



CELEBRATING 50 YEARS OF INNOVATION

26TH COMPRESSOR ENGINEERING • 19TH REFRIGERATION AND AIR CONDITIONING • 7TH HIGH PERFORMANCE BUILDINGS

HOSTED BY PURDUE CENTER FOR HIGH PERFORMANCE BUILDINGS • RAY W. HERRICK LABORATORIES



2022 CONFERENCE FINAL PROGRAM

COMPRESSOR & REFRIGERATION SHORT COURSES • JULY 10, 2022
HERRICK CONFERENCES • JULY 11-14, 2022

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FOREWORD

Dear Attendees,

On behalf of the Organizing Committee, the Ray W. Herrick Laboratories, the Center for High Performance Buildings, Purdue University, the Co-Sponsoring Organizations, and the Endorsing Organizations, it is a great pleasure to present the Final Program of the 26th International Compressor Engineering Conference, the 19th International Refrigeration and Air Conditioning Conference, and the 7th International High Performance Buildings Conference at Purdue, known as the Herrick Conferences.

This year we are celebrating the 50-year anniversary of hosting the compressor conference. Ray Cohen, Werner Soedel, and Jim Hamilton hosted the first compressor conference in 1972. We are honored to continue the tradition of bringing innovation to the HVAC&R industry.

For the first time since 2018, we welcome our friends and colleagues back to campus, and introduce for the first time a hybrid conference. The last several years have been difficult. The challenges of COVID have certainly created a strain on all of our industries, communities, and families. Yet, it has also created opportunity, sparking creative ways to handle these challenges. This week we are excited to read and hear about research born from these trying times.

The Organizing Committee received more than 500 abstracts and accepted 350+ papers for publication. Every effort was made to include papers of current engineering and scientific interest. In addition, an internal review was conducted of each paper. Nevertheless, the Organizing Committee takes no responsibility for the correctness or completeness of the papers published. I would like to thank the authors for having chosen our conferences to present their work and for all their efforts in preparing and submitting papers. Thanks to them we present a conference program that is exciting and informative.

I would also like to thank the session chairs and session co-chairs for their help in supporting the technical program. In addition, I would like to thank the members of the advisory committee, the Co-Sponsoring and Endorsing Organizations and their representatives for their support and helpful suggestions. In particular, I would like to thank the members of the Organizing Committee and the many graduate student helpers that are integral in making our conferences a success.

We hope that you enjoy our conferences and return home with new ideas and professional contacts. For those unable to join us in person, we hope to see you on campus in the near future. The next Herrick Conferences are planned for 2024 and we are excited to build upon the success of this year. We are honored to bring you 50 Years of Innovation.

Yours sincerely,



Dr.-Ing. Eckhard A. Groll

William E. and Florence E. Perry Head of Mechanical
Engineering
Reilly Professor of Mechanical Engineering
College of Engineering, Purdue University

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Davide Ziviani
Yangfan Liu
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Refrigeration Short Courses Organizer

William E. Murphy

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ADC (UK), a member of Daikin group

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Compressor Center of Excellence
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RAC Refrigerants - Sr. Principal Engineer
Sporlan Division of Parker Hannifin, USA

Mr. Jia Xu

Director Assistant of Compressor and Motor Institute
Gree Electric Appliances, Inc. of Zhuhai of China

Mr. Jin Yan

Aero-Thermal Manager
Danfoss Turbocor Compressor Inc., USA

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Professor and Concordia Research Chair Tier I
Scientific Director of NSERC Solar Buildings
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Distinguished Research Staff Member,
Building Equipment Research, Energy and
Transportation Science Division
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Mr. Didier Coulomb

International Institute of Refrigeration, France (IIR)

Dr. Brian Fricke

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Building Equipment Research, Energy and
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AHRI

CONFERENCE KEYNOTE SPEAKER



MONDAY, JULY 11 9:30 AM LOEB THEATRE

DR. JOHNEY GREEN JR.

Associate Laboratory Director for Mechanical and Thermal Engineering Sciences,
National Renewable Energy Laboratory

Dr. Johney Green Jr. serves as the associate laboratory director for Mechanical and Thermal Engineering Sciences (MTES) at the National Renewable Energy Laboratory (NREL). He oversees NREL's transportation, buildings, wind, water, geothermal, advanced manufacturing, concentrating solar power, and Arctic research programs, which encompass a portfolio of over \$150 million and more than 500 employees. The MTES Directorate conducts research and development to enable technology innovations in the areas of energy efficiency, sustainable transportation, and renewable power. Additionally, Green transformed NREL's Wind Site into the Flatirons Campus and transitioned the campus from a single-program wind research site to a multi-program research campus that is the foundational experimental platform for the Department of Energy's Advanced Research on Integrated Energy Systems (ARIES) Initiative.

Prior to assuming his current position, Green held a number of leadership roles at Oak Ridge National Laboratory (ORNL), where he served as director of the Energy and Transportation Science Division and group leader for fuels, engines, and emissions research. Green managed a broad science and technology portfolio and user facilities that made significant science and engineering advances in building technologies; sustainable industrial and manufacturing processes; fuels, engines, emissions, and transportation analysis; and vehicle systems integration. It was during his tenure as a division director that ORNL developed the Additive Manufacturing Integrated Energy (AMIE) demonstration project, a model of innovative vehicle-to-grid integration technologies and next-generation manufacturing processes.

Early in his career, Green conducted combustion research to stabilize gasoline engine operation under extreme conditions. During the course of that research, he joined a team working with Ford Motor Company, seeking ways to simultaneously extend exhaust gas recirculation limits in diesel engines and reduce nitrogen oxide and particulate matter emissions. He continued this collaboration as a visiting scientist at Ford's Scientific Research Laboratory, conducting modeling and experimental research for advanced diesel engines designed for light-duty vehicles. On assignment to the U.S. Department of Energy's Vehicle Technologies Office, Green also served as technical coordinator for the 21st Century Truck Partnership.

