HySEA Newsletter

Improving Hydrogen Safety for Energy Applications (HySEA) through pre-normative research on vented deflagrations

Newsletter
#4
November 2018





Figure 1: HySEA members at the 2018 International Symposium on Hydrogen Fire, Explosion and Safety Standard (ISHFESS2018) in Hefei on 6-8 July 2018.



Figure 2: HySEA members at the Fifth Progress and Advisory Board Meeting in Paris on 10-12 April 2018.

PARTNERS

The partners in the HySEA consortium are Gexcon (coordinator), University of Warwick (UWAR), University of Pisa (UNIPI), Impetus AFEA, Fike Europe and Hefei University of Technology (HFUT).

EDITORIAL

This is the fourth and final Newsletter from the HySEA project. The project started on 1 September 2015 and was originally scheduled to end by 31 August 2018. Due to delays in the large-scale experimental campaign, that resulted in additional delays in the modelling activities, the European Commission approved an amendment that entailed an extension of the project to 30 November 2018. This issue of the newsletter includes an update on the experiments performed by University of Pisa in the small-scale enclosure (SSE) facility, an update on the experiments performed by Gexcon in 20-foot ISO containers, including results from the second blond-prediction benchmark study, and results from the development of simplified engineering models by Warwick University. The Newsletter also includes a comprehensive list of dissemination activities conducted during the project, including an updated list of publications. Further information will be available at the project website: www.hysea.eu

HySEA MEETINGS

Progress and Advisory Board Meetings

10-12 April 2018, Paris

Air Liquide organized the Fifth Progress and Advisory Board meeting in Paris on 10-12 April 2018.

11 July 2018, Hefei

HFUT organized the Sixth Progress and Advisory Board meeting in Hefei on 11 July 2018.

27-28 September 2018, London

Gexcon organised the Seventh Progress and Advisory Board meeting in London on 27-28 September 2018.



Figure 3: Vented deflagration (test 72).

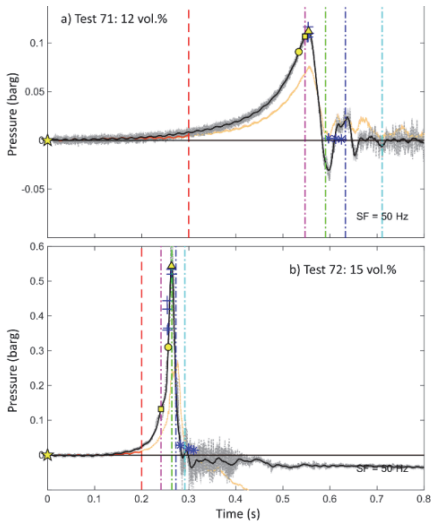


Figure 4: Pressure-time histories.

INHOMOGENEOUS MIXTURES IN 20-FOOT ISO CONTAINERS

Vented deflagrations in 20-foot containers: 66 experiments with homogeneous and inhomogeneous hydrogen-air mixtures

As part of the HySEA project, Gexcon conducted 66 vented deflagration experiments in 20-foot shipping containers. The tests consumed twelve containers, and the scenarios investigated included 42 tests with initially homogeneous and quiescent mixtures (14 tests vented through the doors, one test with closed container, and 27 tests vented through openings on the roof), and 24 tests with inhomogeneous mixtures (17 tests with stratified mixtures and 7 tests with initial turbulence generated by either a fan or a transient jet). The total number of tests was 72, which included five unignited tests and one failed test. Figure 3 shows a series of frames from the high-speed video recording of test 72 with 15 vol.% hydrogen in air and high level of internal congestion.

The results from the experiments in 20-foot containers demonstrate the strong effect of congestion on vented deflagrations, including a rapid increase in explosion violence for a modest increase in fuel concentration for lean hydrogen-air mixtures and high level of internal congestion. Figure 4 shows the pressure-time histories from two tests conducted with high level of internal congestion. Furthermore, for the same amount of fuel, combustion of stratified (inhomogeneous) mixtures resulted in significantly higher maximum reduced explosion pressures, compared to homogeneous (lean) mixtures. The results also highlight the importance of considering projectiles, including the container doors, in risk assessments and design. The experimental results from the HySEA project are particularly well suited for testing and validating engineering models for vented hydrogen deflagrations, and hence for improving the empirical correlations for design of explosion venting protective systems and explosion venting devices in international standards.

Reference: Skjold, T., Hisken, H., Lakshmipathy, S., Atanga, G., van Wingerden, M., Olsen, K.L., Holme, M.N., Turøy, N.M., Mykleby, M. & van Wingerden, K. (2018). Vented hydrogen deflagrations in containers: effect of congestion for homogeneous and inhomogeneous mixtures. *International Journal of Hydrogen Energy*, DOI: https://doi.org/10.1016/j.ijhydene.2018.10.010

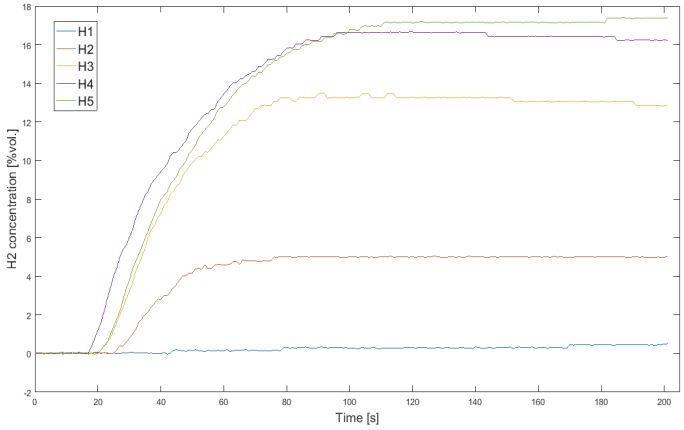


Figure 5: Hydrogen concentration time history during release for test NHTP05

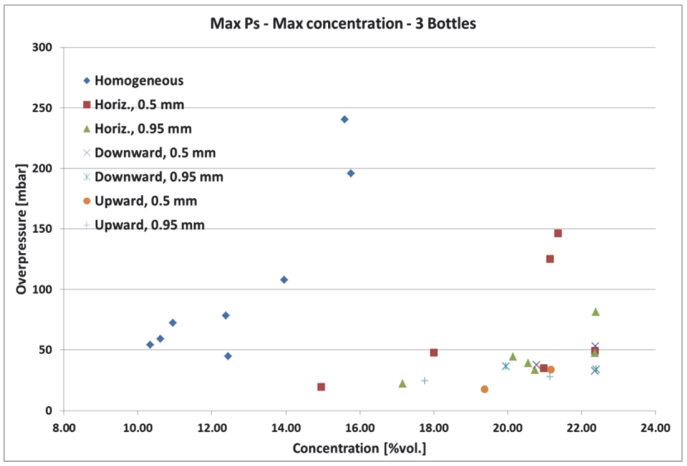


Figure 6: Comparison of maximum overpressure measured at Pside during homogeneous and non-homogeneous deflagrations as a function of the maximum concentration

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.

