

NUSAIR M. HASAN

Senior Cryogenics Staff Engineer

Facility for Rare Isotope Beams, Michigan State University

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EDUCATION

Ph.D., Mechanical Engineering 2014
Drexel University, Philadelphia, PA

Master of Science, Mechanical Engineering 2010
Bangladesh University of Engineering and Technology, Dhaka, Bangladesh

Bachelor of Science (Honors), Mechanical Engineering 2008
Bangladesh University of Engineering and Technology, Dhaka, Bangladesh

RESEARCH INTERESTS

Process optimization of thermal (cryogenic) systems, cryogenic heat exchangers, multi-phase flow and heat transfer, gas purification, thermoacoustic transport phenomena.

PROFESSIONAL EXPERIENCE

July 2018 – Present

Facility for Rare Isotope Beams, Michigan State University, East Lansing, MI

Senior Cryogenics Staff Engineer (2023 - Present)

Cryogenics Staff Engineer (2018 - 2023)

MSU Cryogenics Initiative:

- In cooperation with the MSU-Mechanical Engineering department, lead, and conduct, research, and development in the advancement of cryogenic processes and technology, specifically regarding large-scale cryogenic (helium) refrigeration and critical supporting sub-systems.
- Developed the course material and teaching the following cryogenic engineering classes, with approx. 100 mechanical engineering students trained:
 - ME413 – Cryogenic Thermal Systems, offered each spring semester since 2019.
 - ME414 – Mechanical Design of Cryogenic Systems, offered each fall semester since 2018.
 - ME940 – Cryogenic Process Engineering, 2020.
- Developed the course material and taught at U.S. Particle Accelerator School (USPAS) – Cryogenic Process Engineering, Summer 2022 (full capacity, 30 students)
- *Graduate Students:* Presently advising and directing research work for three (3) graduate students in cryogenic engineering.
 - Duncan Kroll, MSc, Development of the mechanical design for a freeze-out purifier (May 2020)
 - Duncan Kroll, PhD, Process Design and Analysis of a Cryogenics Freeze-Out Heat Exchanger for Helium Purification (Projected Completion: December 2023)
 - Jonathon Howard, PhD, High-Efficiency and Reliable Wide Range Operation of 2 K Helium Cryogenic Systems (Projected Completion: December 2023)
 - Scott Anthony, PhD, Performance Prediction of Twin-Screw Compressors in Helium Refrigeration (Projected Completion: 2025)

- Undergraduate Students: Supervised four (4) mechanical and chemical engineering students and their training through work on various FRIB cryogenic system projects to establish pipeline for potential future graduate students.
- Research assistantship work supervised – development of mathematical model, evaluation, and analysis of data for the following aspects regarding the FRIB cryogenic system:
 - Re-pressurization rates and static boil-off test for FRIB Linac at 2 K
 - Operation of FRIB cryo-plant without using liquid nitrogen assisted pre-cooling
 - Operability study of FRIB cryogenic system during maintenance mode (*e.g.* operation without a specific turbine string, or a warm compressor).
 - FRIB helium purification system water and air capacity, and utility usage measurement
 - FRIB ES cryogenic distribution system process model for cool-down and warm-up
 - FRIB helium inventory monitoring and loss prediction.

Cryogenic Engineering:

- Led the cryogenic process and mechanical design (ASME B31.3, BPVC, piping flexibility) effort for developing the cryogenic distribution system for FRIB’s target and pre-separator segment superconducting magnets. The cryogenic distribution system was fully commissioned by April 2021. Currently, it supports cryogenic operation of all the superconducting magnets at FRIB’s target and pre-separator segment.
- Led the cryogenic process and mechanical design (ASME B31.3, BPVC, piping flexibility) effort for the re-configuration of FRIB’s A1900 fragment separator segment cryogenic distribution system. This cryogenic distribution system was fully commissioned in January 2022.
- Led the cryogenic process and mechanical design (ASME B31.3, BPVC, piping flexibility) effort for a heat exchanger cold box development for FRIB’s experimental system superconducting magnets. This cool-down heat exchanger cold box was commissioned in December 2020, and it was used for controlled cool-down of the superconducting magnets and associated cryogenic distribution for FRIB’s target and pre-separator segment.
- Led the concept planning, process, and mechanical design (modeling, drafting, ASME B31.3, BPVC, piping flexibility) efforts, as well as commissioning (July 2020) of a superconducting magnet test station at the Superconducting Radio Frequency (SRF) test facility in FRIB.
- Led the R&D, process design, commissioning, and operation efforts for a novel superconducting magnet quench energy / inventory management system for FRIB’s experimental system. This system is integrated to the cryogenic distribution for the target and pre-separator segment at FRIB. It has provided a robust and stable operation for the superconducting magnets during training and normal operations, while persevering the helium inventory and allowing a quick turnaround time for operation and availability.
- Led the R&D, process, and mechanical design effort for a freeze-out helium purifier development at FRIB.