Green is a Fellow of the American Association for the Advancement of Science (AAAS) and an SAE International Fellow. He serves on the Faraday Institution's Board of Trustees and the National GEM Consortium Board of Directors. In addition, he has served on numerous advisory boards for organizations, including the Georgia Institute of Technology, the University of Tennessee, and the University of Memphis. He has also been an invited participant in several National Academy of Engineering programs. Green has received several awards during his career and holds two U.S. patents in combustion science. Additionally, he has an h-index of 30, is the lead or co-author of several technical publications, and has given many invited, keynote, and plenary presentations.

Green holds a bachelor's degree in mechanical engineering from the University of Memphis and a master's and doctorate in mechanical engineering from the Georgia Institute of Technology.

REFRIGERATION & AIR CONDITIONING PANEL

TUESDAY, JULY 12 8:30 AM LOEB THEATRE

TOPIC: Global Outlook of Refrigeration



Dr. Andy Pearson Panel Moderator

Group Managing Director, Star Refrigeration

Andy Pearson is the Group Managing Director at Star Refrigeration. He has Bachelor of Science, Bachelor of Engineering and Doctor of Philosophy degrees from the University of Strathclyde. He works in refrigeration safety committees for the British Standards Institute, the European Standards Committee and the International Standards Organisation and contributes a monthly column to the ASHRAE Journal.



Dr. Piotr Domanski

Fellow at the National Institute of Standards and Technology

Piotr A. Domanski works at the National Institute of Standards and Technology, Gaithersburg, MD, USA, where he led the HVAC&R Equipment Performance Group for over two decades. Currently he is a NIST Fellow. His work has focused on modeling of air-conditioning equipment and research of alternative refrigerants. His interests also include evolutionary computation-based optimization methods, automated commissioning, and fault detection and diagnostics.



Mary Koban

**Sr. Director Regulatory Affairs
Air-Conditioning, Heating & Refrigeration Institute (AHRI)**

Mary has 25 years of experience in chemical industry, with 15 of those years in HVAC. She was at the forefront of the automotive safe transition from 134a to the low GWP low flammable refrigerant 1234yf. She is a flammability expert with various publications regarding safety, use and handling of low GWP refrigerants. She has a BS in Physics/Mathematics from Penn State University.



Dr. Reinhard Radermacher

Director, Center for Environmental Energy Engineering

Dr. Reinhard Radermacher conducts research in heat transfer and working fluids for energy conversion systems — in particular heat pumps, air-conditioners, refrigeration systems, and integrated cooling heating and power systems. His work has resulted in more than 600 publications, numerous invention records, and 16 patents. He has co-authored three books. His research includes the development of software for the design and optimization of heat pumps and air-conditioners, which is now in use at more than 80 companies worldwide. Dr. Radermacher holds a Ph.D. in physics and is Minta Martin Professor of Mechanical Engineering and director and co-founder of the Center for Environmental Energy Engineering.

LUNCHEON PLENARY SPEAKER



**TUESDAY, JULY 12 12:00 PM
PURDUE MEMORIAL UNION**

VANESSA WYCHE
Director, NASA's Johnson Space Center

Vanessa E. Wyche is the director of NASA's Johnson Space Center, home to America's astronaut corps, Mission Control Center, International Space Station, Orion and Gateway programs and its more than 10,000 civil service and contractor employees. She is responsible for overseeing a broad range of human spaceflight activities, including development and operation of human spacecraft, commercialization of low-Earth orbit and Johnson's role in landing the first woman and first person of color on the surface of the Moon.

Wyche previously served as deputy director at Johnson, a position she held since 2018. Other key leadership positions include: assistant and acting deputy director of Johnson; director of the Exploration Integration and Science Directorate, flight manager of several missions of the retired Space Shuttle Program, executive officer in the Office of the NASA Administrator, and led additional center-level technical and program organizations. Before joining NASA in 1989, Wyche worked for the Food and Drug Administration in Washington D.C.

A native of South Carolina, Wyche earned a Bachelor of Science in Engineering and Master of Science in Bioengineering from Clemson University. In recognition of her contributions to the engineering profession she was inducted into the Thomas Green Clemson Academy of Engineers and Scientists at Clemson University in 2019.

Wyche is a passionate promoter of science, technology, engineering, and math (STEM), and serves as a member of Clemson University's College of Engineering, Computing and Applied Sciences advisory board, the University of Houston's C. T. Bauer College of Business advisory panel, the Houston Exponential board of directors, and is a past chair of the Space Center Houston board of directors. She is the recipient of two NASA Outstanding Leadership Medals, two NASA Achievement Medals and is a current fellow of the International Women's Forum.

Wyche is married to George Wyche Jr. Esq, and has one son, George Wyche III.

Follow Wyche on Twitter at twitter.com/V_Wyche.

For more information about Johnson Space Center, visit:

<http://www.nasa.gov/johnson>

HIGH PERFORMANCE BUILDINGS PLENARY



WEDNESDAY, JULY 13 8:30 AM LOEB THEATRE

GARY PARSONS

Chairman, NextNav Inc
Executive Chairman, TORAD Engineering LLC

Topic: The current entrepreneurial/venture capital landscape and how it relates to the HVAC&R industry.

Gary Parsons currently serves as Chairman of NextNav Inc (NASDAQ: NN), a Silicon-valley company providing 3D indoor location for First Responders/E911 and GPS backup to US critical infrastructure, and is Executive Chairman of TORAD Engineering LLC, an Atlanta-based technology company pioneering HVAC compressor technology optimized for low and ultra-low GWP refrigerants to reduce Global Warming.

