Flexible Hybrid separation system for H_2 recovery from NG Grids

Newsletter – Issue 5 – December 2019

Editorial

Welcome to this fifth HyGrid newsletter. HyGrid is a four-and-a-half-years project targeting the development of a high-performance, cost effective separation technology for the direct separation of pure hydrogen from natural gas grids. Three different technologies - membrane separation, electrochemical separation and temperature swing adsorption - will be combined in a new separation system to decrease the total cost of hydrogen recovery. The new separation & purification system will increase the value of hydrogen blended into the natural gas grid.

The present newsletter is the fifth release and it is presenting the progress on the project and highlighting information related to the R&D fields addressed. Hope you will find the info in this newsletter interesting. On our website www.hygrid-h2.eu you will find public presentations, all the public deliverables of the project and many other interesting news. Stay tuned!

In this Issue:

What is HyGrid?

The concept

One of the main problems for the implementation of the hydrogen-based economy is the transportation from production centres to the end user both industries and population. To solve this problem, besides the in-situ production of hydrogen, the use of the existing Natural Gas network has been proposed for storing and distributing hydrogen. However, cost effective separation technologies for direct separation of hydrogen from the natural network should be developed for separating and purifying the hydrogen to match the end user requirements.

The HyGrid project proposes an integral solution for developing of an advanced high performance, cost effective separation technology for direct separation of hydrogen from natural gas networks. By using a novel membrane based hybrid technology combining three technologies integrated in a way that enhances the strengths of each of them (Figure 1): membrane separation technology is employed for removing H_2 from the "low H_2 content" (e.g. 2-10 %) followed by electrochemical hydrogen separation (EHP) optimal for the "very low H_2 content" (e.g. <2 %) and finally temperature swing adsorption (TSA) technology to purify from humidity produced in both systems upstream, pure hydrogen production (ISO 14687) will be obtained.

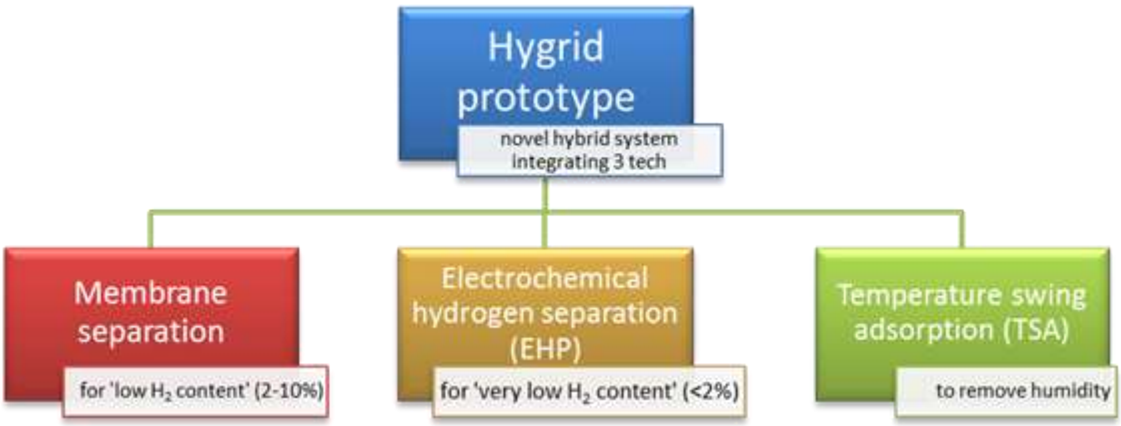

Figure 1. HyGrid concept

The new separation & purification system will increase the value of hydrogen blended into the natural gas grid, improving the economics of central hydrogen production from excess renewable energy couples with natural gas grid injection. In addition, it will reduce cost, and therefore increase the use of hydrogen from very dilute hydrogen streams in energy and transport applications. On the other side, further applications could be found in separating hydrogen from mixtures produced in chemical or biological processes, where it otherwise would be used to generate heat or even be vented.

Project objectives

The HyGrid project will develop, build and demonstrate at industrial relevant condition a novel advanced high performance, cost effective separation technology for the direct separation of pure hydrogen from natural gas grids. By combining the three different technologies (membrane separation, electrochemical separation and temperature swing adsorption) the total cost of hydrogen recovery will be decreased. The project targets a pure hydrogen separation system with power and cost of < 5 kWh/kg_{H2} and < 1.5 €/kg_{H2}. The pilot will be designed for the separation and purification of >25 kg/day of hydrogen (ISO 14687).