The stratification of hydrogen inside the enclosure before the ignition for different configurations was analyzed, Fig. 5. The pressure generated by the deflagrations was studied as a function of many variables: leak pressure, release nozzle diameter, release direction, ignition location, vent type, ignition delay.

Experiments on small scale enclosure additionally provided information on the opening inertia of the vent panel at low hydrogen concentration and on the measurement of the structural response of the enclosure.

The HySEA deliverable D2.07 includes the analysis of experimental data and the comparison between results of the first experimental campaign (homogeneous mixtures) and the second experimental campaign (non-homogeneous mixtures), Fig. 6.

Reference: Carcassi. M., Schiavetti, M. & Pini, T. (2018). Non-homogeneous hydrogen deflagrations in small scale enclosure: Experimental results. *International Journal of Hydrogen Energy*, 43: 19293-19304.
DOI: https://doi.org/10.1016/j.ijhydene.2018.08.172

INHOMOGENEOUS MIXTURE IN 40 FOOT ISO CONTAINER

HFUT has developed a state-of-the-art enclosure with the same dimensions as a standard 40-foot ISO container. The enclosure consists of a solid steel frame and internal walls made from 25 mm steel plates, and 20 separated rectangular vent openings in the roof.

In order to carry out repeated vented deflagration experiments, the enclosure is designed to withstand at least 30-bar internal overpressure. HFUT has conducted around 40 tests with homogenous/nonhomogeneous hydrogen-air mixtures in this 40-foot enclosure, typically as shown in Fig.7.

The effects of various parameters, such as hydrogen concentration, ignition position and the size and number of vents etc., have been explored. In addition, HFUT and Chinese partners has also conducted more than 150 tests on vented explosions in three small-scale vessels (cylinder vessel with the diameter of 250 mm and the length of 250 mm, 0.5 m × 0.5 m × 0.5 m cubic container and 1.2m×0.45m×1.9m gas cabinet model).

Up to November 2018, HFUT has published 7 Journal papers and one conference paper. Through these experiments with various scales, researchers can obtain overpressures for various conditions, validate the CFD code, and develop the more promising engineering model on hydrogen vented explosions toward the international or Chinese standards and codes.

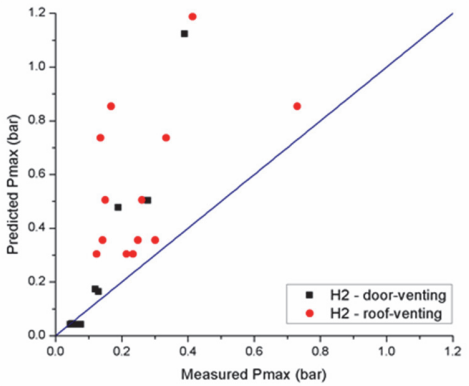


Figure 8: Prediction of HySEA tests with obstacles by the new EM.



Figure 7: Vented explosion with Hydrogen concentration 24% and ceiling vent area 37.5

ENGINEERING MODELS

A major goal of HySEA project is to review the exiting Engineering Models (EM) for vented explosions of hydrogen and propose for improvements in EU and international standards. Review of existing models have already been reported and published. A new EM based on external cloud formation and explosion has been developed and published in published International Journal of Hydrogen Energy (IJHE). To facilitate application and adoption by standards, this model has been simplified to one equation with four parameters. Two of these parameters only depend on the fuel properties and hence can be pre-tabulated. The other two parameters are simple functions of enclosure and obstacle geometry, which are relatively easy to compute. The new model is much simpler than other models in literature and existing standards. Moreover, predictions from this model are found to be either more accurate than or comparable with other existing models. A large set of experimental results have been used to assess the applicability of the new model. These include realistic conditions which involve obstacles, initial turbulence and mixture stratification. The model predictions were found to match well with the available measurements.

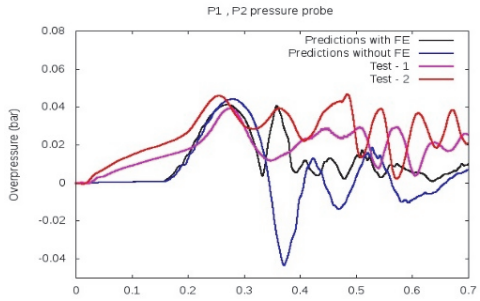


Figure 9: Comparison of HyFOAM predicted peak overpressure with experimental measurements for 15% H_2 concentration for an empty ISO container tested in HySEA.

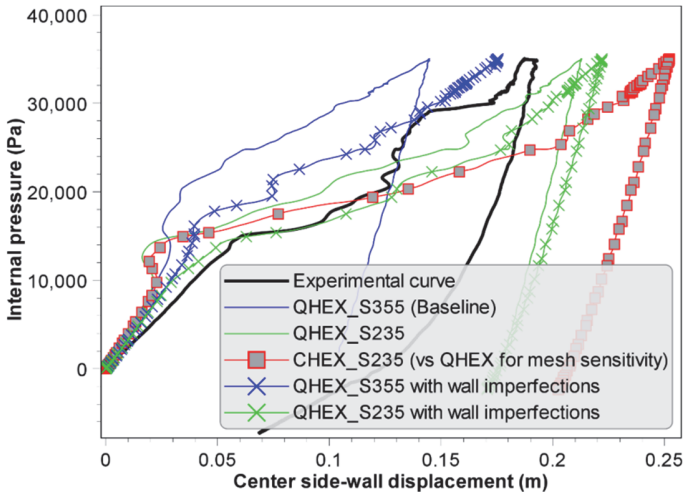


Figure 10: Results from the quasi-static test: simulations vs experiment.

