FireComp

Modelling the Thermo-Mechanical Behaviour of High Pressure Vessels, Made of Composite Materials when Exposed to Fire Conditions

AIP / APPLICATION AREA	AIP 2012 / AA 5: Cross-Cutting Activities
CALL TOPIC	SP1-JTI-FCH.2012.5.4: Pre-normative research on fire safety of pressure vessels in composite materials
START & END DATE	01 Jun. 2013 - 31 May 2016
TOTAL BUDGET	€ 3,543,498
FCH JU CONTRIBUTION	€ 1,877,552
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Air Liquide

Partners: CNRS, University of Edinburgh, Raufoss Fuel Systems, INERIS, Health and Safety Laboratory, LMS Samtech, Alma CG

PROJECT WEBSITE/URL

www.firecomp.info

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

The main objective of the FireComp project is to better characterize the conditions that need to be achieved for improving the performance to fire of composite cylinders.

- Experimental work will be carried out to improve the understanding of heat transfer mechanisms, thermal degradation, combustion and the loss of strength of composite high-pressure vessels in fire conditions.
- Then the modelling of the thermo-mechanical behaviour of these vessels will be set up. The model will be validated by full scale fire tests.

Different applications will be considered: automotive application, stationary application, transportable cylinders, bundles and tube trailers.

PROGRESS/RESULTS TO-DATE

- A thermal degradation model has been developed; based upon an energy balance (to determine temperature through the composite depth) and thermo-gravimetric analysis data (to assess mass loss at each depth)
- Coupled thermo-mechanical tests have shown there is no significant influence of load on temperature evolution
- The material identification has been performed, and a temperature dependent damage model is now available within SAMCEF code
- All parameters for fire calibration have been defined and bonfire tests have started

FUTURE STEPS

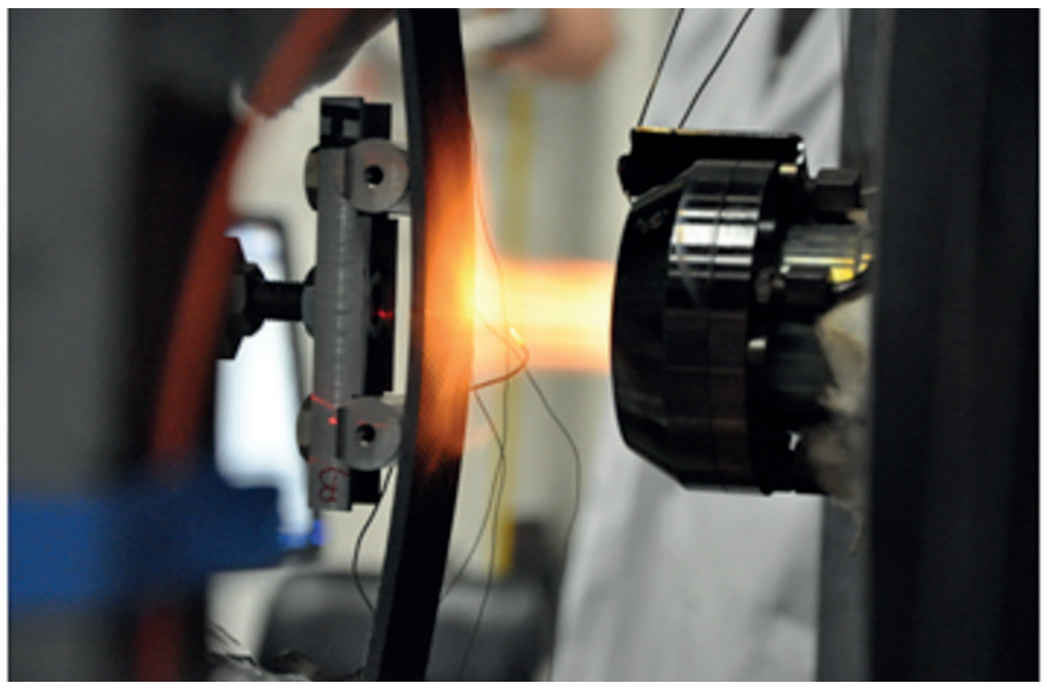
- Work on heat flux measurement during bonfire test: methods tested so far not satisfactory. Possibilities with a thin nickel sensor, with measurements of temperatures on both faces, complete heat transfer model and inverse problem solution (December 2015)
- Update of quantitative risk analysis with bonfire tests results: comparison with currently used technology (December 2015)
- Further development of damage models, involving the char & Coupled thermo-mechanical simulations (December 2015)
- Numerical prediction of vessels lifetime in fire and comparison with bonfire test results (March 2016)

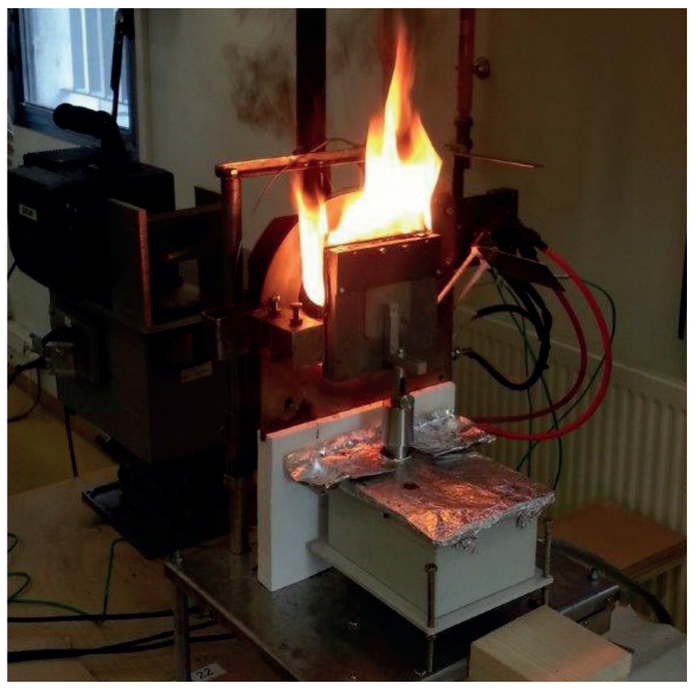
CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- The atmosphere (i.e. oxygen from air) has a critical influence in the decomposition mechanism of composite in fire.
- Measurement of the radiation properties of the composite showed that the emissivity coefficient of the composite is 0.91 (no transmission and thus no internal radiation) at high temperature.
- The fibre orientation does not seem to influence the surface temperature during the degradation process
- The temperature of glass transition of the resin has a critical role in the decay of the mechanical properties of composite at high temperature
- Hydrogen gas fire selected for bonfire tests: characterisation of the test is quite easy (mass flow, injector diameter, distance...) and repeatability is better than with pool fire

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013 AIP 2012	Model integrating the thermo-mechanical behaviour of the pressure vessel in fire conditions	1	1	On going
AIP 2011	Experimental validation of the model	1	1	On going. In the last phase of decisive experiments
AIP 2011	Proposed approach for standardization	1	1	Under construction. Formalized into final guidelines
AIP 2011	Recommendations for implementation in international standards	1	1	Under construction. Formalized into final guidelines and liaisons with ISO TC58/SC3/WG24





H2Sense

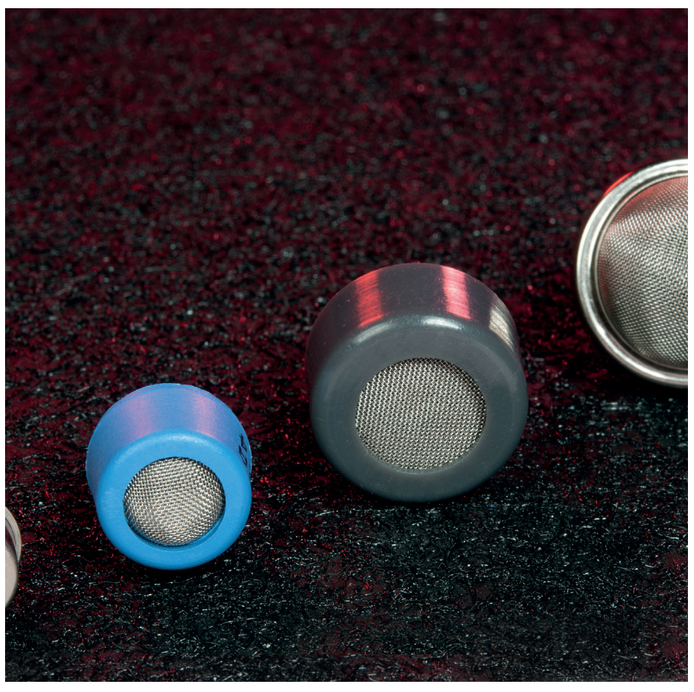
Cost-Effective and Reliable Hydrogen Sensors for Facilitating the Safe Use of Hydrogen

AIP / APPLICATION AREA	AIP 2012 / AA 5: Cross-Cutting Activities
CALL TOPIC	SP1-JTI-FCH.2012.5.1: Hydrogen safety sensors
START & END DATE	01 Jun. 2013 - 31 Aug. 2014
TOTAL BUDGET	€ 785,290
FCH JU CONTRIBUTION	€ 380,348
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

Coordinator: BAM Federal Institute for Materials Research and Testing

Partners: European Commission – Joint Research Centre (JRC) – Institute for Energy and Transport (IET), AppliedSensor GmbH, Sensitron S.r.l., UST Umweltsensortechnik GmbH, Zentrum für Sonnenenergie und Wasserstoff-Forschung Baden-Württemberg (ZSW).



