MSc Thesis - 30-60hp

Conceptual design of compact heat exchanger technology for hydrogen fueled aircraft

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Background:
As industry is challenged to reduce CO_2 emissions from aviation by 75% in 2050, radical technology and new sustainable carbon free fuels are required. Hydrogen powered aviation is seen as a strategic way forward to achieve such ambitious goal. At Chalmers radical concepts for heat management in hydrogen powered gas turbine engines are being developed as part of a major European hydrogen project.
Liquid hydrogen is stored at cryogenic temperatures (-253 C) therefore requiring state-of-the-art fuel tank insulation technology, as well as the integration of heat-exchangers to warm up the hydrogen on its way to the combustion chamber. The combination of hydrogen high specific heat with cryogenic temperatures results in formidable cooling capacity, that can be explored by more compact heat-exchanger solutions.

Description:
In the proposed work the aerothermal performance of a compact vane integrated heat exchanger will be investigated. The heat exchanger can be integrated into one or various vanes that comprise the compression system and uses the existing vane surface to reject core heat to the hydrogen fuel, see Figure 1. Additional profiled plates can be added spanwise to increase the available surface area. The additional spanwise distributed plates (splitter-vanes) will lead to additional pressure losses in the engine core but can also be designed to enhance the radial turning capability of the vane. The enhanced radial turning capability is expected to allow for a reduction of engine length and weight by reducing the axial length of the transition S-duct between the low- and high-pressure compressors.

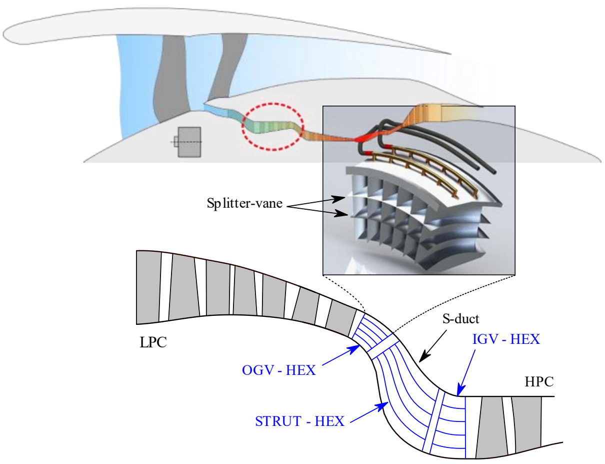

Figure 1: Concept of vane integrated HEX.

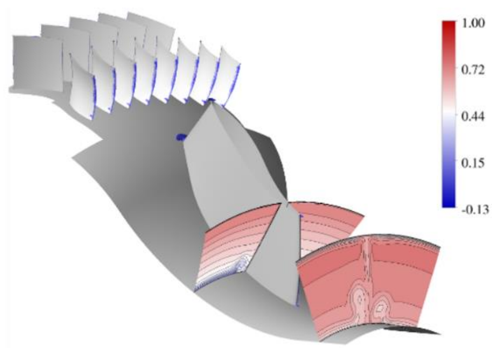

Figure 2. VINK compressor geometry.

The students should provide ingenious solutions on how to integrate the hydrogen distribution system in order to maximize heat transfer rate with minimum losses. The different concepts are expected to be evaluated with respect to mechanical design complexity; aerothermal performance; and operability. The work will be supported with CFD computations of an existing 3 stage compressor including transition duct, see Figure 2, to establish the system aerothermal performance. After completion the student is expected to be familiarized with complex heat transfer problems involving cryogenic fluids at sub-cooled or supercritical conditions.