CFD & FE

The HyFOAM solver, developed in-house within the framework of open source Computational Fluid Dynamics (CFD) code OpenFOAM tool box for vented lean hydrogen explosions, has been further modified to include the dominant flame instabilities present during the vented deflagration process. A pseudo two-way coupled CFD and structural response modelling approach (FSI) has been implemented in HYFOAM to emulate the ISO container wall deflections via a moving wall boundary condition. The information of the structural deflections with respect to the pressure loading obtained from the experiments are fitted to a spring-mass-damper-system to avoid solving complete structural mechanics equation. The modification has resulted in significant improvement in the overpressure trends especially the peak negative pressure trace. Validation has been conducted with HySEA tests of 15% H_2 concentration with obstacles and venting through the door. Additional simulations have also been conducted for other concentrations not covered in the experimental campaign. Contributions have been submitted for the 2nd blind validation exercise for venting through commercial vent panels on the roof and included in the joint paper. Further simulations for the 3rd blind validation exercise organized by HFUT and the published FM Global tests for 16, 18, 19 and 21% H_2 concentration.



Figure 11: Extreme loading of IMPETUS 20-foot container model

CFD & FE

The IMPETUS non-linear finite element model of the 20ft container has been validated against the latest blast tests performed by Gexcon. The model can be used to predict the container deformations during blast loading events. However, there are considerable challenges when using this model for engineering design. Results will depend on initial imperfections of the container wall as well as the description of the inner pressure loading. Pressure-time curves generated by FLACS can be directly imported to the model.

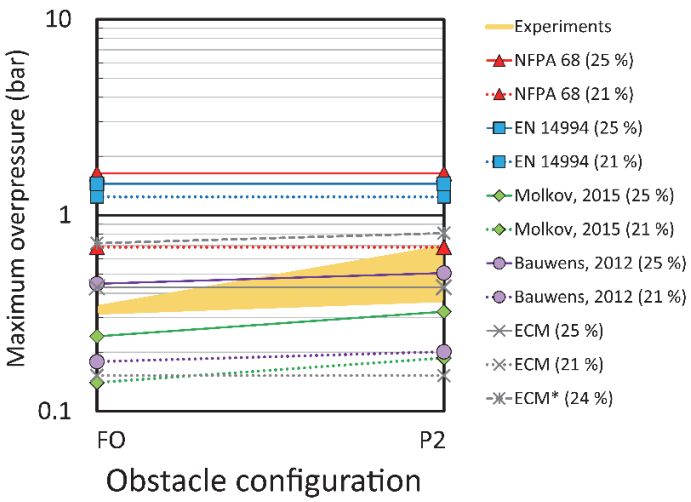


Figure 10: Explosion pressures predicted by simplified engineering models.

SECOND HYSEA BLIND-PREDICTION BENCHMARK STUDY

The call for the second HySEA blind-prediction benchmark study was published on the project website and distributed by e-mail on 23 August 2017. As for the first blind-prediction study, the HySEA consortium invited researchers and engineers to submit model predictions prior to the completion of the actual experiments. The scenarios selected for the second blind-prediction involved two steps: continuous stratification of hydrogen resulting from a vertical jet release inside a closed container, with (P2) or without (FO) a pipe rack, followed by ignition to deflagration and explosion venting through commercial vent panels in the roof. University of Pisa collected the model predictions. After several extensions, the final submission deadline for model prediction was 30 November 2017. Three commissioning tests without ignition were completed in October 2017, but the results from these tests were not communicated to the modellers. Gexcon performed two repetitions for each scenario, i.e. four experiments with vented deflagrations.

Seven individuals/groups submitted predictions obtained with CFD tools, and one group submitted predictions from various engineering models. Although all model predictions were submitted prior to the vented deflagration experiments, one prediction was resubmitted after the first experiment had been completed because the simulation was still running when the deadline expired. It was clear from the results that the resubmitted data were from the same simulation as previously submitted.

Although there was significant spread in the predictions for the concentration profile within the stratified layer, several modellers predicted the experimental results reasonably well. The primary reasons for the spread in results were mistakes by modellers: insufficient refinement of the computational grid near the release point, misplaced monitor points inside the container, and dilution of the cloud with ambient air when mapping results obtained on a fine grid to coarser grids (partly due to incomplete documentation).

Figure 10 and Figure 11 summarise the end results, i.e. the predictions for the maximum reduced explosion pressures for the vented deflagrations. The orange fields indicate the range of experimental values.

Some of the simplified engineering models predicted the explosion pressures reasonably well. The predictions by the users of CFD tools can roughly be divided in two categories: under-predictions by the users of three models that did not include functionality for simulating the opening of the vent panels, and varying degree of overprediction by users of the CFD tool FLACS. Although failure to predict the stratification inside the container may explain some of the spread in the results, there is significant potential for improving both model systems and documentation and guidelines for users. One of the primary knowledge gaps identified in this study appears to be realistic representation of explosion venting devices. Analysis conducted after the completion of the blind-prediction benchmark exercise indicates that the results for these scenarios are highly sensitive to how the vent panels are modelled.

Reference: Skjold, T., Hisken, H., Bernard, L., Mauri, L., Atanga, G., Lakshmipathy, S., Carcassi, M., Schiavetti, M., Rao, V.C.M., Sinha, A., Tolias, I.C., Giannissi, S.G., Venetsanos, A.G., Stewart, J.R., Hansen, O.R., Kumar, C., Krumenacker, L., Laviron, F., Jambut, R. & Huser, A. (2018). Blind-prediction: estimating the consequences of vented hydrogen deflagrations for inhomogeneous mixtures in 20-foot ISO containers. Twelfth International Symposium on Hazards, Prevention and Mitigation of Industrial Explosions (12 ISHPMIE), Kansas City, 12-17 August 2018.

