6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

Entropy Production in Near-Wall Turbulent Flow Inside a Generic Air-To-Air Plate Heat Exchanger

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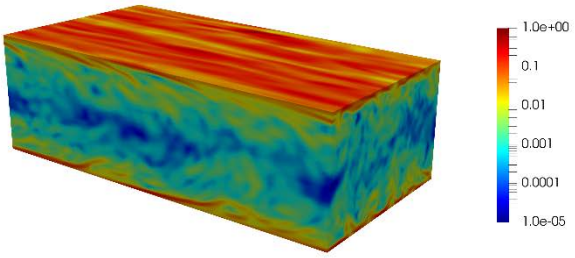
Key Words: *DNS, entropy production, generic plate heat exchanger, moderate Re-number.*

INTRODUCTION

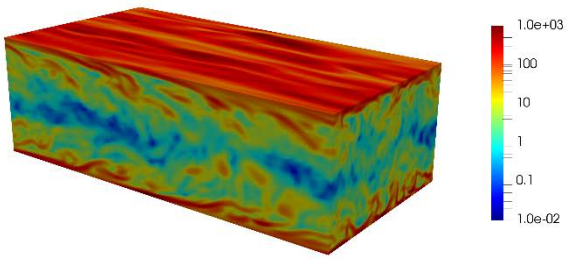
Although air-to-air plate heat exchangers are widely employed in air conditioning systems and waste heat recovery, very little is known about irreversibilities evolving in such thermal devices. Thermodynamic irreversibilities, which can be expressed by means of entropy production, manifest themselves essentially as a loss of degree of freedom in the description of the material behaviour, as well as in the turbulence structure of the heat and fluid flow [1,2] during thermo-fluid processes. The consideration of entropy production appears therefore useful to optimize thermal designs such as air-to-air plate heat exchangers. In the present work, a performance evaluation of a generic air-to-air plate heat exchanger based on local entropy production is conducted using direct numerical simulation technique by means of OpenFOAM 2.4.0. For that purpose, a plate heat exchanger is featured by a heated turbulent channel flow at moderate Re-number of 5500.

RESULTS AND CONCLUSION

From the entropy inequality equation, two main contributions of the entropy production are apparent and are shown in the figure below. It illustrates the instantaneous entropy production by viscous dissipation (left) and by heat transport (right).



Entropy production by viscous dissipation in W/m³K



Entropy production by heat transport in W/m³K

In terms of instantaneous entropy production rates, it appears, that entropy is primary generated by heat transport, while the contribution of viscous dissipation is negligibly small. Furthermore, entropy generations are high at the wall and appears small away from it. This suggests, that especially near-wall effects influence the performance of such thermo-fluid systems and might be of particular importance in the optimization of air-to-air plate heat exchangers.

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