

**Proceedings of ASME  
2024 Heat Transfer  
Summer Conference**

**(HT2024)**

**July 15-17, 2024  
Anaheim, California**

**Conference Sponsor  
Heat Transfer Division**

**THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS**

© 2024, The American Society of Mechanical Engineers, 150 Clove Road, Little Falls, NJ 07424, USA  
(www.asme.org)

All rights reserved. “ASME” and the above ASME symbols are registered trademarks of the American Society of Mechanical Engineers. No part of this document may be copied, modified, distributed, published, displayed, or otherwise reproduced in any form or by any means, electronic, digital, or mechanical, now known or hereafter invented, without the express written permission of ASME. No works derived from this document or any content therein may be created without the express written permission of ASME. Using this document or any content therein to train, create, or improve any artificial intelligence and/or machine learning platform, system, application, model, or algorithm is strictly prohibited.

INFORMATION CONTAINED IN THIS WORK HAS BEEN OBTAINED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS FROM SOURCES BELIEVED TO BE RELIABLE. HOWEVER, NEITHER ASME NOR ITS AUTHORS OR EDITORS GUARANTEE THE ACCURACY OR COMPLETENESS OF ANY INFORMATION PUBLISHED IN THIS WORK. NEITHER ASME NOR ITS AUTHORS AND EDITORS SHALL BE RESPONSIBLE FOR ANY ERRORS, OMISSIONS, OR DAMAGES ARISING OUT OF THE USE OF THIS INFORMATION. THE WORK IS PUBLISHED WITH THE UNDERSTANDING THAT ASME AND ITS AUTHORS AND EDITORS ARE SUPPLYING INFORMATION BUT ARE NOT ATTEMPTING TO RENDER ENGINEERING OR OTHER PROFESSIONAL SERVICES. IF SUCH ENGINEERING OR PROFESSIONAL SERVICES ARE REQUIRED, THE ASSISTANCE OF AN APPROPRIATE PROFESSIONAL SHOULD BE SOUGHT.

ASME shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B7.1.3).  
Statement from the Bylaws.

For authorization to photocopy material for internal or personal use under those circumstances not falling within the fair use provisions of the Copyright Act, contact the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923, tel:978-750-8400, www.copyright.com.

Requests for special permission or bulk reproduction should be addressed to the ASME Publishing Department, or submitted online at: <https://www.asme.org/publications-submissions/journals/information-for-authors/journalguidelines/rights-and-permissions>

ISBN: 978-0-7918-8790-5

## TABLE OF CONTENTS

Heat Transfer Rate Analysis of Hydrogen-Enriched Internal Combustion Engine Under Different Load Conditions .....	1
<i>Muhammad Ihsan Shahid, Anas Rao, Muhammad Farhan, Yongzheng Liu, Ma Fanhua</i>	
Powering a TLUD Biomass Pyrolyzer Using its Own Waste Heat and Thermoelectric Devices.....	12
<i>Ziad Nasef, Nathan Nugen, Edbertho Leal-Quiros, Gerardo Diaz</i>	
Digital Twin Development of a R134a Plate-Tube Evaporator .....	20
<i>Ali Can Ispir, Michel Speetjens</i>	
Gas Species Separation of the Vortex Tube With Six Nozzle-Driven Vortex .....	31
<i>Ngoc Van Trinh, Quan Thien Phan Nghiem, Younghyeon Kim, Wansung Pae, Sangseok Yu</i>	
4E Assessment on Heat Transfer and Optimization of a Novel Cooling-Heating- Power Cogeneration Brayton System.....	37
<i>Yiming Wang, Gongnan Xie, Andrew Rowe</i>	
Advancement in Lithium-Ion Battery Pack Thermal Modeling Based on Electrochemical Principles .....	47
<i>Patryck Ferreira, Shu-Xia Tang</i>	
Carbon Emission Model of Power Industry Based on Life Cycle Perspective in China .....	56
<i>Yurong Zhao, Yahong Dong, Hong Cheng, Tarip Amin Khan, Wei Li, Jasim Mehmood</i>	
Alternative Design of Heat Exchange Systems Improves Power Plant Safety, Operability, Reliability, Cycle Efficiency, and Economics.....	63
<i>Richard Huntington, Loren Starcher, Susan Bradham</i>	
Analytical and Numerical Modeling of Thermal Transport in Liquid Hydrogen Tanks.....	71
<i>Charles Abdol-Hamid Owens, Hoyeon Park, Robert Joseph Flores, Luke Wentlent, Jack Brouwer, Jaeho Lee</i>	
Investigation of Liquid Cooling for Lithium-Based Batteries in Phase Change Materials Using Metal Foams: a Numerical Approach .....	81
<i>Aanandsundar Arumugam, Bernardo Buonomo, Oronzio Manca</i>	
Effect of Reactor Configuration on the Performance of a Closed Thermochemical Energy Storage System .....	91
<i>Akshay Chate, Kartik Jain, Susmita Dash, Pradip Dutta</i>	
A Comprehensive Thermodynamics Investigation of a Solar-Powered Hydrogen Production Plant.....	102
<i>Sulaiman M. Alsaleem</i>	
The Variation of Radiative Heat Loss As a Function of Actuation Angle for an Isothermal Square Twist Origami Radiator .....	112
<i>Mohammed Farhan Aziz Najeeb, Jeremy Price, David Warburton, Rydge Mulford</i>	
Flow and Heat Transfer Characteristics in Arrays of Stationary and Elastically Supported Cylinders .....	121
<i>Sanjeev Kumar, Md. Islam, Yap Yit Fatt, Isam Janajreh</i>	
Pressure Controlled Heat Pipe Based Heat Exchanger for Dynamic Process Heat Extraction Control for Nuclear Power Plants.....	128
<i>Sai Kiran Hota, Andrew Lutz, Srujan Rokkam, Calin Tarau</i>	

