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Belfort-Montbéliard

CSC Propostion thesis - UTBM

1 MISCELLANEOUS INFORMATION

1.1 TITLE

- Development of new metallic structures for highly efficient heat exchangers

1.2 KEY WORDS

- New metal structure, heat exchanger, numerical modeling, CFD, optimization

1.3 ADMINISTRATIVE INFORMATION

➔ Host laboratory/University	ICB UMR 6303, CNRS Université Marie et Louis Pasteur Université de Technologie de Belfort Montbéliard 90010 Belfort cedex
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2 THESIS PROPOSAL

2.1 PROJECT

This thesis aims to develop new metallic structures for thermal components. Increasing the heat transfer between a fluid and a thermal system can help for saving energy resources, preventing undesirable thermal degradation or improving the efficiency of thermal exchangers. Such achievements foster the research of manufacturable solutions. We suggest working in that direction. The PhD works will consist in finding various efficient structures that can improve the heat transfer between an incompressible fluid flow and structures. New structures will be designed and optimized depending on the conjugate heat transfer with the fluid. Velocities and temperatures profiles, Heat transfer and friction coefficients are analyzed for each studied structure. This work includes analytical approaches to find out objective functions we can rely on for a good parameter selection. The optimization task will be coupled with a Multiphysics simulation using finite element and/or finite volume codes (Comsol and Ansys softwares), and virtual tests will be performed to identify some optimal heat transfer devices with general guidance about both heating and flow conditions for an efficient conjugate heat transfer.

This research direction implies some pre-requisites in the field of mechanical engineering. The PhD candidate is expected to work with CFD analysis, convective heat transfer, mathematical modeling and optimization methods [1–10].

2.2 PROPOSED WORK PLAN

- Literature review and theoretical background
- Numerical simulations of 3D lattice structures
- Analysis of different lattice structures
- Experimental validation and application to heat exchanger
- Optimization of lattice system.

2.3 REFERENCES

[1] H. Benzenine, S. Abboudi, R. Saim. Effect of the presence of a shoulder on the thermal and dynamic structure of a laminar flow in an airplane solar collector. *Numerical Heat Transfer, Part B: Fundamentals*, Volume 77, 2020 - Issue 3.

[2] N. Lebaal, Y. Zhang, F. Demoly, S. Roth, S. Gomes, A. Bernard, Optimized lattice structure configuration for additive manufacturing, *CIRP Annals*. 68 (2019) 117–120.

[3] M. Ferhi, R. Djebali, S. Abboudi, H. Kharroubi. Conjugate natural heat transfer scrutiny in differentially heated cavity partitioned with a conducting solid using the lattice Boltzmann method. *J. Therm Anal Calorim.* 138, 3065–3088 (2019).

[4] N. Lebaal, Robust low-cost meta-modeling optimization algorithm based on meta-heuristic and knowledge databases approach: Application to polymer extrusion die design, *Finite Elements in Analysis and Design*. 162 (2019) 51–66.

[5] H. Benzenine, R. Saim, S. Abboudi, H. Oztop, N. Abu-Hamdeh. Three-dimensional analysis of heat transfer in a channel provided with solid baffle, single and double perforation: A heat exchanger application. *Int. Journal of Numerical Methods for Heat & Fluid Flow*, Vol. 30 No. 9, pp. 4267-4280.

[6] Haydn N.G. Wadleya and Douglas T. Queheillaltb Thermal Applications of Cellular Lattice Structures. *Materials Science Forum* Vols. 539-543 (2007) pp. 242-247, online at http://www.scientific.net.

[7] Tong Wu Joel Najmon, Andres Tova. Thermomechanical Topology Optimization of Lattice Heat Transfer Structure Including Natural Convection and Design Dependent Heat Source. *Proceedings of ASME 2019: IDETC/CIE 2019*. Anaheim, CA, USA

[8] Iga, A., Nishiwaki, S., Izui, K., Yoshimura, M., 2009. Topology optimization for thermal conductors considering design-dependent effects, including heat conduction and convection. *International Journal of Heat and Mass Transfer*, 52(11), pp. 2721–2732.

[9] Joo, Y., Lee, I., Kim, S. J., 2017. Topology optimization of heat sinks in natural convection considering the effect of shape-dependent heat transfer coefficient. *International Journal of Heat and Mass Transfer*, 109, pp.123–133.

[10] Wu, T., Tovar A.. Multiscale, thermomechanical topology optimization of self-supporting cellular structures for porous injection molds. *Rapid Prototyping Journal*. August 2018.

Skills required to apply

- Holder of a master's degree in computational mechanics or materials science.
- Strong skills in heat transfer and numerical modelling.
- Good level of English.
- Good communication skills (oral, written) and organizational skills.
- Good autonomy, ability to synthesize.
- Good team-working skills.