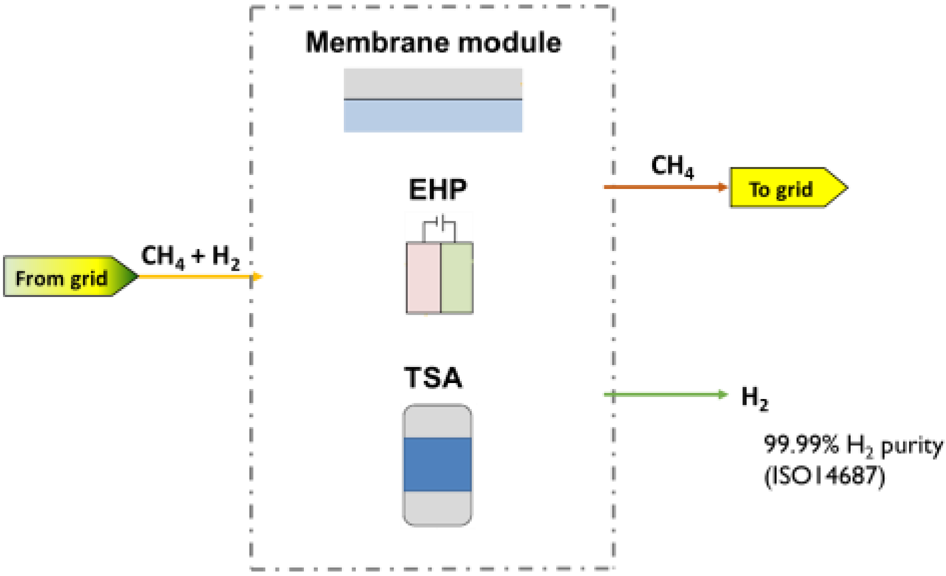

Figure 2. System schematic layout

The main objectives of the HyGrid project are:

- Design, develop, demonstrate and optimise an advanced hydrogen separation system for the production of at least 25 kg/day of hydrogen as per ISO 14687 from low (2-10%) and very low (<2%) H_2 blends in natural gas grids
- Development of stable, high performance and long durability membranes for hydrogen recovery from low (2-10%) hydrogen content streams.
- Development of more stable sealing methods for the membranes at moderate temperatures and reductive atmospheres.
- The further development of EHP for hydrogen recovery from very low (<2%) concentration streams.
- The further development of TSA for water removal from hydrogen/water streams.
- The integration of the new membranes, TSA and EHP in novel hybrid system to achieve high recoveries with low energy penalties.
- Energy analysis of the new HyGrid technology on different scenarios:

- recovery of H_2 from low concentration streams (2% -10%) up to 99.99% H_2 purity (ISO14687) in the whole range of pressures of the NG grid.
- Different configurations/combinations of the three separation technologies

- The validation of the novel hybrid system at prototype scale (TLR 5)
- The environmental analysis through a Life Cycle Assessment of the complete chain.
- Dissemination and exploitation of the results.

Latest news from the project

The latest news on different WP activities are now reported:

Membranes development

In HyGrid project, TECNALIA is developing supported Palladium-based (Pd-Ag) and composite alumina carbon molecular sieves membranes (Al-CMSM). Pd based membranes have very high permeation and selectivity towards hydrogen and their best temperatures of permeation are in the range of 300 to 500 °C. On the other hand, Al-CMSM membranes have lower permeance and selectivity, but they can permeate hydrogen at low temperatures (below 100 °C) where Pd membranes can be damaged; in addition, the Al-CMSM can be prepared from cheap polymeric precursors.

Along the last year TECNALIA has manufactured the membranes for the prototype including spare parts (Figure 3). Overall 75 Pd-Ag 45 cm long membranes (5 µm thick) supported onto tubular finger like alumina supports (14/7 mm o.d/i.d.).

Figure 3. Pd-Ag ceramic supported membranes of 450 mm length.

Electrochemical hydrogen separation development

The main objective of this task is the development of a hydrogen purifier (EHP) prototype for the recovery of the hydrogen from low concentration streams (H_2 ≤2 %) to be integrated in the final hybrid separation/purification prototype.

In the previous newsletter, the need for further development of the EHP on lowering the pressure drop was explained. That development has led to a pressure drop of less than 100 mbar instead of 5 bar in the previous design. This enables the EHP technology to be integrated into a natural gas grid. HyET is now working on verification of the pressure drop in larger stacks. Besides that, preparations also have been made for the full EHP stacks for integration in the HyGrid prototype.

Temperature Swing Adsorption development

Hydrogen separated from natural gas by both the membrane separator and the EHP system contains moisture. To comply with the EN norm for hydrogen, *a.o.*, the hydrogen needs to be dried. Within the HyGrid project HyGear has developed a Temperature Swing Adsorption system for the removal of water from the hydrogen gas. The TSA pilot plant consists of a separate gas humidifier for gas preparation; this will be removed when the TSA is integrated with the other main components of the HyGrid prototype. Performance tests performed with the pilot plant TSA have proven that the unit functions satisfactorily. The required feed flow rates and water content can be handled, and the product dew point specification can be met. Next the TSA will be combined with the membrane separator and EHP system from project partners Tecnalia and HyET.

Using the test results the TSA model build earlier in the project was validated. The TSA model is evolved beyond existing models for drying air.

Lab scale testing

Pd-Ag based membranes and Al-CMSMs have been fully characterised under H_2 and CH_4 single and mix gas permeation studies. Since the mechanism of permeation in both types of membranes are different, the effect of high pressure (up to 40 bar) and composition of the binary gas on the permeation properties were analysed for a proper comparation of the performance of the different membranes.

Concentration polarization effect is observed with Pd-Ag membranes, especially at high pressure and low hydrogen content while CMS membranes do not suffer this effect. Indeed, no reduction in hydrogen permeance is shown between pure gas and mixture permeation tests. Hydrogen permeation of 10% H_2 - 90% CH_4 and 50% H_2 - 50% CH_4 mixtures were performed at 400 °C for Pd-Ag membranes and 20 °C for carbon molecular sieve membranes to compared HRF (hydrogen recovery factor) and purity. For the case of lower hydrogen content very high and competitive purity are reached with the more selective carbon molecular sieve membrane (Figure 4). When working at high pressures (> 30 bar) and low hydrogen content, CMSM are preferable for getting pure hydrogen.