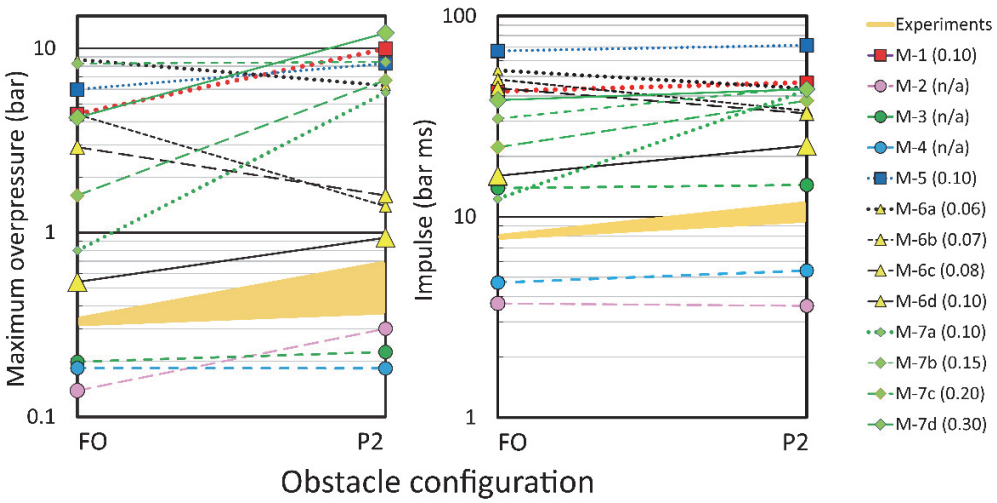


Figure 11: Explosion pressures and impulse predicted by CFD tools.

PUBLICATIONS – CONFERENCE PAPERS

ISHPMIE 2016 in Dalian

Hisken, H., Atanga, G., Skjold, T., Lakshmipathy, S. & Middha, P. (2016). Validating, documenting and qualifying models used for consequence assessment of hydrogen explosion scenarios. Proceedings Eleventh International Symposium on Hazards, Prevention and Mitigation of Industrial Explosions (11 ISHPMIE), Dalian, 24-29 July 2016: 1069-1086. ISBN 978-7-89437-165-2. **DOI**: https://doi.org/10.5281/zenodo.581649 **HySEA deliverable D3.01.**

ICDERS 2017 in Boston

Sinha, A., Rao, V.C.M. & Wen, J.X. (2017). Evaluation of engineering models for vented lean hydrogen deflagrations. Twenty-Sixth International Colloquium on the Dynamics of Explosions and Reactive Systems (26 ICDERS), Boston, 30 July – 4 August 2017, 6 pp. **DOI**: http://doi.org/10.5281/zenodo.1134925 **HySEA deliverable D1.03.**

Rao, V.C.M. & Wen, J.X. (2017). Numerical modelling of vented lean hydrogen–air deflagrations using HyFOAM. Twenty-Sixth International Colloquium on the Dynamics of Explosions and Reactive Systems (26 ICDERS), Boston, 30 July – 4 August 2017, 7 pp. **DOI**: http://doi.org/10.5281/zenodo.1134923 **HySEA deliverable D3.05.**

Skjold, T., Hisken, H., Lakshmipathy, S., Atanga, G., van Wingerden, M., Olsen, K.L., Holme, M.N., Turøy, N.M., Mykleby, M & van Wingerden, K. (2017). Influence of congestion on vented hydrogen deflagrations in 20-foot ISO containers: homogeneous fuel-air mixtures. Twenty-Sixth International Colloquium on the Dynamics of Explosions and Reactive Systems (26 ICDERS), Boston, 30 July – 4 August 2017, 6 pp. **DOI**: http://doi.org/10.5281/zenodo.1218170 **HySEA deliverable D2.06.**

ICHS 2017 in Hamburg

Sinha, A., Rao, V.C.M. & Jennifer X. Wen. (2017). Performance evaluation of empirical models for vented lean hydrogen explosions. Proceedings Seventh International Conference on Hydrogen Safety (ICHS 2017), Paper # 222, Hamburg, 11-13 September 2017: 545-555. ISBN 978-88-902391. **DOI**: http://doi.org/10.5281/zenodo.1137672 **HySEA deliverable D1.03.**

Lakshmipathy, S., Skjold, T., Hisken, H. & Atanga, G. (2017). Consequence models for vented hydrogen deflagrations: CFD vs. engineering models. Proceedings Seventh International Conference on Hydrogen Safety (ICHS 2017), Paper # 222, Hamburg, 11-13 September 2017: 615-626. ISBN 978-88-902391. **DOI**: https://doi.org/10.5281/zenodo.1165350 **HySEA deliverable D1.05.**

Schiavetti, M., Pini, T. & Carcassi, M. (2017). Homogeneous hydrogen deflagrations in small scale enclosure: experimental results. Proceedings Seventh International Conference on Hydrogen Safety (ICHS 2017), Paper # 222, Hamburg, 11-13 September 2017: 533-544. ISBN 978-88-902391. **DOI**: http://doi.org/10.5281/zenodo.1005296 **HySEA deliverable D2.05.**

Schiavetti, M., Pini, T. & Carcassi, M. (2017). The role of the flow field generated by the venting process on the time history of a vented deflagration. Proceedings Seventh International Conference on Hydrogen Safety (ICHS 2017), Paper # 222, Hamburg, 11-13 September 2017: 567-578. ISBN 978-88-902391. **HySEA deliverable D2.05.**

Pini, T., Hanssen, A.G., Schiavetti, M. & Carcassi, M. (2017). Experimental measurements of structural displacement during hydrogen vented deflagrations for FE model validation. Proceedings Seventh International Conference on Hydrogen Safety (ICHS 2017), Paper # 225, Hamburg, 11-13 September 2017: 400-411. ISBN 978-88-902391. **HySEA deliverable D2.05.**

Skjold, T., Hisken, H., Lakshmipathy, S., Atanga, G., van Wingerden, M., Olsen, K.L., Holme, M.N., Turøy, N.M., Mykleby, M. & van Wingerden, K. (2017). Vented hydrogen deflagrations in containers: effect of congestion for homogeneous mixtures. Proceedings Seventh International Conference on Hydrogen Safety (ICHS 2017), Paper # 223, Hamburg, 11-13 September 2017: 591-603. ISBN 978-88-902391. **DOI**: https://doi.org/10.5281/zenodo.998039 **HySEA deliverable D2.06.**

