## Proceedings of ASME 2021 International Mechanical Engineering Congress and Exposition

(IMECE2021)

Volume 11

November 1-5, 2021 Virtual, Online

Conference Sponsor
American Society of
Mechanical Engineers

Two Park Avenue \* New York, N.Y. 10016

© 2021, The American Society of Mechanical Engineers, 2 Park Avenue, New York, NY 10016, USA (www.asme.org)

All rights reserved. Printed in the United States of America. Except as permitted under the United States Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the publisher.

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: 978-0-7918-8567-3

## CONTENTS

Proceedings of ASME 2021 International Mechanical Engineering Congress and Exposition Volume 11	
Heat Transfer and Thermal Engineering	
Additively Manufactured Heat Transfer Equipment	
IMECE2021-68951	
IMECE2021-70712	
Development of a Topology-Optimized Structure for Electronics Cooling Under Natural Convection Conditions	
Yao Song See, Jin Yao Ho, Kai Choong Leong, and Teck Neng Wong	
Application of Machine Learning/Artificial Intelligence in Heat Transfer	
IMECE2021-70639	
Applications of Boiling and Condensation in Industrial Processes	
IMECE2021-72389	
Applications of Computational Heat Transfer	
IMECE2021-68479	
IMECE2021-69330	
Innovation in Hydrotesting Above Ground Pipes: Analytical Solution via Integral Transforms for Discerning Test Fluid Temperatures Subject to Ambient Temperature Variations Pedro A. Isaza and Kamal K. Botros	
IMECE2021-72390	
IMECE2021-72861	
A Comparative Study Between a Sharp and a Diffuse Topology Optimization Method for Thermal Problems  Marc-Étienne Lamarche-Gagnon, Farshad Navah, Florin Ilinca, Marjan Molavi-Zarandi, and Vincent Raymond	
IMECE2021-72916	

IMECE2021-73117
IMECE2021-73254
IMECE2021-73603
Combustion Power and Propulsion Systems
IMECE2021-70403
IMECE2021-70465
IMECE2021-73138
Computational Methods to Develop Ultra-Low/High Thermal Conductivity Materials
IMECE2021-72676
Computations of Thermophysical Properties
IMECE2021-71488
Jonathan Hammond, Chase McCreary, Armin Abbasalinejad, and Sun Ung Kim
Emissions Reduction Technologies
IMECE2021-71198
Evaporation and Condensation Fundamentals
IMECE2021-69545
IMECE2021-72622

Fundamental Processes - Laminar and Turbulent Reacting Flows
IMECE2021-69458
IMECE2021-73235
Fundamentals of Freezing/Melting
IMECE2021-69233
Casey J. Troxler, Thomas B. Freeman, Rafael M. Rodriguez, and Sandra K. S. Boetcher  IMECE2021-69669
Reciprocating Flow for Enhancing Thermal Performance of Latent Thermal Energy Storage Systems
Akashdeep Singh Virk, Chanwoo Park, Constandinos Mitsingas, and Chol-Bum Kweon
IMECE2021-71269
Fundamentals of Machine Learning Assisted Heat Transfer Processes
IMECE2021-71766
Fundamentals of Phase-Change (Boiling/Condensation) Including Micro/Nanoscale Effects
IMECE2021-69858
IMECE2021-70054
Enhanced Pool Boiling Critical Heat Flux on Tilted Heating Surfaces Using Columnar-Post Wicks Mohammad Borumand and Gisuk Hwang
IMECE2021-70949  Nanostructuring of Metallic Additively Manufactured Surfaces for Enhanced Jumping Droplet  Condensation  Jin Yao Ho, Kazi Fazle Rabbi, Soumyadip Sett, Teck Neng Wong, Kai Choong Leong, and Nenad Miljkovic
IMECE2021-72191
ma. Omaroany Bappy, raman rele, ribaan rele onavo, rana moronoa, and man our aan

IMECE2021-73084	V011T11A032
IMECE2021-73455	V011T11A033
IMECE2021-73853	V011T11A034
Fundamentals of Single-Phase Convection	
IMECE2021-69624	V011T11A035
IMECE2021-73293	V011T11A036
Heat and Mass Transfer in Heating, Cooling, and Power Systems	
IMECE2021-67784	V011T11A037
IMECE2021-69055	V011T11A038
IMECE2021-69088  Numerical Simulation of Impinging Slot Air Jet in the Presence of a Cross Flow  Abhay Gudi and Vijaykumar Hindasageri	V011T11A039
IMECE2021-70163	V011T11A040
IMECE2021-71084	V011T11A041
IMECE2021-71615	V011T11A042
IMECE2021-71627	V011T11A043
IMECE2021-71923	V011T11A044
IMECE2021-72073	V011T11A045
IMECE2021-72170	V011T11A046