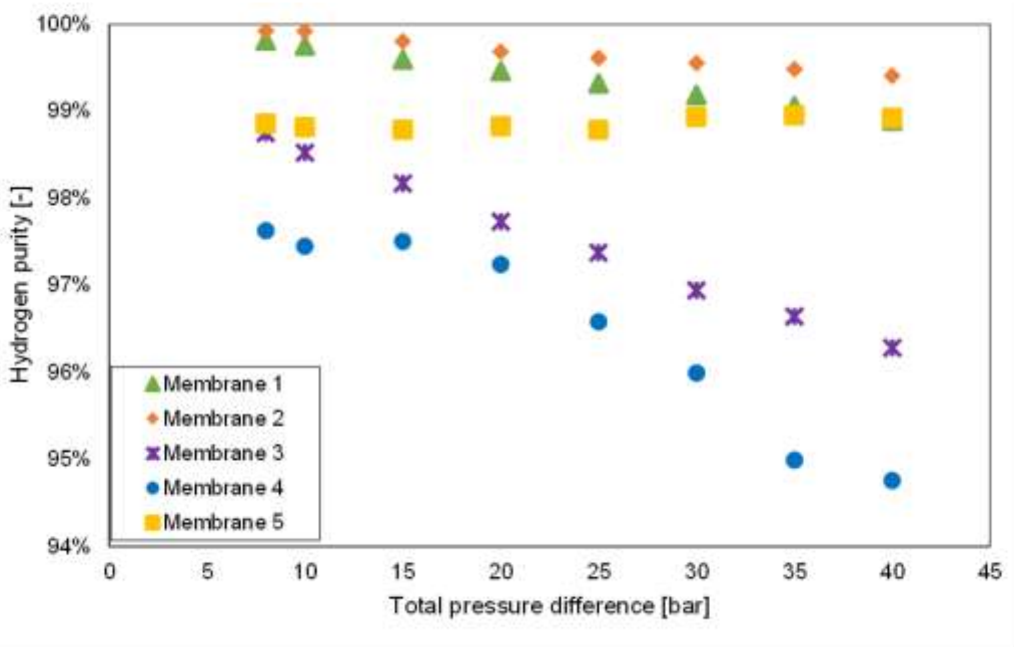

Figure 4. Hydrogen purity at different total pressure difference with Membrane 1 (Pd, H_2 selectivity: 24,300), 2 (Pd DS, H_2 selectivity: 65,200) ,3 (Pd, H_2 selectivity: 4,280), 4 (CMSM1, H_2 selectivity: 527) and 5 (CMSM2, H_2 selectivity: 1020) with a mixture of 90% CH4 and 10% H_2 (PdAg membranes, 400 °C; CMSM 20 °C).

System modelling and simulation

A proper membrane model which includes concentration polarization in the retentate, permeate and mass transfer limitation in the porous support was proposed and validated in comparison with experimental results at different operating conditions. As we could see (Figure 5), the model including concentration polarization in the retentate side is able to simulate the experimental results in presence of mixtures with some minor deviation. The ideal line which does not consider the concentration polarization effect, is not completely linear because of depletion.

The model has been also used to validate the hydrogen purity at different hydrogen content compared to experimental results (Figure 6). There is a slight deviation between modelled and experimental results on hydrogen purity. The possible explanation must be found in the sealing contribution through the Swagelok which is not easily described at different pressures and depends on the different expansion of the Swagelok compared to the graphite ring.

In addition, several aspen simulations were carried out for a proper optimization of the hybrid configuration for the prototype selection.

