PhD-Researcher Position (m/f/d) within the SE²A Research Cluster

Optimized composite material design for liquid hydrogen tank under mechanical and thermo-mechanical load

Temporary Position (up to 4 years) at TU Braunschweig and TU Delft, up to Salary Level EG 13 TV-L, 100%

Background:

The Cluster of Excellence *SE²A - Sustainable and Energy-Efficient Aviation* is a DFG-funded interdisciplinary research center investigating technologies for a sustainable and eco-friendly air transport system. Scientists from aerospace, electrical, energy and chemical engineering as well as economics and social science are working on the reduction of drag, emissions and noise, life-cycle concepts for airframes, improvements in air traffic management and new technologies for energy storage and conversion. Technische Universität Braunschweig, TU Delft, the German Aerospace Center (DLR), Leibniz University Hannover (LUH), the Braunschweig University of Art (HBK) and the National Metrology Institute of Germany (PTB) have joined forces in this extraordinary scientific undertaking. The overall project is structured into the three core research areas "Assessment of the Air Transport System", "Flight Physics and Vehicle Systems" and "Energy Storage & Conversion". (www.tu-braunschweig.de/en/se2a)

The Project:

Composite Pressure Vessels (CPV) are well suited for hydrogen storage of next-generation sustainable aircraft. In this project, we will look at the filament-wound composite shell of the CPV. The project will focus on the tailoring of thermo-mechanical properties of a hydrogen storage tank for cryogenic working conditions using variable stiffness filament winding architectures. The novelty of the research will be the tailoring of thermo-elastic response of filament-wound composite structures to optimize the gravimetric efficiency of CPVs for hydrogen storage. This requires the prediction of the stress state and failure of the laminate factoring in residual stresses of the manufacturing process and thermal stresses under cryogenic (working) conditions, which need specifically developed analysis tools. Thermal stresses and different failure phenomena including failure of the vessel under cryogenic conditions will be considered in the model. Physics-based modelling approaches are being chosen in a finite element analysis framework. After validating the thermal stresses and resulting displacements for a flat plate, the complete composite pressure vessel will be modelled. The developed analysis method will be used to tailor the thermo-mechanical response of the laminate to alleviate the thermal stresses and strains. This will allow on the one hand for a lighter and thus cheaper tank, and on the other hand could be used to create a tank that suffers less from thermal fatigue. A better fatigue life of a CPV for hydrogen storage can also be used to increase the working pressure of the tank, increasing thereby the volumetric efficiency of the system, or to reduce the structural mass of the tank, increasing the gravimetric efficiency of the system. In the final stage of the project this will be investigated as well.

Employment:

This study will be performed as a joint project at TU Braunschweig and TU Delft. The PhD research will take 48 months in total. The PhD candidate will spend the first one and half years of the project at the Institute of Aircraft Design and Lightweight Structures (IFL) at TU Braunschweig. The final two and half years of the project will be spent at the Aerospace Structures & Materials Department of TU Delft, The Netherlands.

The entry date is as soon as possible, ideally January 2023. The position is part-time suitable, but should be occupied 100%. For all doctoral researchers of the cluster, an active participation in SE²A's own qualification programme is mandatory, the time effort for this training measure entails 10% of the working time. The payment is made according to task assignment and fulfillment of personal requirements up to salary group EG 13 TV-L. International applicants may have to successfully complete a visa process before hiring can take place. Applications from international scientist are welcome. The Cluster SE²A aims to increase the share of women in academic positions. Applications from female candidates are very welcome. Where candidates have equal qualifications, preference will be given to female applicants. Candidates with handicaps will be preferred if equally qualified. Please enclose a proof.

Tasks:

- Literature survey
- Modelling of thermo-elastic effects (a predictive model shall be developed in this phase considering appropriate thermal modelling and analysis. Corresponding failure criteria need to be investigated and selected to evaluate the tank safety)
- Application of thermal modelling to composite LH2 tank (the models, which are tailored for the cryogenic conditions need to be adapted for the geometry of the LH2 tank)
- Optimization/Tailoring framework for LH2 tank optimization (the optimisation framework will be set up with the spatial distribution of the fibre angles as design variables. For a set of different aspect ratios, scales and maximum allowable working pressures, a weight optimization will be performed keeping the amount of load cycles fixed.)
- Publishing research results in scientific journals and at international conferences
- The position offers the opportunity to write a PhD thesis

Who we are looking for:

- You are enthusiastic about composite materials and have in-depth knowledge of their analysis methods
- You have extensive experience in the field of finite element methods
- You have a university degree in engineering with above-average grades
- You are a team player and independent, solution-oriented and structured
- You are proficient in the English language for work in an international research environment

Application Process:

Applications should be sent by e-mail to s.heimbs@tu-braunschweig.de or in printed form to

Technische Universität Braunschweig
Institut für Flugzeugbau und Leichtbau
Prof. Dr.-Ing. Sebastian Heimbs
Hermann-Blenk-Straße 35, D 38108 Braunschweig

until 16.12.2022 and must contain the following documents:

- Motivation Letter
- Curriculum Vitae including complete address, phone number, email address, educational background, language skills, and work experience
- Copies of bachelor and master diploma and transcript of grades in original language and in English or German translation
- Additional Documents must be provided on request

All documents should be in PDF format, preferably in a single file. Personal data and documents relating to the application process will be stored electronically.

Please note that application costs cannot be refunded. For the purpose of carrying out the application process, personal data will be stored.

For more information, please call Prof. Dr.-Ing. Sebastian Heimbs at +49 (0) 531 391-9903.