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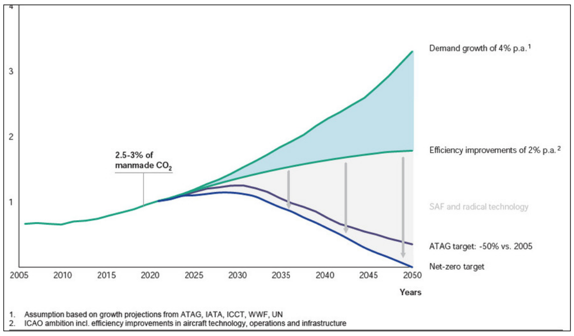
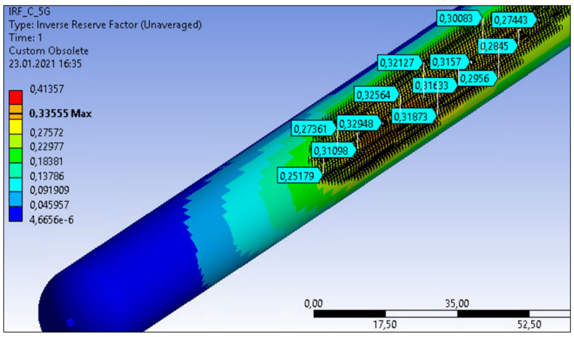
Subject Area	Plastics Technology
Project Partner	KTH Kungliga Tekniska Högskolan, Stockholm, Sweden

Design of a structural hydrogen tank for hybrid-electrical unmanned aerial vehicle



CO2 emissions from aviation until 2050 with the effect of different efficiency improvements
Hydrogen-powered aviation; Publ. Office of the EU, 2020

Green Raven GR001 Prototype, a 1:4 scale down of the MK18
kthaero.com/greenraven



Inverse Reserve Factor for one tank as a result from the FEM analysis
Own presentment

Initial Situation: In December 2019, the European Commission put forth its Green Deal with the objective for decarbonization: net carbon neutrality across all sectors and EU member states by 2050. For aviation, this target is even more ambitious than those from the Air Transport Action Group (ATAG), which call for carbon-neutral growth from 2020 onwards and a 50 percent reduction of emissions by 2050 relative to 2005 levels. Both of these targets put the aviation sector under increasing pressure to decarbonize. Per passenger, the aviation sector has become more carbon-efficient over the past three decades. Higher seat density and utilization, operational improvements, and technology improvements like higher engine and airframe efficiencies have boosted fuel efficiency per revenue passenger kilometer (the number of kilometers traveled by paying passengers) by approximately 50 percent. Supported by the optimization of flights, flight routing, and airport taxiing, this trend is expected to continue.
Nevertheless, rising demand for air travel has led to a significant increase in direct CO2 emissions from aviation – by 34 percent over the past five years. Growing populations and prosperity will further increase demand, with forecasts ranging from 3 to 5 percent per year until 2050.

Problem: The world of aeronautics is undergoing a significant shift in the way it is perceived, with increasingly growing pressure being applied towards making a significant contribution to sustainability and carbon offsetting. This shift has resulted in a large number of efforts – from the conversions of existing frames with electrical or hydrogen/electrical hybrid power systems – to research-focused projects in the application of fuel cells on small and medium sized drones. It is therefore the objective of this project to design a flying platform where to apply KTH-lead technology and validate its applicability. One of the key aspects in the airframe design lies in the integration of the fuel tanks containing pressurized hydrogen for the fuel cells.

Conclusion: Hydrogen has a high energy density, at the same time the density as a gas is very low, thus requiring special techniques to store it. One approach are cryonic tanks in which liquid hydrogen is stored at low temperature and low pressure. Another option are highly pressurized tanks, that do not require low temperatures. Structural cryonic hydrogen tanks were used for spacecrafts, for example by NASA. Pressurized hydrogen fuel tanks with a structural function haven't been used so far. Usually the tanks are built into an existing airframe.
For the Green Raven program, structural wing tanks were designed. An iterative approach using FEM analysis was performed. These tanks can withstand structural loads and also the internal pressure recieved from hydrogen. Situated in the wing, the tanks leave enough space in the central fuselage for payload and sensor equipment. Replacing the central spar in the wing, this solution contributes to saving weight.