Rao, V.C.M. & Wen, J.X. (2017). Vented hydrogen deflagrations in an ISO container. Proceedings Seventh International Conference on Hydrogen Safety (ICHS 2017), Paper # 222, Hamburg, 11-13 September 2017: 579-590. ISBN 978-88-902391. **DOI**: http://doi.org/10.5281/zenodo.1135082 **HySEA deliverable D3.05.**

Atanga, G., Lakshmipathy, S., Skjold, T., Hisken, H. & Hanssen, A.G. (2017). Structural response for vented hydrogen deflagrations: coupling CFD and FE tools. Proceedings Seventh International Conference on Hydrogen Safety (ICHS 2017), Paper # 224, Hamburg, 11-13 September 2017: 378-387. ISBN 978-88-902391. **DOI**: https://doi.org/10.5281/zenodo.1165356 **HySEA deliverable D3.06.**

Skjold, T., Hisken, H., Lakshmipathy, S., Atanga, G., Carcassi, M., Schiavetti, M., Stewart, J.R., Newton, A., Hoyes, J.R., Tolias, I.C., Venetsanos, A.G., Hansen, O.R., Geng, J., Huser, A., Helland, S., Jambut, R., Ren, K., Kotchourko, A., Jordan, T., Daubech, J., Lecocq, G., Hanssen, A.G., Kumar, C., Krumenacker, L., Jallais, S., Miller, D. & Bauwens, C.R. (2017). Blind-prediction: estimating the consequences of vented hydrogen deflagrations for homogeneous mixtures in 20-foot ISO containers. Proceedings Seventh International Conference on Hydrogen Safety (ICHS 2017), Paper # 225, Hamburg, 11-13 September 2017: 639-652. ISBN 978-88-902391. **DOI**: https://doi.org/10.5281/zenodo.1165364 **HySEA deliverable D4.18.**

ISHESS 2018 in Hefei

Rao, V.C.M. & Wen, J.X. (2018). Structural response and CFD modelling of the vented deflagration process in an ISO container. International Symposium on Hydrogen Fire, Explosion and Safety Standard (ISHESS2018), 6-8 July 2018, Hefei, China. Abstract and presentation.

Rao, V.C.M. & Wen, J.X. (2018). Modelling structural responses of an ISO container during vented deflagrations. International Symposium on Hydrogen Fire, Explosion and Safety Standard (ISHESS2018), 6-8 July 2018, Hefei, China. Abstract and presentation.

Schiavetti, M., Pini, T. & Carcassi, M. (2018). Comparison of experimental tests on hydrogen deflagration in homogeneous and non-homogeneous conditions. International Symposium on Hydrogen Fire, Explosion and Safety Standard (ISHESS2018), 6-8 July 2018, Hefei, China.

Sinha, A. & Wen, J.X. (2018). A new model for predicting overpressure in vented hydrogen explosions. International Symposium on Hydrogen Fire, Explosion and Safety Standard (ISHESS2018), 6-8 July 2018, Hefei, China.

Skjold, T., Hisken, H., Bernard, L., Atanga, G. & Grønsund Hanssen, A. (2018). The application of pressure-impulse curves to vented deflagrations in 20-foot ISO containers. International Symposium on Hydrogen Fire, Explosion and Safety Standard (ISHESS2018), 6-8 July 2018, Hefei, China. Abstract and presentation.

Wang, X., Wang, C. & Fan, X. (2018). Effects of concentration and film thickness on the vented explosion in a small rectangular container with an obstacle. International Symposium on Hydrogen Fire, Explosion and Safety Standard (ISHESS2018), 6-8 July 2018, Hefei, China.

ISHPMIE 2018 in Kansas City

Rao, V.C.M. & Wen, J.X. (2018). Fluid structure interactions modelling in vented lean deflagrations. *Twelfth International Symposium on Hazards, Prevention and Mitigation of Industrial Explosions* (12 ISHPMIE), Kansas City, 12-17 August 2018. **HySEA deliverable D3.07.**

Sinha, A., Rao, V.C.M. & Wen, J.X. (2018). Comparison of engineering and CFD model predictions for overpressures in vented explosions. *Twelfth International Symposium on Hazards, Prevention and Mitigation of Industrial Explosions* (12 ISHPMIE), Kansas City, 12-17 August 2018. **HySEA deliverable D1.06.**

Sinha, A. & Wen, J.X. (2018). Phenomenological modelling of external cloud formation in vented explosions. *Twelfth International Symposium on Hazards, Prevention and Mitigation of Industrial Explosions* (12 ISHPMIE), Kansas City, 12-17 August 2018.

Skjold, T. (2018). Vented hydrogen deflagrations in 20-foot ISO containers. *Twelfth International Symposium on Hazards, Prevention and Mitigation of Industrial Explosions* (12 ISHPMIE), Kansas City, 12-17 August 2018.

Skjold, T., Hisken, H., Bernard, L., Mauri, L., Atanga, G., Lakshmipathy, S., Carcassi, M., Schiavetti, M., Rao, V.C.M., Sinha, A., Tolias, I.C., Giannissi, S.G., Venetsanos, A.G., Stewart, J.R., Hansen, O.R., Kumar, C., Krumenacker, L., Laviron, F., Jambut, R. & Huser, A. (2018). Blind-prediction: estimating the consequences of vented hydrogen deflagrations for inhomogeneous mixtures in 20-foot ISO containers. *Twelfth International Symposium on Hazards, Prevention and Mitigation of Industrial Explosions* (12 ISHPMIE), Kansas City, 12-17 August 2018. **HySEA deliverable D4.31.**

FMFP 2018 in Mumbai

Sinha, A. & Wen, J.X. (2018). Modelling of flow past obstacles in vented explosions. Seventh International and Forty-fifth National Fluid Mechanics and Fluid Power Conference (FMFP 2018), Mumbai, India, 10-12 December 2018.

ISFEH 2019 in Saint Petersburg

Rao, V.C.M & Wen, J.X. (2019). Modelling approach for vented lean deflagrations in non-rigid enclosures. Ninth International Seminar on Fire and Explosion Hazards (ISFEH9), 21-24 April 2019, Saint Petersburg, Russia. Accepted for oral presentation.