Gary Parsons has spent over 50 years in the telecom industry, and is noted for the founding or early stage development of a number of innovative telecom companies, including XM Satellite Radio, SkyTerra, TerreStar Networks, Telecom*USA and MCImetro. He served as the founding CEO and then Executive Chairman of XM Satellite Radio from 1997 through its merger with Sirius in July 2008, and continued as Chairman of the combined Sirius XM Radio until 2010.

Gary was a pioneer in the deployment of fiber optic networks in the 80's and 90's and hybrid satellite-terrestrial technologies (such as XM Radio, SkyTerra and TerraStar) during the 2000's. In addition to NextNav and TORAD, Mr. Parsons serves on the Board of Directors of Omnispace LLC, Siden Inc, Devas Multimedia Pvt Ltd, and is the Managing Director of Potomac Capital Partners, LLC and a Venture Partner with Columbia Capital LLC.

He holds a Bachelor in Electrical and Computer Science from Clemson University, a Master in Business Administration from the University of South Carolina, and is Co-Chairman of the National Alliance to End Homelessness. Mr. Parsons was inducted into the US Space Foundation's Space Technology Hall of Fame in 2002.

COMPRESSOR CONFERENCE PANEL

THURSDAY, JULY 14 8:30 AM LOEB THEATRE

TOPIC: State of the Art and Global Outlook of Refrigeration, AC and HP Compressors



Dr. Eckhard Groll Panel Moderator

**William E. and Florence E. Perry Head of Mechanical Engineering
Reilly Professor of Mechanical Engineering**

Dr. Groll's research focuses on the fundamental thermal sciences as applied to advanced energy conversion systems, components, and their working fluids. He has served as the head of Mechanical Engineering since 2019.



Manuel Camacho

Technical Director, J&E Hall

Manuel has been involved in the application of different types of industrial and commercial refrigeration systems and compressors for more than 30 years. Part of his duties are to collaborate on the design and development of new single screw compressors with the Engineering team at the Applied Development Centre (ADC(UK)) and train engineers around the world on the application of single screw technology. Manuel has a BSc. in Electro-mechanical Engineering, a Master of Business Administration, and a Master of Project Management.



Rainer Grosse-kracht

Chief Technology Officer (CTO) at BITZER

With a degree in mechanical engineering, Rainer has worked for more than two decades in the refrigeration and air conditioning industry. As the Chief Technology Officer and a member of board at BITZER, the specialist in refrigeration compressors, he has now represented the company in the ASERCOM association for six years. Grosse-Kracht follows on at ASERCOM from Stephane Nassau from Danfoss.



Ken Monnier

**Chief Technology Officer, HVAC/R Technologies
Emerson Commercial & Residential Solutions**

Ken Monnier has more than 37 years of experience in the HVAC/R industry. Since joining Emerson in 1984, he has held positions of increasing responsibility in the areas of new product engineering, technology management, research and innovation. Much of his career has focused on the design and technical leadership of various scroll and other compressor platforms as well as related electronics and controls.

BREAKFAST FOR PRESENTERS, CHAIRPERSONS, AND VICE CHAIRPERSONS

A complimentary lunch (on Monday) and breakfast (Tuesday – Thursday) are scheduled in the Purdue Memorial Union, West Faculty Lounge for presenting authors, session chairs & vice-chairs scheduled for each day. You can find your presentation time in the Conference Overview. It is important to attend the speakers' lunch or breakfasts if you are presenting a paper to meet your session chair and address any presentation questions you might have. Updated presentations can also be loaded at this time. Instructions concerning audio/visual/projection systems and technical session organization will be addressed. Please only attend the lunch or breakfast on the day in which you present. If you have presentations scheduled for different days, you should attend the lunch or breakfasts each day so that you can meet your Session Chairperson and the other Presenters. If you are the Presenter in more than one session on the same day, please meet both Session Chairpersons. If you are a Presenter but not an author of a technical paper, you should be the person who attends this breakfast so that you may alert the Chairpersons that you are the Presenter.

PROGRAM FORMAT

Presentations are on a strict time schedule this year. Each presenter receives ONLY 20 minutes total, for both presentation and question/answers. Should there be a speaker who does not show up, or there is a gap for whatever reason, we will NOT move the speaker up, as has been done in the past, but instead ask each presenter to speak at their scheduled time as listed in the program.

NEW This year, we will be hosting a hybrid format. This means during the course of your session, presenters may be joining remotely. Please be patient with the session Vice-Chairs as they coordinate the process of executing the online portion of the sessions. If a remote presenter is not available for a live presentation, we will run their pre-recorded video if provided.

PICTURES AND VIDEO TAPING DURING THE CONFERENCES

Conference attendees may NOT take pictures or videos at any presentation without the consent of the author or presenter. An official photographer will be taking pictures during the conferences. Attendees may NOT take pictures during the tours because the research is often highly sensitive.

PRESENTATIONS

If you have last minute changes to your presentation (different from what was uploaded into Conftool), please see your session co-chair during the daily breakfast Tuesday to Thursday or during the luncheon (Monday) to make arrangements to upload your new file.

FUTURE CONFERENCE DATES

July 15 - 18, 2024

July 13 - 16, 2026

SHORT COURSES

Short Courses are organized and presented by the faculty of Herrick Laboratories, in cooperation with our sponsoring organizations. Often, speakers from outside organizations and universities serve as presenters for these courses. One CEU credit can be earned through attendance to any of the offered short courses. The courses will meet from 8:00 a.m. until 5:00 p.m. on Sunday, July 10, 2022 in Rawls Hall, and will meet concurrently.