PROJECT WEBSITE/URL

http://www.h2sense.bam.de/

PROJECT CONTACT INFORMATION

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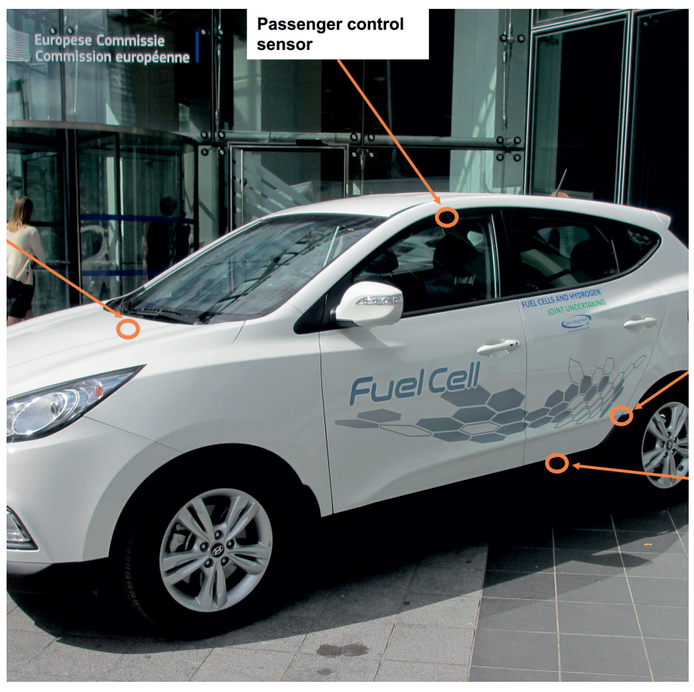
MAIN OBJECTIVES OF THE PROJECT

H2Sense has been initiated to promote the effective deployment and safe use of reliable hydrogen sensors, primarily but not exclusively for applications using hydrogen as an alternative fuel. The main objectives of the project are:

- Evaluation of existing and anticipated sensors and sensor platforms
- Identification of existing and key near-term hydrogen applications and sensor performance requirements
- Identification of commercialisation barriers and approaches in R&D, regulation and standardisation to overcome these barriers
- Performance tests and validation of promising commercial off-the-shelf hydrogen sensors
- Interaction and knowledge transfer with US partner NREL



PROGRESS/RESULTS TO-DATE

- Market survey on commercial hydrogen sensors and sensor platforms www.h2sense.bam.de/.../h2sense_hydrogen_sensor_database_2015
- Brochure "Hydrogen sensors for the safe and reliable use of hydrogen"
- Classification of hydrogen sensor applications and identification of correlated performance requirements is performed
- Approaches to overcome commercialisation barriers have been suggested
- Inter-laboratory testing of commercial off-the-shelf hydrogen sensors and comparison of results has been carried out

FUTURE STEPS

- Dissemination of results in brochure, book, and other publications
- Promoting the use of hydrogen sensors, advice on effective deployment and safe use
- R&D on sensor performance regarding sensor lifetime prognosis, cross sensitivities and time response
- Webinar on hydrogen sensors

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- A large variety of hydrogen sensors are commercially available for safety issues, leak detection and process control
- Further sensor development is needed in order to achieve desired target specifications
- Commercialisation can be promoted by exploiting market potentials, considering the complete H_2 supply chain, adapting and harmonising regulations, increasing functional safety, reducing costs, and dissemination of sensor knowledge to stakeholders
- RCS are needed for specific sensor applications, e.g. leak detection, harmonisation desirable for facilitating commercialisation
- Laboratory testing shows general suitability of commercial off-the-shelf sensors for safety applications

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Priority of the cross-cutting activities application area	Evaluate the socio-economic, environmental and energy impact of FCH technologies Support the growth of the European industry, particularly SMEs	Support of the safe use of hydrogen and the transition to a hydrogen inclusive economy Contribution to minimizing the release of hydrogen into the atmosphere Saving and increase of working places with sensor manufactures Creating an opportunity to translate suggested approaches to overcome barriers of new technology commercialisation	Ongoing
AIP 2012	Assessment of commercially available hydrogen safety sensors in terms of e.g. performance and cost-effectiveness for near-term applications	Assessment of (i) state-of-the-art hydrogen sensor technologies (ii) recommendations for effective deployment for near-term applications (iii) cost-effective manufacture and barriers to commercialisation; implications and recommendations for sensor requirements in RCS	Evaluation of existing and anticipated sensors and sensor platforms Identification of existing and key near-term hydrogen applications and sensor performance requirements Identification of commercialisation barriers and approaches in R&D, regulation and standardisation to overcome these barriers	Fulfilled
AIP 2012	Assessment of safety issues related to fuel cell and hydrogen applications	R&D, testing, validation in laboratory and field conditions to address critical gaps in safety sensor technology	Performance tests and validation of promising commercial off-the-shelf hydrogen sensors	Fulfilled
AIP 2012	Assessment of safety issues related to fuel cell and hydrogen applications	Compendium of existing applications, feedback on sensor performance, experiences and best practices to identify recommendations for more effective deployment	Brochure "Hydrogen sensors for the safe and reliable use of hydrogen"	Fulfilled

H_2TRUST

Development of H_2 Safety Expert Groups and Due Diligence Tools for Public Awareness and Trust in Hydrogen Technologies and Applications

AIP / APPLICATION AREA	AIP 2012 / AA 5: Cross-Cutting Activities
CALL TOPIC	SP1-JTI-FCH.2012.5.5: Assessment of safety issues related to fuel cells and hydrogen applications
START & END DATE	01 Jun. 2013 - 28 Feb. 2015
TOTAL BUDGET	€ 1,208,416.22
FCH JU CONTRIBUTION	€ 796,678
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

MATGAS 2000 AIE (coordinator), Air Products PLC, European Hydrogen Association (Federazione delle Associazioni Scientifiche e Techniche), Solvay Speciliaty Polymers Italy S.P.A., Politecnico di Milano, McPhy Energy SA, SOL S.p.A., Ciaotech S.r.l, Technische Universiteit Eindhoven.

PROJECT WEBSITE/URL

h2trust.eu

PROJECT CONTACT INFORMATION

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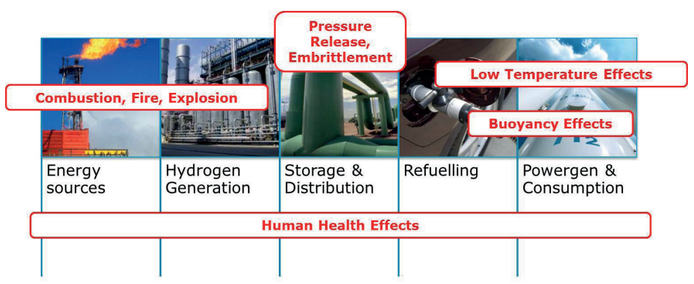
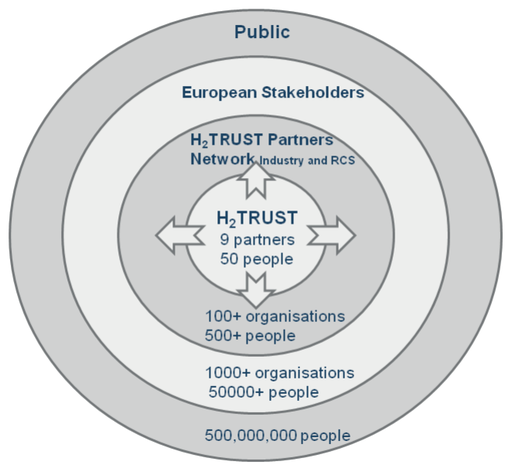
MAIN OBJECTIVES OF THE PROJECT

1. Assess industry efforts to assure FCH technology is safe, adequate regulation, hazard awareness, incident readiness, and ability to respond to public concerns.
2. Hazard & risk assessment in FCH industry in each of the main application areas.
3. Systematically map safety issues and assess how they are addressed.
4. Compile information demonstrating safety due diligence and best practices.
5. Make recommendations for further safety efforts by FCH community.
6. Develop communications network to manage public reaction to incidents and give documented responses.
7. Disseminate the results creating a culture of safety practices.

PROGRESS/RESULTS TO-DATE

- An info gathering process has been carried out in WP3, taking into account data from existing industries in different sectors. The data collected from stakeholders (questionnaires, surveys, interviews, etc.) was analysed together with additional information from desk research and results from EU-funded projects and other initiatives, to map the safety issues, identify best practices, and make a safety risk assessment as well as a public safety assessment and recommendations (WP4).





- The methodology for risk assessment (Task 4.3) was designed and developed, taking into account all the areas for hydrogen applications considered in the project. The online H_2 safety due-diligence tool (Task 5.2) was based on it.
- The dissemination of this project was done through the participation in different conferences, press releases, newsletters, publications, lectures, and the project website (h2trust.eu/).
- The on-line portal was implemented with additional features and tools such as a crawler for an advanced search, an on-line forum, an online library, a news section and the risk assessment tool.
- Dissemination: in addition to the website and the participation in conferences, a kit (book, brochure, banner and video) was prepared, as well as an online tool enabling FCH stakeholders to rapidly analyze and assess a particular H_2 application.

FUTURE STEPS

- Further dissemination activities at different levels.
- Looking for future collaborations related to hydrogen safety and social awareness, including similar initiatives outside Europe.
- Active search of similar initiatives to leverage the work done in the H_2TRUST. Work to build a permanent structure with EU support.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- A website has been created to disseminate the results of the project.
- The main outcomes of the project are the report of best practices, safety risk assessment and public safety assessment, and recommendations. Moreover, the risk assessment tool is made available for whoever wants to use it to assess its safety readiness/adequacy.
- The project has concluded according to the Description of Work of the Grant Agreement (taking into account the amendment sent in October 2014).
- Dissemination activities have been carried out in order to maximize the diffusion of this knowledge to the widest possible audience, including stakeholders, industries and the society in general. A dissemination book was published.
- A good acceptance of the project objectives and results by H_2 researchers, stakeholders & partners of related projects has been detected along the execution of the project. Further work in this topic should be encouraged and supported by the JU and the EU.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Awareness.	Education and public awareness.	Assess FCH industry, make recommendations, develop communications network to manage public reaction to incidents, and give documented responses.	Best practices, safety risk assessment, public safety assessment and final recommendations were reported. A website and kit for demonstrations, was created to disseminate the results of this project.
MAIP/AIP	Regulations, Codes and Standards (RCS) and Pre-normative Research (PNR) needs.	Identify and prioritize RCS and PNR needs. Coverage by standards and/or regulations of the relevant safety requirements.	Data collection from the regulatory and safety stakeholders, consumers and incident response bodies associated with FCH industries. Make recommendations for further safety efforts by FCH community.	RCS were considered for the whole project. WP4 included reporting on the regulatory and safety state of the art, in order to define the recommended actions required to assure the successful and incident free development of the industry.
AIP 2012	Lessons learnt.	Application of existing knowledge and lessons learnt from past experience. Implementation of product concepts that are inherently safe; assurance of fitness for service; and control of accidental situations, and mitigation of impacts.	Compile information demonstrating safety due diligence and best practice. Seek inputs from other projects and similar international activities.	In WP3 an info gathering process was carried out. An online literature database has been prepared, available online at h2trust.eu.
AIP 2012	Hazards.	Identification and understanding of hazards.	Hazard and risk assessment. Systematically map safety issues and assess how they are addressed.	Best practices, safety risk assessment, public safety assessment, as well as recommendations have been reported.
AIP 2012	Best practices.	Preparedness to emergency situation and effectiveness of emergency response measures; ability of safety officials to exercise their responsibility; and operators and end-users awareness of hazards.	Develop communications network to manage public reaction to incidents and give documented responses. Disseminate the results so as to create a long lasting culture of safety practices in the industry and a legacy of tools and knowledge serving to reinforce best practices and assure public confidence.	An online tool was created to analyse and assess a particular application area for safety hazard, risk and preparedness. Participation in numerous dissemination activities: 28 conferences, 22 press appearance, 4 newsletters, 1 exhibitor, 2 papers in international journals and 1 dissemination book. 25 websites links lead to the H_2TRUST website.