Convergent and Divergent Shell and Tube TES Partially Filled With PCM and Metal Foam .....	135
<i>Bernardo Buonomo, Maria Rita Golia, Oronzio Manca, Sergio Nardini, Renato Elpidio Plomitallo</i>	
Numerical Analysis Comparing the Thermal Performance of Two Solar Chimneys Combined With Thermal Energy Storage Made of Phase Change Materials Embedded in a Metal Foam .....	145
<i>Bernardo Buonomo, Tommaso Antonio Famoso, Maria Rita Golia, Oronzio Manca, Sergio Nardini, Renato Elpidio Plomitallo</i>	
Optimisation of Energy Usage in Some Senior High Schools in Tarkwa and its Environs .....	155
<i>Anthony Simons, Daniel Offei</i>	
Analysis of Building Cooling System's Load Under the Effect of the Phase Change Material-Based Thermal Energy Storage System .....	165
<i>Stuart McKenna, Peyton Clark, Soheil Omiddezyani, Krishna Shah, Forooza Samadi</i>	
Exploring the Energy and Exergy Performance of an Integrated Heat Recovery System in Aluminum Smelters Using a Parallel Two-Stage Organic Rankine Cycle .....	171
<i>Mostafa M. Abdelsamie, Mohamed Ibrahim Ali</i>	
Exergy Analysis on an Innovative Vapor-Compression Ejector Heat Pump Water Heater .....	176
<i>Jeremy Spitzenberger, Hongbin Ma</i>	
Determining the Thermal Properties of Insulating Material Intended for Steering Plasma Beams .....	185
<i>Robert L. McMasters, Ethan E. Keyser, Ralph B. Dinwiddie</i>	
Measurements of Heat Transfer in Flowing Granular Media .....	190
<i>Mohamed Alsharif</i>	
Thermal Transport Mechanisms in Lunar Regolith at Low and High Temperatures.....	200
<i>Jiahui Cao, Jaeho Lee</i>	
Thermal Conductivity of Advanced 3D Printed Polymers .....	208
<i>Cory Jacques, Todd Letcher, Gregory J. Michna</i>	
Improvement of a Low-Cost Apparatus for Measuring Thermal Conductivities of Solids at Steady-State .....	213
<i>Brandon Bunt, Kamau Wright, Benjamin Davis</i>	
Measuring Thermal Conductivity of Mycelium-Based Thermal Insulation Materials Produced With Locally Available Organic Waste Products As Substrate.....	224
<i>Brandon Bunt, Kamau Wright, Benjamin Davis</i>	
Experimental Investigation Into Combined Fluctuating Airflow and Mist Evaporative Cooling .....	233
<i>Jaafar Younes, Nesreen Ghaddar, Kamel Ghali</i>	
Generation of Controlled Single Bubbles for Phenomenological Study of Nucleate Boiling Using a Dual-Lens Laser Spot Heating Approach .....	241
<i>Salma Subhani, Jesus Fuentes, Karen Melendez, Eileen Lee, Michael Quintero, Navdeep Singh Dhillon</i>	
Prediction of Critical Heat Flux for Liquid Helium Using Machine Learning Models Assisted by Physics-Based Correlation.....	248
<i>Jiayuan Li, Chirag R. Kharangate</i>	

