

Hydrogen Pressure Vessels – AZL Aachen GmbH delivers Deep-Dive into Design and Production Trends

AACHEN, December 2024 — Fibre-reinforced pressure vessels are increasingly becoming the cornerstone of the hydrogen economy, playing a key role in the transport, storage and use of hydrogen for both mobile and stationary applications. AZL Aachen GmbH, in collaboration with a consortium of 25 leading industry players, has successfully completed a 12-month R&D project entitled 'Trends & Design Factors for Hydrogen Pressure Vessels'.

The 550-pages report, presented to the 40 participants of the final project meeting in November, provides a comprehensive overview of the market and technology trends related to the development of thermoset and thermoplastic pressure vessels. By addressing material impacts, complex design considerations and advanced manufacturing technologies, the project provides business- and technology insights. Companies along the whole value chain of pressure vessels have been involved, resins, fibres, liners, production systems, vessel manufacturers, hydrogen system integrators and OEMs.

The first phase of the project involved an in-depth review of regulations, requirements and safety standards, together with examples of state-of-the-art hydrogen pressure vessels. Key aspects covered included manufacturing processes, supply chains and production technologies, as well as a comprehensive patent analysis. In addition, the study examined winding patterns, design strategies, material models and software tools used in the development of pressure vessels.

The second phase of the project involved extensive engineering studies. Warden Schijve, Design Leader at AZL, explained the procedure: "Our team of experts developed CAE models for 12 different layouts of a two-metre, 350-litre Type IV pressure vessel designed for 700 respectively 350 bar applications. These models incorporated different resin and fibre types, layup variations and boss designs to evaluate the impact on mechanics, weight, cost and carbon footprint. We also explored hybrid fibre combinations and dome reinforcement using patch technologies. Detailed process chain modelling provided further insight into cost structures and CO₂ footprints."

The results of the project also show initial future trends: Through the targeted use of advanced material combinations, adapted designs and manufacturing techniques, it is possible to significantly reduce the weight and cost of the vessels while maintaining the necessary safety standards. Compared to state-of-the-art vessels, hydrogen over tank weight efficiencies could be improved from the standard 6 to 7% up to more than 11%. These developments could strengthen the competitiveness of hydrogen technology in various mobility and energy sectors in the future.

"The knowledge gained from the project provides a solid foundation for the use of new technologies to meet the hydrogen economy's requirements for safe and cost-effective pressure vessels," commented Celal Beysel, Chairman of the Board at FLOTEKS Plastik San. Tic. A.Ş.

Floteks, a Tier 1 supplier of plastic components, has launched numerous R&D initiatives in the design and development of Type IV vessels in recent years. In 2023, the company joined the AZL Composite Pipes and



Image 2: Project Consortium at the Final Report Meeting © AZL Aachen GmbH



Image 3: Project Leader Warden Schijve © AZL Aachen GmbH

About AZL Aachen GmbH

AZL stands for excellence in lightweight production. As one-stop shop for market and technology know-how, the senior staff of AZL supports companies of the entire value chain, in the development, benchmarking and improvement of design methodologies, manufacturing techniques and products. Located in the heart of one of the leading high-tech ecosystems, RWTH Aachen University, AZL assist in experimental evaluation of all relevant technologies related to composite-based multi-material technologies with decades of technology expertise and cutting-edge infrastructure.

In addition to individual cooperation, the AZL Partnership framework offer access to services and a network of 80+ international companies along the lightweight value chain. With three pillars advisory, engineering and partnership network, the AZL develops competitive innovations for economically highly relevant market segments and finds suitable partners for industrial implementation and establishment in the market.

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