HYACINTH

Hydrogen Acceptance in the Transition Phase

AIP / APPLICATION AREA	AIP 2013 / AA 5: Cross-Cutting Activities
CALL TOPIC	SP1-JTI-FCH.2013.5.3: Social acceptance of FCH technologies throughout Europe
START & END DATE	01Sep. 2014 - 28 Feb. 2017
TOTAL BUDGET	€ 1,002,288
FCH JU CONTRIBUTION	€ 661,584
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Centro Nacional de Experimentación de Tecnologías de Hidrógeno y Pilas de Combustible (CNH2)

Partners: I Plus F France SARL (IPLUSF FRANCE), Fraunhofer Gesellschaft zur Förderung der Angewandten Forschung E.V. (FRAUNHOFER), Aberdeen City Council (ABERDEEN), Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT), Fundación Cidaut (CIDAUT), Razvojni Center Za Vodikove Tehnologije (RCVT), Norstat Deutschland GmbH (NORSTAT), University of Leeds - Center for Integrated Energy Research (LEEDS), University of Sunderland (SUNDERLAND), Consultoría de Innovación y Financiación S.l.(IPLUSF ESPAÑA)

PROJECT WEBSITE/URL

www.hyacinthproject.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

The overall purpose of HYACINTH is to gain a deeper understanding of the social acceptance of hydrogen technologies across Europe in the transition phase, between demonstration projects and a full market deployment, by combining specific qualitative and quantitative methods and samples of European citizens and stakeholders. The main aims are to: identify and understand awareness and acceptance and the perceived potential benefits, identify the main drivers of social awareness and acceptance and support stakeholders by providing a social acceptance research toolbox, enabling a regional understanding of the acceptance process and providing tools to manage expectations and to increase acceptance.

PROGRESS/RESULTS TO-DATE

- Context analysis: former projects and studies, list of potential stakeholders, methodologies and factors

FUTURE STEPS

- Methodological design
- Data collection
- Data analysis and interpretation
- Development of management toolbox

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Levels of acceptance found in previous research are quite theoretical and only of limited validity.
- The research of acceptance in the transition phase has to differentiate between technology performance and operational, organizational or economic challenges.
- Research on acceptance has to acknowledge its process character and identify means to understand and manage the acceptance process.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
AIP 2013	Current state of public awareness and public acceptance of FCH technologies in Europe?	N/A	Interviews of up to 7,000 European citizens and 455 stakeholders in 7 different countries with different degree of penetration of H2&FC technologies.	To be done the 2nd year
AIP 2013	What kind of fears is associated with FCH technologies to date? How is hydrogen safety perceived by the general public?	N/A	To identify bottlenecks for H2&FC technologies commercialization. To discern handicaps that may be geographically linked or appear for a certain H2&FC technology.	To be done the 2nd year
AIP 2013	How can a successful transition towards the use of hydrogen in the mobility sector be achieved?	N/A	Development of a specific toolbox	To be done the 3rd year

HyCoRA

Hydrogen Contaminant Risk Assessment

AIP / APPLICATION AREA	AIP 2013 / AA 1: Transportation and Refuelling Infrastructure
CALL TOPIC	SP1-JTI-FCH.2013.1.5: Fuel Quality Assurance for Hydrogen Refuelling Stations
START & END DATE	01 Apr. 2014 - 31 Mar. 2017
TOTAL BUDGET	€ 3,906,912.00
FCH JU CONTRIBUTION	€ 2,159,024.00
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

Coordinator: VTT Technical Research Centre of Finland

Partners: CEA, JRC, Protea ltd, SINTEF, Powercell Sweden AB

PROJECT WEBSITE/URL

http://hycora.eu

PROJECT CONTACT INFORMATION

Jari Ihonen, project coordinator,
jari.ihonen@vtt.fi

MAIN OBJECTIVES OF THE PROJECT

The main objective of HyCoRA project is to provide information to reduce cost of hydrogen fuel quality assurance (QA).

However, it will also provide recommendations for revision of existing ISO 14687-2:2012 standard for hydrogen fuel in automotive applications.

PROGRESS/RESULTS TO-DATE

- A recirculation single cell hardware has been developed, enabling anode gas humidification by recirculation and fuel utilisation of 99.5%.
- The results showing the effect of drive cycle with CO as contaminant has been recorded.
- Acquisition of hydrogen pre-concentration device through collaboration with Argonne/Dept. of Energy.
- A first sampling campaign at hydrogen refuelling stations has been completed and results have been disseminated.
- The first version of qualitative risk model for hydrogen fuel contamination has been developed.

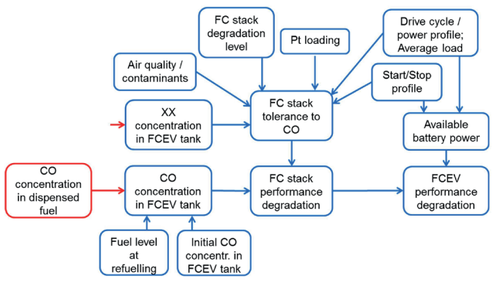
FUTURE STEPS

- The results from a single cell with recirculation and an automotive type PEMFC system are compared to define applicability of single cell measurements for Task 1.3
- Evaluation of analytical techniques with focus on challenging/cost driving analyses (ie. Total sulphur and halogenates).
- Conduct and analyse hydrogen samples from second measurement campaign from hydrogen refuelling stations.
- Quantitative risk model for hydrogen fuel contamination will be developed with focus on carbon monoxide.
- The effect of formic acid and formaldehyde will be studied using the cells and systems with anode gas recirculation.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Hydrogen fuel contamination studies require high fuel utilisation and development of experimental techniques for that both in single cell and PEMFC system level.
- A pre-concentration device may be necessary for reducing the analytical techniques in hydrogen quality assurance.
- The limits of formic acid and formaldehyde in ISO 14687-2:2012 may be conservative and more research on the effect of these contaminants is needed.
- A first sampling campaign at hydrogen refuelling stations shows that the use of CO canary species may be problematic when contaminant levels are very low.

Influence diagram model for FCEV performance degradation due to CO contamination in fuel



CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Hydrogen delivered to retail station	cost under 5 €/kg	To reduce cost of hydrogen fuel quality assurance (QA) so that 5 €/kg is possible to reach.	Work is progressing as planned.
AIP 2013	Understanding the effect of contaminants in automotive PEMFC systems.	Completing current knowledge by identifying the impurity limits of PEMFCs for various poisonous species under actual automotive drive cycles	Understanding hydrogen contaminant research in PEMFC system level	Literature review has been completed. Critical contaminants for the quality assurance (formic acid, formaldehyde) have been identified and work is focused on those in addition to carbon monoxide.
AIP 2013	Impurity levels in HRS.	Providing technical data on fuel composition and impurity concentrations at HRS	The objective of is to find out quality variation for automotive grade hydrogen in production and HRS nozzle for different fuel feedstock and production technologies. The work will provide technical and statistically relevant data for impurity concentrations at HRS nozzle.	The first measurement campaign has been completed.
AIP 2013	Understanding the effect of contaminants in automotive PEMFC systems.	Build on existing knowledge, through extensive use of results achieved in previous and on-going European projects as well as international networking and exchange.	Work is performed International co-operation with USA (LANL, Argonne NL), Japan (Japan, Automotive Research Institute, JARI) and Korea (KIST) will be established, as this type of work requires international co-operation.	Contacts have been established and practical co-operation have been started with LANL and ANL.
AIP 2013	The cost of hydrogen quality assurance.	Establishing a simplified and diversified set of requirements for hydrogen fuel quality depending on fuel feedstock and production technologies (biogas, reforming, electrolysis, by-product etc.)	The objective of is to construct a probabilistic risk assessment model that integrates the data on hydrogen quality variation and correlations between impurity concentrations, hydrogen impurity analysis methods and instrumentation, and the susceptibility of fuel cells to hydrogen fuel contaminants.	Work started and first version of qualitative risk model is completed.
AIP 2013	The cost of hydrogen quality assurance.	Simplifying fuel quality control by enhance knowledge of correlations between gas impurity concentrations based on extensive in field measurements at HRS fuel nozzle	The objective of is to construct a probabilistic risk assessment model that integrates the data on hydrogen quality variation and correlations between impurity concentrations, hydrogen impurity analysis methods and instrumentation, and the susceptibility of fuel cells to hydrogen fuel contaminants.	The first measurement campaign has been completed and results have been analysed.
AIP 2013	The cost of hydrogen quality assurance.	Assessing ways to reduce the number of analysis methods required for complete QA	The objective of is to construct a probabilistic risk assessment model that integrates the data on hydrogen quality variation and correlations between impurity concentrations, hydrogen impurity analysis methods and instrumentation, and the susceptibility of fuel cells to hydrogen fuel contaminants.	The work with quantitative risk model has been started.
AIP 2013	The cost of hydrogen quality assurance.	Establishing new analytical methodology relevant for gas impurity quantification	Simplify and reduce cost of analysis by reducing the number of analytical techniques required, partly through the establishment and validation of a pre-concentration device.	Work started and numbers of methods have been evaluated.
AIP 2013	The cost of hydrogen quality assurance.	Designing and verifying of gas sampling instrumentation applicable to HRS operation, including e.g., novel sensors for identification of ultra-low impurity concentrations.	Simplify and reduce cost of analysis by reducing the number of analytical techniques required, partly through the establishment and validation of a pre-concentration device.	Work started
AIP 2013	Understanding the effect of contaminants in automotive PEMFC systems and true need of quality assurance level.	Providing feedback to ISO TC 197/WG 12 and to equipment manufacturers	Validate the performance and accuracy of methods for the quality assurance of hydrogen fuel which are currently used by industry.	Work started and numbers of methods have been evaluated.