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Carcassi. M., Schiavetti, M. & Pini, T. (2018). Non-homogeneous hydrogen deflagrations in small scale enclosure: Experimental results. *International Journal of Hydrogen Energy*, 43: 19293-19304. DOI: https://doi.org/10.1016/j.ijhydene.2018.08.172 **HySEA deliverable D2.09.**

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Guo, J., Liu, X. & Wang, C.J. (2017). Experiments on vented hydrogen-air deflagrations: the influence of hydrogen concentration. *Journal of Loss Prevention in the Process Industries*, 48:254-259. DOI: http://doi.org/10.1016/j.jlp.2017.05.013

Guo, J., Wang, C.J., Liu, X. & Chen, Y. (2017). Explosion venting of rich hydrogen-air mixtures in a small cylindrical vessel with two symmetrical vents. *International Journal of Hydrogen Energy*, 42: 7644-7650. DOI: http://doi.org/10.1016/j.ijhydene.2016.05.097

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Pini, T., Grønsund Hanssen, A., Schiavetti, M. & Carcassi, M. (2018). Small scale experiments and FE model validation of structural response during hydrogen vented deflagrations. *International Journal of Hydrogen Energy*, DOI: https://doi.org/10.1016/j.ijhydene.2018.05.052

Rao, V.C.M. & Wen, J.X. (2018). Numerical modelling of vented lean hydrogen deflagrations in an ISO container. Accepted for publication in *International Journal of Hydrogen Energy*.

Rui, S., Guo, J., Li, G. & Wang, C. (2018). The effect of vent burst pressure on a vented hydrogen-air deflagration in a 1 m3 vessel. *International Journal of Hydrogen Energy*, 43: 21169-21174. DOI: https://doi.org/10.1016/j.ijhydene.2018.09.124

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EVENTS

30 November 2018

The end of the official project period for HySEA.

14-17 November 2018

Gexcon presented results from the HySEA project at the Programme Review Days in Brussels on 14-15 November and attended the Stakeholder Forum on 16 November 2018.

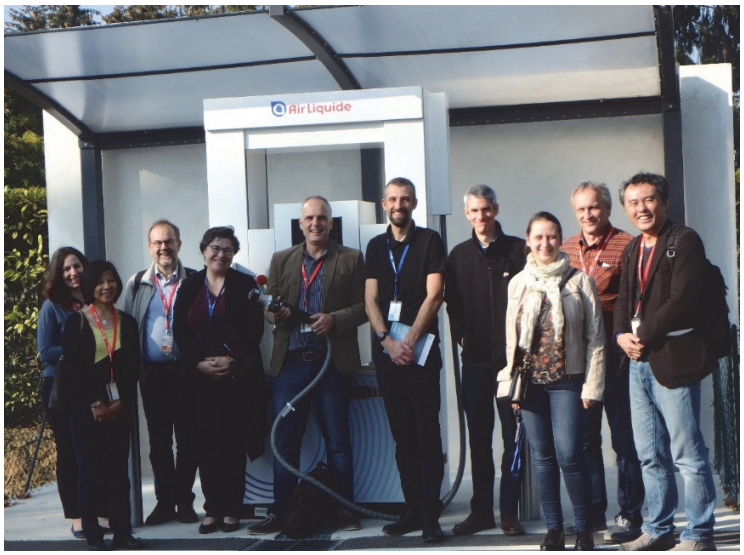


25 October 2018

Gexcon presented results from the HySEA project at the CEN/TC 305 Working Group 3 meeting in Dublin on 25 October 2018.

19 October 2018

Gexcon presented results from the HySEA project at the IEA Hydrogen Task 37 on Hydrogen Safety meeting in Paris on Friday 19 October 2018 (part of HySEA deliverable **D4.33**).

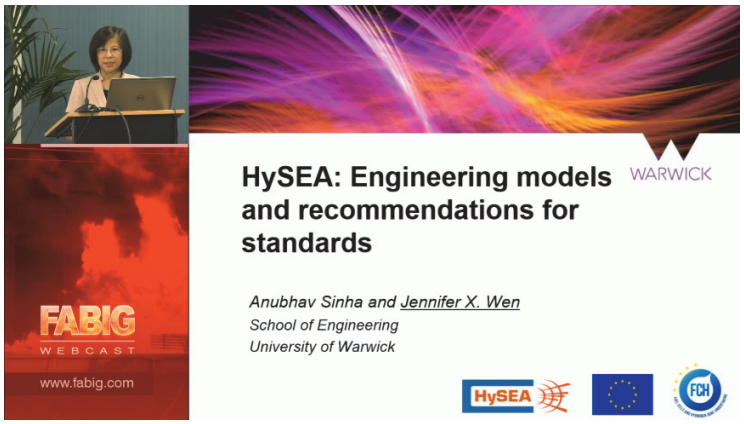


27-28 September 2018

Gexcon organised the Seventh Progress meeting for the HySEA project in London on 27-28 September 2018 (part of HySEA deliverable **D5.12**).

26-27 September 2018

Gexcon, UWAR and Air Liquide presented project results from the HySEA project at the FABIG technical meetings 'Developments in Fire & Explosion Engineering towards a Hydrogen Economy' in Aberdeen on Wednesday 26 September and in London on Thursday 27 September 2018 (HySEA deliverable **D4.28**).



18-20 September 2018

Gexcon and UWAR presented results from the HySEA project at the HySafe Research Priorities Workshop in Buxton on 18-20 September 2018 (part of HySEA deliverable **D4.33**).



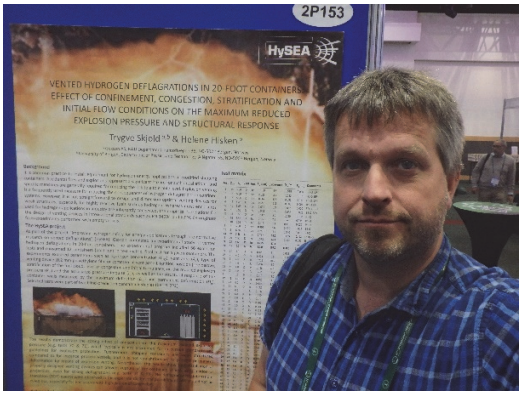
12-17 August 2018

Gexcon and UWAR presented results from the HySEA project at the Twelfth International Symposium on Hazards, Prevention, and Mitigation of Industrial Explosions (12 ISHPMIE) in Kansas City on 12-17 August 2018 (HySEA deliverables **D1.06**, **D3.07** and **D4.31**).