SHORT COURSE DESCRIPTIONS

Compressor 104 – Numerical and Experimental Techniques Applied to Noise and Vibration in Positive Displacement Compressors

Coordinated by: Eckhard A. Groll (Purdue University), Davide Ziviani (Purdue University), Yangfan Liu (Purdue University), Haotian Liu (Purdue University)

In this fourth edition of the Compressor Short Course, the fundamentals and the practical aspects of noise and vibration phenomena in positive displacement compressors will be covered. It is well known that compressor performance heavily relies on each single component and its unique interaction inside the compressor housing, and subsequently requires a thorough understanding of the composite system to resolve issues arising from noise and vibration. Each positive displacement compressor type is characterized by different compression mechanisms and fluid-structure interactions. During the course, lectures will focus on the main noise and vibration sources of each compressor type and provide numerical and experimental methodologies to identify and mitigate such effects. The short-course consists of eight 45-minute lectures and will provide ample time for hands-on experience and discussion.

Refrigeration Short Course 1 – Ejector Design for Vapor Compression Systems (Morning Session)

Coordinated by: Prof. William Murphy (retired University of Kentucky) and the U.S. National Committee of the IIR in collaboration with Herrick Laboratories Faculty

Ejectors are being developed as a way to improve vapor compression cycle efficiency by replacing the isenthalpic expansion process. Ejectors have no moving parts, like expander work recovery devices, so they have the potential to produce simpler and lower cost designs with improved system reliability.

Refrigeration Short Course 2 – Update on Flammable Refrigerants (Afternoon Session)

Coordinated by: Prof. William Murphy (retired University of Kentucky) and the U.S. National Committee of the IIR in collaboration with Herrick Laboratories Faculty

The demand for refrigerants with lower GWPs has led to a class of refrigerants that are considered mildly flammable. The use of flammable refrigerants will require changes in various safety codes and guidelines related to building design, installation and service requirements, and system design. This course provides detailed information on the latest code changes as well as experimental results involving flammable refrigerant safety testing.

MONDAY, JULY 11

Reception at the Lafayette Brewing Company, 622 Main St, Lafayette, IN 47901

The reception is hosted by Carrier Corporation and will be held from 6:00 to 8:00 p.m. Shuttle buses will depart from the State Street bus stop in front of Stewart Center between 5:30 and 6:00 p.m. transporting attendees and guests to the reception. Attendees may also use CityBus or walk to the Reception. There will be transportation available after the Reception to take attendees back to the Stewart Center.. Additional local restaurants and bars are open on Monday evenings in downtown Lafayette and the Purdue campus for attendees who may be interested after the reception.

TUESDAY, JULY 12

Luncheon – Purdue Memorial Union, North & South Ballrooms

The luncheon will be held from 11:50 a.m. to 1:20 p.m. It is hosted by Trane Technologies. Vanessa Wyche, Director of NASA's Johnson Space Center is our special guest for the event.

WEDNESDAY, JULY 13

Gala Celebration – The Stables Event Center, 7071 S 100 E, Lafayette, IN 47909

The all conference dinner will be held from 6 p.m. to dusk and is hosted by Emerson Climate Technologies.

Buses will begin departing from the State Street bus stop in front of Stewart Center at 5:45 p.m. The last bus will leave at approximately 6:15 p.m. for the dinner. There will be games, a beer wagon, awards, live entertainment, and a chance to visit outside. The buses will begin to return attendees and guests to campus starting at 9:00 p.m. Shuttles will continue through 10:00 p.m.. You may also drive your own vehicle to this venue, but given limited parking, you are encouraged to use the provided transportation.

STUDENT EVENTS

Student Paper Competition: Winners of the Student Paper Competition from each conference will be announced and awarded at the Gala Celebration at The Stables Event Center. Plan to join us and congratulate these students on a job well done.

ASHRAE Student Meeting – Monday, July 11 from 3:30-5:30 pm, Stewart 313

Purdue Student Chapter of ASHRAE meeting. (Open to ALL student ASHRAE members, not just Purdue student members).

Student Mixer – Tuesday, July 12 from 8-10 pm, Harry's Chocolate Shop

Gather with other students from around the world at the historic Harry's Chocolate Shop located at 329 W State St, West Lafayette, IN 47906. This event is hosted by Rheem.

PRACTICAL GUIDE

CONFERENCE OFFICE / HOSPITALITY ROOM

The Conference Office is located in Stewart Center, Room 279. Conference Hospitality is located in Stewart Center, Room 302/306

Monday 8:00 a.m. to 4:00 p.m.

Tuesday 8:00 a.m. to 4:00 p.m.

Wednesday 8:00 a.m. to 4:00 p.m.

Thursday 8:00 a.m. to 12:00 p.m.

INTERNET ACCESS

Wireless internet is available to all attendees via the ATT WIFI hotspot. Please choose ATT Wifi as your internet connection. When you open a browser, you will be automatically connected. You will need to provide your email address and accept terms & conditions. If you have difficulties, please visit the Conference Office, Stewart Center, 279.

COVID GUIDELINES

The Conferences will follow all of the current University guidelines outlined on the Protect Purdue website. A negative Covid test is not required to attend. Attendees are encouraged to travel with Covid Rapid Tests in case they begin to exhibit symptoms. In the case of a positive test, the attendee must contact Conference officials, and asked to leave campus. The conferences will assist in quarantining and making arrangements to return home.

Attendees that require a negative Covid test in order to return home may contact the Conference Coordinator, Brian Barrett (barret71@purdue.edu) in order to coordinate the scheduling of test. They may also visit the Conference Office in STEW 279.

SMOKING POLICIES ON CAMPUS

Smoking is prohibited on the West Lafayette Campus, except in designated smoking areas. All smoking material shall be extinguished and disposed of in an appropriate receptacle at the perimeter of the campus. Designated smoking areas are published in maps around the Purdue campus. The closest smoking area to Stewart Center is located across Sate Street, north of the Agricultural Administration Building.

