Udit Sharma

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EDUCATION

PhD
Aug 2017-July 2024
Michigan Technological University, Houghton, MI, USA
Mechanical Engineering-Engineering Mechanics
Modelling the Impact of Thermophoresis on Nanoparticle Distribution in Nanofluid with Phase Change Material as Basefluid

MS, Thesis
Aug 2015- May 2017
Michigan Technological University, Houghton, MI, USA
Mechanical Engineering-Engineering Mechanics
A Study of High Temperature Heat Pipes and the Impact of Magnetic Field on the Flow of Liquid Metal

B.Tech
Sep 2009 - June 2013
Moradabad Institute of Technology, Moradabad, India
Mechanical Engineering
Fabrication of Pedal Operated Juicer.

RESEARCH EXPERIENCE

PhD RESEARCH
2017-present
STUDY OF NANOPARTICLE DISPERSED PHASE CHANGE MATERIALS AND THE IMPACT OF TEMPERATURE GRADIENT ON THE POTENTIAL FOR PARTICLE MIGRATION

- Provide insights into optimizing nanofluid design for maximum thermal performance enhancements
- Hypothesize that nucleating sites may migrate under temperature gradients due to thermophoresis, leading to one part of the system becoming nucleation-free
- Model the migration of nucleating sites by replacing clusters with nanoparticles
- Investigate how the degree of supercooling changes with the number of phase change cycles
- Attribute the increase in supercooling to the movement of nucleating sites under temperature gradients
- Replace nucleating site clusters with nanoparticles to model the behavior
- Analyze the impact of factors such as nanoparticle material composition, size, volume fraction, temperature, and base fluid properties on thermal conductivity enhancement
- Explore the interplay between nanoparticle Brownian motion and thermophoresis, which affects particle distribution and thermal conductivity
- Present numerical models based on the Suratman number to characterize interfacial phenomena and predict nanoparticle migration patterns driven by thermophoresis
- Introduce the concept of a critical Suratman number to determine whether nanofluids will develop concentration gradients or remain uniformly dispersed
- Examine the role of Kapitza resistance at the solid-liquid interface in limiting heat transfer across nanoparticle surfaces

MASTER'S RESEARCH

2015-2017

A Study of High Temperature Heat Pipes and the Impact of Magnetic Field on the Flow of Liquid Metal

- Investigate high-temperature heat pipes (HTHPs) and their behavior under magnetic fields, focusing on liquid metal circulation
- Analyze the impact of magnetic fields, heat flux, and temperature on HTHP performance
- Highlight that magnetic fields reduce pumping capacity due to a pressure drop caused by the Lorentz force on the conductive liquid metal
- Explore the relationship between flow effects using dimensionless numbers like Hartmann number and Reynold's number
- Propose a mathematical model showing that a non-uniform magnetic field, specifically one that varies exponentially along the heat pipe's length, can potentially enhance the heat transfer capability of HTHPs