Exploration of the Effects of Nanoscale Surface Morphology Variations on Onset of Bubble Nucleation in Water Droplets Impinging and Boiling on Nanostructured Surfaces .....	258
<i>Anisa D. Silva, Van P. Carey</i>	
A Convolution Neural Network Design for Combined Image and Sensor Data Analysis to Determine Droplet Vaporization Regime and Heat Transfer Performance.....	268
<i>Ursan Tchouteng Njike, Anisa Silva, Van P. Carey</i>	
Inferring Flow Boiling Interfacial Shear Stress Using Physics Informed Neural Networks From Control Volume Models.....	280
<i>Logan M. Pirnstill, Chirag Kharangate</i>	
Numerical Study on Effect of Aspect Ratio in Natural Convection With Nanofluids in Vertical Channels Asymmetrically Heated .....	287
<i>Bernardo Buonomo, Oronzio Manca, Sergio Nardini, Gianluca Sarli</i>	
Creating Fluid Flow Through Bubble Squeezing in Tapered Microgap.....	297
<i>Maharshi Y. Shukla, Divyprakash Pal, Isaac Perez-Raya, Satish G. Kandlikar</i>	
Machine Learning Algorithms for Predicting Condensation Pressure Drop in Mini/Micro Channels .....	305
<i>Farshad Barghi Golezani, Jiayuan Li, Logan Pirnstill, Chirag Kharangate</i>	
Water Depth and Surface Area Extension Correlation Effect on Single Basin Solar Still.....	312
<i>Agboola Phillips</i>	
Choked Gas and Liquid Carbon Dioxide Flow Through Microchannels With Parallel Multi Orifices .....	321
<i>Soroush Niazi, Yoav Peles</i>	
Modeling Periodic Asymmetric Light Transmitting Nanostructures for Luminescent Solar Concentrators Using COMSOL Multiphysics Wave Optics Module .....	325
<i>Hannah Arnow, Vincent Oliveto, Duncan Smith, Michael Hughes, Diana-Andra Borca-Tasciuc</i>	
Simulation of Time-Domain Thermo-Reflectance Experiments Using the Anisotropic Fourier Heat Conduction Equation and the Phonon Boltzmann Transport Equation .....	332
<i>Siddharth Saurav, Sandip Mazumder</i>	
Transport and Flow Characteristics of Graphene-Doped Nanofluids at Moderate Temperatures in Double-Pipe Heat Exchangers.....	342
<i>Philip J. Gaudio, Jerome M. Skelly, Cy C. Yavuzturk, Andrew D. Chiasson, Drew W. Johnson</i>	
Advancements in Ni-P Plating Surfaces for Mitigating Crystallization Fouling in Microchannel Heat Exchangers.....	355
<i>Jia Sun, Wei Li, Biqi Cao, Jianxin Zhou, Zan Wu</i>	
CFD Modeling of End Effects of Gas Cooler Heat Exchanger for sCO <sub>2</sub> Power Blocks .....	364
<i>Vyas Duggirala, Venkata N. Hegde, Venkateswara Reddy, Pramod Kumar, Arun Muley</i>	
Fast Cooling Technology for Sample Stick in Top Loading Cryostats.....	374
<i>An Zou, Reese Davis, Dennis Winters, David Carlson, Daksh Adhikari, Patryk Radyjowski, Chien-Hua Chen</i>	
Design of Test Bench for the Analysis of Efficiency and Effectiveness of Extended Surfaces for Educational Purpose .....	380
<i>Freddy X. Jervis, Gabriela Cando, Daniel Moreira, Cesar Moreira, Gonzalo Zabala</i>	

