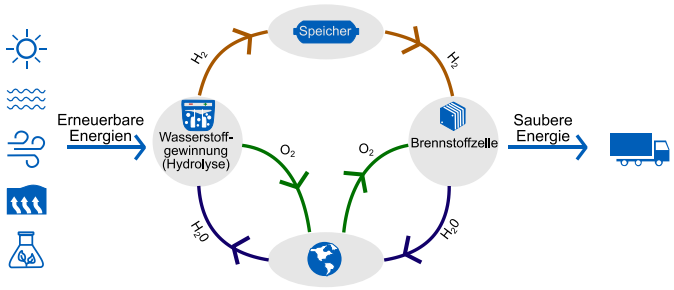
Lehrstuhl für Umformtechnik und Gießereiwesen
School of Engineering and Design
Technische Universität München

Design and development of the manufacturing technology of a hydrogen gas pressure vessel for cryogenic applications

Motivation

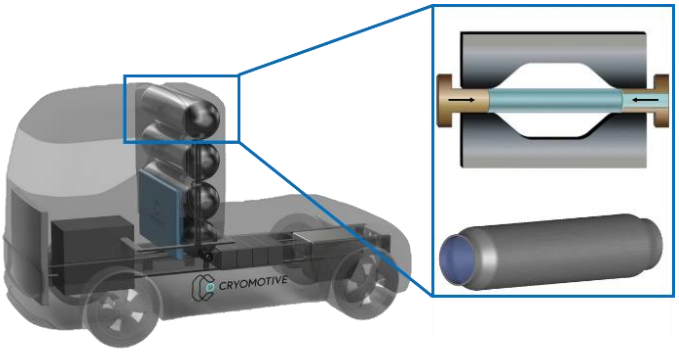
In Germany, about 20 % of greenhouse gas emissions could be attributed to transport in 2020. In order to achieve the goals of the Paris Climate Agreement, a drastic decarbonisation is necessary, which also includes the conversion of the commercial vehicle sector to emission-free engines.



For this purpose, the implementation of cryogenic storage and refuelling technology in the transport sector for operating fuel cell trucks is being driven forward. In this context, it is essential to design and manufacture the necessary components in accordance with the requirements. This also includes the mobile hydrogen gas pressure vessel, which is an aluminium liner whose outer skin is completely wrapped in carbon fibre-reinforced plastic (CFRP). The particular challenges of the research project are, on the one hand, the forming of the required pressure vessel volumes and, on the other hand, the effects of the thermo-mechanical loads on the materials used (aluminium alloy/CFRP) and their interaction, particularly with regard to the cryogenic temperature conditions.

Approach

The first main objective of this research project is the qualification of a forming process route that makes it possible to produce the required large-volume hydrogen gas pressure vessel from aluminium. Various manufacturing processes, such as stretch-forming, reverse cup extrusion and (hot-) metal spinning, as well as combinations of these processes, are available for selection. Another promising process in connection with liner dimensioning is hydroforming with seamless tubes as semi-finished products.



Since the hydrogen gas pressure vessel is a safety-relevant component, failure under the specified conditions of use must be absolutely excluded. This poses particular challenges for the materials, which have to withstand pressures of up to 450 bar and temperatures between -150 °C and -230 °C. In order to be able to make an application-appropriate material selection, another focus of the research project is therefore on the construction of a cryogenic measurement test rig to determine relevant material parameters.

In addition, finite element models are to be created which, on the one hand, will be used for process design and, on the other hand, will represent the thermal and mechanical loads acting on the Type III-cylinder during use.

Edgar Marker, M.Sc.
Tel. +49 89 289 13770
edgar.marker@tum.de

Alina Reimer, M.Sc.
Tel. +49 89 289 13981
alina.reimer@tum.de

Walther-Meißner-Straße 4
85748 Garching
www.mec.ed.tum.de/utg

Gefördert durch: Bundesministerium für Verkehr und digitale Infrastruktur
Koordiniert durch: NOW GMBH
Projektträger: PTJ Projektträger Jülich Forschungszentrum Jülich