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RECENT TRENDS ON PRINTED CIRCUIT HEAT EXCHANGER DESIGN AND MANUFACTURING AND APPLICATIONS

Yitung Chen

Professor

Chair of the Department of Mechanical Engineering

University of Nevada-Las Vegas

ABSTRACT:

Recently, one type of heat exchangers with mini-flow channels, called the printed circuit heat exchanger (PCHE), has received considerable attention for its potential applications under ultra-high-temperature and high-pressure conditions. One typical feature is that the PCHE channels are manufactured by the photochemical etching technique, with hydraulic diameters of about 0.5~2.0 mm and compactness up to 2,500 m2/m3 for high heat transfer performance. The other typical feature is that the PCHE core is fabricated by the diffusion bonding technique, which can offer the joints with almost the same strength as the base or parent material. It has been reported that the PCHEs could withstand high temperature up to 900oC and high pressure up to 90 MPa. Due to these advantages, the PCHE has been considered as one of the most promising heat exchanger candidates for many high-temperature and high-pressure energy systems, such as high-temperature gas-cooled reactors, supercritical carbon dioxide (sCO2) Brayton power cycle, LNG floating production storage and offloading (FLNG) plants, and pressurized water reactors. However, there are still many challenges for wide applications of PCHEs in such high-temperature and high-pressure applications. This presentation gives a comprehensive on the latest research and development on the PCHEs, including the heat transfer and fluid flow, mechanical and thermal stress, flow maldistribution, structural and design optimization, experimental testing, machine learning (ML), and additive manufacturing. Finally, the challenges and developing trends of PCHE are discussed.

BIOGRAPHY:

Dr. Yitung Chen is Professor and Chair of the Department of Mechanical Engineering at the University of Nevada-Las Vegas (UNLV). He is an ASME Fellow. He received his Ph.D. degree from the Department of Mechanical Engineering at University of Utah in 1991. He also has a minor in nuclear engineering. He has extensive technical backgrounds of mechanical engineering, nuclear engineering, and chemical engineering. His academic and industrial experiences in numerical and experimental fluid mechanics and thermal-fluid sciences cover multidisciplinary areas of mechanical, nuclear, biomedical, environmental, and chemical engineering. His professional and scholarly developments are to establish the multidisciplinary advanced experimental and computational group includes fluid dynamics, heat transfer, mass transfer, computational mathematics and physics, electrochemical, and material sciences and engineering in order to solve the multi-scale and multi-physics engineering, science, and energy problems. He has received many awards including the Alex G. and Faye Spanos Distinguished Teaching Award which is the highest award of teaching at UNLV, the Barrick Distinguished Scholar Award which is the highest award of scholar at UNLV, and the "Eminent Engineer and Distinguished Professor of the Year 2012" of the Tau Beta Pi Honor Engineering Society, and the Outstanding Teacher Awards from Department of Mechanical Engineering and the Distinguished Researcher Award from College of Engineering during his tenure at UNLV. He has served as PI and Co-PI on many funded research projects. The research funding for various projects amounted to more than $16M from the U.S. government agencies and private sectors. Dr. Chen is co-author of three books "Computational Partial Differential Equations using MATLAB, 1st Ed. and 2nd Ed." and "Emerging Topics in Heat Transfer Enhancement and Heat Exchangers" and contributed 6 book chapters and he is author or co-author nearly 180 technical peer-review journals and 175 conference proceedings and 120 technical presentations in different fields that include computational fluid dynamics and numerical heat and mass transfer, finite element, finite volume, and meshless numerical techniques, lattice Boltzmann method, perturbation method, compressible flow simulation, nuclides atmospheric and environmental pollution modeling, nuclides contaminant groundwater flow, thermal system design, renewable energy, energy conversion, Gen IV advance pressurized water reactor, high temperature gas reactor, lead-bismuth reactor, and molten salt reactor designs and developments, advance nuclear fuel cycle, solar cell design using metamaterials, fuel cells, high temperature heat exchanger and decomposer design, corrosion and oxide layer growth modeling, solar and nuclear hydrogen production, and biomedical engineering. Both analytical/numerical studies and experimental studies are reported. He has also received the best paper award from ASME in 2008-2009. He was the President-elected of the Chinese in America Thermal Engineering Association (CATEA) in 2010. Currently, he is also the Director of Center for Energy Research (CER) at UNLV.