

Kashif Nawaz

Dr. Nawaz is a distinguished researcher in fundamental and applied energy conversion science and technology. He is widely recognized for his contributions to various aspects of industrial process heat, as well as building heating, cooling, and dehumidification systems. His expertise includes novel heat exchangers, enhanced phase change processes using additive manufacturing, and advancements in porous media and surface morphology. Dr. Nawaz has pioneered the development of a new generation of high-temperature heat exchangers, utilizing ceramics and composites through additive manufacturing. His research has also led to unique concepts for direct air capture of carbon dioxide, integrated within existing building infrastructure. Additionally, Dr. Nawaz has played a crucial role in the research and deployment of high-temperature heat pumps and the development of ultra-low Global Warming Potential (GWP) refrigerants, making significant strides toward more sustainable energy solutions.

Education

- Ph.D., Mechanical Engineering, 2013, University of Illinois at Urbana Champaign
- M.S., Mechanical Engineering, 2010, University of Illinois at Urbana Champaign.
- BS, Mechanical Engineering, 2007, Ghulam Ishaq Khan Institute of Science and Technology, Pakistan

Employment History

- Distinguished Research Staff and Section Head, Building Technologies Research, ORNL, Oak Ridge, TN (12/22–present)
- Sub-Program Manager, Cross-sector Technologies for Decarbonization, ORNL, Oak Ridge, TN (01/21–present)
- Group Leader, Multifunctional Equipment Integration, ORNL, Oak Ridge, TN (10/20–06/2024)
- Research Scientist, Building Equipment Research, ORNL, Oak Ridge, TN (8/16–10/20)
- Senior Heat Transfer Engineer, Heat Transfer Center of Excellence, Johnson Controls Inc. Norman, OK (9/13–7/16)
- Lecturer and Research Staff, Aerospace and Mechanical Engineering, University of Oklahoma, Norman, OK (1/14–7/16)
- Graduate Research Assistant, Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, Urbana, IL (8/08–8/13)

Honors and Awards

- Fellow American Society of Heating, Refrigerating and Air-Conditioning Engineers (2024)
- Fellow American Society of Mechanical Engineers (2024)
- R&D 100 Award “MBE-DAC: Multifunctional Building Equipment for Direct Air Capture” (2024)
- R&D 100 Award “High-Efficiency Micro Combined Heat and Power Device” (2024)
- ASHRAE Crosby Field Award (2023)
- Knox.biz 40 under 40 Award (2023)
- R&D 100 Award “Ultraclean Condensing Gas Furnace” (2022)
- ASHRAE Exceptional Service Award (2022)
- ORNL Innovation Award (2021)
- R&D 100 Award “BIG-NET: Bis-iminoguanidine Negative Emission Technology” (2021)
- ASHRAE Distinguished Service Award (2018)
- Johnson Controls Inc. Merit Award for Excellence in Research and Innovation (2015)
- ASHRAE Graduate Student Grant-in-Aid Award (2011)
- University of Illinois at Urbana Champaign Alumni Teaching Fellowship (2011 and 2012)

Selected Journal Publications

1. M. Mousa, N. Miljkovic, K. Nawaz, “Review of Heat Transfer Enhancement Techniques for Single Phase Flows,” *Renewable and Sustainable Energy Reviews*, 2021, 137, 110566
2. Z. Dai, K. Nawaz, Y. G. Park, J. Bock, A. M. Jacobi “Correcting and extending the Boomsma-Poulikakos effective thermal conductivity model for three-dimensional, fluid-saturated metal foams,” *International Communication in Heat and Mass Transfer*, 2010, 37, 6, 575–580
3. N. Miljkovic, S. Chavan, H. Cha, D. Orejon, K. Nawaz, N. Singla, Y. F. Yeung, D. Park, D. H. Kang, Y. Chang, Y. Takata, “Heat Transfer through a Condensate Droplet on Hydrophobic and Nanostructured Superhydrophobic Surfaces” *Langmuir*, 32, 7774-7787.
4. K. Nawaz, B. Shen, A. Elatar, V. Baxter, O. Abdelaziz, “R290 and R600a as Natural Refrigerants for Residential Heat Pump Water Heaters,” *Applied Thermal Engineering*, 2017, 127, 870–883