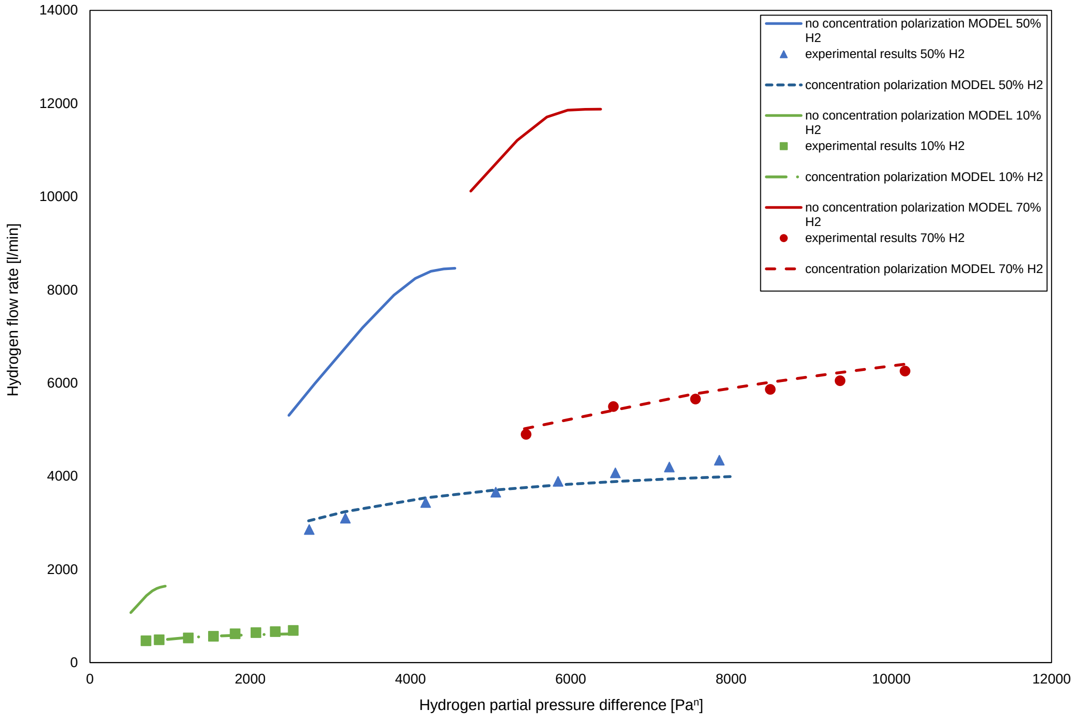

Figure 5. Comparison between hydrogen flux from experimental (dots) and modelled results in mixture tests at different hydrogen inlet content (10% green, 50% blue, 70% red); continuous line to described ideal case and dotted line includes mass transfer limitation at a working temperature of 400 °C.

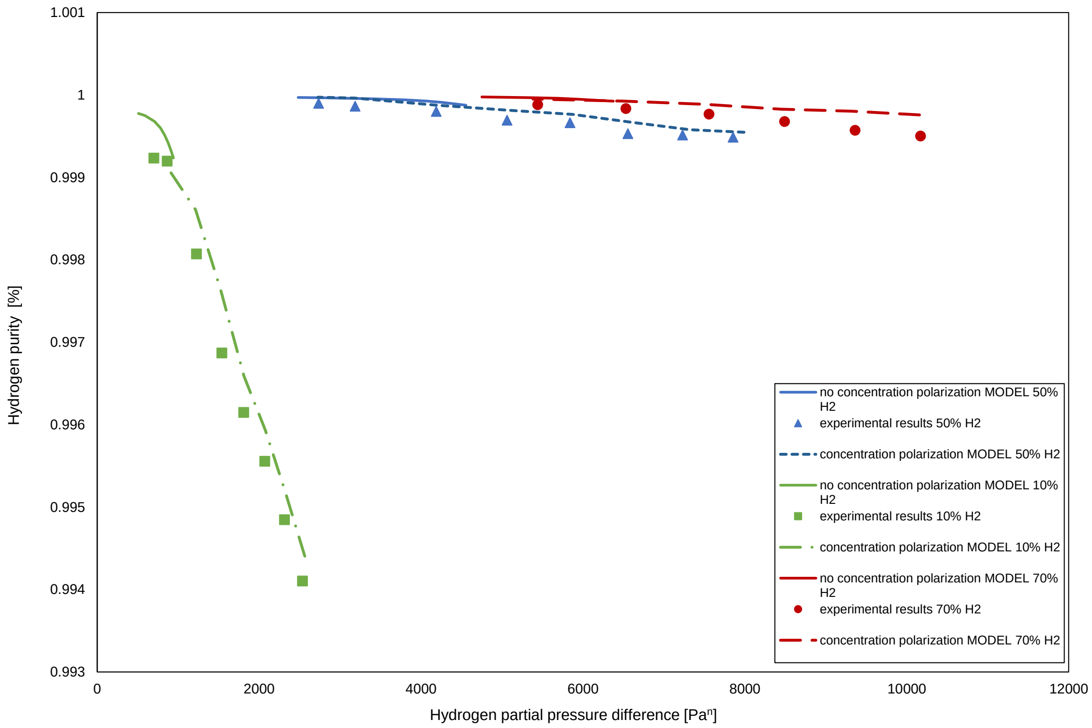

Figure 6. Comparison between hydrogen purity from experimental (dots) and modelled results in mixture tests at different hydrogen inlet content (10% green, 50% blue, 70% red); continuous line to described ideal case and dotted line includes mass transfer limitation at a working temperature of 400 °C

Prototype development

Extensive discussions on integration (mechanical, controls, safety) were held with the other partners supplying the main units. This has resulted in the procurement of the required balance of plant for the prototype. This is finished. To comply with the high operation temperatures of the membrane separator and the requirement to decrease the carbon footprint of the prototype HyGear developed innovative recuperative high temperature heat exchangers for the prototype. HyGear also prepared the 3D model of the prototype including the membrane separator, the EHP system and the balance of plant. Moreover, in order to drastically decrease the methane emissions during testing the gas is recycled within the project. Figure 7 shows the 3D model of the HyGrid prototype.