IMECE2021-72960
IMECE2021-73190
Heat and Mass Transfer in the Natural and Built Environment
IMECE2021-66381
IMECE2021-69072
Heat Pipes
IMECE2021-73182
IMECE2021-73527
Heat Transfer Equipment in Electronics
IMECE2021-72040
Heat Transfer in Electronic Equipment
IMECE2021-68217
IMECE2021-70472
IMECE2021-71372
ma rrasi Saam, Hassan Sharmar Ayon, Tamma Mohammaa Mohas, aha Najmas Saquis Shar
Heat Transfer in Gas Turbines
IMECE2021-69405
IMECE2021-70168

IMECE2021-71713
and Infrared Thermometry
Nathan Humbert, Jack Galante, F. Todd Davidson, David B. Helmer, Christopher J. Elkins, Gunnar O. Tamm, and Michael J. Benson
IMECE2021-73135
Effect of Inlet Geometry on Flat Plate, Film Cooling Effectiveness From Shaped Holes Hanlin Wang and Lesley M. Wright
IMECE2021-73536
Analysis of Film Cooling Effectiveness on a Gas Turbine Blade With An Unsteady Wake Using Fast Response Pressure Sensitive Paint
Jeremy L. Sounik and Lesley M. Wright
Heat Transfer in Oales and Danswickle France Outland
Heat Transfer in Solar and Renewable Energy Systems
IMECE2021-67195
IMECE2021-69681
Irreversibility Analysis, Design, and Optimization of a Combined Hybrid Hot Air and Buoyant Gas
Balloon for Stratospheric Persistence  Michele Trancossi and Pascoa Jose
IMECE2021-71477
Heat Sink Optimization for Collection of Potable Water Using Renewable Energy
Luz A. Amaya and David J. Broderick
IMECE2021-72889
Manufacturing and Performance Assessment of Solar Photo-Voltaic Modules by Adopting Various Heat Dissipation Techniques: A Review
Abdul Subhan and Abdel-Hamid I. Mourad
IMECE2021-73008
Thermal Performance of a Packed Bed Latent Heat Thermal Energy Storage With Pure Silicon as
PCM Sumit Saha, Abu Raj Md. Ruslan, A. K. M. M. Morshed, and Titan C. Paul
IMECE2021-73089
The Encapsulation Effect on Thermal Performance of Micro-Encapsulated Phase Change
Materials During Energy Absorption  Jingru Z. Benner, Rebecca C. Shannon, Wentao Wu, Austen P. Metsack, Lu Shen, and
Jingzhou Zhao
Heat Transfer Under Extreme Conditions of Temperature and Pressure
IMECE2021-68974
Ultra-Cold Environments
Minghan Xu, Saad Akhtar, and Agus P. Sasmito
IMECE2021-70203
Numerical Analysis of Flow and Heat Transfer for Supercritical CO <sub>2</sub> and Liquid Sodium in
Semicircular Mini-Channels  Lei Qin, Gongnan Xie, and Shulei Li
IMECE2021-70869
Study on Convective Heat Transfer Characteristics of Supercritical CO <sub>2</sub> in Printed Circuit Heat
Exchanger Under Ocean Condition Shulei Li, Dechao Liu, Lei Qin, and Gongnan Xie
Shalet Li, Dechao Liu, Let Qili, and Gonghan Ale