TEMPERATURES INSIDE & OUTSIDE DURING THE CONFERENCES

Outside summer temperatures in Indiana are usually between 75-95°F and very humid. Room temperatures in technical session rooms are often cool for our International visitors; come prepared!

TIME DURING CONFERENCES

The time zone in Indiana is Eastern Daylight Time. This is the same time as New York City in the summer.

TRANSPORTATION DURING THE CONFERENCE

There will be organized transportation available for the Conference Social Events or you may choose to use your own vehicles. The Conference Hotels may provide shuttle service between the hotels and the Purdue Memorial Union. They do not operate on a regular schedule so you may call for pick-up service. Please make sure that you obtain a contact number for your hotel shuttle. The Greater Lafayette Transit System will also be available.

LIMO SERVICE TO AND FROM INDIANAPOLIS AND CHICAGO AIRPORTS

LAFAYETTE LIMO SERVICE

Provides service to and from the Indianapolis International Airport
(765) 497-3828 or lafayettelimo.com

REINDEER

Shuttle service to and from the Indianapolis International Airport
(765) 637-5124 or reindeershuttle.com

EXPRESS AIR COACH

Provides shuttle service to and from the Chicago O'Hare Airport
expressaircoach.com/purdue/

Check their websites. Attendees must contact the companies themselves.

TRANSPORTATION SERVICES

AMTRAK - TRAIN

Riehle Plaza
Big Four Depot, 200 North 2nd Street
(800) 872-7245

GREYHOUND BUS

Riehle Plaza
Big Four Depot, 200 North 2nd Street
(765) 742-8836 or (800) 231-2222

PARKING ON CAMPUS

Parking is available in garages on the Purdue campus. The Grant Street Garage is the closest garage to the Purdue Memorial Union and Stewart Center. Attendees may park in that garage for a maximum price of \$10/day. Guests at the Union Club Hotel can park for free. Visitors can purchase "A" garage permits or multiple day passes at the Parking facilities office (494-9494) Monday-Friday 7:30-4:30. The price is \$5.00/day and allows parking in any garage EXCEPT Grant Street and Harrison Street garages.

Do not park in marked parking spaces or you will be ticketed. We are not able to get your ticket dismissed. Attendees with Government issued plates are able to park in any A, B, or C parking spaces.

For detailed information visit <https://www.purdue.edu/parking/>

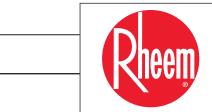
MONDAY, JULY 11

7:00 - 10:00am	Conference Registration - <i>Main Lounge, Purdue Memorial Union</i>				
8:00am - 4:00pm	Hospitality Room - STEW 302/306 Hosted by Saginomiya				
9:30am - 11:30am	Opening Session, Welcome, and Keynote Address - Loeb Playhouse, Stewart Center				
11:30am - 1:00pm	Complimentary Lunch for Chairpersons & Presenting Authors for Monday's Sessions - <i>West Faculty Lounge, Second Floor, Purdue Memorial Union</i>				
11:30am - 1:00pm	Lunch Break				
	STEW 214 A&B	STEW 214 C&D	STEW 218 A&B	STEW 218 C&D	STEW 310
1:00 - 3:00pm	B-01: Thermal Storage, Heat Pumps and Materials	R-01: Experimental Characterization and Modeling of Two-Phase Flow	R-02: Alternative Refrigerants Modeling and Test I	R-03: Vapor Compression System Performance and Enhancements	R-04: Automotive and Transportation HVAC&R
	STEW 278	STEW 202	STEW 206	STEW 311	STEW 313
	R-05: PCM TES Devices	C-01: Scroll Compressors I	C-02: Modeling Techniques		
3:00 - 3:30pm	Conference Break STEW 302/306 Hosted by Saginomiya				
	STEW 214 A&B	STEW 214 C&D	STEW 218 A&B	STEW 218 C&D	STEW 310
3:30 - 5:30pm	B-02: Building Simulation and Energy Modeling	R-06: Thermal Management of Electric Batteries	R-07: CO ₂ Assessment I	R-08: Alternative Air-conditioning, refrigeration and heat pumping I	R-09: Automated Fault Detection and Diagnostics for Equipment (IBO)
	STEW 278	STEW 202	STEW 206	STEW 311	STEW 313
	R-10: Flammable Refrigerants	C-03: Compressor Valves	C-04: Oil & Lubrication	Kick-off Meeting of IIR	Student Branch ASHRAE Meeting
5:30 - 6:00pm	Bus Transportation provided from Grant Street Garage to Lafayette Brewing Company				
6:00 - 8:30pm	Opening Night Reception - <i>Lafayette Brewing Company (LBC)</i> - Hosted by Carrier Corporation				
8:30 - 9:00pm	Bus Transportation provided from Lafayette Brewing Company to Grant Street Garage				