29 July - 3 August 2018

Gexcon presented results from the HySEA project at the Thirty-seventh International Symposium on Combustion in Dublin from Sunday 29 July to Friday 3 August 2018.



11 July 2018

Hefei University of Technology organised the Sixth Progress and Advisory Board meeting for the HySEA project in Hefei on 11 July 2018 (part of HySEA deliverable **D5.12**).

10 July 2018

Hefei University of Technology organised the third HySEA Workshop in Hefei on 10 July 2018.

9 July 2018

Hefei University of Technology organised a demonstration for the third HySEA blind-prediction exercise on 9 July 2018, featuring live demonstration of vented hydrogen explosions in a 40-foot enclosure.

6-8 July 2018

UWAR, UNIPI and Gexcon presented results from the HySEA project at the 2018 International Symposium on Hydrogen Fire, Explosion and Safety Standard (ISHFESS2018) in Hefei on 6-8 July 2018.



6 July 2018

The deadline for submitting model predictions for the third HySEA blind-prediction study.

29 June 2018

Impetus organised a structural response workshop with Gexcon in Flekkefjord on Friday 29 June 2018.



29 June 2018

The deadline for registering for the third HySEA blind-prediction study.

22-23 May 2018

Gexcon presented results from the HySEA meeting at the FLACS User Group (FLUG) meeting in Bergen on 22-23 May 2018 (part of HySEA deliverable **D4.26**).

14-15 May 2018

Gexcon presented results from the HySEA project at the International Hydrogen & Fuel Cell Conference in Trondheim on 14-15 May 2018.

19 April 2018

UWAR presented results from the HySEA project at the CEN/TC 305 Working Group 3 meeting in Paris on Thursday 19 April 2018.

10-12 April 2018

Air Liquide organized the Fifth Progress and Advisory Board meeting for the HySEA project in Paris on 10-12 April 2018 (HySEA deliverable **D5.10**).





28 February - 2 March 2018

Gexcon presented the HySEA project at the Fourteenth International Hydrogen & Fuel Cell Expo (FC EXPO 2018) in Tokyo during the World Smart Energy Week 2018.



13 December 2017

The deadline for submitting model predictions for the second HySEA blind-prediction was Wednesday 13 December 2017 (part of HySEA deliverables **D4.24** and **D4.31**).

7 December 2017

Gexcon presented results from the HySEA project at the CEN/TC 305 Working Group 3 meeting in Angers, Saint-Georges-sur-Loire, on 7 December 2017.

30 November 2017

University of Pisa distributed the Third HySEA Newsletter on 30 November 2017 (HySEA deliverable **D4.19**).

23-24 November 2017

Gexcon presented results from the HySEA project at the FCH JU Programme Review Days in Brussels on 23-24 November 2017.



13 November 2017

The registration deadline for participants in the second HySEA blind-prediction study expired on Monday 13 November 2017 (part of HySEA deliverables **D4.24** and **D4.31**).

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.

29 September 2017

Gexcon organized the Second HySEA Workshop in Bergen on Friday 29 September 2017 (HySEA deliverable **4.20**).

28 September 2017

Gexcon organized the Second HySEA Demonstration at the test site on Sotra on Thursday 28 September 2017 (HySEA deliverable **D4.21**).



25-27 September 2017

Gexcon organized the Fourth Progress and Advisory Board meeting in the HySEA project in Bergen on 25-27 September 2017 (HySEA deliverable **D5.09**).

21 September 2017

University of Warwick presented results from the HySEA project at the CEN/TC 305 Working Group 3 meeting in Ratingen on 21 September 2017.

14 September 2017

Gexcon and UWAR presented results from the HySEA project at the workshop "Hydrogen Safety: Prospects for Hydrogen Technologies and Applications" in Hamburg on 14 September 2017. The workshop was hosted by IEA Hydrogen Task 37 on Hydrogen Safety (part of HySEA deliverable **D4.33**).

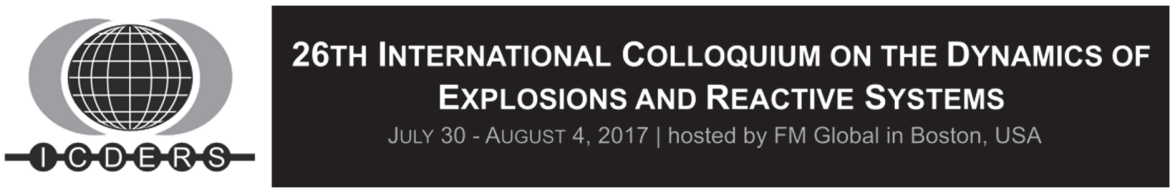
11-13 September 2017

UNIPI, UWAR and Gexcon presented results from the HySEA project at the Seventh International Conference on Hydrogen Safety (ICHS 2017) in Hamburg, Germany, on 11-13 September 2017 (HySEA deliverables **D1.03**, **D1.05**, **D2.05**, **D2.06**, **D3.03**, **D3.06** and **D4.18**).



30 July - 4 August 2017

Gexcon and the UWAR 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 on 30 July - 4 August 2017 (HySEA deliverables **D1.03**, **D2.06** and **D3.05**).



5 July 2017

Gexcon participated in a meeting with representatives from Health and Safety Executive (HSE) at Harpur Hill, Buxton on 5 July 2017. The purpose of the meeting was to learn from the experiences gained during the experimental campaigns performed as part of the HyIndoor project.

3-4 July 2017

Gexcon and UWAR presented results from the HySEA project at the IEA Hydrogen Task 37 on Hydrogen Safety meeting hosted by Health and Safety Executive (HSE) at Harpur Hill, Buxton on 3-4 July 2017 (part of HySEA deliverable **D4.33**).

28-30 June 2017

UNIPI presented results from the HySEA project at the Twelfth HYdrogen POwer THeoretical and Engineering Solutions International Symposium (HYPOTHESIS XII) in Syracuse, Sicily on 28-30 June 2017.

29-31 May 2017

UNIPI, Gexcon and UWAR participated in the HySafe meeting hosted by University of Pisa in Tirrenia on 29-31 May 2017. In connection with the HySafe meeting, the members of the HySEA consortium organized a separate meeting with representatives from of the HyIndoor project.



