Lightweight composite hydrogen storage tank

E-LASS SEMINAR #16

ERWAN JUIN

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Content

- Presentation of Polymer, Fibre & Composites Department
- Overview on Hydrogen
- Summary of previous and current projects
- Ambition

Polymer, Fibre & Composites department

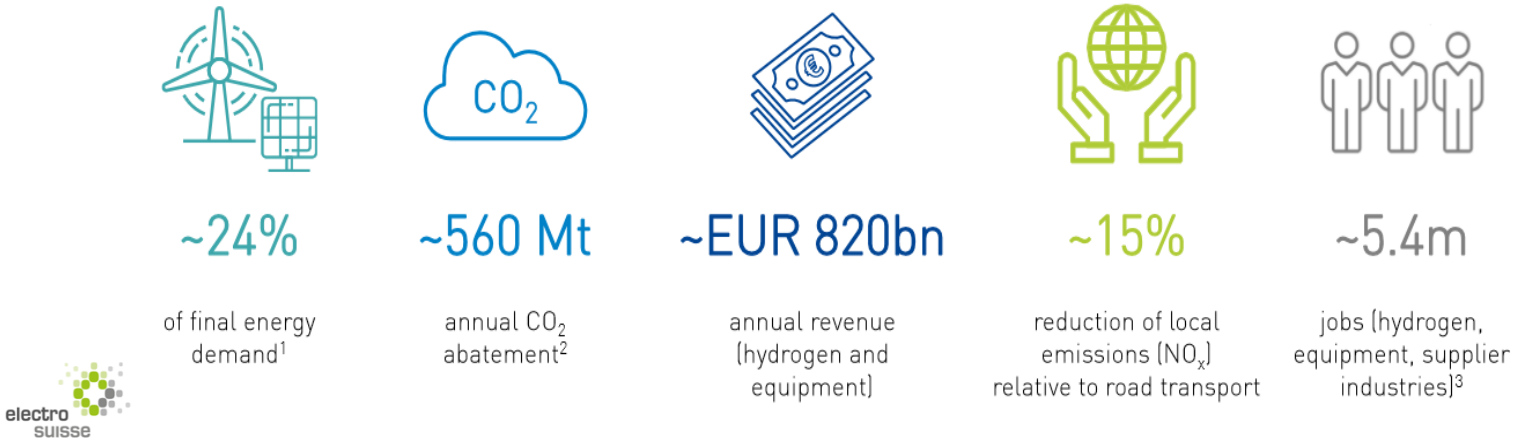
RI.
SE

Overview and location

- Part of the Materials and Production division at RISE
- Around 120 researchers, scientist , technicians and project managers
- Three main focus:
  - Fibre technology
  - Polymer technology
  - Composite material technology
- Work across many industries:
  - Aerospace, marine, automotive, space, defence, packaging, construction, furniture, textiles
- History of research on storage tanks:
  - Technology knowledge from 1990 onwards
  - Working with hydrogen specific project from 2010
  - Currently working on ~ 5 research project, mainly aerospace and land transport

Overview

The hydrogen economy in Europe in 2050



electro suisse

Estimated figures

Motivation

Transport accounts for approximately 8 gigatons of CO_2 emissions globally

Heavy transport accounts for just over 4 gigatons

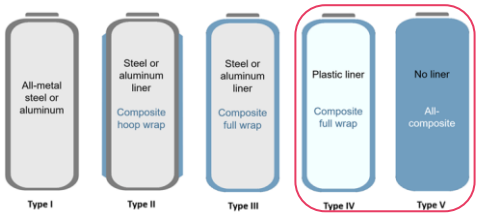
=> Can be converted to hydrogen operation

Potential to be very sustainable specifically if linked to a sustainable energy source.

Previous and current projects

CHATT – Project facts

- Full Title: **C**ryogenic **H**ypersonic **A**dvanced **T**ank **T**echnologies
- Project time: 2012-2015
- Funding programme: FP7 Europe
- Participants: 11
- Budget: 4 M€
- Application : a 50-meter-long reusable liquid hydrogen rocket booster
- Project focused on the design of 4 scaled cryo-tanks in CFRP
  - Dry wounded tank
  - Type 4 (with liner)
  - Type 5 (linerless tank)
  - Multi bubble tank

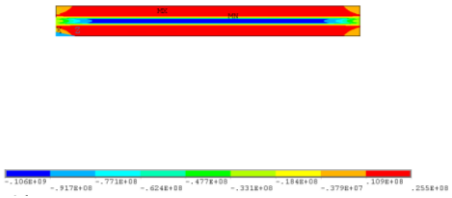


CHATT – Work realized by RISE

Development on the tank with liner:

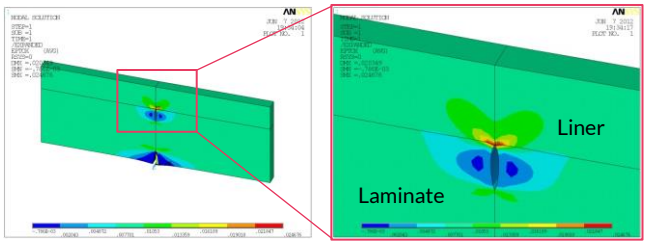
- Specification , Material selection
- Theoritical design:

