

Figure 1. HySEA consortium

PARTNERS

The partners in the HySEA consortium are [Gexcon](#) (coordinator), [University of Warwick](#), [Università di Pisa](#), [Impetus](#), [Fike Europe](#) and [Hefei University of Technology \(HFUT\)](#).

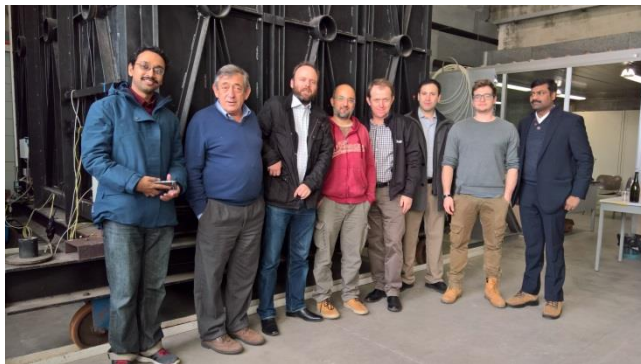


Figure 2. HySEA members during Third Progress meeting in Pisa

HySEA MEETING

Progress and Advisory Board Meeting

23-24 February 2017, Pisa

Università di Pisa organized the Third Progress and Advisory Board meeting in the HySEA project in Pisa on 23-24 February 2017.

25-27 September 2017, Bergen

Gexcon organized the Fourth Progress and Advisory Board meeting in the HySEA project in Bergen on 25-27 September 2017.

Review Meeting

23-24 November 2017, Brussels

Gexcon will present the HySEA project at the FCH JU Programme Review Days in Brussels.

16 May 2017, Brussels

FCH JU hosted the mid-term review meeting for the HySEA project in Brussels.

Workshop Meeting

29 September 2017, Bergen

Gexcon organized the Second HySEA Workshop

Demonstration Meeting

28 September 2017, Bergen

Gexcon organized the Second HySEA Demonstration at the test site on Sotra.



Figure 3. HySEA members during Second Demonstration meeting in Bergen

EXPERIMENTAL CAMPAIGNS



Figure 4. 3.785 lt Hydrogen buffer tank



Figure 5. Release nozzle

INHOMOGENEOUS MIXTURE IN SMALL SCALE ENCLOSURE

University of Pisa has performed the inhomogeneous mixture experimental campaign. A total amount of 82 tests were conducted to explore the effect of hydrogen stratification and initial turbulence. Hydrogen was accumulated in a 3.785 liters buffer tank at pressures up to 60 bar and then released into the enclosure through a nozzle to reproduce a leakage from a bottle. Release direction (horizontal, downward, upward) and nozzle diameter (0.5, 0.95mm) were varied to investigate their influence on hydrogen stratification and mixture turbulence. Five sampling tubes were positioned at different heights inside the facility to measure hydrogen concentration characterizing the stratification. The influence of initial turbulence was tested by varying the ignition delay, namely after 10 minutes or 5 seconds after the end of the release. Tests were conducted with empty enclosure as well as placing three 50 liters bottles inside the SSE. Two type of vents were employed: plastic sheet or Fike panel, while the venting surface was always the top one. Overpressure resulting from deflagrations was recorded by 2 pressure transducers while a laser sensor was used to measure the displacement of a test plate (2 or 5 mm thick). The results from Phase 2 of the small scale enclosure tests in the HySEA project, including overpressures, test plate displacement and hydrogen release concentrations will be published in HySEA

Variable	Notes
Reservoir pressure	20 ..60 bar
Release orifice diameter	0.5 –0.95 mm
Release direction	Downward, Horizontal, Upward
Ignition delay	5 s – 600 s
Ignition location	3 ignition location
Obstacle configuration	Empty, 3 bottles
Vent type	Plastic sheet, FIKE 2
Vent location	Top

Table 1. Parameters under investigation during inhomogeneous mixture experimental campaign in small scale enclosure

ENGINEERING MODELS

Engineering Models available in literature have been assessed for various enclosure geometries and parametric conditions. Model predictions have been compared with existing experimental results as well as new data generated from HySEA experiments. Issues in existing models have been highlighted and suitable qualities of a robust model have been identified.

A new model has been proposed based on external cloud explosion. The model considers flame-front inside an enclosure as a piston moving towards the vent and calculates the geometry of the vented gas cloud. The pressure generated by this external cloud is calculated by invoking the spherical piston expansion theory by Taylor. Using this external pressure, the peak overpressure inside the enclosure is calculated. This model is presently being extended to include the effect of obstacles and stratified mixture composition.

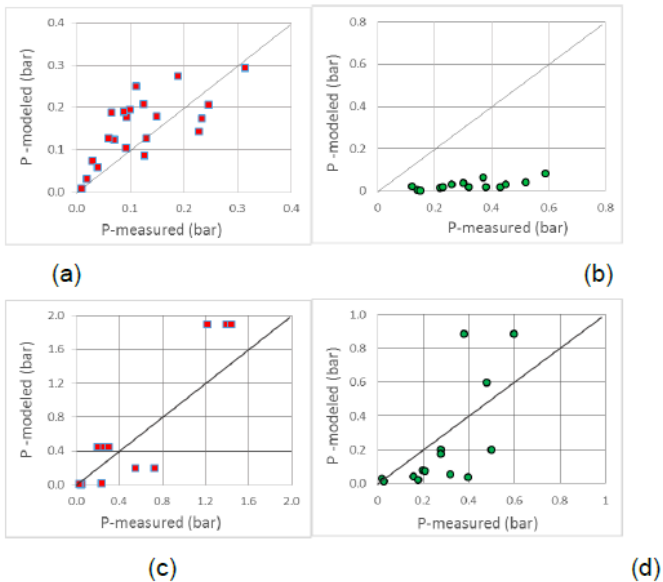


Figure 6. Comparison of the measured and calculated values of overpressure for (a) Bauwens et al., (b) Kumar, (c) Daubech et al., and (d) Kumar cases using the model of Bauwens et al.