October 2014 – June 2018

Thomas Jefferson National Accelerator Facility (JLab), Newport News, VA

Cryogenics Process Engineer

Major Responsibilities:

- Process engineering support for design/development of large-scale 2.0 K and 4.5 K helium refrigeration systems, cryostats, and cryogenic systems at JLab and several other US-DOE user facilities.
- Support around the clock continuous cryogenic plant operations for CHL1 and CHL2 – the two Central Helium Liquefiers that support JLab’s Linear Particle Accelerator.

Accomplishments:

- Lead Process Engineer for sub-atmospheric cold box replacement and Experimental Systems refrigerator upgrade projects. Developed technical requirements for key equipment (cold compressors, heat exchangers etc.) and aiding as the SOTR for the procurement of these equipment.
- Served as a key member of the 12 GeV upgrade cryogenic system re-commissioning team. Aided in characterization and performance mapping of the 12 GeV upgrade cryogenic refrigeration system.

- Led teams of junior engineers and technicians for commissioning and acceptance testing of several cryogenic system components, such as 750W cold box at Cryogenic Test Facility (CTF), stand-by warm helium compressor for 12 GeV upgrade, CHL recovery compressors etc.
- Provided cryogenic process related support (analysis, component selection and procedure development) to several inter-departmental projects/activities on a regular basis, such as SLAC LSLCII cryo-module commissioning at CTF, UITF cryo-module commissioning, LERF cryo-module test bench development, CEBAF gradient improvement etc.

September 2010 – August 2014

Drexel University, Philadelphia, PA

Teaching Assistant

Courses Taught:

Heat Transfer (MEM 345), Thermal Systems Analysis (MEM 440), Introduction to Thermodynamics (ENGR 210), Thermodynamic Analysis I (MEM 310), Foundations of Fluid Mechanics (MEM 621).

February 2008 – August 2010

Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh

Lecturer

Courses Taught:

Engineering Numerical Analysis, Heat Engine Laboratory, Thermal and Fluid Sciences Laboratory.

RESEARCH GRANTS

- (*Pending*) Principal Investigator, US-DOE Early Career Research Program, “Characterization and Management of Thermal Energy Release During Superconducting Magnet Quench”, \$2.5 Million, September 2023 – August 2028
- (*Pending*) Principal Investigator, NSF Major Research Instrumentation Program, "MRI: Development of Helium Recovery Equipment: Development of a freeze-out helium purifier for MSU-FRIB Cryogenic System”, \$2.0 Million, September 2023 – August 2028

HONORS / AWARDS

- Received Cryogenic Society of America (CSA) Roger W. Boom Award, 2022
 - *Given to a young professional (under 40 years of age) who shows promise for making significant contributions to the fields of cryogenic engineering and applied superconductivity.*
- Received Drexel University Doctoral Research Excellence – ‘Highly Commended’ citation, 2014
- Received Drexel University George Hill, Jr. Endowed Fellowship, 2014
 - *Given to students who demonstrated excellence in their graduate careers and the potential to achieve academic excellence at the PhD level.*
- Received Bangladesh Univ. of Engineering and Technology V.G. Desa Gold Medal, 2007
 - *Given to outstanding Mechanical Engineering Graduates who secures first position in their graduating class with a GPA of 3.75 or more.*



CSA Roger W. Boom Award, 2022

PROFESSIONAL SERVICES AND ACTIVITIES

Editor / Reviewer Service

- Co-editor, Special Issue on Energy, Frontiers of Thermal Engineering (*Ongoing*)

- Reviewer, US-DOE Office of High Energy Physics, SBIR/STTR Proposals (2021, 2022, 2023)
- Reviewer, The Journal of Supercritical Fluids
- Reviewer, ASME International Mechanical Engineering Congress & Exposition (2012 - Present)
- International Cryogenic Engineering Conference (2022)
- Reviewer, ASME Summer Heat Transfer Conference (2012, 2016, 2017)

Professional Memberships

- Cryogenic Society of America

LIST OF SEMINARS / PUBLICATIONS / PRESENTATIONS

Invited Lectures:

1. Large-Scale Cryogenics for Particle Accelerators, *The 21st International Conference on Radio-Frequency Superconductivity (SRF 2023)*, June 22, 2023, Grand Rapids, MI
2. Cryogenic Instrumentation, *2023 International Accelerator School (IAS)*, July 16-17, 2023, Saskatoon, SK

Peer-Reviewed Journal Articles:

1. Kroll, D., Hasan, N., Exergetic Analysis and Design of a Freeze-out Heat Exchanger for Helium Purification, 2022, *Cryogenics* (Under-Review)
2. Howard, J, Hasan, N., Knudsen, P., Thermal-hydraulic characterization of shell-side flow in a cryogenic coiled finned-tube heat exchanger, 2020, *ASME Journal of Heat Transfer*, v. 143
3. Farouk, B., Antao, D. and Hasan, N., “Acoustically driven oscillatory flow fields in a cylindrical resonator at resonance”, 2019, *Journal of the Acoustical Society of America*, v. 145
4. Farouk, B. and Hasan, N., “Trans-critical Carbon Dioxide Flow in a Heat Exchanger: Applications in Waste Heat Recovery”, 2016, *Journal of Computational Heat Transfer*, v. 8(4)
5. Hasan, N. and Farouk, B., “Experimental and Numerical Investigations of Resonant Acoustic Waves in Near-Critical CO₂”, 2015, *Journal of the Acoustical Society of America*, v. 138
6. Farouk, B. and Hasan, N., “Acoustic Wave Generation in Near-Critical Supercritical Fluids: Effects on Mass Transfer and Extraction”, 2015, *Journal of Supercritical Fluids*, v. 96
7. Hasan, N., Antao, D. and Farouk, B., “DC Negative Corona Discharge in Atmospheric Pressure Helium: Transition from the Corona to the ‘Normal’ Glow Regime”, 2014, *Plasma Sources Science and Technology*, v. 23
8. Hasan, N. and Farouk, B., “Fast Heating Induced Thermoacoustic Waves in Supercritical Fluids: Experimental and Numerical Studies”, 2013, *Journal of Heat Transfer*, v. 135
9. Hasan, N. and Farouk, B., “Mass Transfer Enhancement in Supercritical Fluid Extraction by Acoustic Excitations”, 2013, *Journal of Supercritical Fluids*, v. 80
10. Hasan, N. and Farouk, B. “Buoyancy Driven Convection in Near-Critical and Supercritical Fluids”, 2012, *International Journal of Heat and Mass Transfer*, v. 55
11. Hasan, N. and Farouk, B. “Thermoacoustic Transport in Supercritical Fluids at Near-critical and Near-pseudo-critical States”, 2012, *Journal of Supercritical Fluids*, v. 68

Peer-Reviewed Conference Publications and Presentations:

1. Hasan, N., Ganni, V., Knudsen, P., Process Design for FRIB’s Experimental System Cold Box, *2023 Cryogenic Engineering Conference and International Cryogenic Materials Conference*, July 8-13th, 2023, Honolulu, HI (To be Presented)

2. Howard, J., Knudsen, P., Engeda, A., Hasan, N., Characterization of centrifugal compressors operating in FRIB's sub-atmospheric compression system, *2023 Cryogenic Engineering Conference and International Cryogenic Materials Conference, July 8-13th, 2023, Honolulu, HI* (To be Presented)
3. Kroll, D., Howard, J., Knudsen, P., Hasan, N., Numerical modeling of the cool-down of the helium transfer-lines for FRIB Linac and experimental systems, *2023 Cryogenic Engineering Conference and International Cryogenic Materials Conference, July 8-13th, 2023, Honolulu, HI* (To be Presented)
4. Wright, M., Hasan, N., Ganni, V., Jones, S., Knudsen, P., Nguyen, C., Mechanical and Process Design of the Interface to a 20,000 Liter Liquid Helium Dewar, *2023 Cryogenic Engineering Conference and International Cryogenic Materials Conference, July 8-13th, 2023, Honolulu, HI* (To be Presented)
5. Hasan, N., Ganni, V., Knudsen, P., Analysis and Management of Thermal Energy Release during Quench in a Superconducting Magnet, *ASME 2022 International Mechanical Engineering Congress and Exposition, October 30 – November 3, 2022, Columbus, OH*
6. Kroll, D., Hasan, N., Modeling Frost Formation in Freeze-out Purification of Gases for Cryogenic Applications, *ASME 2022 International Mechanical Engineering Congress and Exposition, October 30 – November 3, 2022, Columbus, OH*
7. Hasan, N., Wright, M., *et al.*, Design, Fabrication and Installation of the Cryogenic Distribution System for Re-configured FRIB A1900 Fragment Separator, 2022, *The 28th International Cryogenic Engineering Conference and International Cryogenic Materials Conference (Online)*
8. Hasan, N., Ganni, V., *et al.*, Commissioning and Operational Experience from FRIB Target and Fragment Pre-Separator Superconducting Magnet Quench Management System, 2022, *The 28th International Cryogenic Engineering Conference and International Cryogenic Materials Conference (Online)*
9. Hasan, N., Wright, M., *et al.*, Design, Fabrication, and Installation of the Cryogenic Distribution System for FRIB Target and Fragment Pre-Separator Superconducting Magnets, 2022, *IOP Conf. Ser.: Mater. Sci. Eng.* 1240 012083
10. Hasan, N., Ganni, V., *et al.*, Design of Cryogenic Heat Exchangers and associated Sub-Systems for Controlled Cool-down and Testing of Superconducting Magnets at FRIB, 2022, *IOP Conf. Ser.: Mater. Sci. Eng.* 1240 012063
11. Howard, J., Knudsen, P., Hasan, N., Ganni, V., Sub-atmospheric re-pressurization analysis of FRIB LINAC segment 2 cryogenic distribution system, 2022, *IOP Conf. Ser.: Mater. Sci. Eng.* 1240 012097
12. Kroll, D., Howard, J., Knudsen, P., Hasan, N., Ganni, V., Testing and analysis of stand-by operating modes for FRIB helium refrigeration system, 2022, *IOP Conf. Ser.: Mater. Sci. Eng.* 1240 012063
13. Kroll, D., Hasan, N., Ganni, V., "Freeze-Out Purifier for Helium Refrigeration System Applications", 2020, *IOP Conf. Ser.: Mater. Sci. Eng.* 755 012056
14. Knudsen, P., Ganni, V., Hasan, N., Wright, M., Casagrande, F., Vargas, G., Joseph, N., "FRIB Helium Refrigeration System Commissioning and Performance Test Results", 2020, *IOP Conf. Ser.: Mater. Sci. Eng.* 755 012090
15. Knudsen, P., Ganni, V., Casagrande, F., Fila, A., Hasan, N., Wright, M., Vargas, G., Joseph, N., Design, fabrication, commissioning, and testing of FRIB 2 K cold compressor system, 2020, *IOP Conf. Ser.: Mater. Sci. Eng.* 755 012092