5. Z. Dai, K. Nawaz, Y. Park, Q. Chen, A. M. Jacobi, "A comparison of metal-foam heat exchangers to compact multi-louver designs for air-side heat transfer applications," *Journal of Heat Transfer Engineering*, 2012, 33, 1, 21–30
6. H. Bahraseman, F. Mashali, E. M. Languri, J. Davidson, D. Kerns, W. Johnson, K. Nawaz, G. Cunningham, "Thermo-physical properties of diamond nanofluids: A review," *International Journal of Heat and Mass Transfer*, 2019, 129, 1123–1135
7. K. Nawaz, B. Shen, A. Elatar, V. Baxter, O. Abdelaziz, "Performance Optimization of CO₂ HPWH System," *International Journal of Refrigeration*, 2017, 85, 213–218
8. K. Nawaz, B. Shen, A. Elatar, V. Baxter, O. Abdelaziz, "R1234yf and R1234ze(E) as Low GWP Refrigerants for Residential Heat Pump Water Heaters," *International Journal of Refrigeration*, 2017, 82, 348–365
9. K. Nawaz, J. Bock, Z. Dai, A. Jacobi, "Thermal-hydraulic performance of metal foam heat exchangers under dry operating conditions," *Applied Thermal Engineering*, 2017, 119, 5, 222–232
10. T. Venegas, M. Qu, K. Nawaz, L. Wang, "Critical review and future prospects for desiccant coated heat exchangers: materials, design, and manufacturing," *Renewable and Sustainable Energy Reviews*, 2021, 151, 111531
11. M. Mousa, N. Miljkovic, K. Nawaz, "Review of Heat Transfer Enhancement Techniques for Two Phase Flows," *Renewable and Sustainable Energy Reviews*, 2021, 111896
12. C. L. Cramer, E. Lara-Curzio, A. M. Elliott, M. Sandlin, B. Fricke, V. Rao, P. Jain, K. Nawaz, "Properties of SiC-Si made via Binder Jet 3D Printing of SiC Powder, Carbon addition, and Silicon Melt Infiltration," *Journal of the American Ceramic Society*, 2021.
13. Z. Ayub, T. S. Khan, S. Salam, K. Nawaz, A. Ayub, S. Khan, "Literature survey and a Universal evaporation correlation for plate type heat exchangers," *International Journal of Refrigeration*, 2018, 99, 408–418
14. C. L. Cramer, H. Armstrong, A. Flores-Betancourt, L. Han, A. M. Elliott, E. Lara-Curzio, T. Saito, K. Nawaz, "Processing and Properties of SiC Composites made via Binder Jet 3D Printing and Infiltration and Pyrolysis of Pre-ceramic Polymer," *International Journal of Ceramic Engineering and Science*, 2, 320–331.
15. J. Sun, M. Zhang, A. Gehl, B. Fricke, K. Nawaz, K. Gluesenkamp, B. Shen, J. Munk, J. Hagerman, M. Lapsa, "COVID-19 vaccine distribution solution to the last mile challenge: Experimental and simulation studies of ultra-low temperature refrigeration system," *International Journal of Refrigeration*, 2022, 133, 313–325.
16. T. B. Freeman, M. Messenger, C. Troxler, K. Nawaz, R. M. Rodriguez, S. K. S. Boetcher, "Fused filament fabrication of novel phase-change material functional composites," *Additive Manufacturing*, 2021, 39, 101839
17. Z. Dai, Y. Zhang, S. Wany, K. Nawaz, A. M. Jacobi, "Falling-film heat exchangers used in desalination systems: A review," *International Journal of Heat and Mass Transfer*, 2022, 185, 122407
18. K. Copenhaver, K. Li, L. Wang, M. Lamm, X. Zhao, M. K., D. Neivandt, B. Dixon, S. Sultana, P. Kelly, W. M. Gramlich, H. Tekinalp, D. J. Gardner, S. MacKay, K. Nawaz, S. Ozcan, "Pretreatment of lignocellulosic feedstocks for cellulose nanofibril production", *Cellulose*, 2022, 29, 4835–4876.
19. J. Cheng, R. Lane, M. Kesler, J. Brechtel, X. Hu, R. Mirzaeifar, O. Rios, A. M. Momen, K. Nawaz, "Experiment and Non-Local Crystal Plasticity Finite Element Study of Nanoindentation on Al-8Ce-10Mg Alloy," *International Journal of Solids and Structures*, 2021, 111233
20. X. Zhao, S. Bhagia, D. G. Maldonado, X. Tang, S. Wasti, S. Lu, S. Zhang, M. Parit, M. L. Rencheck, M. Korey, H. Jiang, J. Zhu, X. Meng, M. E. Lamm, K. Copenhaver, M. S. Peresin, L. Wang, H. Tekinalp, G. Yang, V. Kumar, G. Chen, K. Nawaz, X. C. Chen, U. Vaidya, A. J. Ragauskas, E. Webb, D. J. Gardner, P. He, X. He, K. Li, S. Ozcan, "Bioinspired design toward nanocellulose-based materials" *Materials Today*, 66, 2023, 409-430

Selected Conference Papers:

1. M. Murugan, C. Yang, J. Brechtel, K. Nawaz, "Microchannel Geometries for Improved Heat Transfer with Low-GWP refrigerants", 20th International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, IN, July 15–18, 2024.
2. Y. Hu, S. F. Yana Motta, S. A. Jajja, C. Yang, B. Fricke, K. Nawaz, "Experimental Study on Flow Condensation of Low Global Warming Potential Refrigerants in a Micro-fin Aluminum Tube", 20th International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, IN, July 15–18, 2024.
3. K. Nawaz, P. Wang, J. Sun, Jian; S. Kowalski, "High-Temperature Heat Pumps And Their Role In The Decarbonization Of Buildings And Industry", 20th International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, IN, July 15–18, 2024.