Enhanced Heat Transfer Through Additively Manufactured Architected Lattice Frame Materials in SS316L and Ti-6Al-4V.....	389
<i>Youssef Aider, Inderjot Kaur, Shiraz Mujahid, YubRaj Paudel, Hongjoo Rhee, Prashant Singh</i>	
Pyrolysis and Heat Release Rate Predictions of Heated Solid Specimens in the OSU Apparatus .....	401
<i>Bakhtier Farouk, Garrett Cappello, Michael Burns</i>	
Study of Liquid Breakup Process in Solid Fuel Booster Rocket Chamber.....	409
<i>Ryo S. Amano</i>	
Numerical Analysis of Surface Coatings Performances for In-Flight Icing Device Performance Enhancement .....	417
<i>Giulio Croce, Nicola Suzzi</i>	
Heat Transfer Characteristics of Oscillating Electrohydrodynamic Liquid Flow .....	425
<i>Alexander J. Castaneda, Jamal Yagoobi</i>	
Examining the Symmetry of a Turbulent Wake Arising From Asymmetric Turbulent Shear Layers: An Experimental and Analytical Study .....	434
<i>Ladan Momayez, Marouen Dghim, Mohsen Ferchichi, Farhang Daneshmand</i>	
Comprehensive Analysis of Critical Heat Flux and Heat Transfers in a Confined Jet Impingement Boiling Cooling System .....	442
<i>Djamel Eddine Guerfi, Stephane Roux, Nadine Allanic, Alain Sarda, Damien Lecointe</i>	
Flow Boiling Heat Transfer Characteristics of R32 Outside Three-Dimensional Enhanced Tubes .....	452
<i>Chenglin Zhang, Wei Li, Xu Wang, David John Kukulka, Keshuai Ma, S. A. Sherif, Zepeng Wang</i>	
Heat Transfer Coefficients and Film Cooling Effectiveness on the Endwall of a Transonic Turbine Vane Measured With Binary Pressure Sensitive Paint.....	465
<i>Timothy A. Burdett, Lesley M. Wright</i>	
Effect of Blowing Ratio on the Film Cooling Effectiveness on a Flat Plate With Various Blockage Ratios.....	479
<i>Omar Deyab Aly, Lesley M. Wright, Ibrahim Hassan</i>	
Numerical Heat Transfer Analysis of NACA Pin-Fin Thickness .....	490
<i>Rutledge Fogel, Srinath V. Ekkad</i>	
Centrifugal Compressor Design Optimization for S R-30 Small Scale Gas Turbine Engine Using Numerical Simulations and Machine Learning Approach.....	501
<i>Sowmya Raghu, Jamil A. Khan</i>	
Modeling Microwave-Enhanced Chemical Vapor Infiltration Process for Preventing Premature Pore Closure .....	510
<i>Wenjun Ge, Vimal Ramanuj, Mengnan Li, Ramanan Sankaran, Ying She, Zisis Dardas</i>	
Distributed Single-Mode Optical Fiber High Temperatures Measurements.....	522
<i>Brian M. Hlifka, Edward C. Kinzel</i>	
Infrared Assisted Convective Drying of Moist Paper Handsheet: A Numerical Study.....	529
<i>Hanshen Yu, Jamal Yagoobi</i>	
A High-Power Volumetric Two-Photon Polymerization/Lithography Scheme Without Using Beam Splitters.....	538
<i>Aravind Jakkinaipalli, Sy-Bor Wen</i>	

Thermal Tensegrity.....	545
<i>Grace E. Conneely, Gary L. Kinzel, Thomas J. Juliano, Edward C. Kinzel</i>	
3D Printed Capillary-Driven Cold Plate for Hybrid Two-Phase Cooling System.....	550
<i>Mohammad Reza Shaeri, Maksym Demydovych</i>	
Thermal Management of SOI-Based Devices Using Holey Silicon-Based Lateral Thermoelectric Cooler.....	556
<i>Jiajian Luo, Jingjing Chen, Archana Venugopal, Jaeho Lee</i>	
Liquid Cooling of Li-Ion Cells Based on a Constructal Canopy-To-Canopy Approach .....	563
<i>Sahin Gungor, Erdal Cetkin, Sylvie Lorente</i>	
Analytical Study of the Thermal Performance for an Embedded Microfluidic Cooling System .....	570
<i>Jarred Wilhite, Chirag Kharangate</i>	
Review of Thermal Cooling of EV Batteries With Heat Pipes.....	575
<i>Anthony Dunn, Maryam Shafahi</i>	
Enhancing Thermal Performance in a PCM Heatsink Assembly By Incorporating Fins and Copper Oxide Nanoparticles .....	588
<i>Austin Jones, Jeff Darabi</i>	
Assessment of Optimal Fin Structure and Shroud Size in Fan-Cooled Heat Sinks for Next-Generation EV Battery Chargers .....	597
<i>Sahand Najafpour, Chris Botting, Majid Bahrami</i>	
Optimization of Thermal Management in Power Electronics by the Design of Split Channel Cooling Systems Through Numerical Simulations.....	604
<i>Hooman Taghavi, Sowmya Raghu, Jamil A. Khan</i>	
An Embedded Microfluidic Approach for Direct Cooling of Copper Windings in Printed Circuit Boards.....	614
<i>Daniel A. Moguel, Steven D. Pekarek, Justin A. Weibel</i>	
Local Variation of Heat Transfer for Laminar Flow Over a Finite Width Flat Plate .....	621
<i>Matthew E. Taliaferro</i>	
Modeling and Simulation of Aerodynamic Nosecone Ablation .....	633
<i>Iqbal Mehmedagic, Siva Thangam</i>	
Rapid Cooling Technology for Extreme Sample Environment Neutron Vacuum Furnaces .....	639
<i>Daksh Adhikari, Patryk Radyjowski, David Carlson, Reese Davis, An Zou, Parthib Rao, Chien-Hua Chen</i>	
Design of a Continuous Suspension Freeze Crystallizer for Desalination Brine Treatment.....	644
<i>Khadije El Kadi, Anas Al Aghbari, Isam Janajreh</i>	
Impact of Clean Energy on the Carbon Emission Structure of the Power Grid in China .....	651
<i>Xingsheng Li, Wei Li, Yahong Dong, S. A. Sherif</i>	
Coupled Flow and Thermal Radiation Simulation for Molten Salt Flow in Random Pebble Bed .....	658
<i>Haomin Yuan, Dezhi Dai, Yu-Hsiang Lan</i>	
Machine Learning Algorithm for Predicting Heat Transfer Coefficient and Pressure Drop in Dimpled Ducts.....	667
<i>Mohammad Reza Shaeri, Andoniaina M. Randriambololona, Daksh Adhikari</i>	