HYINDOOR

Pre-normative Research on Safe Indoor Use of Fuel Cells and Hydrogen Systems

AIP / APPLICATION AREA	AIP 2010 / AA 4: Early Markets
CALL TOPIC	SP1-JTI-FCH.2010.4.6: Pre-normative research on the indoor use of hydrogen and fuel cells
START & END DATE	02 Jan. 2012 - 01 Jan. 2015
TOTAL BUDGET	€ 3,657,760
FCH JU CONTRIBUTION	€ 1,528,974
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Air Liquide

Partners: Commissariat à l'Energie Atomique et aux energies alternatives (CEA), Karlsruhe Institute of technology (KIT), University of Ulster (UU), The CCS Global Group (CCS), Joint Research Center (JRC), Hygear Fuel cell Systems (HFCS), Health and Safety Laboratory (HSL), National Center for Scientific Research Demokritos (NCSRD), LGI consulting (LGI)

PROJECT WEBSITE/URL

http://hyindoor.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

This project addresses the issue of safe indoor use of hydrogen and fuel cells systems (priority 4.6 of the call FCH-JU-2010-1) for early markets (forklift refuelling and operation, back-up power supply, portable power generation, etc.): It aims to provide scientific and engineering knowledge for the specification of cost-effective means to control hazards specific to the use of hydrogen indoors or in confined space and developing state-of-the-art, guidelines for European stakeholders including specific engineering tools supporting their implementation and recommendations with regards to evolutions needed in the RCS framework .

PROGRESS/RESULTS TO-DATE

- Public deliverables for end users and policy makers: Widely accepted guidelines on Fuel Cell indoor installation and use and RCS recommendations
- Contribution to technical educational training
- International dissemination workshop Paris, December 11th

FUTURE STEPS

- Concerning RCS, since project partners (AL, UU, CCS, CEA) are also members to the ISO/IEC committees, they will attempt to push forward so that the HyIndoor recommendations may be implemented in the new international norms
- Dissemination within specific events like ICHS 2015, Oct. Japan

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- The four following main topics were identified and treated experimentally, analytically and/or numerically:
  - Hydrogen release inside semi-confined enclosure,
  - Indoor hydrogen-air deflagration,
  - Jet fire and under-ventilated fire,
  - Hydrogen detection for confined spaces.
- In conclusion of the work performed in HyIndoor project, research results obtained in each work package were critically analysed and translated in easily understandable and usable general rules and calculation means for consequences and mitigation assessment and/or sizing.
- Thus this Guidelines document presents recommendations to integrate safety through the applications.
- For the design and for consequences or mitigation effectiveness assessment several calculation means are proposed and possible, nomograms were built for easy and quick handling of phenomena consequences assessment.
- Simple engineering approaches are proposed as well, and recommendations are given for proper use of the numerical simulation tools.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
AIP 2010	Safe indoor use of hydrogen and fuel cells systems for early markets, forklift refuelling and operation, back-up power supply, portable power generation, etc.)	4	4	Public guidelines, public RCS recommendations and final report are delivered and available in the web site. Final dissemination workshop was organized in Paris, December 11th with international and a diversity of large participants Update educational training course at UU)
AIP 2010	Provide scientific and engineering knowledge for the specification of cost-effective means to control hazards specific to the use of hydrogen indoors or in confined space and developing state-of-the-art guidelines for European stakeholders. Safety guidelines with criterias.	1	1	Preparation of guidelines for installation: • methodologies for calculation of risk assessment considering different phenomena: dispersion, deflagration and under-ventilated fires) • useful trends and criteria when total validation is not possible (experimental vs. modelling) • proposition of mitigation strategies RCS recommendations towards ISO/TC 197 and IEC/ TC 105. Several publications and participation to different international conferences • Realization of the advanced research workshop in September 2013 in Bruxelles, • Realization of the final dissemination workshop in Paris, the 11st of December 2014
AIP 2010	Definition of an RCS transfer strategy	1	1	Strategy defined- liaisons with different international standards groups ISO/TC 197 CEN/TC 268 and IEC/TC 105, Hysafe and EIGA
AIP 2010	Dissemination, contribution to technical educational trainings	1	1	HyIndoor project staff participated in the work of different sessions of technical School of H2FC European Infrastructure organized by University of Ulster within H2FC project. Project outcomes in areas of hydrogen releases, dispersion and ventilation, as well as in mitigation of deflagrations and dealing with hydrogen jet fires indoors will be introduced to teaching and training programs at the University of Ulster: • PGCert/PGDip/MSc in Hydrogen Safety Engineering • Short courses "Progress in Hydrogen Safety" • Teaching hydrogen safety within UK EPSRC Centre for Doctoral Training "Fuel Cells and their Fuels – Clean Power for the 21st Century".

HyPactor

Pre-Normative Research on Resistance to Mechanical Impact of Composite Overwrapped Pressure Vessels

AIP / APPLICATION AREA	AIP 2013 / AA 5: Cross-Cutting Activities
CALL TOPIC	SP1-JTI-FCH.2013.5.6: Pre-normative research on resistance to mechanical impact of pressure vessels in composite materials
START & END DATE	01 Apr. 2014 - 31 Mar. 2017
TOTAL BUDGET	€ 4,049,293
FCH JU CONTRIBUTION	€ 2,143,665
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

Coordinator: COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES

Partners: L'AIR LIQUIDE S.A, HEXAGON RAUFOSS AS, INSTITUT DE SOUDURE ASSOCIATION, POLITECHNIKA WROCLAWSKA, NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET, ALMA CONSULTING GROUP SAS

PROJECT WEBSITE/URL

http://www.hypactor.eu/

PROJECT CONTACT INFORMATION

Fabien Nony
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MAIN OBJECTIVES OF THE PROJECT

HYPACTOR aims at providing recommendations for Regulation Codes and Standards (RCS) regarding the qualification of composite overwrapped pressure vessels (COPV) and the procedures for periodic inspection in service of COPV subjected to mechanical impacts.

- Build a database gathering data from literature and from experience (~100 cylinders to be tested) to link well characterized damages induced by impact with residual performance
- Determine the consequences of the different kinds of impacts on vessels' properties and safety
- Define criteria for standardisation organisms in order to optimize vessels' use and safety
- Disseminate the results / make recommendations to the scientific and normalisation communities

PROGRESS/RESULTS TO-DATE

- Review of international impact related incidents on pressure composite cylinders
- Investigation of industrial constraints for the use of NDT in industrial sites
- Definition of project impact test matrix
- Review of NDT techniques and protocols to characterize impact damage
- First results of impact campaign on 36L 70MPa tanks with first estimation of immediate failure level, influence of internal load (unpressurized, 20bar/700bar/875bar gas, water), impact testing on vessel with 700 bars water inside will be done at the end of 2015
- Definition of NDT protocols
- First results of NDT characterisation on impacted COPV

FUTURE STEPS

- Technical report on impact testing with characterization of induced tank damage
- Choice of 2-3 relevant impact conditions from preliminary study (WP2) to study residual performance at short and long term (WP3)
- Definition of WP3 test matrix on the impact testing and residual performance assessment; technical report on short/long term residual performance of impacted tanks
- Definition of NDT protocols
- Modelling of residual performance of impacted COPV with given damage.

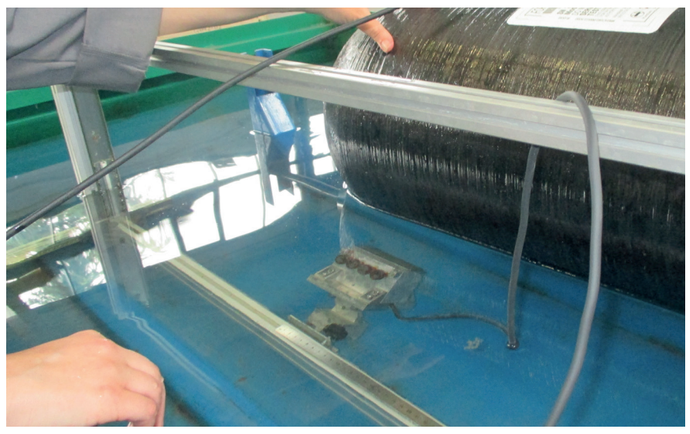
CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

Major results:

- First experimental database with impact parameters and characteristics of induced damage (WP2 step1, 15 impacted tanks which accounts for ~90 impacts under various impact parameters like speed/weight/energy/internal load/drop tower or pneumatic canon…)
- First assessment of impact conditions that lead to immediate failure on 36L 70MPa COPV as a function of internal load (empty, 20bar up to 875bar gaz)
- First comparative assessment of NDT techniques and protocols to characterize impact damage

Main perspectives:

- Conclusions on short/long term residual performance of impacted tanks
- Define most appropriate NDT and pass/fail criteria for periodic inspection or qualification
- Provide normative committees with scientific feedback



CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
AIP 2013	Identify types of alterations produced by mechanical impacts and develop an understanding of their consequences on short and long term structural integrity	-	• To determine damage characteristics induced by impacts • To identify impact conditions that produce short term failure	On-going (WP2 and WP3) Conditions that lead to immediate failure as a function of internal load First database filled with 90 impacts
AIP 2013	Through a combination of experimental, analytical and/ or modelling approaches, establish a relation between severity of impact, level of damage, and effect on structural integrity.in order to determine which impacts may cause a pressure vessel to fail in service.	-	• To identify impact conditions that produce short term failure; by testing, immediate failure (leakage or burst) has been studied • To determine residual burst performance after impact, and long term influence of damage induced by impact • To develop numerical model to predict the influence of well-characterized damage induced by impact on tank performance and safety	On-going
AIP 2013	Apply the results of the above to assess the reliability of composite pressure vessels in the foreseen applications and potential needs of protection and/or opportunities of design optimization.	-	• identify most relevant impact conditions • assess reliability of COPV with respect to field/in-service experience.	Not started
AIP 2013	Evaluate non-destructive examination methods, such as analysis of acoustic emissions, and associated pass/fail criteria for controlling pressure vessels in service with regards to potential damage from impact	-	• assess non-destructive techniques and define protocols to inspect composite damaged by impact • define critical damage and pass/fail criteria	On-going on WP2 impacted tanks
AIP 2013 MAIP 2008-2013	Recommendations to industry and for international standards development	-	• dissemination of experimental results, revised methodology for qualification, inspection and testing to RCS committees	Not started
MAIP 2008-2013	International cooperation strategy /safety	-		Consortium contacted by DoE for exchange

HyResponse

European Hydrogen Emergency Response Training Programme for First Responders

AIP / APPLICATION AREA	AIP 2012 / AA 5: Cross-Cutting Activities
CALL TOPIC	SP1-JTI-FCH.2012.5.3 : First responder educational and practical hydrogen safety training
START & END DATE	01 Jun. 2013 - 31 May 2016
TOTAL BUDGET	€ 2,640,284.40
FCH JU CONTRIBUTION	€ 1,858,453.00
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

Coordinator: ENSOSP

Partners: AIR LIQUIDE BUSINESS, UNIVERSITY OF ULSTER, AREVA ENERGY STORAGE, FAST, CCS GLOBAL GROUP, CRISE

PROJECT WEBSITE/URL

www.hyresponse.eu

PROJECT CONTACT INFORMATION

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Dr Franck VERBECKE (AREVA)
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MAIN OBJECTIVES OF THE PROJECT

The HyResponse project set itself six main objectives:

1. Define emergency scenarios and first response strategies,
2. Create an educational training material,
3. Build an operational training facility as a plateform with with multiple workshops exercises,
4. Imagine and develop an virtual reality training platform (reproduce a nerve center for crisis management to simulate frames exercises),
5. Execute three pilot training sessions to 50 first responders,
6. Promote recommandations and dissemination all around Europe (also in US and Japan countries)

PROGRESS/RESULTS TO-DATE

- Definition of risks associated with the use of hydrogen in professional and industrial areas (leak, fire, explosion, etc.),
- For each risk, definition of strategic and tactical maneuvers to eliminate the hazard or due incidents / accidents to the use of responders (firemen or industrial sites security guards),
- For each risk, definition of educational training scenarios using the above defined tactical maneuvers,
- Creating the educational matrix of a training week nesting theoretical courses (risk knowledge, standards, feedback), the practical training sequences on a physical platform and virtual reality exercises,
- Definition of the training platform plans (5 modules) / exercise scenarios in virtual reality / main courses.

