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LOCAL THERMAL RESISTANCE METHOD: A COMPUTATIONAL HEAT TRANSFER METHOD FOR PRECISE ANALYSIS AND OPTIMISATION OF HEAT TRANSFER PROCESSES

Qiuwang Wang*, Shihong Ma, Xiangxuan Li, Ting Ma
Key Laboratory of Thermal-Fluid Science and Engineering, Ministry of Education,
School of Energy and Power Engineering, Xi'an Jiaotong University,
Xi'an, Shaanxi, 710049, China
*Correspondence author. Fax: +86 29 82663502 Email: wangqw@mail.xjtu.edu.cn

ABSTRACT Efficient energy systems are widely used in energy, power, petrochemical, metallurgy, refrigeration, aerospace and other fields. Developing advanced and efficient energy saving and storage technologies is urgent to achieve carbon neutrality. For energy systems, traditional design calculation often relies on the overall lumped parameter method, which will face problems such as hard to clearly show local characteristics and calculated difficulties in the analysis process. This report presents a local thermal resistance method, based on thermal resistance networks and thermoelectric analogy. The thermal resistance field is constructed by assigning the thermal resistance for discrete control units at points. From the energy transfer, the concept of multi-dimensional conduction-advection thermal resistance in parallel in fluid domain is proposed, and the conduction-advection thermal resistance network with heat capacity is constructed, which enables the integration of momentum and heat transfer in the fluid domain and explains the mechanism of local energy exchange. Meanwhile, the computational heat transfer expression for local thermal resistance is investigated. The relative relationship between thermal resistance and energy is investigated by order-of-magnitude analysis from the parallel thermal resistance analysis. Subsequently, based on analysing the relative magnitude of the thermal resistance distribution, a computational expression for the local thermal resistance is obtained. On this basis, typical heat transfer processes such as double-sided heat transfer are studied, and local thermal resistance analysis methods such as local thermal resistance ratio and local total thermal resistance are proposed. Afterwards, a large amount of data is further analyzed and fitted to construct a correlation equation between the local thermal resistance and the macroscopic parameters, which provides the means to guide the practical engineering applications. The conduction-advection parallel thermal resistance network is important to analyze the flow and heat transfer processes and guide the regulation and optimization of the heat transfer processes. The local thermal resistance method, on the other hand, achieves the accuracy of calculation and the simplicity of design from the computational heat transfer method, and provides the approach to realization for engineering applications. The thermal resistance adjustment principle based on the local thermal resistance method is an important guide for the accurate design of energy saving and storage devices.

Keywords: Heat transfer analysis and optimisation, Thermal resistance networks, Local thermal resistance, Computational heat transfer, Thermal resistance adjustment

SHORT BIOGRAPHY

Dr. Qiuwang Wang, Professor of School of Energy & Power Engineering, Dean of Department for Undergraduate Education, Executive Director of International Joint Research Laboratory of Thermal Science and Engineering, Xi'an Jiaotong University, China. He was a visiting scholar at City University of Hong Kong from May 1998 to March 1999, a guest professor at Kyushu University of Japan from September to December 2003, a senior visiting scholar at Rutgers, The State University of New Jersey, USA from December 2012 to June 2013, and a visiting professor at Nantes University of Frances from February to March 2024. His research interests include heat transfer enhancement and energy saving, energy storage fundamental and technology, heat transfer under extreme conditions, heat transfer in porous media, prediction and optimization of thermal and fluid problems. He is a Fellow of ASME, a China Delegate of Assembly for Intl Heat Transfer Conference (AIHTC), an executive member of Scientific Council of Intl Centre for Heat & Mass Transfer (ICHMT), a Vice President of Chinese Society of Engineering Thermophysics in Heat & Mass Transfer. He is the founding Editor-in-Chief of Energy Storage and Saving, the Associate Editor of International Journal of Heat and Mass Transfer, Heat Transfer Engineering, and Editorial Board Members for several international journals such as Renewable and Sustainable Energy Reviews, Energy Conversion and Management, Energy, Applied Thermal Engineering, etc. He is the founding chair of two international conferences: International Workshop on Heat Transfer Advances for Energy Conservation and Pollution Control (IWHT, since 2011) and the International Conference on Energy Storage and Saving (ICENSS, since 2022). He has also delivered more than 50 Invited/Keynote lectures in international conferences or foreign Universities. He has also been authors or co-authors of 4 books and more than 300 international journal papers. He has obtained more than 50 China Invent Patents and 5 US Patents.

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