17 May 2017

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



16 May 2017

FCH JU hosted the mid-term review meeting for the HySEA project in Brussels on Tuesday 16 May 2017 (part of HySEA deliverables **D5.07** and **D5.08**).

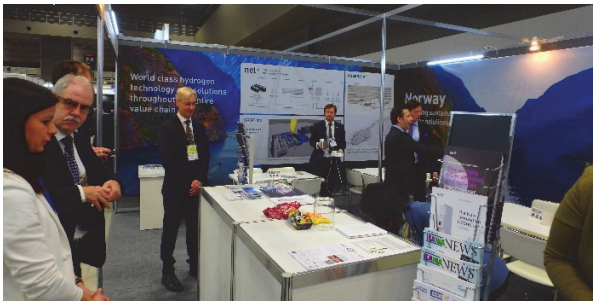
10-12 May 2017

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.

Held inside World Smart Energy Week 2017
13th Int'l Hydrogen & Fuel Cell Expo
FC EXPO 2017



28 February 2017

Gexcon presented the HySEA project at the Japan-Norway Hydrogen seminar "Collaboration within hydrogen future market and value chain" at the Norwegian Embassy in Tokyo on 28 February 2017.

30 November 2016

UNIPI distributed the Second HySEA Newsletter on 30 November 2016 (HySEA deliverable **D4.08**).

28-29 November 2016

Gexcon presented the HySEA project at the IEA HIA Task 37 meeting in Bethesda, Maryland, USA on 28-29 November 2016 (part of HySEA deliverable **D4.15**).

21 November 2016

Gexcon presented a poster describing the HySEA project at the FCH 2 JU Programme Review Days in Brussels, Belgium on 21-22 November 2016.





18 November 2016

The European Commission approved an amendment to the HySEA Grant Agreement (AMD-671461-3), where the University of Science and Technology of China (USTC) was replaced by Hefei University of Technology (HFUT) replaces in the HySEA consortium, on 18 November 2016.

8-9 November 2016

Gexcon presented the HySEA project at the FLACS User Group (FLUG) meeting in Paris, France on 8-9 November 2016 (HySEA deliverable **D4.17**).

26-28 September 2016

Gexcon presented the HySEA project at the HySafe Research Priority Workshop and HySafe General Assembly in Petten, the Netherlands, on 26-28 September 2016 (part of HySEA deliverable **D4.25**).

23 September 2016

Gexcon presented the HySEA project at Green Energy Day in Bergen, Norway on 23 September 2016.

9 September 2016

Gexcon organized the first HySEA Workshop in Bergen, Norway, on 9 September 2016 (HySEA deliverable **D4.07**).

8 September 2016

The newspaper SYSLA published an article on the HySEA project on 8 September 2016 (HySEA deliverable **D4.25**).

8 September 2016

Gexcon organized live demonstration experiments of hydrogen explosions in containers for the HySEA consortium and the modellers that participated in the first blind-prediction study in the HySEA project on 8 September 2016 (HySEA deliverable **D4.09**).



6-7 September 2016

Gexcon organized the Second Progress Meeting in the HySEA project in Bergen, Norway. Four members of the Advisory Board attended the meeting on 6-7 September 2016 (HySEA deliverable **5.04**).

24-29 August 2016

Gexcon presented a paper describing the model evaluation protocol for HySEA at the Eleventh International Symposium on Hazards, Prevention, and Mitigation of Industrial Explosions (11 ISHPMIE) in Dalian, China, on 24-29 August 2016 (HySEA deliverable **D3.01**).



17 June 2016

Gexcon presented the HySEA project at the IEA HIA Task 37 meeting in San Sebastian, Spain, on 17 June 2016 (part of HySEA deliverable **D4.15**).



31 May - 1 June 2016

Gexcon presented the HySEA project at the FLACS User Group (FLUG) meeting in Bergen, Norway, on 31 May - 1 June 2016 (HySEA deliverable **D4.06**).

30 May 2016

Gexcon and University of Pisa announced the first HySEA blind prediction study and the First HySEA Workshop (Scheduled for 8-9 September 2016) on 30 May 2016 (HySEA deliverable **D4.05**).

29 April 2016

Gexcon visited Hefei University of Technology and presented the HySEA project in connection with the Eight International Seminar on Fire and Explosion Hazards in Hefei, China (25-28 April 2016) on 26 April 2016.

25 April 2016

Gexcon and University of Warwick visited University of Science and Technology of China (USTC), State Key Laboratory of Fire Science, in connection with the Eight International Seminar on Fire and Explosion Hazards in Hefei, China, on 25-28 April 2016.

3-5 April 2016

Fike Europe hosted the First Progress Meeting in the HySEA project in Herentals, Belgium, on 3-5 April 2016 (HySEA deliverable **D5.02**)



16-18 December 2015

University of Pisa promoted the HySEA project at the Piero Lunghi Conference (EFC15) in Naples on 16-18 December 2015.

28 November 2015

University of Pisa distributed the First HySEA Newsletter on 28 November 2015 (HySEA deliverable **D4.03**).

30 October 2015

Gexcon presented the HySEA project during the Fifty-fourth UKELG Discussion Meeting "Advances in Explosion Modelling" at University of Warwick on 30 October 2015.

23 October 2015

Gexcon presented the status for the HySEA project during the International Energy Agency Hydrogen Implementation Agreement (IEA-HIA) Task 37 on Hydrogen Safety meeting in Tokyo on 23 October 2015 (part of HySEA deliverable **D4.15**).

19-21 October 2015

Partners from the HySEA project presented the project during the Sixth International Conference on Hydrogen Safety (ICHS) in Yokohama, Japan, on 19-21 October 2015 (HySEA deliverable **D4.04**).



14-16 September 2015

Gexcon hosted the Kick-off meeting for the HySEA project in Bergen, Norway, on 14-16 September 2015 (HySEA deliverable **D5.01**).



1 September 2015

The official start-up date for the HySEA project was 1 September 2015.

26 March 2015

Helene Hisken and Sigrid Skaar from Gexcon attended the GAP-meeting in Brussels on 26 March 2015.



HySEA WEBSITE: http://www.hysea.eu

*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.*