FUTURE STEPS

- Construction of the physical platform with the 5 modules (clarinets, explosion area, simulating hydrogen vehicules, mikados, refuelling station),
- Construction of the virtual reality plateform (informatic network (computers, software) allowing simultaneous teamwork in separate box),
- Implementation of a best practices guide
- Animation of the three pilot training sessions

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- This project will be the first European training center at the discretion of the hydrogen risk,
- It will regularly offer to all European stakeholders training sessions mixing theorical courses, practical exercises and educational and scientific approaches through virtual reality,
- This program also aims to create and meet together a community of experts in this domain,
- After the project, in a logical sequence, creation of multi level operational and virtual training exercices

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Developing training programmes at all levels	2 levels: regulators and technical project managers.	3 levels: discovery, advanced (as regulators), and expert	Lectures, practical training scenarios and 2 exercises in virtual reality for each level have been developed
MAIP 2008-2013	Dissemination of the programme results through public awareness events and initiatives	Qualitative	2 international worhshops for European firefighters and decision makers of the crise 3 advisoring consultating panel meetings Events participations	1 internationalworkshop realised in 2014 (September) and 2 ACP meetings (2014 and 2015) Participation to several international events on hydrogen (e.g. ICHS 2015 in Japan)
AIP 2012	Develop and disseminate first-responder hydrogen safety educational materials in Europe		A full week training session will be developed with lectures, practical training scenarios and 2 exercises in virtual reality. This week will allow learner progress through three levels: discovery, advanced (as regulators), and expert	The plan of the training week is ready, some lectures and RCS (regulations, codes and standards) also. A matrix is used to identify each application using hydrogen, the possible risk for maneuver and response (reduction in risk) tactical or strategic. Within this context on the risk, of the tool (application) created and the expected response, at each time some exercises scenarios are determined, both on the operational platform but also with virtual reality.
AIP 2012	Build and disseminate hydrogen safety response approach based on feedback and responders' best practices		A full week training session will be developed with lectures, practical training scenarios and 2 exercises in virtual reality. This week will allow learner progress through three levels: discovery, advanced (as regulators), and expert	The plan of the training week is ready, some lectures and RCS (regulations, codes and standards) also. A matrix is used to identify each application using hydrogen, the possible risk for maneuver and response (reduction in risk) tactical or strategic. Within this context on the risk, of the tool (application) created and the expected response, at each time some exercises scenarios are determined, both on the operational platform but also with virtual reality.
AIP 2012	Develop and disseminate first-responder intervention guide		idem	At the end of the three experimental training sessions planned in the project (the last in June 2016) and their feedback, the good practice guide will be finalized
AIP 2012	Install an European Hydrogen Training Platform on which will be realised full scale exercises		Construction of the physical platform with the 5 modules (clarinets, explosion area, simulating hydrogen vehicles, mikados, refuelling station), Construction of the virtual reality platform (informatic network (computers, software) allowing simultaneous teamwork in separate box),	The deposite of the building permit of this platform is being investigated. Work will begin in November 2015 and it will be operational with tests phase in February 2016 The virtual reality platform already exists but it will be improved and better dimensioned at the end of this year 2015
AIP 2012	Perpetuate practical training using the platform disseminate best practices using online tools		After the project, the EHSTP (European hydrogen safety training platform) will survive and will propose trainings sessions with lectures, practical and virtual exercise scenarios	A part of the online tools are ready on website site of HyResponse but not publicly available yet

IRMFC

Development of a Portable Internal Reforming Methanol High Temperature PEM Fuel Cell System

AIP / APPLICATION AREA	AIP 2012 / AA 4: Early Markets
CALL TOPIC	SP1-JTI-FCH.2012.4.4: Demonstration of portable fuel cell systems for various applications SP1-JTI-FCH.2012.4.2: Demonstration of portable generators, back-up power and Uninterruptible Power Systems Energy
START & END DATE	01 May 2013 - 30 Apr. 2016
TOTAL BUDGET	€ 3,440,043.65
FCH JU CONTRIBUTION	€ 1,586,038.00
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

Coordinator: FORTH/ICE-HT (Greece)

Partners: Advent (Greece), UMCS (Poland), Fraunhofer ICT-Fraunhofer ICT-IMM (Germany), UPAT (Greece), ZBT (Germany), JRC-IET (Belgium), ARPEDON (Greece)

PROJECT WEBSITE/URL

irmfc.iceht.forth.gr

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

Development/demonstration of 100 W internal reforming methanol high temperature PEM fuel cell system for portable applications. Main goals to be accomplished: Scale-up synthesis and optimization of the main components (HT-MEAs, methanol reforming catalysts, BoP) developed within the framework of previous FCH-JU IRAFC 245202 project.

PROGRESS/RESULTS TO-DATE

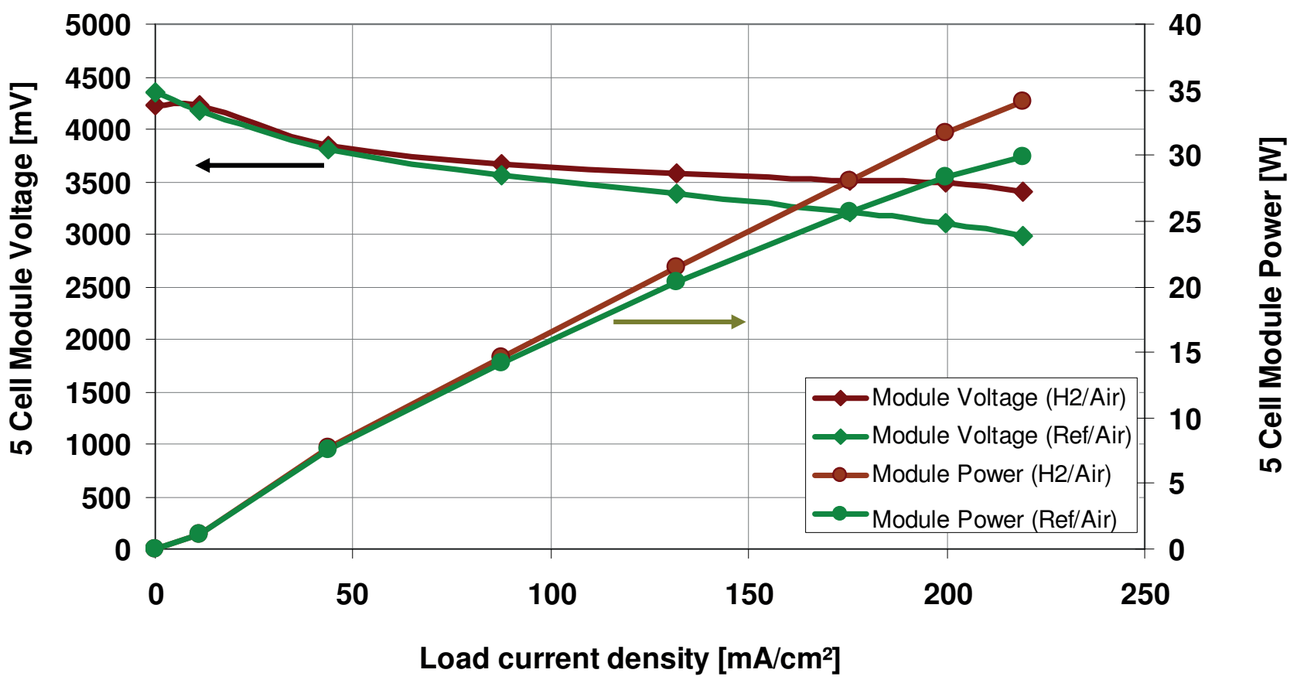
- Scale-up synthesis and long term testing of ultra thin Cu-based methanol reformer; highly active at 210°C; double reformer arrangement; easy embedding in the cell
- Polymer electrolyte membranes operating at 210-220°C with high stability (>500 h fuel cell testing)
- New metal- and graphite-based bipolar plates operating at 200-230°C
- Successful single cell testing of new materials at 0.2 A/cm^2 at 210°C; 5-cell IRMFC modules testing under run
- BoP design done; all main components delivered; further simplifications in BoP architecture are under way

FUTURE STEPS

- 5-cell modules testing
- All BoP components tested, integrated and delivered
- 100 W stacks integrated and tested
- Self-sustaining operation at 100 W net power output (no external power supply) for 1000 h (including startup/shutdown cycles)

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- The first 24 months results clearly demonstrate the IRMFC project progress, feasibility and future success
- Crosslinking methodology adopted herein for the first time has demonstrated some excellent results leading to MEAs operating at 210-220°C under reformate conditions
- New-type methanol reformer (ultrathin and lightweight) and bipolar plates (operation at 200-230°C) have been successfully prepared (scale-up) and tested for >1000 h
- Promising results from single cell testing with a new double reformer arrangement gives high perspective to achieve the objectives of the project



CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	FC stack cost (€/kW)	<5,000	<5,000	N/A (components being scaled up and tested)
AIP 2012	FC stack life time (h)	>1,000	>1,000	N/A (main components under testing / optimization)
AIP 2012	FC system electrical efficiency (%)	>30%	>30	N/A (Integration/testing of the final system will start at the end of 2015)

KnowHy

Improving the Knowledge in Hydrogen and Fuel Cell Technology for Technicians and Workers

AIP / APPLICATION AREA	AIP 2013 / AA 5: Cross-Cutting Activities
CALL TOPIC	SP1-JTI-FCH.2013.5.2: Training on H2&FC technologies for operation and maintenance
START & END DATE	01 Sep. 2014 - 31 Aug. 2017
TOTAL BUDGET	€ 1,437,062.40
FCH JU CONTRIBUTION	€ 1,000,000.00
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Technical University Delft

Partners: Fundacion para el Desarollo de las Nuevas Tecnologias del Hidrogeno en Aragon, Fundacion San Valero, Technische Universitat Munchen, Environment Park, Campus Automobile, University of Birmingham, Instituto Superior Tecnico – Universidade Tecnica de Lisboa, Federazione delle Associazioni scientifiche e tecniche, Vetigo Games B. V., ONO Consultants B. V., Kiwa Netherlands, McPhy Energy S.A.