Industrial and Applied Combustion Systems
IMECE2021-69702
Shiny Choudhury, Vincent G. McDonell, and Scott Samuelsen
IMECE2021-71770
Measurements of Thermophysical Properties
IMECE2021-72946
High Temperature LVDT Design and Modeling Yuan Gao, Heng Ban, and Austin Fleming
IMECE2021-73000
Ezekiel Villarreal, Nicolas Horny, and Heng Ban
IMECE2021-73381
Methods in Computational Heat Transfer
IMECE2021-71748
Modeling and Simulation Methods
•
Modeling and Simulation Methods  IMECE2021-69509
IMECE2021-69509
IMECE2021-69509
IMECE2021-69509  Closed Greenhouse Heating in an Arid Egyptian Winter Using Earth-Air Heat Exchangers  Anwar Hegazy, Alison Subiantoro, and Stuart Norris  IMECE2021-69657  Neural Differential Equations for Inverse Modeling in Model Combustors  Xingyu Su, Weiqi Ji, Long Zhang, Wantong Wu, Zhuyin Ren, and Sili Deng
IMECE2021-69509
IMECE2021-69509  Closed Greenhouse Heating in an Arid Egyptian Winter Using Earth-Air Heat Exchangers  Anwar Hegazy, Alison Subiantoro, and Stuart Norris  IMECE2021-69657  Neural Differential Equations for Inverse Modeling in Model Combustors  Xingyu Su, Weiqi Ji, Long Zhang, Wantong Wu, Zhuyin Ren, and Sili Deng  IMECE2021-70373  Modeling and Simulation of Convective Heat Transfer Caused by a Rotating Disk  David Ruiz, Donald Mueller, and Hosni Abu-Mulaweh  IMECE2021-70529  Performance Analysis of a Travelling-Wave Thermo-Acoustic Engine Using Artificial Neural
IMECE2021-69509 . V011T11A077  Closed Greenhouse Heating in an Arid Egyptian Winter Using Earth-Air Heat Exchangers  Anwar Hegazy, Alison Subiantoro, and Stuart Norris  IMECE2021-69657 . V011T11A078  Neural Differential Equations for Inverse Modeling in Model Combustors  Xingyu Su, Weiqi Ji, Long Zhang, Wantong Wu, Zhuyin Ren, and Sili Deng  IMECE2021-70373 . V011T11A079  Modeling and Simulation of Convective Heat Transfer Caused by a Rotating Disk  David Ruiz, Donald Mueller, and Hosni Abu-Mulaweh  IMECE2021-70529 . V011T11A080  Performance Analysis of a Travelling-Wave Thermo-Acoustic Engine Using Artificial Neural  Network
IMECE2021-69509 Closed Greenhouse Heating in an Arid Egyptian Winter Using Earth-Air Heat Exchangers Anwar Hegazy, Alison Subiantoro, and Stuart Norris  IMECE2021-69657 Neural Differential Equations for Inverse Modeling in Model Combustors Xingyu Su, Weiqi Ji, Long Zhang, Wantong Wu, Zhuyin Ren, and Sili Deng  IMECE2021-70373 V011T11A079  Modeling and Simulation of Convective Heat Transfer Caused by a Rotating Disk David Ruiz, Donald Mueller, and Hosni Abu-Mulaweh  IMECE2021-70529 V011T11A080  Performance Analysis of a Travelling-Wave Thermo-Acoustic Engine Using Artificial Neural Network M. Ngcukayitobi, L. K. Tartibu, and F. C. Bannwart
IMECE2021-69509 . V011T11A077  Closed Greenhouse Heating in an Arid Egyptian Winter Using Earth-Air Heat Exchangers  Anwar Hegazy, Alison Subiantoro, and Stuart Norris  IMECE2021-69657 . V011T11A078  Neural Differential Equations for Inverse Modeling in Model Combustors  Xingyu Su, Weiqi Ji, Long Zhang, Wantong Wu, Zhuyin Ren, and Sili Deng  IMECE2021-70373 . V011T11A079  Modeling and Simulation of Convective Heat Transfer Caused by a Rotating Disk  David Ruiz, Donald Mueller, and Hosni Abu-Mulaweh  IMECE2021-70529 . V011T11A080  Performance Analysis of a Travelling-Wave Thermo-Acoustic Engine Using Artificial Neural  Network
IMECE2021-69509 V011T11A077 Closed Greenhouse Heating in an Arid Egyptian Winter Using Earth-Air Heat Exchangers  Anwar Hegazy, Alison Subiantoro, and Stuart Norris  IMECE2021-69657 V011T11A078  Neural Differential Equations for Inverse Modeling in Model Combustors  Xingyu Su, Weiqi Ji, Long Zhang, Wantong Wu, Zhuyin Ren, and Sili Deng  IMECE2021-70373 V011T11A079  Modeling and Simulation of Convective Heat Transfer Caused by a Rotating Disk  David Ruiz, Donald Mueller, and Hosni Abu-Mulaweh  IMECE2021-70529 V011T11A080  Performance Analysis of a Travelling-Wave Thermo-Acoustic Engine Using Artificial Neural Network  M. Ngcukayitobi, L. K. Tartibu, and F. C. Bannwart  IMECE2021-73359 V011T11A081  A High-Order Spectral Difference Solver for 2D Ideal MHD Equations With Constrained Transport
IMECE2021-69509
IMECE2021-69509
IMECE2021-69509

Panel on Thermal Engineering at Extreme Conditions
IMECE2021-68924
Dong-Ming Mo, Li Zhang, Deng-Fang Ruan, and You-Rong Li
Porous Media Based Heat and Mass Transfer Equipment
IMECE2021-68157
Thermal Transport Across Interfaces
IMECE2021-69159
IMECE2021-70349
IMECE2021-70556
IMECE2021-73012 Thermal Circuit Analysis of Droplet Evaporation on Hot Microstructured Superhydrophobic Surfaces Wenge Huang, Xukun He, and Jiangtao Cheng
Transport Phenomena in Manufacturing and Materials Processing
IMECE2021-68987