Universität Stuttgart
INSTITUT FÜR THERMODYNAMIK DER LUFT- UND RAUMFAHRT
Direktor: Professor Dr.-Ing. B. Weigand
Pfaffenwaldring 31, 70569 Stuttgart, Germany · http://www.itlr.uni-stuttgart.de

Bachelorarbeit / Masterarbeit

17/06/2025

CFD-Based Optimization of Advanced Dimpled Fin Channel Heat Exchangers for Aerospace Cooling Applications

Motivation:

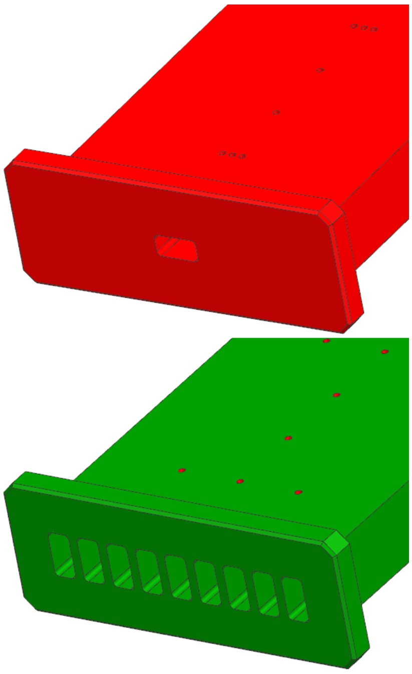

Fig. 1. Channel types

Fig. 2. Dimple fin types

Are you passionate about **fluid dynamics**, **heat transfer**, and solving real-world engineering challenges? Do you want to contribute to the next generation of **aerospace thermal management systems** while gaining hands-on experience with **state-of-the-art simulation tools** like ANSYS Fluent? If so, this thesis project presents a unique opportunity to immerse yourself in a cutting-edge research topic with high relevance to both academia and industry.

In the aerospace sector, the demand for **lightweight**, **high-efficiency**, and **compact** cooling systems is more critical than ever. The rising thermal loads in modern aircraft engine, aircraft electronics, and propulsion components call for **innovative heat exchanger designs** that go far beyond conventional systems. This thesis focuses on the investigation and optimization of **mini-channel heat exchangers enhanced with dimpled fins**, which are known for their ability to promote **vortex generation**, intensify **mixing**, and significantly improve **heat transfer performance** without excessive pressure loss.

The study will begin with a **single-channel simulation** to validate numerical accuracy and then extend to a **9-channel straight mini heat exchanger** configuration. You will analyse a wide variety of **dimple fin geometries**—including **spherical**, **elliptical**, **capsule**, and **teardrop**—to compare their performance under different **flow regimes** (laminar and turbulent), across a **Reynolds number range of 500 to 20,000**. After identifying the most promising geometry, further studies will vary **fin diameter** and **fin-to-fin spacing** to determine the **optimal configuration** for maximum thermal efficiency.

The outcomes of this work will not only deepen your understanding of **computational fluid dynamics (CFD)** and **convection enhancement techniques**, but also contribute valuable insights toward the development of next-generation aerospace cooling technologies.

This thesis is ideal for **ambitious and curious students**, especially those looking to combine theoretical insight with practical simulation expertise. If you are driven by innovation, fascinated by fluid behaviour, and excited about solving critical thermal design challenges, this is your chance to make a meaningful impact.

Work Plan / Research Plan:

- Literature Review
- Mesh Sensitivity Analysis and Parametric Setup on ANSYS Fluent
- Model Validation Using Benchmark Single-Channel Case
- Simulation of Multi-Channel Heat Exchanger (9 Channels)
- Systematic Evaluation of Dimple Fin Geometries
- Performance Metrics and Optimization
- Documentation and Presentation of Results

Research Site and Project Timeframe:

z.B.: Die Bachelor/Masterarbeit soll am Institut für Thermodynamik der Luft- und Raumfahrt durchgeführt und innerhalb eines Zeitraums von 4/6 Monaten abgeschlossen werden.

Examiner&Supervisor:

- Hayati Kadir Pazarlioglu, M.Sc., hayati-kadir.pazarlioglu@itlr.uni-stuttgart.de, Raum:1-16 Pfaffenwaldring 31,
- Prof. Dr.-Ing. habil. Bernhard Weigand, bernhard.weigand@itlr.uni.stuttgart.de