PROJECT WEBSITE/URL

www.knowhy.eu

PROJECT CONTACT INFORMATION

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knowhy@tudelft.nl

MAIN OBJECTIVES OF THE PROJECT

To train technicians in the field of fuel cells and Hydrogen with theoretical as well as hands-on learning. The course will be offered in 7 languages throughout Europe. It is desired to make the course self sustainable to the point that the only personal contact is during the practical sessions. Rest of the time will be spent on e-learning complimented by serious game. After undertaking this course successfully, the technicians would be able to have the basic knowledge as well as in depth knowledge of one specialization such as Fuel Cells based transport.

PROGRESS/RESULTS TO-DATE

- Target group and training module definition
- Teaching methodology set up
- Specification for the on-line platform, set-up and validation of the platform
- Performance indicators and protocols definition
- Development, validation and translation of the contents

FUTURE STEPS

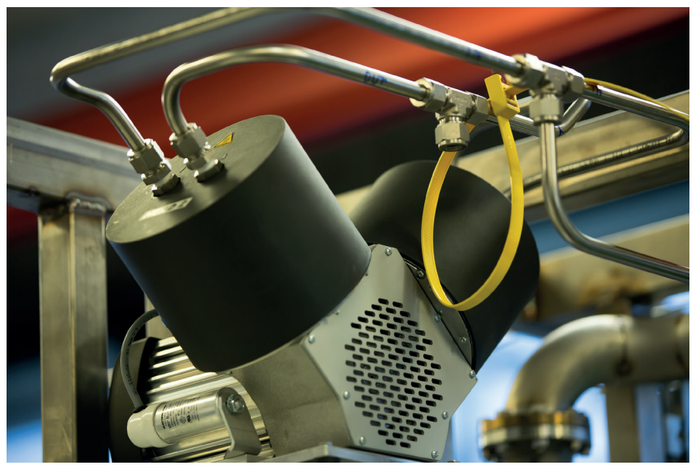
- Development, validation and translation of the contents
- Trial and Evaluation of KnowHy curriculum
- Running of the training
- Monitoring of progress
- Fostering project promotion, liaison establishment and dissemination to stakeholders

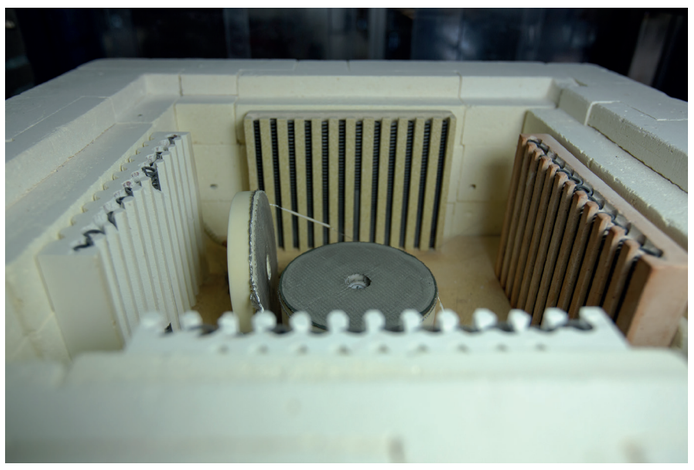
CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

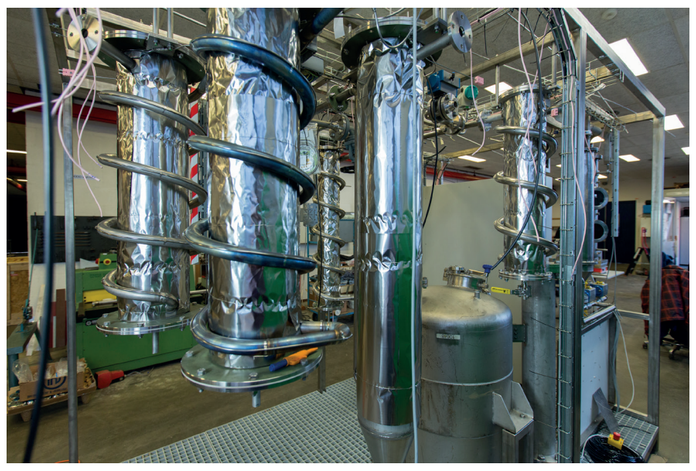
- E-learning cum hands-on sessions can be used to train technicians
- Serious games are a valid tool for teaching
- Uniqueness of the program allows the technicians to have basic knowledge accompanied by in-depth knowledge of one specialisation
- Consortium collaboration comes in handy allowing sharing of resources

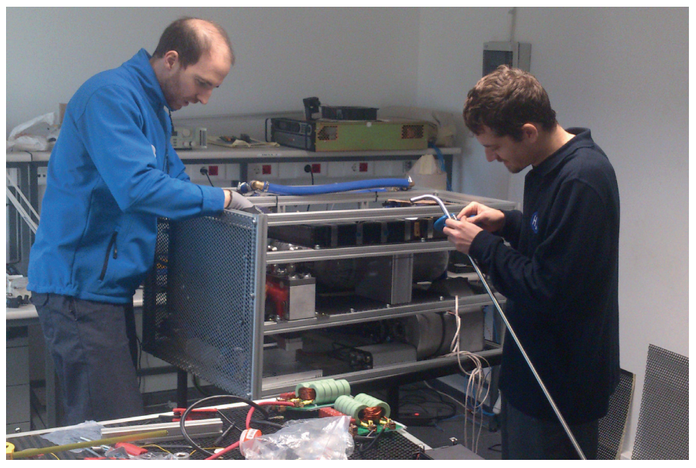
CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013 AIP 2013	projects that will ensure the human capital necessary in deploying FC & H2 technology in the mid-term is developed		providing the technicians with the required training in the field of Fuel Cells and Hydrogen with foremost importance on the safety aspects	• Target group and training module of KnowHy curriculm defined • Teaching methodology and the specification for the online platform hosting KnowHy course determined • Contents of KnowHy course and the didactic resources are being developed • The partners have started with the dissemination of the project









PROGRAMME REVIEW 2015

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

MATHRYCE

Material Testing and Recommendations for Hydrogen Components Under Fatigue

AIP / APPLICATION AREA	AIP 2011 / AA 2: Hydrogen Production and Distribution
CALL TOPIC	SP1-JTI-FCH.2011.2.8: Pre-normative research on design and testing requirements for metallic components exposed to H2 enhanced fatigue
START & END DATE	01 Oct. 2012 - 30 Sep. 2015
TOTAL BUDGET	€ 2,446,372.60
FCH JU CONTRIBUTION	€ 1,296,249
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

Coordinator: CEA/LITEN

Partners: L'Air Liquide SA, Teknologian Tutkimuskeskus VTT, Joint Research Center Petten, The CCS Global Group Limited, Centro Sviluppo Mateiali SPA, Dalmine SPA.

PROJECT WEBSITE/URL

www.mathryce.eu

PROJECT CONTACT INFORMATION

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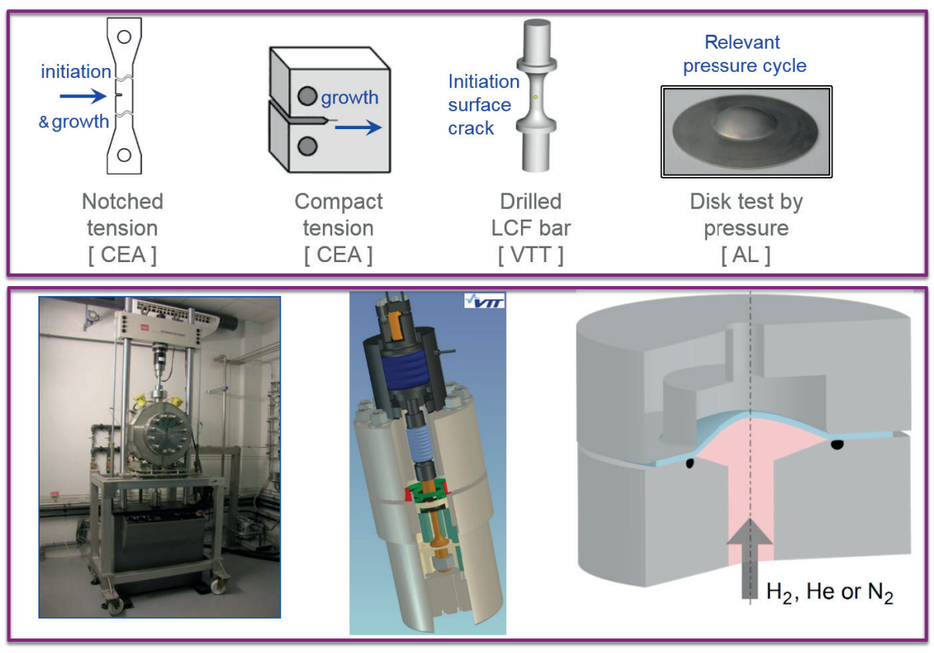
MAIN OBJECTIVES OF THE PROJECT

The MATRHYCE project aims to develop an easy to implement vessel design and service life assessment methodology based on lab-scale tests under hydrogen gas. The main outcomes are:

1. The development of a reliable testing method to characterize materials exposed to hydrogen-enhanced fatigue,
2. The experimental implementation of this testing approach, generating extensive characterization of metallic materials for hydrogen service,
3. The definition of a methodology for the design of metallic components exposed to hydrogen enhanced fatigue; this methodology being liable to be recognized for pressure equipment regulation,
4. The dissemination of prioritized recommendations for implementations in international standards.



PROGRESS/RESULTS TO-DATE

- Comparison of existing codes on a given case, highlighting the main differences (advantages and drawbacks)
- 3 types of lab-scale tests under hydrogen pressure have been developed to address both fatigue crack initiation and fatigue crack propagation.
- Hydraulic as well as hydrogen pressure cyclic tests on full components performed.
- Preliminary analysis of the results at lab-scale and full scale, helped by numerical simulations.
- Preliminary methodology proposal.