TUESDAY, JULY 12

7:15am - 8:15am	Complimentary Breakfast for Chairpersons & Presenting Authors for Tuesday's Sessions <i>West Faculty Lounge, Second Floor, Purdue Memorial Union</i>				
8:00am - 4:00pm	Hospitality Room - STEW 302/306				
8:30am - 9:20am	Refrigeration Conference Plenary Session - Global Outlook of Refrigeration - <i>Loeb Playhouse, Stewart Center</i>				
9:20am - 9:40am	Information Session: GT-SUITE Multi-Physics Simulation for Compressors, HVACR, and Buildings - <i>STEW 311</i>				
	STEW 214 A&B	STEW 214 C&D	STEW 218 A&B	STEW 218 C&D	STEW 310
9:40am - 11:40am	B-03: Smart Sensing, Data Analytics & IEQ	R-11: Frost and Defrost Characterization and Modeling	R-12: Advanced System Control	R-13: Advance equipment sensing	R-14: Alternative Refrigerants Modeling and Test II
	STEW 278	STEW 202	STEW 206	STEW 311	STEW 313
	Student Paper Competition: Refrigeration & A.C.	C-05: Compressor Testing & Evaluation I	C-06: Screw Compressors I		
11:30am - 1:30pm	Sponsor Expo - <i>Purdue Memorial Union (outside of luncheon)</i>				
11:50am - 1:20pm	Conference Luncheon (included in Registration) <i>North and South Ballrooms, Purdue Memorial Union</i> Hosted by Trane Technologies				
	STEW 214 A&B	STEW 214 C&D	STEW 218 A&B	STEW 218 C&D	STEW 310
1:30pm - 3:50pm	B-04: MPC & Smart Building Controls	R-15: Oil and Lubrication I	R-16: Alternative Refrigerants Properties	R-17: Heat pump applications (Dryers & Water Heater)	R-18: Heat Exchanger Design
	STEW 278	STEW 202	STEW 206	STEW 311	STEW 313
	Student Paper Competition: Compressors	C-07: Novel Compressors I	C-08: Compressor Modeling II		
3:50pm - 4:20pm	Conference Break: Hospitality Room - <i>STEW 302/306</i>				
3:50pm - 4:20pm	Information Session: GT-SUITE Multi-Physics Simulation for Compressors, HVACR, and Buildings - <i>STEW 311</i>				
	STEW 214 A&B	STEW 214 C&D	STEW 218 A&B	STEW 218 C&D	STEW 310
4:20pm - 6:20pm		R-19: Load Based Testing I	R-20: Heat Pump Design and Applications I	R-21: Experimental Characterization of Two-phase Flow I	R-22: Systems Integrated with PCM based TES
	STEW 278	STEW 202	STEW 206	STEW 311	STEW 313
	Student Paper Competition: High Performance Buildings	C-09: Reciprocating Compressors I	C-10: NVH I		
4:00pm - 5:30pm	IIR Combined Commission Meeting				
6:00pm - 8:00pm	Tours of Herrick Laboratories				
6:30pm - 8:00pm	Conference Advisory Committee Meeting (by invitation only) - <i>Spurgeon Club, Mackey Arena</i>				
8:00pm - 10:00pm	Student Mixer - <i>Harry's Chocolate Shop</i> Hosted by Rheem				



WEDNESDAY, JULY 13

7:15 - 8:15am	Complimentary Breakfast for Chairpersons & Presenting Authors for Wednesday's Sessions <i>West Faculty Lounge, Second Floor, Purdue Memorial Union</i>				
8:00am - 4:00pm	Hospitality Room - STEW 302/306 Hosted by Rheem				
8:30am - 9:20am	High-Performance Buildings Plenary Session <i>Loeb Playhouse, Stewart Center</i>				
	STEW 214 A&B	STEW 214 C&D	STEW 218 A&B	STEW 218 C&D	STEW 310
9:40am - 12:00pm	B-05: Building Performance Monitoring, Energy Management & FDD	R-23: Absorption Technology	R-24: Vapor Compression System Modeling I	R-25: Heat Exchangers Testing	R-26: Domestic and Light-Commercial Refrigeration
	STEW 278	STEW 202	STEW 206	STEW 311	STEW 313
	R-27: Oil and Lubrication II	C-11: Compressor Testing & Evaluation II	C-12: Compressors for Alternative Refrigeration		
12:00 - 1:00pm	Lunch Break				
	STEW 214 A&B	STEW 214 C&D	STEW 218 A&B	STEW 218 C&D	STEW 310
1:00 - 3:00pm	B-06: IAQ, Disinfection & Air Cleaning, Outdoors	R-28: Advanced HX and Manufacturing	R-29: Vapor Compression System Modeling II	R-30: Application of Ejectors	R-31: Power and Co-generation Equipment I
	STEW 278	STEW 202	STEW 206	STEW 311	STEW 313
		C-13: Novel Compressors II	C-14: Compressor Modeling III		
3:00 - 3:30pm	Conference Break STEW 302/306				
	STEW 214 A&B	STEW 214 C&D	STEW 218 A&B	STEW 218 C&D	STEW 310
3:30 - 5:30pm		R-32: Heat Exchanger Modeling	R-33: Commercial and Industrial HVAC&R	R-34: Alternative Technologies for Sensible and Latent Load Management	R-35: Energy Storage
	STEW 278	STEW 202	STEW 206	STEW 311	STEW 313
		C-15: NVH II	C-16: Tribology		
5:30 - 6:00pm	Shuttle buses will transport attendees from the Grant Street Parking Garage to the Gala Dinner				
6:00 - 10:00pm	50th Anniversary Gala Dinner - The Stables, West Lafayette, IN Hosted by Emerson Climate Technologies				
9:30 - 10:30pm	Shuttle buses will transport attendees from Gala Dinner to the Grant Street Parking Garage				



THURSDAY JULY 14

7:15 - 8:15am	Complimentary Breakfast for Chairpersons & Presenting Authors for Thursday's Sessions <i>West Faculty Lounge, Second Floor, Purdue Memorial Union</i>				
8:00am - 4:00pm	Hospitality Room - STEW 302/306				
8:30am - 9:20am	Compressor Conference Plenary Session - Industry Panel: State of the Art and Global Outlook of Refrigeration, AC and HP Compressors <i>Loeb Playhouse, Stewart Center</i>				
	STEW 214 C&D	STEW 218 A&B	STEW 218 C&D	STEW 310	STEW 278
9:40am - 12:00pm	R-36: Load Based Testing II	R-37: Alternative Refrigerants Modeling and Test III	R-38: CO ₂ Assessment II	R-39: Alternative Air-conditioning, refrigeration and heat pumping	R-40: Power and Co-generation Equipment II
12:00pm	End of Conference				
1:00 - 3:00pm	Advisory Committee Meeting (by invitation only) - STEW 307				
1:00 - 3:00pm	Additional Ray W. Herrick Laboratory Tours by Request				