4. K. Nawaz, J. Sun, A. Elatar, J. Rendall, B. Shen. "Deployment of R290 In Heat Pump Water Heaters And Implications for Decarbonization", 20th International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, IN, July 15–18, 2024.
5. K. Nawaz, A. Jacobi "The Impact of Base Metal on the Thermal-Hydraulic Performance of Metal Foam Heat Exchanger for Cooling and Dehumidification Applications", 16th International Heat Transfer Conference, 2018, August 10-15, Beijing, China.
6. K. Nawaz, A. M. Jacobi, "Open Cell Metal Foam Heat Exchangers for Air-dehumidification Applications", 3rd Thermal and Fluids Engineering Conference, 2018, March 4-7, Fort Lauderdale, FL USA.
7. K. Nawaz, "Thermal-Hydraulic Performance of Wavy-Fin Heat Exchanger Under Dehumidifying Conditions", ASHRAE 2018 Winter Conference January 20-24, Chicago, IL USA.
8. K. Nawaz, A. M. Jacobi, "The Impact of Base Metal on the Thermal-Hydraulic Performance of Metal Foam Heat Exchanger for Cooling and Dehumidification Applications", ASME Heat Transfer Conference, July. 9-14, 2017, Bellevue, Washington, USA.
9. K. Nawaz, J. Bock, and A. Jacobi, "Thermal-hydraulic performance of metal foam heat exchangers", 14th International Refrigeration and Air Conditioning Conference, July 14th 2012, Purdue University Lafayette, IN
10. Z. Dai, K. Nawaz, Y. Park, Q. Chen, A. M. Jacobi, "A comparison of Metal-Foam heat exchangers to compact multilouver design for air-side heat transfer applications", 7th International Conference on Enhanced, Compact and Ultra-Compact Heat Exchangers: From Microscale Phenomena to Industrial Applications, Sep. 13-18, 2009, Heredia, Costa Rica.

Selected Intellectual Property:

1. U.S. Non-Provisional Patent App. 202205193, R. Sacci, G. Veith, K. Nawaz, K. Li "Conversion of liquid CO₂"
2. U.S. Patent App. 63/534,893, G. Jang, C. Tsouris, R. Custelcean, K. Li, D. Stamberg, K. Nawaz "Methods of Energy Efficient Sorbent Regeneration Used for Direct Air Capture"
3. U.S. Patent App. 63/535,383, R. Custelcean, K. Li, K. Nawaz, "Direct Air Capture of CO₂ using RAC (Rotating Air Contactor) with Potassium Hydroxide and Guanidine-based Ligands"
4. U.S. Patent App. 18/409,522, J. Klett, K. Nawaz, E. Lara-Curzio, "Process for Manufacturing Fiber-Reinforced Additively Manufactured Composites"
5. US Patent App. 63/541,723, R. Sacci, K. Nawaz, A. Ullman, J. Brechtel, "Multifunctional Materials for Combined Electrochemical and Thermal Storage (COMETS)"
6. US Patent App. 17/974,227, K. Nawaz, B. A. Fricke, X. Sun, S. Sluder, C. Tsouris, M. K. Kidder, C. J. Janke, K. Li, J. A. Thompson "Multi-functional equipment for direct decarbonization with improved indoor air quality"
7. US Patent App. 17/974,232, K. Nawaz, B. A. Fricke, X. Sun, "Intensified carbon capture using building infrastructure"
8. US Patent 11,633,789, E. Lara-Curzio, C. L. Cramer, A. M. Elliott, B. A. Fricke, P. K. Jain, R. R. Lowden, K. Nawaz, V. M. Rao, M. J. Sandlin, "Compliant heat exchangers, heat pipes and methods for making same"
9. US Patent 17/890,791, J. D. Rendall, K. Nawaz, W. E. Asher, A. F. Elatar, J. Sun, J. Brechtel, X. Liu, K. An, M. Zhang, "Density controlled phase-changing material (PCM) spheres for increased heating power and optimal delivery temperature in hot-water tanks"
10. US Patent 63/460,911, Gabriel M Veith, Robert L Sacci, Kashif Nawaz, Kai Li, conversion of liquid CO₂, provisional patent application,
11. US patent application 63/272,345, "Intensified Carbon Capture Using Buildings Infrastructure."
12. US patent application 63/272,351, "Multi-functional Equipment for Direct Decarbonization with Improved Indoor Air Quality (IAQ)."
13. US patent application 17/171,323, "Compliant heat exchangers, heat pipes and methods for making same."
14. US patent application 11,802,692, "Monolithic gas trap adsorber for high efficiency, cost effective, low-emission condensing furnace."
15. US patent application 11,828,501, "Metal Foam Heat Exchangers for Air and Gas Cooling and Heating Applications."