Design and Validation Strategy for an X-Ray Target Subject to Ultra-High Heat Flux Loading .....	674
<i>Mahadevan Ravichandran, Johanna Winter, Anton Dimroth, Stefan Bartzsch, Kim Melanie Kraus, Markus Zimmermann</i>	
A Model Reduction Method for Conduction-Based Thermal Analysis of a Complex System to Obtain an Equivalent Numerical Model .....	684
<i>Yener Usul, Emir Ozkokdemir</i>	
Temperature Field Reconstruction of Surfaces Heated Through Radiative Heat Transfer Using Convolutional Neural Networks .....	691
<i>Luiz C. Aldeia Machado, Victor Coppo Leite, Elia Merzari, Lesley Wright, Lander Ibarra, Roberto Ponciroli, Pramatha Bhat, Yassin Hassan</i>	
Effectiveness of Multi Baffles With Trefoils on the Performance of Shell and Tube Heat Exchanger .....	703
<i>Farhad Ali, Tariq Amin Khan, Zahid Ahmad Qureshi, Muhammad Muzafer, Wei Li</i>	
Flow Measurement Through Machine Learning: A Novel Non-Intrusive Volumetric Flow Meter.....	711
<i>Ramon Peruchi Pacheco da Silva, Forooza Samadi, Keith Woodbury, Joseph Carpenter</i>	
A Reproducible Molecular Dynamics Approach to Investigate the Thermal Conductivity of Al <sub>2</sub> O <sub>3</sub> Mono Nanofluid .....	717
<i>Araf Mim Ahmed Smrity, Peng Yin</i>	
Development of the Temperature Profile Optimization Method for Thermal Conditioning of Large Bodies.....	724
<i>Ramazan Aykut Sezmen</i>	
Two-Degrees of Freedom Flow-Induced Vibrations and Heat Transfer of Twin Cylinders in Tandem and Staggered Arrangements .....	728
<i>Ussama Ali, Md. Islam, Isam Janajreh</i>	
Influence of Stirring in Seawater Freeze Desalination Inside a Cooled Jacketed Crystallizer .....	735
<i>Hongtao Zhang, Symeon Savvopoulos, Md Didarul Islam, Isam Janajreh</i>	
Numerical Estimation of Heat Transfer Parameters: A Study on Inverse Methods in Combustion Chambers.....	744
<i>Meryem Tahan, Emir Ozkokdemir</i>	
Simulation of Supercritical Fluids With Reduced Domains In Horizontal Flows .....	751
<i>Devon Hardy, Marc Ricklick, Sandra Boetcher</i>	
Optimization of a Hybrid Thermal Protection System for Space Vehicles.....	762
<i>Syed Arafun Nabi, Hamidreza Najafi</i>	
Adaptive Determination of the Damping Coefficient of the Levenberg-Marquardt Algorithm Using Type-2 Fuzzy in Inverse Heat Transfer Problems.....	771
<i>Ramin Sajedi, Javad Faraji, Forooza Samadi, Farshad Kowsary</i>	
Recent Advancements in the Pressure Sensitive Paint (PSP) Technique for Film Cooling Effectiveness Measurements .....	781
<i>Lesley M. Wright, Je-Chin Han</i>	
Prediction of Airflow and Temperature Distribution in Data Centers With Focus on Containments .....	801
<i>Kailash Karki, Amir Radmehr, Suhas Patankar</i>	
Thermoelectric Waste Heat Recovery in a Concentric Tube Silencer for Automotive System .....	810
<i>Michael Lucidi, Bakhtier Farouk</i>	

## Author Index