Master thesis (m/f/d): Design Optimization of Liquid Hydrogen Tanks with Spring Connections

The DLR Institute of Maritime Energy Systems in Geesthacht/Kiel researches and develops innovative solutions for decarbonization and emission reduction in shipping and transfers them into practice by cooperation with industry. To support this, the department of Ship Reliability conducts research and develops methods to ensure the safe and reliable operation of novel energy components and related infrastructure within maritime energy systems.

As the demand for clean energy sources increases, liquid hydrogen is gaining attention as a promising alternative fuel for various applications. However, unique properties of liquid hydrogen present challenges in ensuring the structural integrity and safety of fuel storage tanks. To maintain the temperature of liquid hydrogen, various insulation solutions were proposed. Spring connection is one of the probable solutions to reduce thermal transfer between inner and outer tanks. On the other hand, it introduces significant structural problem under multi-axial loading conditions due to the properties of spring being able to withstand only axial loadings. This thesis aims to provide a comprehensive analysis of design optimization for liquid hydrogen tanks with spring connections. An in-depth investigation of structural behaviour under different conditions (e.g., pressure, temperature, external loads) needs to be conducted. Optimization of tank geometry and location of springs also needs to be performed while analysing internal pressure resistance and external forces due to wave loads. The objective is to ensure that the tank design with spring connection is functional and sage for storing liquid hydrogen at cryogenic temperatures to be used on ships. We also welcome own proposals by students.

The tasks related to this position will include-

- State of the art review on design for liquid hydrogen fuel tanks and optimization procedures. Explore the key concepts, theories, and methodologies employed in this field.
- Synthesize and critically evaluate the strengths, limitations, and gaps in existing methodologies and models for optimization.
- Evaluate different materials suitable for cryogenic temperature and with good thermal insulation.
- Perform geometry, shape optimization of the tank and springs.
- Conduct pressure and stress analysis for different structural failure modes.
- Analyze and interpret data collected from the literature review and case study to draw meaningful conclusions and insights.

Qualifications sought:

- Study in the fields of mechanical/ thermal/ electrical/ renewable/ energy system - engineering/ technology, physics, or any comparable degree program.
- Proficiency in conducting literature reviews, gathering and analyzing data, and interpreting research findings.
- Familiarity with tank design principles, materials selection, and structural analysis is beneficial.
- Critical thinking and problem-solving skills.
- Ability to work independently, enthusiasm, and thirst for knowledge.
- Good English language skills.

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