OTHER RESEARCH PROJECTS

- **NASA's Water Extraction from Moon using Water Jet Machining**(May 2018 - December 2018)
  - The high-pressure water jet is used to disaggregate and mobilize material from the regolith surface, creating a slurry of regolith particles and water.
  - The collected slurry is dried up and analyzed for the amount of water content.
  - The study focuses on efficient water extraction by optimizing nozzle size and incident angle.
  - Building upon this research, the current investigation shifts its attention to studying the phase transitions of solidified ice under high heat flux conditions.
  - To achieve this, a thermal probe is utilized for precise temperature measurements, enabling a detailed examination of how ice behaves under intense thermal conditions.
  - This research contributes to a deeper understanding of thermal dynamics in environments relevant to lunar and planetary surfaces, offering insights that could inform future space exploration missions.
- **Investigation of Heat Transfer Enhancement using Piezoelctric Materials**(May 2021 - April 2022)
  - An investigation was conducted into enhancing heat transfer in boiling using piezoelectric materials.
  - The approach involved inducing vibrations in the channel mesh at its resonance frequency.
  - By varying the frequency and amplitude of the vibrations, the study aimed to observe any enhancement in heat transfer.
  - High-speed cameras and microscopy were employed to visualize the effects on the boiling process.
  - The experiments utilized HFE-7100 and water as the test fluids, with the mesh consisting of 100 mesh copper wire with a 0.11mm opening.
- **Evaluation of Photovoltaic Battery and Combined Heat and Power (PV-B-CHP) for Residential Applications**(Course: Special Topic 1, Spring 2016)
  - An LCOE (Levelized Cost of Energy) study was conducted to assess the feasibility of integrating photovoltaics (PV), batteries, and Combined Heat and Power (CHP) systems for residential applications.
  - Three locations were selected to represent different climatic conditions: Houghton (cold), St. Louis (intermediate temperature), and Austin (hot temperature).
  - The system primarily relied on PV generation, with excess energy stored in the battery.

  - The CHP system was designed to activate when the battery's State of Charge (SOC) dropped below 50%, providing additional power generation.
  - Both the thermal and electrical demands of each location were taken into account to calculate the LCOE, providing valuable insights into the economic viability of such integrated systems in diverse environments.
  - The analysis was done using Simulink and Matlab.

- **Economics and Comparison of Natural Gas Combined Power Plant with Steam and Nuclear Power Plant**(Course: Special Topic 2, Spring 2016)
  - This work compared natural gas, steam, and nuclear power plants in terms of their economics, environmental impact, and efficiency.
  - Natural gas combined-cycle plants are highlighted for their low construction and operational costs, quick installation, and lower emissions compared to steam and nuclear plants.
  - Steam power plants have higher initial costs and longer construction times, while nuclear plants require significant upfront investments but have low fuel costs in the long run.
  - Environmental impact analysis shows natural gas plants produce fewer emissions, steam plants emit pollutants contributing to air pollution, and nuclear plants generate radioactive waste.
  - In terms of efficiency, natural gas plants are highly efficient, followed by steam plants and then nuclear plants.
  - The choice of power plant depends on factors like fuel availability, regulatory environment, and long-term energy strategy.

- **Exploration of Feasibility of MagnetoHydroDynamic (MHD) in Conjunction with Gas Turbine Power Plant**(Course: MEEM 5290, Fall 2015)
  - This study investigated the potential benefits of integrating MagnetoHydroDynamic (MHD) technology with gas turbine power plants to enhance efficiency and performance.
  - The feasibility of integrating an MHD system with a combined Brayton/Rankine cycle power plant was examined using theoretical calculations and experimental data.
  - The MHD system utilized CsOH as a seeding material, and the enthalpies of the flue gas at various temperatures were determined using data from the MHD Symposium.
  - The integration of the MHD system was found to increase the efficiency of the combined cycle plant by 17.73
  - The study recommended further research to optimize seeding materials, explore alternative ionization methods, and optimize MHD generator size.
  - Additionally, applying MHD to other power plant cycles was suggested as a potential avenue for improving efficiency.
  - The study concludes that integrating an MHD system with a combined cycle plant is feasible and could significantly enhance efficiency and power output.

TEACHING EXPERIENCE

Lead Graduate Teaching Assistant(Mechanical Engineering Practice 2)
Fall 2019 - Spring 2023, Spring 2024
Recent Evaluation Ratings: 4.85/5 (Sp 2024), 4.98/5 (Sp 2023), 4.3/5 (Fall 2022), 4.35/5 (Sp 2022)
Michigan Technological University
Mechanical Engineering-Engineering Mechanics

- Developed and maintained the laboratory for testing and simulating dynamic mechanical, thermal, and fluid systems

- Conducted training sessions for new Graduate Teaching Assistants (GTAs) on course guidelines, equipment operation, and grading procedures
- Oversaw the assessment of individual and group assignments, including the development of grading criteria
- Managed the procurement of laboratory equipment and resources

