The CEA gets successful results using SYSPLY to engineer 700-bar hydrogen storage tanks

THE CHALLENGE

- Accelerate the engineering of onboard 700-bar hydrogen storage technology
- Environmental challenge: use a cleaner energy
- Reduce the production of greenhouse gases

THE STORY

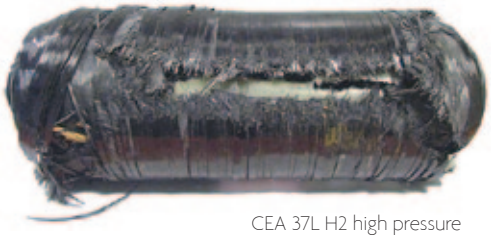
"Working on the StorHy project, we used SYSPLY to simulate the tank composite elements structure behavior in contact with hydrogen. SYSPLY provided us with tools to manage, through an intuitive Graphical User Interface, the full complexity of the laminate found structures. ***We had a very detailed 3D vision of our material and we accelerated our design process to get the right simulated prototype, avoiding material waste. SYSPLY helped us save cost and time during our research."***

Stéphane Villalonga, Research Engineer, Military Applications Division, Material Department, Polymers Synthesys and Processing Laboratory, CEA.

THE BENEFITS

- Use Simulation-Based Design to compute the composite structure of the tank prior to manufacturing
- Decrease overall costs by reducing material waste
- Benefit from a comprehensive material database facilitating laminate definition through a variety of 3D structure applications

The CEA (Commissariat à l'Energie Atomique or Atomic Energy Commission) is a strong partner for European Technological Research and a major support to industry. One of its main missions is to develop competitive, safe and clean energy technologies, in particular free of greenhouse gas emissions. Work is based on nuclear, solar, non alimentary biomass, microorganisms, and microalgae energy sources in order to optimize existing energy storage carriers (batteries, biofuels). The CEA aims at introducing hydrogen as an energy carrier by achieving technological breakthroughs from early-adopters to mass market (biofuels to hydrogen, hydrogen and fuel cells). The CEA represents 20%-25% of French investments in low carbon New Energy Technologies.



CEA 37L H2 high pressure vessel after burst test. Courtesy of the CEA.

OUTSTANDING RESULTS IN TANK COMPOSITE ELEMENTS STRUCTURE TESTING

As part of "StorHy" (acronym for hydrogen storage systems in automotive applications), an integrated project funded by the European Union, the CEA partnered with Ullit (high-pressure ultra light tanks manufacturer) to work on accelerating the engineering of onboard gas hydrogen storage technologies for automobiles. Working together, the CEA used SYSPLY, ESI's advanced software for designing, analyzing and optimizing composite material structures, to measure tanks properties such as durability and safety.

The gas hydrogen storage tanks have a liner made in a polymer using an innovative simultaneous synthesis and transformation rotomolding process, and a composite external shell. The liner ensures hydrogen sealing and the hull provides mechanical resistance and protection.

Working with ESI's SYSPLY simulation solution, the CEA managed to build a final prototype of the tank demonstrating the best results in terms of safety and durability. This tank is the only current technology meeting the three main criteria: life span, sealing and safety, which are required by European specifications for onboard 700-bar storage. The CEA tanks have proven their resistance at more than 15,000 filling cycles from 20 to 875 bar without any notable loss of properties. Reservoir leakage rate was at least twenty times lower than the standard requisite value (1cm3/L/hr). The tanks have also demonstrated their resistance to internal pressures higher than the bursting pressure set by the standard - 1645 bars, i.e. 2.35 times service pressure.

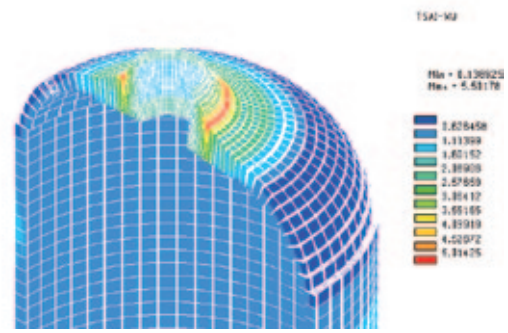
CEA engineered reservoir Courtesy of the CEA.

MINIMIZING THE MATERIAL WASTE

The CEA team worked during 54 months on the development of hydrogen storage technologies. Using SYSPLY early in the tank manufacturing development process allowed them to make huge savings in composites materials. The external shell of the tank was constructed out of composite materials offering tremendous mechanical performance for reduced weight structures. More precisely, filament winding with optimal high performance materials such as carbon fibers was used to manufacture the composite shell. Simulation of the hydrogen storage into the tank, taking into account the complexity of designing and manufacturing composites, helped the CEA team reduce material waste, and thus save cost and time.

BEST-IN-CLASS TO REACH GREEN TARGETS

Project "StorHy" ended in June 2008. The CEA and its partners presented the best results: 4.5 kilos of hydrogen can be stored onboard in a three-tank configuration where each tank is 3 times 37 liters of internal volume. With current technologies, this means a self-powered range of about 500 kilometers for a family car equipped with a 70 to 80kW PEMPC fuel cell. These results represent a huge advance in research and development for the Energy sector and, from an environmental perspective, brings us close to decreasing air and atmospheric pollution with new sources of energy. Nowadays, the CEA is continuing research to accelerate the industrial maturity of this type of tank and facilitate its integration into a car. At this stage of development, ESI will be able to provide the CEA with a complete endurance study on crash and explosive integrated in Virtual Performance Solution.



Tsaï Wu criterium
Courtesy of the CEA

To find out more about ESI Group's Composites Simulation Suite, visit: www.esi-group.com/composites

ABOUT CEA

The CEA is the French Atomic Energy Commission (Commissariat à l'Energie Atomique). It is a public body established in 1945. A leader in research, development and innovation, the CEA mission statement has two main objectives: to become the leading technological research organization in Europe and to ensure that the nuclear deterrent remains effective in the future. The CEA is active in three main fields: Energy, information and health technologies, and defense and national security. In each of these fields, the CEA maintains a cross-disciplinary culture of engineers and researchers, building on the synergies between fundamental and technological research. In 2006, the CEA had a budget of 3.3 billion euros and its total workforce consisted of 15 332 employees. For more information, visit: www.cea.fr

ABOUT ESI GROUP

ESI is a world-leading supplier and pioneer of digital simulation software for prototyping and manufacturing processes that take into account the physics of materials. ESI has developed an extensive suite of coherent, industry-oriented applications to realistically simulate a product's behavior during testing, to fine-tune manufacturing processes in accordance with desired product performance, and to evaluate the environment's impact on product performance. ESI's products represent a unique collaborative and open environment for Simulation-Based Design, enabling virtual prototypes to be improved in a continuous and collaborative manner while eliminating the need for physical prototypes during product development. The company employs over 750 high-level specialists worldwide covering more than 30 countries. ESI Group is listed in compartment C of NYSE Euronext Paris. For further information, visit www.esi-group.com.

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