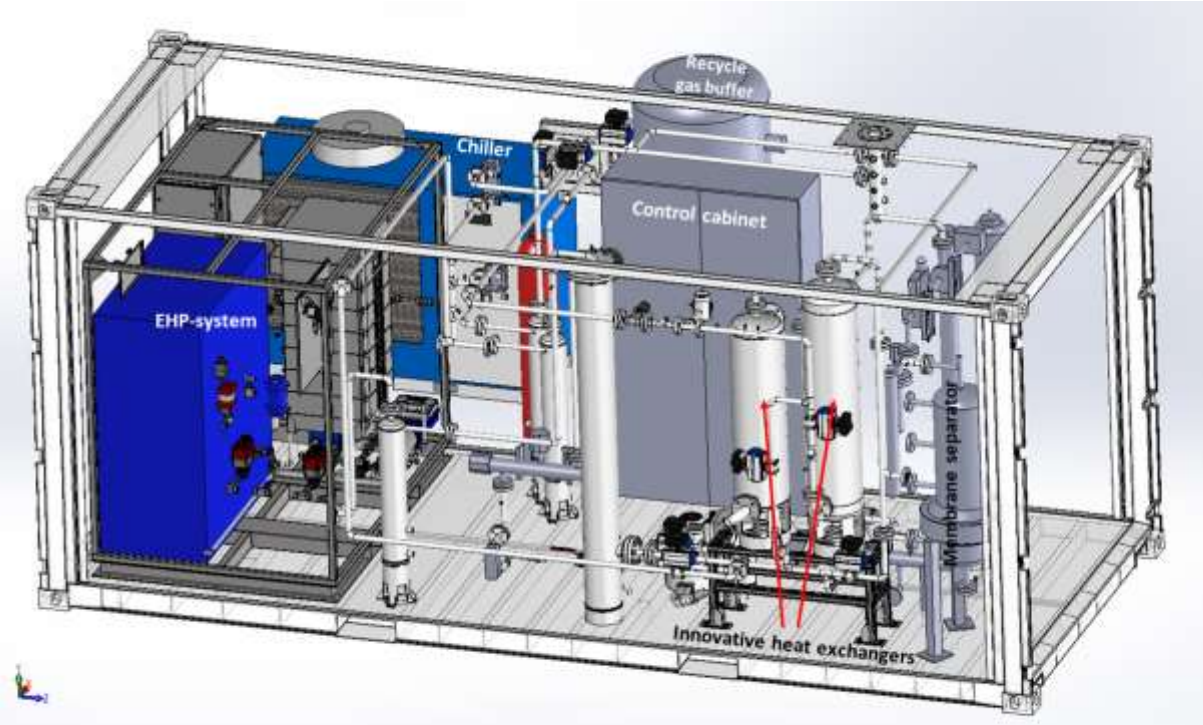

Figure 7. 3D model of the HyGrid prototype including the gas recycling system behind the container

The assembly of the prototype was started. Soon we will integrate the membrane separator of partner Tecnalia and the EHP system of partner HyET and testing of the prototype will start.

Membrane module has been built and 66 membranes (with a total area of 1.26 m^2 of selective layer) have been integrated in the module (Figure 8). Following the leak test the next steps will be to perform the Factory Acceptance Test to ensure the proper work of the module and later, deliver the module prototype to HyGear for building the HyGrid prototype and validation.

Figure 8. (left) The 66 Pd-Ag ceramic supported membranes already welded to the flange and ready to be integrated in the prototype and (right) HyGrid membrane module prototype after the membrane integration where all the flanges have been closed and the reactor is already face up.

The electrochemical hydrogen separation (EHP) stacks will be delivered to HyGear on a complete sub skid, see Figure 9. Interfaces between the sub skid and the HyGrid prototype have been extensively discussed between HyET and HyGear. Besides that, the safety concept and the control strategy of the sub skid have been explored.

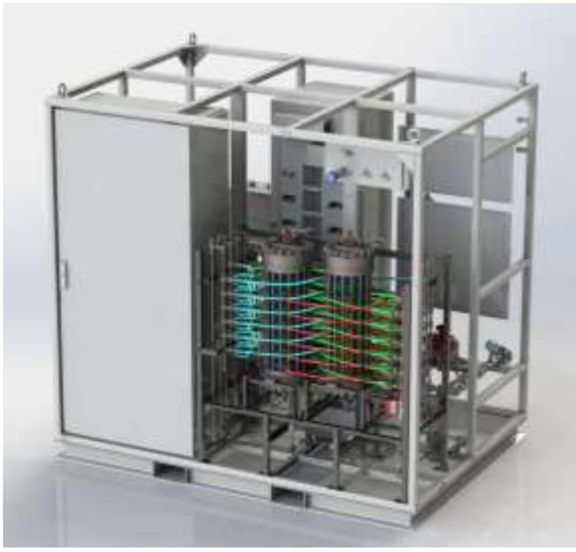

Figure 9. Render of the sub skid for the EHP stacks

The EHP sub skid will, for example, control the temperature of the EHP stacks, convert the electrical demand to the right DC voltage, and will monitor whether there would be a small gas leakage.

At this moment, all larger components have been ordered and the assembly of the sub skid will soon start. Once ready, the EHP stacks will be installed in the sub skid and after commissioning the tests with the complete HyGrid prototype can be started following the test plan.

Environmental and economic assessment

The environmental and economic assessment of the new hydrogen recovery systems developed within the HyGrid project will also be evaluated. The aim is not only to compare the developed technologies to current hydrogen recovery systems, but also to guide the design of the investigated technologies towards more environmentally friendly solutions. The core methodology that will be used to achieve this is life cycle assessment (LCA), a quantitative environmental assessment tool which estimates the environmental impacts of products or services looking at their entire life cycle as shown in Figure 10 below.