MONDAY • 1:00PM - 3:00PM

B-01: Thermal Storage, Heat Pumps and Materials

Session Chair: Bill Hutzel

1:00pm - 1:20pm **ID: 3385**

Operating Cost Assessment of Space Conditioning and Water Heating Technologies in a Residential Building Across the United States

Zechao Lu, James E. Braun, Davide Ziviani

Purdue University, United States of America

1:20pm - 1:40pm **ID: 3516**

PCM Material Selection For Heat Pump Integrated With Thermal Energy Storage For Demand Response in Residential Buildings

Sara Sultan¹, Tugba Turnaoglu³, Damilola Akamo¹, Jason Hirsche², Tim Laclair³, Xiaobing Liu³, Kyle R. Gluesenkamp³

¹ University of Tennessee, Bredesen Center for Interdisciplinary Education, Knoxville, TN, USA; ² Georgia Institute of Technology Atlanta, GA, USA; ³ Oak Ridge National Laboratory, Oak Ridge, TN, USA

1:40pm - 2:00pm **ID: 3509**

Demonstration of Thermal Energy Storage System with Salt Hydrate Phase Change Material Composite

Jason R. Hirsche¹, Kyle R. Gluesenkamp², Samuel Graham¹

¹ George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, United States of America; ² Oak Ridge National Lab

2:00pm - 2:20pm **ID: 3539**

Assessment Of Short-Term Aquifer Thermal Energy Storage For Energy Management In Greenhouse Horticulture: Modeling And Optimization

Queralt Altes-Buch, Sylvain Quoilin, Vincent Lemort

University of Liège, Belgium

2:20pm - 2:40pm **ID: 3510**

A Review on Carbon Emissions of Ultra-High-Performance Fiber Reinforced Concrete as a Building Construction Material

Syed Muhammad Aqib, Z. John Ma

University of Tennessee, Knoxville, United States of America

2:40pm - 3:00pm **ID: 3507**

A Framework for Analyzing Widespread Grid Intervening Technologies: A Case Study of Heat Pump-Integrated Thermal Energy Storage Systems in Buildings

Jason R. Hirsche¹, Richard A. Simmons¹, Tim J. Laclair², Kyle R. Gluesenkamp², Samuel Graham¹

¹ George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, United States of America; ² Oak Ridge National Lab, United States of America

R-01: Experimental Characterization and Modeling of Two-Phase Flow

Session Chair: Anthony Jacobi

1:00pm - 1:20pm **ID: 2345**

Developing Adiabatic Two-phase Flow In An 8-mm Tube After An Expansion Valve

Yufang Yao¹, Pega Hrnjak^{1,2}

¹ University of Illinois Urbana-Champaign, Urbana, IL, USA; ² Creative Thermal Solutions, Urbana, IL, USA

MONDAY • 1:00PM - 3:00PM

1:20pm - 1:40pm ID: 2346

Effect of Tube Size and Oil on Developing Adiabatic Two-phase Flow

Yufang Yao¹, Pega Hrnjak^{1,2}

¹ University of Illinois Urbana-Champaign, Urbana, IL, USA; ² Creative Thermal Solutions, Urbana, IL, USA

1:40pm - 2:00pm ID: 2120

A Neural-network Approach to Develop Algebraic Correlations for Heat Transfer and Fluid Flow

Lingnan Lin¹, Lei Gao², Yunho Hwang², Mark A. Kedzierski¹

¹ National Institute of Standards and Technology, United States of America; ² University of Maryland, United States of America

2:00pm - 2:20pm ID: 2589

The Two-phase Flow Boiling Heat Transfer Coefficient of R448A Inside Multiport Mini-Channel Tube

Hoang Ngoc Hieu, Nurlaily Agustiarini, Jong-Taek Oh

Department of Refrigeration and Air-Conditioning, Chonnam National University, Yeosu, Chonnam, South Korea

2:20pm - 2:40pm ID: 2537

Study On Quality Measurement Using Multiple Small Holes

Shusuke Hara¹, Mitsuhiro Fukuta², Masaaki Motozawa², Yusuke Hagiwara¹, Atsushi Inaba³, Haruyuki Nishijima³

¹ Graduate School of Science and Technology, Shizuoka University; ² Department of Mechanical Engineering, Shizuoka University 3-5-1 Johoku, Naka-ku, Hamamatsu, Japan; ³ DENSO Corporation, Kariya, Aichi, Japan

2:40pm - 3:00pm ID: 2398

Local Heat Transfer Coefficient of R245fa Flow Boiling in Plate Heat Exchanger with Simultaneous Flow Visualization

Abdel-Rahman Farraj¹, Pega Hrnjak^{1,2}

¹ ACRC, University of Illinois at Urbana-Champaign, USA; ² Creative Thermal Solutions, Inc., Urbana, Illinois, US

R-02: Alternative Refrigerants Modeling and Test I

Session Chair: Stephen Kujak

1:00pm - 1:20pm ID: 2117

Observations of Water-Cooled Chillers with Tube-in-Shell Heat Exchangers Operated with Mildly Zeotropic Low Pressure Refrigerant Blends

Kenneth Schultz

Trane Technologies

1:20pm - 1:40pm ID: 2130

Experimental Investigation of R1336mzz(E) in a High-temperature Heat Pump

Cordin Arpagaus¹, Sidharth Paranjape¹, Leon Brendel¹, Luke D. Simoni², Konstantinos Kontomaris², Stefan S. Bertsch¹

¹ Eastern Switzerland University of Applied Sciences, Institute for Energy Systems, Werdenbergstrasse 4, 9471 Buchs, Switzerland;