Instructor(Introduction to Manufacturing)
Fall 2023
Evaluation Ratings: 4.3/5
Michigan Technological University
Mechanical Engineering-Engineering Mechanics

- Introduced students to diverse manufacturing processes, including deformation, subtractive, additive, and molding techniques
- Implemented inclusive learning strategies such as flipped learning and active learning, incorporating videos for illustration
- Utilized relatable examples and live demonstrations to enhance comprehension
- Presented case studies to illustrate practical relevance and connect theoretical concepts to real-world applications

Graduate Teaching Assistant(Mechanical Engineering Practice 2)
Fall 2017 - Spring 2019
Evaluation Ratings: 4.1/5 and 4.55/5 (Sp 2019), 4.1/5 and 3.2/5 (Sp 2018), 4.0/5 and 3.3/5 (Fall 2017)
Michigan Technological University
Mechanical Engineering-Engineering Mechanics

- Conducted two lab sessions for Mechanical Engineering Practice 2, each with approximately 16 students
- Responsible for grading individual and team assignments and assisting with team-related issues
- Primarily used MATLAB for data processing and debugging students' code

Mentoring, Senior Design and others(2015-Present)

- Actively contributed to the development of senior design projects for undergraduate students at Michigan Tech
- Provided mentorship on problem-solving approaches and assisted in setting up experiments
- Aided in equipment procurement and supported the modeling process for their concepts
- Guided students on design concepts, including flow measurement using orifice, nozzle, or MAF sensors
- Mentored students regarding their career paths, including writing recommendation letters and facilitating their involvement in faculty research projects
- Provided support during challenging times in their curriculum

AWARDS, HONORS AND FELLOWSHIPS

Finishing Fellowship
Year: 2024
Michigan Technological University
Houghton, MI

Midwestern Association of Graduate School (MAGS) Teaching Reward, Nomination from the department

Year: 2023
Michigan Technological University

Distinguished Department Teaching Fellowship
Year: 2023
Michigan Technological University
Houghton, MI

3 Minute Thesis (3MT), 3rd position
Year: 2022
Michigan Technological University

Outstanding Graduate Teaching Assistant
Year: 2020
Michigan Technological University

Outstanding Alumni
Year: 2014
Moradabad Institute of Technology

CERTIFICATIONS

Leadership Development Series
Year: 2023-present
Michigan Technological University

The Inclusive STEM Teaching Project
Year: 2024
University of Wisconsin

Becoming a Successful Leader (Inclusive Leadership Training)
Year: 2024
CATALYSTX

Fundamentals of Macroscopic and Microscopic Thermodynamics
Year: 2022
University of Michigan

Python for Everybody
Year: 2020
University of Michigan

Machine Learning using MATLAB
Year: 2020
Mathworks Limited

Proposal Experience

F.5 Future Investigators in NASA Earth and Space Science and Technology as

Fundamental Investigator (FI)
This proposal responds to NASA's FINESST Appendix F.5., §2.5 BPS Research Program, aiming to explore fundamental fluid physics processes in reduced gravity space exploration systems. It focuses on understanding phase-change nucleation and thermophoresis during thermal energy storage, crucial for terrestrial and space-based thermal management. Phase Change Materials (PCMs) are key to this research, offering benefits including physical and chemical stability, improved thermal behavior, and environmental safety. NASA's interest in using PCMs for thermal management in power electronics and heat rejection/storage underscores the importance of this research. The proposal also explores the concept of thermophoresis, which has potential in microgravity research, aligning with NASA's interest in understanding nonequilibrium structure formation and temperature gradient effects. This work sims to significantly impact spacecraft thermal management, with applications ranging from small satellites to future Mars rovers and lunar surface missions.