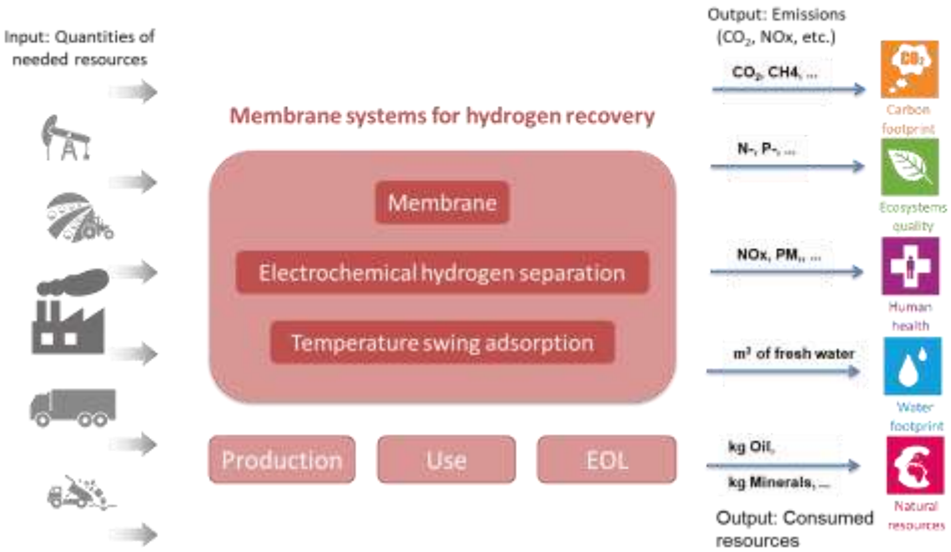

Figure 10. LCA approach.

In the first 12 months, the first task of this assessment was completed which involved developing the framework for the environmental and economic assessment. In technical LCA terms, this corresponds to developing the goal and scope of the study which involves clearly defining what different systems will be analysed, what system boundaries and functional unit will be used for the study and what reference technology the HyGrid system will be compared to.

The functional unit for this study was determined to be: "the recovery of 1 kg of hydrogen with a purity of at least 99.97% from an average European natural gas grid". Pressure swing adsorption (PSA), which had been identified as a suitable reference technology in the first period of the project, was further scrutinized. The results of this further analysis showed that PSA is not suitable for separating hydrogen from methane. Therefore, there are no real comparable systems to the HyGrid system.

The preliminary LCA results were presented at the M24 meeting. They show a high contribution of the electricity use of the system in all environmental impact indicators. The most important components in terms of impacts are so far the TSA and the EHP, due to the high metal consumption of these two components.

In the last months, the work was focused on developing scenarios which show the sensitivity of the environmental results on varying parameters like the sweep gas quantity or the temperature of the membrane. Further, data collection for the final environmental and economic results for the consortium's prototype was initiated, which will last until October 2019. Goal is to refine the modelling so as to have a more detailed representation of the components as well as to include their end-of-life. The final LCA and LCC (Life Cycle Costing) results will be available at M54.

Highlights

14th International Conference on Catalysis in Membrane Reactors July 8 - 11, 2019 in Eindhoven, The Netherlands

On July 8 – 11, 2019, the 14th International Conference on Catalysis in Membrane Reactors (ICCMR14) was held in Eindhoven, The Netherlands. The ICCMR14 was organized by the Eindhoven University of Technology, coordinator of the HyGrid project.

The aim of the ICCMR conferences is to promote the research and progress in the area of catalytic membrane systems by bringing together academic scientists and industry working in the membrane, catalysis and process engineering fields. The meeting highlighted recent developments, brought new ideas, helped making contacts and create a platform for discussion between academics and practitioners. The conference was addressed also to young researchers who had a chance to interact closely with senior scientists. The overall HyGrid project activities were presented in the EC funded project session.

Finally, we should point out that TECNALIA, beneficiary of the HyGrid project, has been appointed for the organization of the 16th International Conference on Catalyst in Membrane Reactors (ICCMR16) in 2023.

Current Trends and Future Developments on (Bio-) Membranes (1st Edition): Recent Advances in Metallic Membranes

Current Trends and Future Developments in (Bio-) Membranes: Recent Advances in Metallic Membranes presents recent developments in metallic membranes used in membrane reactors to save energy. It also offers a comprehensive review of the present state-of-the-art on the fabrication and design of metallic membranes and membrane reactors, considering various applications. This book focuses on the structure, preparation, characterization and applications of metallic membranes and membrane reactors, as well as transport mechanisms and simulation aspects. As recent research has focused on the development of metallic membranes and their applications, this book is an ideal reference on different production procedures and their use.

The book was published by Elsevier in January 8th, 2020 (https://www.elsevier.com/books/current-trends-and-future-developments-on-bio-membranes/basile/978-0-12-818332-8) being Professor Fausto Gallucci, coordinator of the HyGrid project, one of the editors. Beneficiaries of the HyGrid project have contributed to several chapters.

Dissemination activities, publications and presentations:

HyGrid public presentations as well as open access articles and public reports are available online in the dissemination section of the project website: www.hygrid-h2.eu.

Peer reviewed articles:

1. Margot A. Llosa Tanco, David A. Pacheco Tanaka. Recent Advances on Carbon Molecular Sieve Membranes (CMSMs) and Reactors. Processes 2016, 4, 29; doi:10.3390/pr4030029.

2. A.M. Gutierrez, J.R. Arraibi, M.A. Llosa Tanco, J. Zúñiga, J.L. Viviente, L. García Gómez. Development of carbon molecular sieve Membranes for the use of renewable gases, biomethane and hydrogen in natural gas networks. Proceeding of the International Gas Union Research Conference 2017 (IGRC2017). Rio de Janeiro, Brazil (24-26/05/2017).

3. M. Nordio, F. Rizzi, G. Manzolini, M. Mulder, L. Raymakers, M. Van Sint Annaland, F. Gallucci, Experimental and modelling study of an electrochemical hydrogen compressor, Chem. Eng. J., 369 (2019) 432–442. https://doi.org/10.1016/j.cej.2019.03.106.