- FEA of residual stress from manufacturing



Stresses in the $[90/0]_S$ layup

FEA of micro-cracking behaviour of liner with laminate



Stress distribution in a $[90/0]_s$ laminate

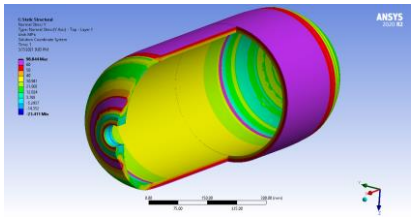
- Test of liners with and without laminate

Manufacturing of the liner less tank

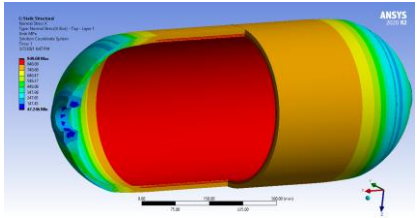
Personal Air Land Vehicule Application

- Project time: 2020-2021
- Work for KCTECH
- Development of a 50 liters Type 5 tank operating at 700 bar
- Design solution:
  - Thin-ply laminate (Textreme 50 UD)
  - Traditonal layers (T700)
  - Aluminum dome ends
  - Process: Wet winding

Transverse fibre direction stress



Fibre direction stress



CF "liner" with dome ends for final winding

Final winding

Finished vessel

LH2-Tanks – Project facts

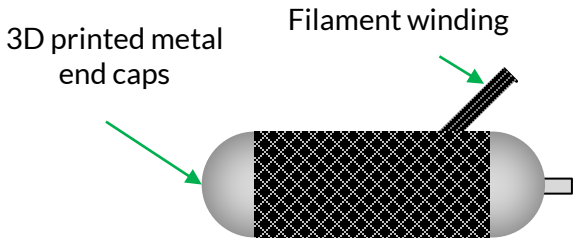
- Full Title: Linerless **liquid hydrogen** aircraft **tanks** using thin ply composites
- Project time: July 2021 to June 2023
- Funding programme: “Fossil free aviation” Swedish Energy Agency
- Participants: RISE, Chalmers University, KonveGas, Linköping University, Oxeon

LH2-Tanks – Goals and role of RISE

- Improvement of existing **material models** for **thin ply** composites
- Determination of **material properties** at **RT** and at -**253°C** (LH_2)
- Development of simplified **fatigue model** for **cryogenic temperatures**
- **Design** and **manufacture** of **demonstrator** tank for liquid hydrogen (LH_2)
- Study of **manufacturing routes** for **industrialisation**
- Role of RISE: Composites modelling, manufacture & testing

Laminate tests

Demonstrator tank

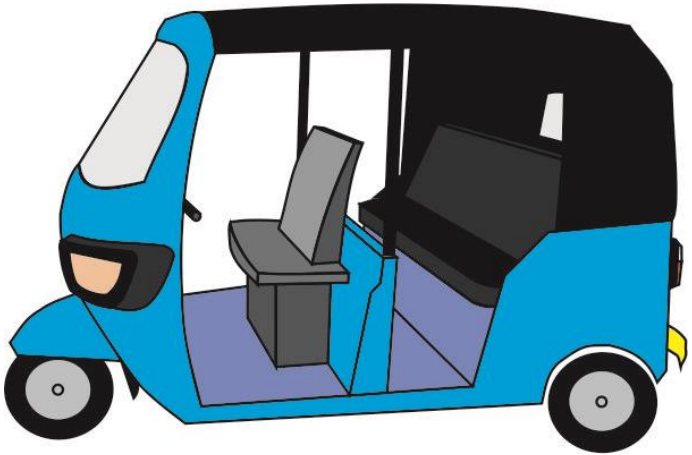


El Tuk – Project facts

- Full Title: Increasing knowledge for small, environmentally friendly, safe, cost and energy efficient vehicles through construction
- Project time: October **2021** to December **2023**
- Funding programme: “Energy and Environment” **Swedish Energy Agency**
- Participants: RISE, Clean Motion, BEVI, Adigo, myFC, Oxeon
- Budget: **9.6** MSEK

El Tuk – Goals and role of RISE

- Convert two fossil-powered tuk-tuks to :
  - One with **electric powertrain** (battery and electric engine)
  - One with **fuel cells, electric engine, battery and hydrogen tank**
- Develop **a solar cell body**
- **Compare characteristics** of the various vehicle concepts produced



- Increased understanding of the **safety requirements** that should apply to small vehicles
- Role of RISE:
  - Risk investigation of fuel cell vehicles and safety
  - Design of powertrain and electric machine design including gear
  - Design and manufacture of hydrogen tank in composite material
  - Validation of vehicle concepts

Tech4H2 - Technologies and innovations for a future sustainable hydrogen economy

- A new competence centre
- Broad research disciplines with hydrogen and vehicle relevance
- Focus on technology integration and development for heavy transport:
- Partners:

Ambition

Application to marine

- Knowledge gained from aerospace and automotive to be transferred and applied to marine
- Goal : To develop hydrogen as a fuel technology for the marine environment
- Focus on storage and transfer: i.e. from hydrogen storage on land to transfer of hydrogen to vessel and then storage of hydrogen on the vessel.
- Work subjects:
    1. Early study comparing liquid vs. gas options vs. vessel size and type
    2. Study on policy and regs, risk management, gaps and improvements
    3. Sustainable solutions – reuse, recycling and biobased etc.
    4. Scale testing of components with a reference to a marine environment e.g. fire retardancy, leakages and salt environments
    5. Development of a virtual reality test system

Erwan Juin
Erwan.juin@ri.se
+46 76 784 43 07