PREFACE: PROGRESS IN HEAT TRANSFER ENHANCEMENT RESEARCH

Technological revolutions have increased the world's wealth to a level that was once unimaginable, but at the cost of accelerating climate change and ecological devastation. To limit global warming to between 1.5°C and 2.0°C, in line with the Paris Agreement, the world's greenhouse gas emissions must decline to net zero by 2050 and become negative in the second half of this century. Achieving this target will require a rapid and systemic transformation of the energy sector, starting with energy conservation and efficiency and the progressive replacement of fossil fuels with renewable energy. The adoption of more sustainable industrial practices and the penetration of renewable energy technologies currently appears to be more necessary than ever, owing to the imminent threats of global warming and depletion of natural resources. However, fossil fuels still represent about 80% of global energy production.

Increasing global energy needs, urbanization, and population growth are predicted to increase demand for fossil fuels by more than 25% compared to today's levels over the next two decades. Widespread deployment and mass-scale transfer of low-carbon technologies are needed. To this end, heat transfer enhancement technologies play a key role in the development of sustainable energy systems as well as in the reduction of emissions and pollutants. To a large extent, attempts to achieve high efficiency, low emissions, and low costs in various thermal processes and thermodynamic cycles will include heat transfer and heat exchangers. Sustainable energy development can be achieved by reducing final energy consumption, improving overall conversion efficiency and making use of renewable energy sources. To make the most of these resources, it is important to apply advanced heat transfer enhancement and heat exchanger technologies. Heat transfer enhancement technologies provide efficient, compact, and inexpensive heat transfer methods. To develop the next generation of heat transfer enhancement technologies, both experimental and theoretical investigations must be conducted.

Enhanced heat transfer plays a critical role in various industrial and civil applications such as thermal energy, power, electronics, automotive, process, heating, air-conditioning, ventilation and cooling systems, and so on. Techniques for enhancing heat transfer can be divided into passive, active, and compound methods. Passive methods do not require external power sources, such as special geometries, treated surfaces, extended surface (fins), rough surfaces, additives for fluid, and so on; whereas active methods require an external power source (electrical/mechanical) to enhance heat transfer, such as stirring of ferrofluids with an electromagnetic field, vibrating surfaces, and so on. Compound techniques combine both passive and active methods. In recent years, new techniques for enhancing heat transfer have appeared in engineering research, such as the addition of nanoparticles or porous medium, with high thermal conductivity, in working fluids to increase the thermal conductivity and convective heat transfer coefficients. Furthermore, many research activities on heat transfer have addressed microflow due to its new applications of microfluidic systems and components, such as biochemical cell reaction, micro-electric chip cooling, micro-channel heat exchangers, nozzles, diffusers, pumps, mixers, heat pipes, sensors, transducers, and actuators. Nowadays, a significant number of thermal engineering researchers are seeking new heat transfer enhancement methods for both traditional and emerging technology and applications.

To advance research in heat transfer enhancement, we have edited this special issue entitled “Progress in Heat Transfer Enhancement Research,” which reflects recent research in this important area. Five articles are included, covering various topics in experimental and numerical studies of heat transfer enhancement: (1) subcooled jet impingement boiling enhanced by porous surface with micro-column array; (2) numerical investigation of internal cooling enhancement with Coriolis force in rotating gas turbine blades; (3) enhanced uniformity of airflow and temperature distribution for produce cooling in a cold room based on the field synergy principle; (4) enhanced heat transfer and thermal performance factor of coiled wire inserted rGO/Co₃O₄ hybrid nanofluid circulate in a horizontal tube; and (5) experimental investigation of the influences of fluid properties on heat transfer for spray cooling.

We would like to express our great thanks to all authors and reviewers for their contributions to this special issue. We would also like to express our thanks to the Editor-in-Chief, Prof. Zhixiong Guo, for his great support. It is our great wish that this special issue provides advanced and innovative research, inspiration, and reference for future work in the field of heat transfer enhancement.

Guest Editors:

Dr. Lixin Cheng,
Department of Engineering and Mathematics,
Sheffield Hallam University, United Kingdom
E-mail: lixincheng@hotmail.com

Dr. Francesco Coletti,
Department of Chemical Engineering,
Brunel University London, United Kingdom