4. M. Nordio, S. Soresi, G. Manzolini, J. Melendez, M. Van Sint Annaland, D.A. Pacheco Tanaka, F. Gallucci, Effect of sweep gas on hydrogen permeation of supported Pd membranes: experimental and modelling, Int. J. Hydrogen En., 44 (2019) 4228-4239. https://doi.org/10.1016/j.ijhydene.2018.12.137.

5. Maria Nordio, Mikel Eguaras Barain, Martijn Mulder, Leonard Raymakers, Martin Van Sint Annaland, Fausto Gallucci, Effect of CO_2 on the performance of an electrochemical hydrogen compressor, Chemical Engineering Journal, Accepted

6. Maria L. V. Nordio, José A. Medrano Jimenez, Martin Van Sint Annaland, D. Alfredo Pacheco Tanaka, Margot Llosa Tanco, Fausto Gallucci, Water adsorption effect on carbon molecular sieve membranes in H_2-CH_4 mixture at high pressure, Submitted

7. Maria Nordio, Jon Melendez, Martin Van Sint Annaland, D. Alfredo Pacheco Tanaka, Margot Llosa Tanco, Fausto Gallucci, Comparison between carbon molecular sieve

and Pd-Ag membranes at high pressure in H_2-CH_4 mixtures on purity and costs evaluation, Submitted

8. Margot A. Llosa Tanco, Jose A. Medrano, Valentina Cecchetto, Fausto Gallucci, David A. Pacheco Tanaka, Hydrogen permeation studies of composite alumina-carbon molecular sieves membranes: separation of diluted hydrogen from mixtures with methane. Submitted to Int. J. Hydrogen En.

Other dissemination activities:

1. M. Nordio, F. Gallucci, M. van Sint Annaland, V. Spallina. *Flexible Hybrid separation system for Hydrogen recovery from Natural gas Grids*. Dutch membrane meeting (2016). Poster

2. Naturgas. *Una industria energéticamente sostenible.* Newspaper El Correo – Innovation section. Bilbao, Spain (1st June 2016).

3. Martijn J.J. Mulder, Peter J. Bouwman. The need for High Temperature Proton Exchange Membranes for electrochemical hydrogen purification and compression. EMEA workshop 2016. Bad Zwischenahn, Germany (27-29/06/2016). Poster.

4. A.M. Gutierrez, Flexible Hybrid separation system for H2 recovery from Natural Gas Grids (HyGrid). GERG Meeting with DG ENERGY, Brussels, Belgium (06/02/2017). Oral

5. F. Gallucci, J.L. Viviente. Flexible Hybrid separation system for H2 recovery from NG Grids. Third European Workshop on Membrane reactors: Membrane Reactors for Process Intensification (MR4PI2017). Villafranca di Verona, Italy (9-10/03/2017). Poster.

6. Marco Succi, Giorgio Macchi. Pd Supported Membrane Hydrogen Purifier: a comparison with other technologies. Third European Workshop on Membrane reactors: Membrane Reactors for Process Intensification (MR4PI2017). Villafranca di Verona, Italy (9-10/03/2017). Poster.

7. A.M. Gutierrez. Hidrógeno en redes de gas natural. Fronteras Tecnológicas en Generación de Electricidad, Energías Renovables e Hidrógeno Whorshop. Madrid, Spain (26/04/2017). Oral

8. A.M. Gutierrez, J.R. Arraibi, M.A. Llosa Tanco, J. Zúñiga, J.L. Viviente, L. García Gómez. Development of carbon molecular sieve Membranes for the use of renewable gases, biomethane and hydrogen in natural gas networks. International Gas Union Research Conference 2017 (IGRC2017). Rio de Janeiro, Brazil (24-26/05/2017). Poster.

9. M. Succi, G. Macchi, E. Fernandez, J. Melendez, J. L. Viviente, D.A Pacheco Tanaka. Advancement in Palladium Membranes Hydrogen Purification. 6th European PEFC and Electrolyser Forum. Lucerne, Switzerland (4-7/07/2017). Poster

10. D.A. Pacheco Tanaka, M.A. Llosa Tanco, J. Medrano, J. Melendez, E. Fernández, M. Nordio, F. Gallucci. Preparation and hydrogen permeation studies of ultra-thin Palladium (≈1 micrometer) and carbon membranes from mixtures containing low concentration of hydrogen (< 30%). 13th International Conference on Catalysis in Membrane Reactors (ICCMR13). Houston (Texas), USA (10-13/07/2017). Oral presentation: Key note.

11. M. Nordio, M. Van Sint Annaland, F. Gallucci, V. Spallina, M. Mulder, L. Raymakers, P. Bouwman. Electrochemical Compressor for Hydrogen Separation in a Small-Scale Hybrid System. 13th International Conference on Catalysis in Membrane Reactors (ICCMR13). Houston (Texas), USA (10-13/07/2017). Oral presentation.

12. M. Nordio, J. Meléndez, E. Fernández, M. Van Sint Annaland, D.A. Pacheco Tanaka, F. Gallucci. Ultra-thin palladium-silver membranes for pure hydrogen production and separation: modelling and effect of sweep gas. 13th International Conference on Catalysis in Membrane Reactors (ICCMR13). Houston (Texas), USA (10-13/07/2017). Oral presentation.

13. M. Nordio, J. Meléndez, D.A. Pacheco Tanaka, M. Mulder, P. Bouwman, L. Raymakers, M. Van Sint Annaland, F. Gallucci. Hybrid separation system for hydrogen recovery from natural gas grids. 10th World Congress of Chemical Engineering (WCCE10). Barcelona, Spain (1-5/11/2017). Oral presentation.