Professional Experience

Software Engineer
March 2014-May2015
Tata Consultancy Services, India

- In this role, for our client Royal Bank of Scotland, the focus was on banking and financial services, including outsourcing customer services and data encryption.
- Proficiency in Sequence Query Language (SQL), Common Business Oriented Language (COBOL), and data management was crucial for handling various aspects of financial operations and customer interactions.
- The position involved ensuring the security and integrity of sensitive financial data, as well as efficient management of databases and customer information.

Teaching Courses

Expertise
Engineering Thermodynamics, Non-equilibrium Thermodynamics, Heat Transfer, Fluid Mechanics, Two Phase Flow, Experimental Methods

Other Courses able to Teach
Computational Fluid Dynamics, Compressible Flow and Gas Dynamics, Principles of Energy Conversion, Viscous Fluid Flow, Continuum Mechanics, Capillary and Porous Media, Manufacturing, Material Science

PROFESSIONAL SKILLS

Thermodynamics and Heat Transfer
Numerical and Analytical Modelling, Non-equilibrium, Statistical, Advanced Thermodynamics, Entropy Analysis, Energy Storage, Phase Change Mechanisms, Microfluidics

Imaging and Software
High Speed Camera Imaging, Stereo Microscopy, MATLAB, LateX, EES (Engineering Equation Solver), LabVIEW.

PUBLICATIONS

Manuscript in Submission

- An Analytical Examination of Thermophoresis Effects on Nanofluid Thermal Conductivity (Journal of Colloid and Interfacial Science)
- Numerical Modelling of the Nanoparticle Distribution Pattern in Nanofluid
- Numerical Modelling of the Particle Distribution Pattern in Phase Change Material Dispersed Nanoparticles

Conference Proceedings

- Sharma, U., & Allen, J. (2024). Modeling Thermophoresis in Nanofluids. Proceedings of the Thermal and Fluids Engineering Summer Conference, 2024-April.(Accepted)
- Sharma, U., & Allen, J. (2022). Role of thermophoresis on binary phase change materials for thermal energy storage. Proceedings of the Thermal and Fluids Engineering Summer Conference, 2022-May, 383-389.

Oral Presentations/ Campus Talks

- Sharma, U., & Allen, J. (2024). Modelling Thermophoresis in Nanofluids. ASTFE, 2024-April, Portland, OR [Peer Reviewed]
- Sharma, U.(2024). Understanding Particle Distribution in Nanofluids due to Thermophoresis. Midwest Universities Fluid Mechanics (MUFMECH) Retreat 2024-April.
- Sharma, U. & Allen, J. (2024). Thermophoresis in Nanoparticle Loaded Phase Change Materials. American Society of Mechanical Engineers, *Summer Heat Transfer Conference*, 2023-July.
- Sharma, U.(2023). Thermophoresis in Nanoparticle Dispersed Phase Change Materials for Thermal Energy Storage. Midwest Universities Fluid Mechanics (MUFMECH) Retreat 2023-April.
- Sharma, U., & Allen, J. (2022). Role of Thermophoresis on Binary Phase Change Materials for Thermal Energy Storage. ASTFE, Las Vegas, NV.[Peer Reviewed]

Other Presentations

- Sharma, Udit, and Jeffrey S. Allen. "Thermophoresis in Thermal Energy Storage."Graduate Research Colloquium ,MTU, 2023, Houghton, MI.[Oral]
- Sharma, Udit, and Jeffrey S. Allen. "Role of Thermophoresis on Binary Phase Change Materials for Thermal Energy Storage."Graduate Research Colloquium,MTU, 2022, Houghton, MI. [Oral]
- Sharma, Udit, and Jeffrey S. Allen. "Role of Thermophoresis on Binary Phase Change Materials for Thermal Energy Storage."3 Minute Thesis,MTU, 2022, Houghton, MI. [Oral, 3rd Position]
- Sharma, Udit, and Jeffrey S. Allen. "Thermophoresis in Binary Phase Change Materials"3 Minute Thesis,MTU, 2021, Houghton, MI. [Oral]

REFERENCES

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