COSMHYC INTERVIEW

Interview with David Colomar (project coordinator COSMHYC and COSMHYC XL) and of Dominique Perreux (CEO from MAHYTEC)

Successful cooperation between a German Research Institute and a French SME for the development of an innovative concept for Hydrogen compression

Working on a common project with different international partners often can be challenging but at the same time very fruitful. One very good example that a cooperation can continue beyond a projects' life span and even result in new projects is the relationship between EIFER and MAHYTEC. Both organisations are involved in common FCH projects since 2011. David Colomar (project coordinator COSMHYC and COSMHYC XL) from EIFER and of Dominique Perreux (CEO from MAHYTEC) will give special insights in their work in COSMHYC and why their cooperation works so well.

David Colomar is R&D project leader in charge of hydrogen infrastructure at EIFER. As dynamic and innovative project manager he has been involved in many different national and European projects as well as in the Hydrogen Europe Research grouping. Currently he is the project coordinator of COSMHYC and COSMHYC XL. In addition, David is representing EIFER and the EDF group in the French association AFHYPAC dedicated to hydrogen energy and in the French working group "mobilité hydrogène France".

Dominque Perreux is co-founder and CEO of MAHYTEC. He is an outstanding scientist and entrepreneur and has been involved in over 10 European projects dedicated to hydrogen storage or hydrogen applications. He is a Professor of Material and Mechanical Science at University of Franche-Comté, author of over 100 publications in the field of materials and mechanical science. He is also the author of more than 10 patents.

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1. Dominique, MAHYTEC is an innovative SME well known for its performant hydrogen storage systems. Could you describe the storage solutions you offer to your customers?

Hydrogen is a very light gas and it is necessary to compress it to reduce the storage volume for different applications, such as for hydrogen mobility or microgrids. Several technologies for hydrogen storage exist, on hydride storage for example in the solid form or compressed storage in the gaseous form. MAHYTEC is the only company to master both of them. This allows us to offer our customers the best suited hydrogen storage solutions to their needs. In addition, the solutions we offer are certified, ensuring safety for the end-user.
MAHYTEC develops for example composite tanks for compressed storage of gaseous hydrogen, at medium pressure (60bar, i.e. 60 times the atmospheric pressure) but also at higher pressure (500bar). MAHYTEC can provide integrated systems around storage for specific applications, e.g. 500bar tanks for gas transport.

2. Dominique, you are a professor for Material and Mechanical Sciences and you have been working in the field of hydrogen storage for the last 15 years. Could you explain what a metal hydride is and how it can be used to store hydrogen?

Metal hydrides are binary compounds formed by hydrogen and a metal element (e.g alloys). For hydride storage, hydrogen is absorbed in the hydride, in a reversible way, which means that hydrogen is being released or "desorbed" when it needs to be used. The challenge is to increase the absorption capacity of the hydrides. The storage system weight is significantly impacted by the weight of the hydrides. Therefore, those tanks are mainly used for stationary applications or for small mobile and nomadic applications.

3. David, EIFER and MAHYTEC have been working jointly on hydride compression in the past 10 years. How does compression with hydride work? And how did you progress on this technology within the COSMHYC project?

Metal hydride compression is driven by a chemical process. The main principle of metal hydride compression utilizes a reversible, heat driven interaction between the hydride-forming metal alloy, and hydrogen gas, to form a metal hydride. After hydrogen was absorbed in the metal alloy at a low temperature and a low pressure providing heat at a higher temperature enables to release the hydrogen at a higher pressure, producing a compression effect.

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More than 2000 metal alloys have been identified up to now. The physical feasibility of hydrogen compression up to 1000 bar has been proven and is not questioned anymore. Nevertheless, the challenge is to find the right alloy to optimise the process, i.e. maximising the amount of hydride absorbed in the metal hydrides while minimising the energy needed for the whole compression cycle (i.e. absorption, heating, desorption and cooling).
One main achievement of the COSMHYC project was to identify, select and manufacture rare earth free hydrides with the right properties and performances. The desorption temperature has been successfully adapted to improve the performances, enabling compression steps similar to those of mechanical. In addition, a huge amount of work has been performed on system integration for adapting hydrides technologies to requirements of end users.