14. A. Bos, M. Mulder, P. Veltman. Electrochemical Hydrogen Compression as New Disruptive Technology in Hydrogen Purification and Storage. European Hydrogen Energy Conference 2018 (EHEC). Malaga, Spain (March 14th, 2018). Oral presentation.

15. F. Gallucci. HyGrid Project: Objectives and scope. HyGrid Workshop 2018: Exploitation Workshop on Flexible Hybrid Separation System for H2 Recovery from Natural-Gas Grids. Lainate (Mi), Italy (May 17th, 2018). Oral presentation.

16. A. Gutierrez. The challenge of distributing Hydrogen into the natural gas network. HyGrid Workshop 2018: Exploitation Workshop on Flexible Hybrid Separation System for H2 Recovery from Natural-Gas Grids. Lainate (Mi), Italy (May 17th, 2018). Oral presentation.

17. A. Pacheco, G. Macchi. Hydrogen separation using membranes. HyGrid Workshop 2018: Exploitation Workshop on Flexible Hybrid Separation System for H2 Recovery from Natural-Gas Grids. Lainate (Mi), Italy (May 17th, 2018). Oral presentation.

18. L. Raymeakers. Electrochemical hydrogen compression and purification. HyGrid Workshop 2018: Exploitation Workshop on Flexible Hybrid Separation System for H2 Recovery from Natural-Gas Grids. Lainate (Mi), Italy (May 17th, 2018). Oral presentation.

19. L. Roses. Design of the HyGrid prototype. HyGrid Workshop 2018: Exploitation Workshop on Flexible Hybrid Separation System for H2 Recovery from Natural-Gas Grids. Lainate (Mi), Italy (May 17th, 2018). Oral presentation.

20. R. Swanborn. Electrochemical hydrogen compression coming to age. Hydrogen + Fuel Cells North America 2018. Anaheim (CA), USA (September 26th, 2018). Oral presentation.

21. Margot A. Llosa Tanco. HyGrid Project. Flexible Hybrid separation system for H2 recovery from NG Grids. International Conference on Catalysis in Membrane Reactors (ICCMR14). Eindhoven The Netherlands (8-11/07/2019). Oral presentation.

22. Margot A. Llosa Tanco, Jose A. Medrano, Valentina Ceccetto, Alba Arratibel, Fausto Gallucci, David A. Pacheco Tanaka. Supported Composite Alumina-Carbon Molecular Sieves Membranes (Al-CMSM) for Hydrogen Separation. International Conference on Catalysis in Membrane Reactors (ICCMR14). Eindhoven The Netherlands (8-11/07/2019). Poster.

23. Maria Nordio, Martin Sint Annaland, Fausto Gallucci. Flexible Hybrid separation system for H2 recovery from Natural Gas Grids. International Conference on Catalysis in Membrane Reactors (ICCMR14). Eindhoven The Netherlands (8-11/07/2019). Poster.

24. Maria Nordio, Jon Melendez, Alfredo Pacheco, Martin Van Sint Annaland, Fausto Gallucci. On the effect of steam as sweep gas in palladium supported membrane. 12th European Congress of Chemical Engineering (ECCE12). Florence, Italy (15-19/09/2019). Oral presentation.

25. I. Rey. What´s next? Toward the future in combustion technologies. NORTEGAS visión, challenges and needs. Centro Tecnológico IKERLAN Mondragón Guipúzcoa, Spain (Nov 29th, 2019).

Upcoming events

May 3-6, 2020	Hydrogen power Theoretical & Engineering Solutions International Symposium (HYPOTHESIS XV), Cape Town (South Africa) http://hypothesis.ws/
May 18-19, 2020	7th Edition of International Conference on Catalysis, Chemical Engineering and Technology (CCT 2020), Tokyo (Japan) https://catalysis-conferences.com/
July 5-9, 2020	23rd World Hydrogen Energy Conference (WHEC 2020) Istambul (Turkey) http://whec2020.org/
July 15-16, 2020	US Hydrogen & Fuel Cells Energy Summit 2020 Boston, MA (USA) https://www.wplgroup.com/aci/ehfn2-mkt-agenda/
July 12-17, 2020	12th International Congress on Membranes and Membrane Processes (ICOM2020), London (UK) http://www.icom2020.co.uk/
July 27-28, 2020	SCON International Congress on Chemical Engineering and Catalysis Tokyo (Japan) http://www.scholarenaconferences.com/catalysis/
November 4-6, 2020	European Hydrogen Energy Conference 2020 (EHEC2020) Madrid (Spain) http://www.ehec.info/

HyGrid in figures:

- *7 partners (2RES, 2 IND, 3 SME)*
- *4 countries*
- *2,847,710 € project (2,527,710 € EU funded)*
- *Start May 2016*
- *Duration: 54 months*

Project coordinators:

Prof. Fausto Gallucci
TU/e
f.gallucci@tue.nl

Dissemination manager:

Dr. José-Luis Viviente
TECNALIA
joseluis.viviente@tecnalia.com

Exploitation manager :

Leonard Raymakers
HyET
leonard.raymakers@hyet.nl

More information on HyGrid (including a non-confidential presentation of the project) is available at the project website: www.hygrid-h2.eu

Acknowledgement:

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 700355. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and Hydrogen Europe and N. ERGHY.