16. Casagrande, F., Ganni, V., Knudsen, P., Wright, M., Jones, S., Nguyen, C., Fila, A., Hasan, N., Vargas, G., Joseph, N., Stanley, S., FRIB cryogenic system status, 2020, *IOP Conf. Ser.: Mater. Sci. Eng.* 755 012089
17. Yang, S., Dixon, K., Laverdure, N., Norton, R., Creel, J., Hasan, N., JLAB CHL1 2K Cold Box Replacement, 2020, *IOP Conf. Ser.: Mater. Sci. Eng.* 755 012120
18. Hasan, N., Knudsen, P. and Ganni, V., “Applicability of ASST-A helium refrigeration system for JLab End Station Refrigerator”, 2017, *IOP Conf. Ser.: Mater. Sci. Eng.* 278 012114
19. Hasan, N., Knudsen, P. and Wright, M., “Online helium inventory monitoring of JLab cryogenic systems”, 2017, *IOP Conf. Ser.: Mater. Sci. Eng.* 278 012113
20. Wijeratne, T., Hasan, N., Wright, M., Ganni, V., Dixon, K., Creel, J., and Knudsen, P., “Commissioning and Testing of a new 4.5K Cold Box for JLab Cryogenic Test Facility”, 2017, *IOP Conf. Ser.: Mater. Sci. Eng.* 278 012094
21. Knudsen, P., Ganni, V., Hasan, N., Dixon, K., Norton, R. and Creel, J., “Mod. to JLab 12 GeV Refrigerator and Wide Range Mix Mode Performance Testing Results”, 2017, *IOP Conf. Ser.: Mater. Sci. Eng.* 171 012015
22. Farouk, B., Hasan, N., Trans-critical Carbon Dioxide Flow in a Tubular Heat Exchanger, *CHT-15: 6th International Symposium on Advances in Computational Heat Transfer*, May, 25-29, 2015, New Brunswick, NJ, USA
23. Hasan, N., Farouk, B., Forced Convective Thermal Transport and Flow Stability Characteristics in Near-Critical Supercritical Fluid, *66th Annual Meeting of the APS Division of Fluid Dynamics*, November 25-27th, 2013, Pittsburgh, PA
24. Hasan, N., Farouk, B., Acoustically Augmented Flow and Transport in Supercritical Fluids, *ASME 2013 International Mechanical Engineering Congress and Exposition*, November 15–21st, 2013, San Diego, CA
25. Hasan, N., Farouk, B., Enhancing Supercritical Fluid Extraction Using Acoustic Excitations, *ASME 2012 International Mechanical Engineering Congress and Exposition*, November 9-15th, 2012, Houston, TX
26. Hasan, N., Farouk, B., Convective Thermal Transport in Near-Critical Fluids, *64th Annual Meeting of the APS Division of Fluid Dynamics*, November 21-23rd, 2011, Baltimore, MD
27. Hasan, N., Farouk, B., Numerical Studies of Thermoacoustic Convection in Near-Critical Fluids, *ASME 2011 International Mechanical Engineering Congress and Exposition*, November 11-17th, 2011, Denver, CO