Subject title

Mixed convection for air cooling: identification, characterization et optimization

Keywords

Mixed convection, heat dissipator, geometric optimization, heat transfer intensification, experimental fluid mechanics.

Background and objectives

Mixed convection, a combination of natural and forced convection, is a fundamental phenomenon of heat transfer, as well as a promising solution for air cooling. This mode of transfer, if controlled precisely, makes it possible to take advantage of both the effects of buoyancy (natural convection) and the imposed flow (forced convection). It is particularly relevant for the cooling of electronic devices, characterized by increasing complexity and an increasingly high heat density to be evacuated. In this context, understanding and judicious exploitation of mixed convection mechanisms becomes crucial. This interdisciplinary field intersects fluid mechanics, heat transfer, and thermodynamic analysis, providing a nuanced perspective for the design and optimization of chillers, while seeking a balance between energy consumption and intensification of transfers.

This thesis aims to understand and master the fundamental phenomenon of mixed convection in order to intensify heat transfer on the one hand, and to design, optimize and develop innovative heatsinks for air cooling on the other hand, to ensure effective thermal management of electronic devices.

Proposed methodology

The planned research work encompasses several aspects, involving an interactive combination of theoretical analysis, numerical simulation, optimization algorithm, machine learning and experimentation.

1. *Fundamental part on the physical phenomena of mixed convection:* this part will particularly focus on the respective influence of the buoyancy effect and external forces. Starting from a simple geometry such as a cylinder or a heating plate with fins, the flow and heat transfer behaviors will be characterized. This will involve the use of existing devices such as a wind tunnel and optical measurement techniques (PIV, IR, even LIF)

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2. *Design and geometric optimization of an air cooler:* once the mixed convection phenomenon has been mastered, the study will move towards the design and geometric optimization of an air cooler using different optimization methods already developed at LTeN laboratory. Manufacturing, test bench setup, and experimental testing will showcase the superior cooling performance of this innovative and optimized cooler.

3. *Particular focus on the proposal of new prediction models, new evaluation criteria for mixed convection through a thermodynamic analysis:* the large quantity of data sets accumulated during prototype tests will be used to compare and explore the links inherent between the models and indicators proposed and those conventionally used, possibly using machine learning tools.

Candidate profile

The candidate must hold a Master's level diploma or equivalent in training including a significant part devoted to fluid mechanics and heat transfer. The bases must be solid, both on the theoretical, experimental and to a lesser extent numerical aspects.

He must demonstrate, through his experiences (internships, etc.) his ability to work on experimental subjects linked to these themes.

Experience in signal processing, image processing or physical modeling would be a plus.

Practical information

This thesis will take place at the **Laboratory of heat Transfer and Energy of Nantes** (LTeN) – UMR 6607 CNRS, Nantes University, within the TFSE team (Transfers in Fluids and Energy systems) lten.cnrs.fr

Start date: **autumn 2024**

Gross Salary: 2100 € monthly minimum, possibility of additional income (teaching)

Applications (detailed CV + cover letter + minimum L3, M1 and M2 report cards + possible reference letters) must be submitted before **July 12, 2024** on the SIS doctoral school website: https://theses.doctorat-bretagneloire.fr/sis/campagne-2024

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