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4. David, which are the benefits of using a hydride compression system compared to other compression systems?

Different mechanical compression technologies are available today to compress hydrogen at refuelling stations, including hydraulic or crankshaft driven piston compressors, pneumatic boosters and diaphragm (or membrane) compressors. The main advantage of the metal hydride compressor is that it has no moving parts. Therefore, it has intrinsically very low maintenance costs, and thus very little wear and tear. In addition, metal hydride compressors use heat instead of electricity, which enables to reduce strongly the energy consumption of the hydrogen refuelling station when a waste heat source is available.

5. Dominique, what is the role of MAHYTEC in the COSMHYC project?

MAHYTEC is playing an essential role in COSMHYC as they are responsible for the development of the core technology the whole COSMHYC concept is relying on. In specific, MAHYTEC is responsible for the development of the optimised hydride reactors. This includes the following steps:

- Identify, specify and develop new rare earth free metal hydrides well adapted for HRS applications.
- Develop adapted tanks from a mechanical and thermal point of view, including new materials in the compressive structure. Some parts of the tank design have been jointly developed with EIFER, such as the thermal integration.
- Manufacture the hydrides and reactors of the prototype and obtain the appropriate approvals for long-term tests.

6. David, EIFER and MAHYTEC developed a close partnership over the last years. Could you describe achieved milestones of this joint work?

The collaboration of EIFER and MAHYTEC started with MobyPost, a common FCH-JU project in 2011. In collaboration with other European partners, including La Poste, UTBM, Ducati Energia and SEZ, EIFER and MAHYTEC developed small innovative refuelling stations fed with PV electricity to supply fleets of FC vehicles for mail delivery.

Since 2015, EIFER and MAHYTEC have been working jointly on preliminary prototypes of metal hydride compressor with own resources and in the scope of projects funded by the French agency for environment and energy.

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Over these years, a relation of trust has been established and solid common skills were developed. EIFER became an expert in system integration of metal hydrides, while MAHYTEC reinforced its position as the only European company developing high-pressure storage as well as solid storage with metallic hydrides. It is also one of the companies having the strongest involvement in international regulation and certification activities related to hydride tanks. Thus, MAHYTEC is the perfect partner for a research organisation such as EIFER for implementing new hydrogen compression concepts.

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7. David, the COSMHYC consortium is developing a hybrid compression concept, based on the optimal coupling of a mechanical compressor and the metal hydride compressor. What is the added-value of such a hybrid concept?

For a 950 bar compression (necessary to refuel a 700 bar fuel cell car), the compression between 1 bar and 450 bar represents about 90% of the compression effort, while the energy to compress hydrogen from 450 bar to 950 bar is only 10%. The metal hydride compressor presents the advantage of being very efficient from very low pressure to 450 bar. The use of mechanical compressor for low pressure compression steps is very costly, as very large compressors would be required to enable the required flow rates. On the other hand, mechanical compression is well adapted to the high pressure compression. As a whole, the combination of both technologies enables a very high electrical efficiency, as well as a flexible solution able to adapt to different client requirements.

The European Institute for Energy Research (EIFER)…

… is a European Economic Interest Grouping founded in 2001 by the French utility EDF and the German institute KIT (Karlsruhe Institute of Technology) located in Karlsruhe, Germany. The aim is to bridge the gap between science and industry on a range of energy related topics.
Together with high level scientific and industrial partners EIFER conducts research on smart and sustainable cities, energy systems, local energy concepts and low carbon solutions. EIFER participates in several national and European public funded projects on high temperature electrolysis, fuel cells, and hydrogen mobility.

MAHYTEC SAS…

…is a company of 23 people founded in 2008 and located in Dole (France). MAHYTEC is specialised in the design and manufacturing of hydrogen storage systems for mobile and stationary applications. MAHYTEC is a spin off from a University and 60% of its staff is dedicated to research. MAHYTEC is the only European company developing high pressure storage as well as solid storage with metallic hydride. It's the only European company mastering two technologies of hydrogen storage: compressed hydrogen storage and solid hydrogen storage under hydride from.

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