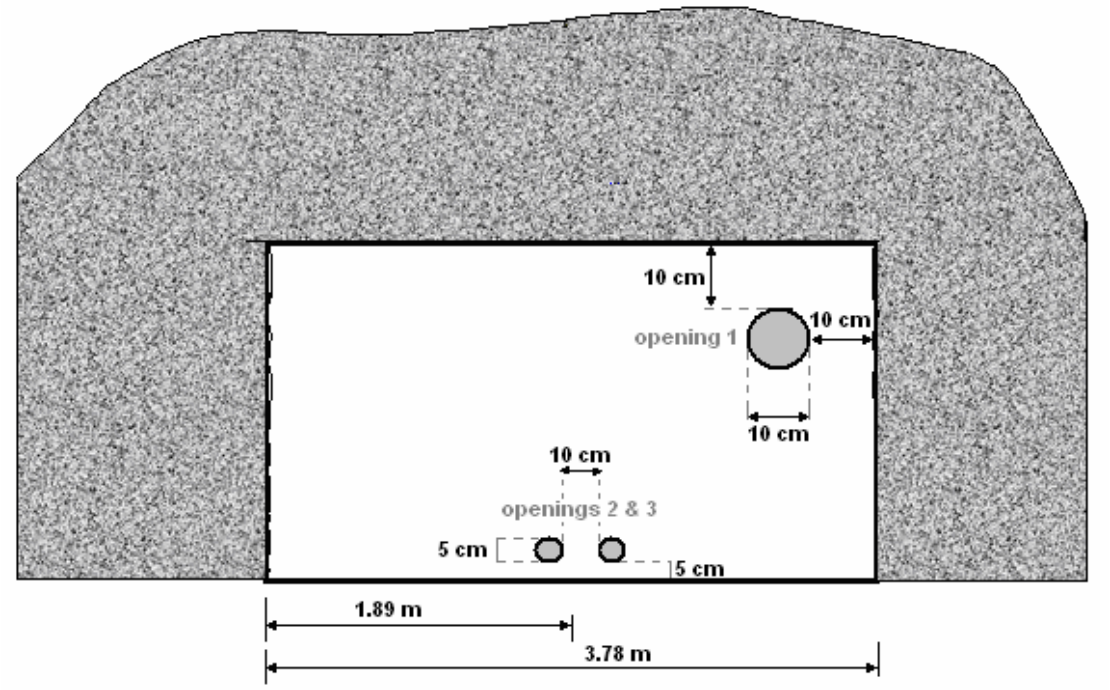

Figure 5: Location of the openings (front view), note that opening 1 will be sealed during the experiment

1.1.3 Initial conditions

The experimental facility will be filled with air at temperature of 10 ^{0}C while the atmosphere will be quiescent. The facility's walls will be at the same temperature (10 ^{0}C) while the curtain at the entrance will be hermetically closed.

2.3 Measurements

1.1.4 Concentration sensors

In total 12 experimental sensors (numbered 1-12) will be used to measure hydrogen concentration, located on the plane y = 0, as shown in Figure 1. Four additional sensor locations (numbered 13-16) are defined along the vertical jet axis for inter-model comparisons (see Figure 1).

The measurement error is expected to be less than 1%. Table 3 summarizes the sensors location and the location of openings 1, 2 and 3 with the x-y-z axes located at the bottom of the release chamber.

	X (cm)	Y (cm)	Z (cm)
Chamber size	378	720	288
Source location	0	0	0
Opening 1 centre location	180	-380	273
Opening 2 centre location	7,5	-380	7,5
Opening 3 centre location	-7,5	-380	7,5
Sensor 1 location	0	0	283
Sensor 2 location	10	0	283
Sensor 3 location	20	0	283
Sensor 4 location	40	0	283
Sensor 5 location	90	0	283
Sensor 6 location	140	0	283
Sensor 7 location	190	0	283
Sensor 8 location	140	0	268
Sensor 9 location	140	0	238
Sensor 10 location	140	0	188
Sensor 11 location	140	0	138
Sensor 12 location	140	0	88
Sensor 13 location	0	0	268
Sensor 14 location	0	0	238
Sensor 15 location	0	0	188
Sensor 16 location	0	0	138

Table 3: Sensors and openings location

1.1.5 Video recording

A laser beam will be used to light the flow (H2 + ammonium chlorine) in the plane y = 0, see Figure 1. Visualization of the release on this plane will be performed by video recording through a camera placed at the front side face of the facility (figure 3).

1.1.6 Temperature measurements

Temperature will be measured in the mixing tank, prior to the stabilization chamber, and at the facility centre (ambient temperature).

Temperature will also be measured at the jet exit separately to the dispersion experiments.

3 Blind SBEP requirements

3.1 Output requirements for modelers

Test 6C will be modeled.
The computational time is set to 5400 seconds.

Description	Document Name
A document containing a description of the applied modeling methodology such as model specifications, initial and boundary conditions, numerical specifications, code used, grid specifications, computer equipment used, CPU time… The document should also contain a figure of the predicted concentration contours plot on the plane y = 0 at time 240 seconds	SBEP_INR6C_ORG.doc
A file with 4 columns as follows (the first row should have the headings indicated below): 1. Time (s) 2. Total H2 mass (g) 3. Flammable mass in (g) (volume between LFL=4% and UFL=75%) 4. Flammable volume in (m3) (volume between LFL and UFL) 5. H2 mass flow rate (g/s) through openings 2 and 3 (total value for both)	SBEP_INR6C_ORG_1.xls
A file with 17 columns as follows (the first row should have the headings indicated below): 1. Time (s) 2. H2 concentration (vol. %) at sensor 1 …. 17. H2 concentration (vol. %) at sensor 16	SBEP_INR6C_ORG_2.xls
Video showing the evolution of concentration field on the plane y = 0	SBEP_INR6C_ORG.avi

Note that ORG stands for the participant organization name. In case of submitting results of more than one code or model the participant is advised to include lower case letters (a, b, c…) in the acronym ORG (for example: SBEP_INR6C_NCSRDa.doc, SBEP_INR6C_NCSRDb.doc).

Deadline for delivering of results will be 30 November 2005.
Results should be uploaded directly to HYSAFE website at the special slot which will be provided for this.
External organizations (not HYSAFE partners) may take part in this exercise.

4 References

1. "Compilation of description of experimental facilities", Deliverable 9, HYSAFE project. Lead participant FZJ

2. HYSAFE-INSHYDE PROJECT, “Hydrogen release in a chamber with a low flow rate”, Report for pre-test calculations (DRAFT_2), INERIS, 04/07/05