ADVANCED MODELLING: CFD & FE



Figure 7. 20 feet-ISO container used for second blind-prediction tests, external and internal view

SECOND BLIND PREDICTION STUDY

The second blind-prediction study is based on two experimental scenarios carried out with 20 feet-ISO containers. Tests have been performed at Gexcon test site on the island of Sotra outside Bergen.

The participants to the second HySEA blind-prediction study were:

- NCSR Demokritos
- FLUIDYN France
- HSL: HSE's Health & Safety Laboratory
- Gexcon
- University of Warwick
- Lloyd's Register
- DNV GL Oil & Gas

PUBLICATIONS

HySEA partners presented:

- 13 Conference papers at several conferences.
- 4 Journal papers
- 2 Reports

The detailed list of papers can be found in the HySEA website:

<http://www.gexcon.com/hysea/article/publications>.

During ICHS 2017 in Hamburg, HySEA presented various papers on a special session on Tuesday 12th September. The list of papers presented in the session is in Figure 8.



Tuesday, September 12, 2017	
2nd Floor: "Galerie"	2nd Floor: "Galerie"
Vented Deflagrations Chair Trygve Skjold	Vented Deflagrations Chair Sergey Dorofeev
ID109, Homogeneous hydrogen deflagrations in small scale enclosure. Experimental results. Martino Schiavetti, Tommaso Pini, Marco Nicola Carcassi	ID223, Vented hydrogen deflagrations in containers: effect of congestion for homogeneous mixtures Trygve Skjold, Helene Hisken, Sunil Lakshmiopathy, et.al.
ID155, Performance evaluation of empirical models for vented lean hydrogen explosions Anubhav Sinha, C. Madhav Rao Vendra, Jernnifer X Wen	ID142, A new approach to vented deflagration modeling Ilias Tollas, Alexandros Venetsanos
ID146, Vented explosion of hydrogen / air mixtures: influence of vent cover and stratification Elena Vyazmina, Simon Jallais, Mikhail Kuznetsov	ID222, Consequence models for vented hydrogen deflagrations: CFD vs. engineering models Trygve Skjold, Helene Hisken, Gordon Atanga, et.al.
ID108, The role of the flow field generated by venting process on the pressure time history of a vented deflagration Martino Schiavetti, Tommaso Pini, Marco Nicola Carcassi	ID149, Vented explosion of hydrogen / air mixture: an inter comparison benchmark exercise Elena Vyazmina, Simon Jallais, Laurent Krumenacker, et.al.
ID154, Vented hydrogen deflagrations in an ISO container C. Madhav Rao Vendra, Jennifer X Wen	ID225, Blind-prediction: estimating the consequences of vented hydrogen deflagrations for homogeneous mixtures in a 20-foot ISO container Trygve Skjold, Helene Hisken, Marco Carcassi, et. al.

Figure 8. Some of the articles presented at ICHS by HySEA members



Figure 9. HySEA members at ICHS 2017, Hamburg

EVENTS

23-24 November 2017

The HySEA project will be presented at the FCH JU Programme Review Days in Brussels on 23-24 November 2017.

10-12 October 2017

Gexcon and UWAR presented results from the project during the Thirty-Fifth United Kingdom Explosion Liaison Group (35 UKELG) meeting, hosted by DNV GL at the Spadeadam test site on 10-12 October 2017.

28 September 2017

Gexcon organized the Second HySEA Demonstration at the test site on Sotra on Thursday 28 September 2017. The Demonstration and Workshop are linked to the second HySEA blind-prediction study, that focuses on vented hydrogen deflagrations in 20-foot ISO containers with inhomogeneous mixtures.

11-13 September 2017

Partners in the HySEA consortium presented results from the project at the Seventh International Conference on Hydrogen Safety (ICHHS 2017) in Hamburg, Germany, on 11-13 September 2017.

30 July - 4 August 2017

Gexcon and the University of Warwick presented results from the HySEA project at the Twenty-sixth International Colloquium on the Dynamics of Explosions and Reactive Systems (26 ICDERS) in Boston, USA.

28-30 June 2017

University of Pisa presented results from the HySEA project at the Twelfth HYdrogen POWer THEoretical and Engineering Solutions International Symposium (HYPOTHESIS XII) in Syracuse, Sicily.

17 May 2017

Fike presented the HySEA project at the Process Safety Congress in Dordrecht, the Netherlands, on 17 May 2017.

10-12 May 2017

Fike and Gexcon presented the HySEA project at Hazards 27 in Birmingham, UK, on 10-12 May 2017.

1-3 March 2017

Gexcon presented the HySEA project at the Thirteenth International Hydrogen & Fuel Cell Expo (FC EXPO 2017) in Tokyo during the World Smart Energy Week 2017. A representative from Gexcon was present at the Norwegian pavilion (Booth Number E60-23) at FC EXPO on 1-2 March.

28-29 November 2016

Gexcon presented the HySEA project at the IEA HIA Task 37 meeting in Bethesda, Maryland, USA

HySEA WEBSITE: <http://www.gexcon.com/hysea/article/home>



The Hysea project receives funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 671461. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and United Kingdom, Italy, Belgium and Norway.

