Master Thesis – "Approximation of multiphase heat and mass transfer using a tuned single phase fluid approximation" (30 credits/20 weeks – x1 student)

About us

GKN Aerospace is the world's leading multi-technology tier 1 aerospace supplier. With 55 manufacturing locations in 15 countries, we serve over 90% of the world's aircraft and engine manufacturers. We design and manufacture innovative smart aerospace systems and components. Our technologies are used in aircraft ranging from the most used civil aircraft to the world's advanced 5th generation fighter aircraft and the Ariane orbital rockets used by ESA.

Project Background

High fidelity computational modelling of multiphase systems including heat and mass transfer typically require the solution of multiple systems of equations in a coupled fashion. Depending on the methods and degree of fidelity required, these systems of equations may include one or more equations for the turbulence characteristics, energy, mass and energy conservation equations of each phase. In cases where mass and energy are transferred between phases, coupling of the phases may be achieved through the manipulation of momentum and energy source and sink terms in between each phase. Further, depending on the nature of the physical mechanism through which the mass exchange occurs (evaporation, boiling, or condensation) complex submodels may be used to represent these processes. In totality, the net effect of this situation is that these simulations invariably become complex and oftentimes difficult to solve stabily (if at all) as well as very difficult to calibrate.

In response to these difficulties, a less physically accurate by simpler approach in which a single phase material with tuned temperature dependant properties (such as specific heat, viscosity and density) may be used to represent the change in the flow medium from one phase to another. As a result of the removal of the secondary phase, as well as the need to transfer energy and mass between different phases, a single phase tuned model is likely to be significantly faster, easier set up as well as easier to solve, whilst still providing accurate enough results to model many multiphase systems.

In this project, the student would be expected to review the current relavent literature (including open correlations from the literature) and then develop or determine a repsentative set of temperature dependant material properties to emulate experimental data provided by GKN Aerospace.

Assignment Description

Heat exchanger technology is becoming an increasingly important aspect of modern aircraft engine technology development. An example of this is SWITCH[1] WET[2] engine, which is a revolutionary concept in which the overall specific fuel consumption and thermal efficiency of the core engine cycle is enhanced through recovery of the waste engine heat normally exhausted in the engine exhaust. This project contributes to the overall technology development of such endevours by investigating computational methods for the modelling of the heat and mass transfer mechanisms which occur in such heat exchangers.

- Content and milestone
    - Review of existant literature including correlations for water boiling (vaporization)
    - Development of a tuned material model for a single fluid which mimics the vaporization process of water in a heated tube
    - Comparison with experimental results
- Deliverables
    - Technical report or similar detailing
        - Overview of existing correlations for the boiling process
        - Development of the tuned fluid model

---

[1] Sustainable Water-Injecting Turbofan Comprising Hybrid-Electrics
[2] Water Enhanced Turbofan

    - Demonstration of the approximated boiling process against experimental data
  - Presentation at GKN Aerospace

Qualifications

- Bachelors degree with strong interest in aerothermodynamics and / or computational mechanics

Apply by

Send your resume and cover letter including a brief description of previous engineering experience or interest to **Jonathan Bergh,** jonathan.bergh@gknaerospace.com & **Sonny Andersson**, sonny.andersson@gknaerospace.com.

Last date for application: **As soon as possible**

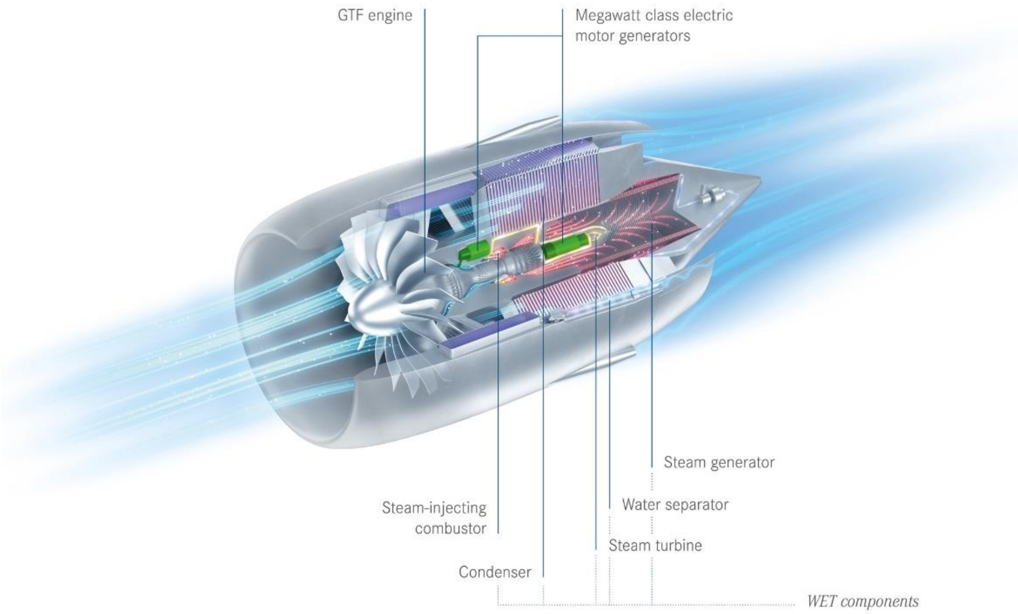
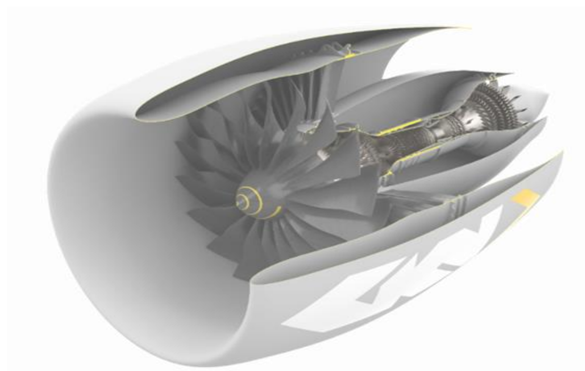


Figure 1 The SWITCH WET concept aero engine. Reproduced from [1].



[1] Henrich, I (2022). A brief guide: How the WET concept works. MTU Aeroreport, The Aviation magazine of MTU Aero Engines. Online: https://aeroreport.de/en/good-to-know/a-brief-guide-how-the-wet-concept-works. Last accessed: 05/07/2022