FUTURE STEPS

- Finalising, the last lab-scale results on a specific type of test (fatigue discs tests) in which the cycling loading is closer to the real life of a cylinder than in other types of tests.
- Identify the lab-scale test the most appropriate to be used in the design methodology.
- Methodology development. The proposal will be discuss with international experts during September 18 workshop dedicated to hydrogen enhanced fatigue.
- Validation of the methodology from both lab-scale and full-scale tests.
- Organisation of a workshop (September 21) to disseminate the RCS recommendations to ISO and CEN groups.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- The results obtained favour the use of a fracture mechanics approach to design cylinders under hydrogen cyclic pressure.
- In presence of a defect, it appears that the fatigue crack initiation step under hydrogen can be neglected.
- For initially low ΔK loadings, it has been shown that it is necessary to use the fatigue crack growth rate law including the change of behaviour at such low values, in order to not to be too conservative.
- Development of an ISO standard is tentatively considered possible within 5 years following the project.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	RCS strategy	Development of RCS to avoid major barriers for the commercialisation of FCH products	To propose dedicated RCS	The RCS proposals will be presented to the ISO and CEN experts on the September 21 workshop.
AIP 2011	Metallic material characterization for hydrogen service	-	Three types of tests are developed and applied to the metallic material AISI 4130	The experimental tests are achieved at 90%.
AIP 2011	Experimental implementation of design approach and design testing approach	-	Development of service life assessment methodology based on lab-scale tests under hydrogen gas and taking into account fatigue.	The experimental data are used to select the appropriate testing method (or methods) that will be proposed in the methodology.
AIP 2011	Design code for pressure equipment with metallic components in hydrogen service	-	Development of a design methodology taking into account hydrogen enhanced fatigue.	The methodology is still under discussion but a first draft has been circulating. The final proposal will be discussed with international expert on the September 21 workshop.

SOCTESQA

Solid Oxide Cell and Stack Testing, Safety and Quality Assurance

AIP / APPLICATION AREA	AIP 2013 / AA 5: Cross-Cutting Activities
CALL TOPIC	SP1-JTI-FCH.2013.5.4: Development of industry wide uniform performance test schemes for SOFC/SOEC cells & stacks
START & END DATE	01 May 2014 - 30 Apr. 2017
TOTAL BUDGET	€ 3,212,186
FCH JU CONTRIBUTION	€ 1,626,373
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)

Partners: Commissariat à l'énergie atomique et aux énergies alternatives (CEA), Danmarks Tekniske Universitet (DTU), Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA), Joint Research Centre-European Commission (JRC), Europäisches Institut für Energieforschung EDF-KIT EWIV (EIFER), Nanyang Technological University (NTU)

Generic Test Modules		Applications			
		Stationary SOFC	Mobile SOFC	SOEC	Combined SOFC/SOEC
TM01	Leakage test	x	x	x	x
TM02	Start-up	x	x	x	x
TM03	Current-voltage characteristics	x	x	x	x
TM04	Electrochemical impedance spectroscopy	x	x	x	x
TM05	Current interruption	x	x	x	x
TM06	Cyclic voltammetry	-	-	-	-
TM07	Reactant utilisation	x	x	x	x
TM08	Reactant gas composition	x	x	x	x
TM09	Temperature sensitivity	x	x	x	x
TM10	Pressure sensitivity	-	-	x	x
TM11	Mechanical load sensitivity	x	x	x	x
TM12	Operation under constant current	x	x	x	x
TM13	Operation under varying current	x	x	x	x
TM14	Thermal cycling	x	x	x	x
TM15	Redox cycling	x	x	x	x
TM16	Shut-down	x	x	x	x
TM17	Vibration test	-	x	-	-
TM18	Emergency stop	x	x	x	x

PROJECT WEBSITE/URL

http://www.soctesqa.eu/

PROJECT CONTACT INFORMATION

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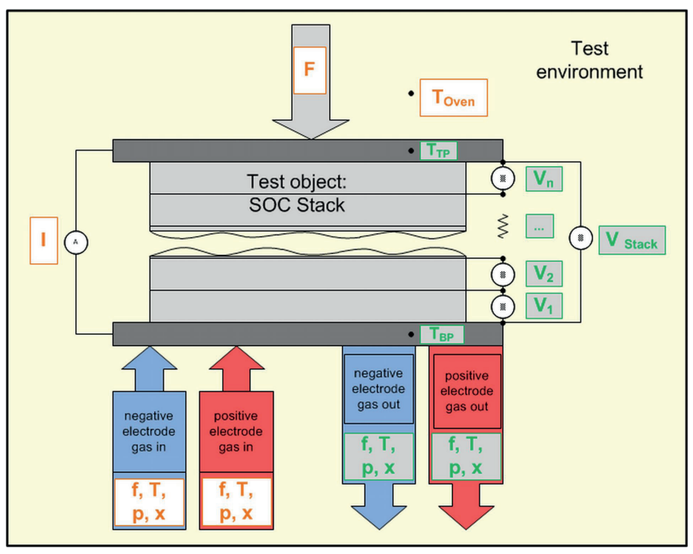
MAIN OBJECTIVES OF THE PROJECT

The main objective of the project is to develop uniform and industry wide test programs for solid oxide cell (SOC)/stack assembly units. The project will address three different operation modes, which are solid oxide fuel cell (SOFC), solid oxide electrolysis cell (SOEC) and combined SOFC/SOEC operations. Both stationary and mobile applications areas will be covered. Moreover, advanced characterization techniques, as electrochemical impedance spectroscopy, will be integrated in the test programs. The test modules will be experimentally validated on SOC short stacks. Moreover, the project will address safety aspects, liaise with standards developing organizations (SDO) and establish contact with industrial practice.



PROGRESS/RESULTS TO-DATE

- Project start phase (specifications, literature review, delivery of SOC short stacks...) finished
- Test matrix, test master document and first test program developed
- Application specific fact sheets were supplied by industries and active liaison with the most important standards developing organisations (SDOs) in the field were established
- Test stations specified and adapted for testing
- Five important test modules drafted and validated, e.g. current-voltage curve, electrochemical impedance spectroscopy and operation at constant current

FUTURE STEPS

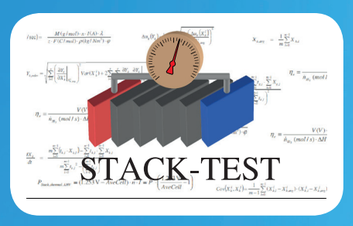
- Optimization of test modules by future validation loops
- Development of further test modules, e.g. for dynamic operation of SOC stacks
- Data sensitivity analysis related to interfaces between a common stack and different test stations
- Synchronisation of the project outcome to SDO and industrial advisory board (IAB) in the frame of a joint liaison project workshop

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Proper definition and monitoring of all interfaces between short stack and test station are very important
- The first results between the partners shows a high consistency
- A high sensitivity of the stack behaviour towards operating temperatures and the process gases was found
- Even little changes/differences of the operating conditions at the interfaces can strongly influence the stack results
- These high sensitivity parameters have to be addressed properly in the test modules and programs

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	testing and certification procedures	Establishment of frameworks and schemes to support SMEs to develop a supply chain for fuel cell and hydrogen technologies (e.g. by facilitating testing and certification procedures).	Definition, development and experimental validation of commonly accepted testing procedures and test protocols for a selected number of SOFC/SOEC applications.	Altogether 18 test modules were identified in the test matrix, which cover a wide range of system applications. The most important test modules (TM02, TM03, TM04, TM12 and TM16) have been developed and a first test program was established. The validation of these test modules in the frame of the test station comparison was performed and is currently under optimization.
AIP 2013	standardisation	testing standards for SOFC and SOEC	Identification of the most relevant testing procedures and test protocols for Solid Oxide Cell technology based on fuel cell applications and electrolysis application.	This topic was addressed by the specifications in WP 2 and by the definition of the test matrix and the test program in WP 3.The definition of the test matrix is finalized. The Deliverable D3.1 (Test Matrix) has been uploaded to FCH-JU platform (SESAM).
AIP 2013	standardisation	testing standards for SOFC and SOEC	It is very important to identify the most relevant parameters to be included in the testing procedures and test protocols addressing performance and endurance.	This topic was addressed by the development of the test program in WP 3. The corresponding Deliverable 3.2 was uploaded on SESAM. In order to determine the conditions for this test program a fact sheet was developed. The SOC industrial stakeholders have given input to these fact sheets according to the different system applications.
AIP 2013	standardisation	testing standards for SOFC and SOEC	Description of the required test infrastructure (test benches, system environments, hardware in the loop installations etc.)	This objective was addressed by Tasks 4.1, Task 5.1 and Task 6.1: Adaptation and commissioning of test stations for SOFC, SOFC and combined SOFC/SOEC testing, respectively. The corresponding deliverables D4.1, D5.1 and D6.1 have been uploaded to FCH-JU platform (SESAM).
AIP 2013	standardisation	testing standards for SOFC and SOEC	Moreover, besides current voltage curves, more detailed electrochemical characterisation methods with improved technical methods are now possible, e.g. electrochemical impedance spectroscopy (EIS).	In WP3 a test module (TM04) was developed, which is dedicated to electrochemical impedance spectroscopy. It is being validated in the different testing campaigns.
AIP 2013	standardisation	testing standards for SOFC and SOEC	Establishment of methodologies for the uniform collection, analysis and presentation of test data	In WP3 a test module (TM00) was developed, which is dedicated to general testing guidelines. These guidelines describe methodologies, collection, analysis and presentation of test data.
AIP 2013	standardisation	testing standards for SOFC and SOEC	Establishing liaison to standards development organisations (SDOs),... is encouraged.	In Task 7.1of WP 7 the interaction and liaison with standards development organisations (SDO) was intensified. Up to now strong liaison with the International Electrotechnical Commission IEC and the European CEN/CENELEC was established. A joint liaison workshop with SDO and IAB will take place at 15.12.2015.



Stack-Test

Development of PEM Fuel Cell Stack Reference Test Procedures for Industry

AIP / APPLICATION AREA	AIP 2011 / AA 5: Cross-Cutting Activities
CALL TOPIC	SP1-JTI-FCH.2011.5.4: Development of EU-wide uniform performance test schemes for PEM fuel cell stacks
START & END DATE	01 Sep. 2012 - 31 Aug. 2015
TOTAL BUDGET	€ 5,637,780
FCH JU CONTRIBUTION	€ 2,909,898
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)

Partners: CEA, DTU, DLR, ICRI, AAU, NEXT ENERGY, CITEDEC, Fraunhofer ISE, JRC-IE, SymbioFC

PROJECT WEBSITE/URL

http://stacktest.zsw-bw.de

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

- Propose and validate harmonized, and industrially relevant test procedures for PEM fuel cell stacks in form of generic test modules and application specific test programs.
- Address functional / performance, endurance, and safety testing,
- Interact with industry.

PROGRESS/RESULTS TO-DATE

- Generic test modules, and application specific test programs for performance, endurance and safety testing developed.
- Experimental validation completed.
- Four Stakeholder workshops held
- Feedback from workshops and industrial advisory group included into the documents.
- Test modules and test programs in their final versions publicly available starting from November 2015.

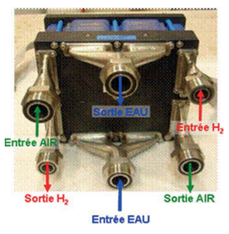
FUTURE STEPS

The project ends in August 2015, all tasks in the project will be closed by then.

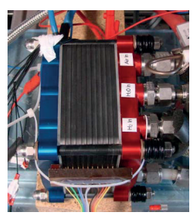
CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

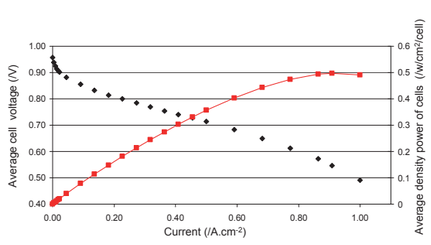
- Based on results from previous projects, the methodology of PEM fuel cell stack testing has been reviewed and improved.
- Generic test modules and application oriented test programs have been defined and finally validated after two iterations.
- Two different sets of stack test samples were supplied to the participants for validation purpose.
- Consistent results in performance testing were achieved using static and dynamic load.
- Endurance testing experiments have been carried out, however, understanding of the test results needs to be refined.

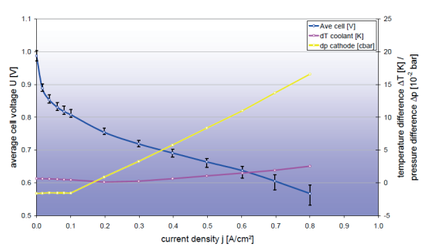
CEA Stack
representative for automotive

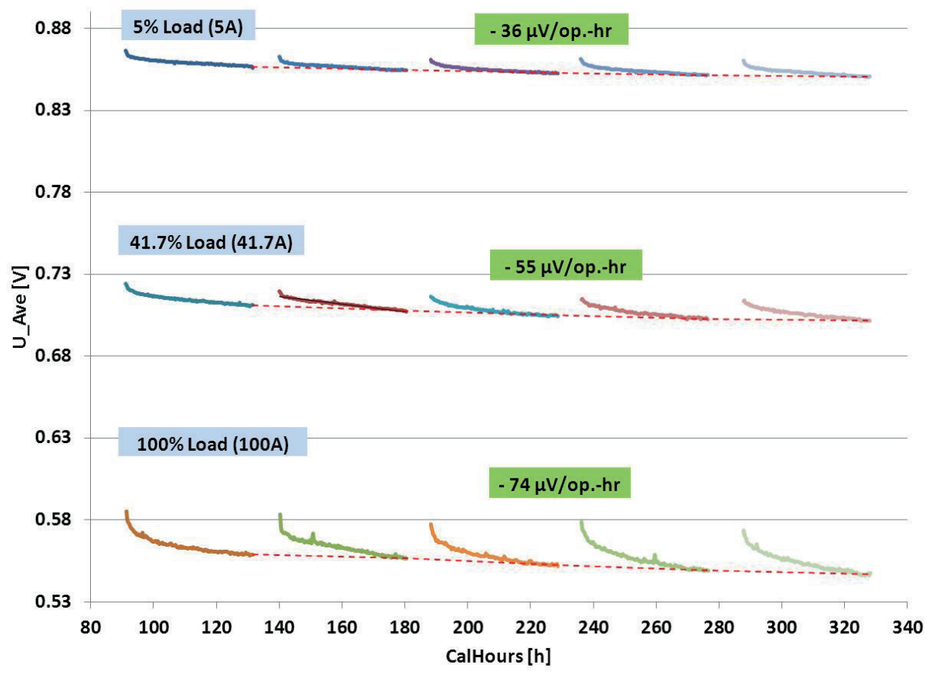


ZSW Stack
Representative for stationary









CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Provide a coherent framework to monitor progress	-	Provide a methodology of performance, endurance, and safety / environmental testing on a PEM-FC stack level	Generic test modules and application oriented test programs for performance, endurance and safety testing are ready for final release.
MAIP 2008-2013	Maintain, consolidate and disseminate results of RCS and PNR activities	-	Provide annually updated review of RCS relevant for PEM fuel cell stack testing	Basic assessment including 2 updated versions keeping track of changes are available.
AIP 2011	Development of harmonised testing protocols for PEM stacks, in order to achieve a set of testing procedures that provide a uniform look at their characteristics.	-	Provide experimentally validated test procedures for performance, endurance and safety / environmental testing	Generic test modules and application oriented test programs for performance, endurance and safety testing are available in for final release.

SUSANA

Support to Safety Analysis of Hydrogen and Fuel Cell Technologies

AIP / APPLICATION AREA	AIP 2012 / AA 5: Cross-Cutting Activities
CALL TOPIC	SP1-JTI-FCH.2012.5.2: Computational Fluid Dynamics (CFD) model evaluation protocol for safety analysis of hydrogen and fuel cell technologies
START & END DATE	01 Sep. 2013 - 31 Aug. 2016
TOTAL BUDGET	€ 2,119,669.90
FCH JU CONTRIBUTION	€ 1,159,124.00
PANEL	Panel 6- Cross-Cutting

PARTNERSHIP/CONSORTIUM LIST

Coordinator: KIT

Partners: UU, NCSRD, JRC, HSL, EE, AREVA

PROJECT WEBSITE/URL

www.support-cfd.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

The project is built on the complementarities of expertise of leading European experts in the field of CFD use for provision of hydrogen safety to achieve the synergy and consolidate the CFD excellence in application to safety design of FCH systems and infrastructure.

The project aims to support all stakeholders using CFD for safety engineering design and assessment of FCH systems and infrastructure, especially those who have no specialised knowledge in hydrogen safety and associated CFD modelling/ simulations practice, through the development of the CFD Model Evaluation Protocol, specialised databases, etc.

PROGRESS/RESULTS TO-DATE

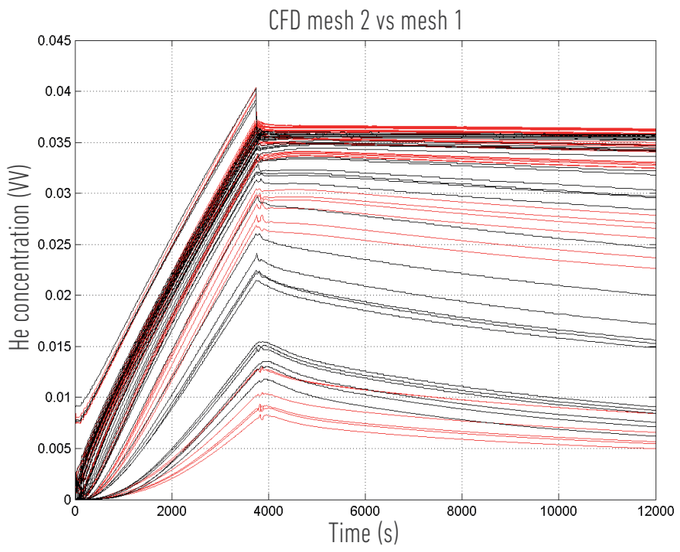
- Report on 1st CFD benchmarking exercice
- Database of verification problems
- Model validation database part I
- Best practice in numerical simulation – Interim Report
- State of the art review concerning FCH technologies
- SUSANA database and multitude of data sets

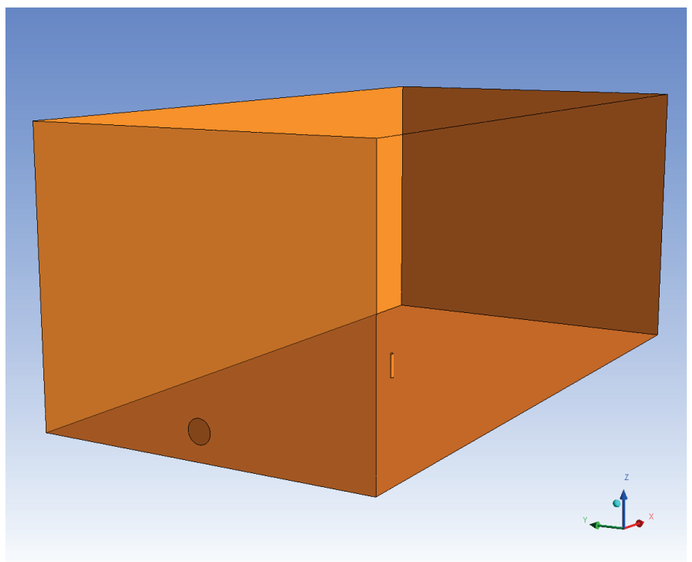
FUTURE STEPS

- 2nd CFD benchmarking exercice
- Critical analysis and requirements to models
- Final report on verification and validation procedures
- Final «The CFD model evaluation protocol
- Dissemination seminar to the database 2016 (by workshop or webinar)
- Development of further data sets and experiments for CFD database

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Intermediate report on best practice
- Database of verification problems
- State of the art review on CFD protocols
- Running Database and multitude data sets





CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Support to numerical simulation on FCH	Support to CFD applicable in FCH simulation	Database for CFD to support numerical simulation in FCH	Structure on database and provision to free access database related to CFD modelling and simulation in FCH Collection of protocols (50%)
AIP 2012	Support to CFD model evaluation protocols for safety analysis of hydrogen and fuel cell technologies	Development of a CFD model evaluation protocol for safety analysis and fuel cells	Development of a CFD model evaluation protocol for safety analysis	State of the art review on international level (achieved). Development of protocols for safety analysis. Database of the suitable experiments created (~70%)
AIP 2012	Protocol containing procedures, recommendations and criteria	See above	Critical analysis and requirements to physical and mathematical models, verification and validation procedures, best practice in CFD	Protocols containing procedures, recommendations and criteria to be discussed with international experts. Validation and Verification procedure. Best practice procedure ready to be discussed with international experts.
AIP 2012	Simulation Benchmarking	See above	Benchmarking on specific numerical simulation	Benchmarking exercise and 1st report on the benchmarking