² The Chemours Company, Wilmington, Delaware, USA

1:40pm - 2:00pm ID: 2206

Experimental Investigation of a New Ultra-Low Temperature Refrigerant in an Environmental Test Chamber

Tom Winkler, Melanie Cop, Riley B. Barta, Ullrich Hesse

Technical University of Dresden, Germany

MONDAY • 1:00PM - 3:00PM

2:00pm - 2:20pm ID: 2414

Material Compatibility of 3D Printed Polymer Composites with Low GWP Refrigerants

Kai Li, Tyler Smith, Samuel Yana Motta, Mingkan Zhang, Amit Naskar, Kashif Nawaz

Oak Ridge National Laboratory, United States of America

2:20pm - 2:40pm ID: 2576

Recent Advances in Solubility, Miscibility and Material Compatibility Studies for R134a and R404A non-flammable low GWP alternative

Henna Tangri, Kaimi Gao, Nilesh Purohit, Elizabet VeraBecerra, Ankit Sethi, Ryan Hulse

Honeywell, United States of America

R-03: Vapor Compression System Performance and Enhancements

Session Chair: Andy Pearson

1:00pm - 1:20pm ID: 2106

Performance Prediction and Calibration of a Clean-Room Air Conditioner Using an Embedded Artificial Neural Network

Myung-Sup Yoon¹, Dong-Hyuk Yi¹, Myung-Kyo Seo², Seung-Yup Ryu³

¹ Korea Testing Laboratory, Seoul, Republic of Korea; ²F lakt Korea, Seoul, Republic of Korea;

³ Seungil Electronics, Bucheon, Republic of Korea

1:20pm - 1:40pm ID: 2156

Annual Thermal Performance Assessment for an Economized Vapor Injection System in Hot Climate

Abdullah Abdal, Ammar Bahman

Mechanical Engineering Department, College of Engineering and Petroleum, Kuwait University

1:40pm - 2:00pm ID: 2400

Modeling of an Ultra-Low Temperature Refrigeration System for Independent Vaccines and Medical Supplies Storage

Abd Alrhman M. Bani Issa, Elias N. Pergantis, John K. Brehm, Eckhard A. Groll, Davide Ziviani

Ray W. Herrick Laboratories, School of Mechanical Engineering, Purdue University

2:00pm - 2:20pm ID: 2423

Numerical Investigation on Effects of Sub-cooled & Super-heating degree on Performance of VRF System with Simultaneous Operation

Been Oh¹, Hosik Jeong¹, Dongwon Kim¹, Yeseul Park¹, Jiyeon Choi³, Byungchae Min³, Gyungmin Choi²

¹ School of Mechanical Engineering, Pusan National University, Busan, Korea; ² Department of Mechanical Engineering, Pusan National University, Busan, Korea; ³ SAC Research/Engineering Division, H&A Solution company, LG Electronics, Chagnwon, Korea

2:20pm - 2:40pm ID: 2392

Impact of High-Efficiency and Variable-Speed Motors on the Performance of a Residential Split-System Air Conditioning System

John Kevin Brehm¹, Florian R Raditsch¹, Rick Hepperla², Davide Ziviani¹, Eckhard A. Groll¹

¹ Purdue University, United States of America; ² QM Power, Inc, United States of America

2:40pm - 3:00pm ID: 2343

Gravity Dependence Quantifiers for Vapor Compression Cycles Subjected to Inclination Testing and Parabolic Flights

Leon P. M. Brendel¹, Stephen L. Caskey², James E. Braun¹, Eckhard A. Groll¹

¹ Purdue University, United States of America; ² Air Squared Inc., United States of America

R-04: Automotive and Transportation HVAC&R**Session Chair:** Yunho Hwang**1:00pm - 1:20pm ID: 2242***Integration of a Cooling System Architecture with a Skin Heat Exchanger for High Thermal Loads in Fuel Cell Powered Aircraft*Saija Schaefer¹, Farid Quaum², Nick Muhsal³, Arne Speerforck¹, Frank Thielecke², Christian Becker³¹Hamburg University of Technology, Germany, Institute of Engineering Thermodynamics; ²Hamburg University of Technology, Germany, Institute for Aircraft Systems Engineering; ³Hamburg University of Technology, Germany, Institute of Electrical Power and Energy Technology**1:20pm - 1:40pm ID: 2358***Air Conditioning in Public Transport Vehicles. Numerical Simulation of Contaminants Transport and Infection Probability.*Jordi Vera¹, Eugenio Schillaci¹, Joaquim Rigola¹, Marc Arolas², Oriol Del Rivero²¹CTTC UPC, Spain; ²ROLEN, Spain**1:40pm - 2:00pm ID: 2368***Thermo-economic Design and Optimization of Cooling Systems Employed in Cruise Ship*Alfonso William Mauro¹, Giovanni Napoli^{1,2}, Francesco Pelella¹, Luca Viscito¹¹Department of Industrial Engineering, Università degli studi di Napoli – Federico II, P.le Tecchio 80, 80125 Naples, Italy; ²Dipartimento di Ingegneria Gestionale, dell'Informazione e della Produzione, Università degli Studi di Bergamo, Viale Marconi 5, Dalmine, BG 24044, Italy**2:00pm - 2:20pm ID: 2378***Energy Efficient Heating and Air Conditioning Concept for City cars and Microcars*

Joerg Aurich, Rico Baumgart

IAV GmbH, Germany

2:20pm - 2:40pm ID: 2441*Latent Thermal Energy Storage for Thermal Management of Refrigerated Trucks*Michele Calati¹, Giulia Righetti¹, Claudio Zilio¹, Kamel Hooman², Simone Mancin¹¹University of Padova, Italy; ²Delft University of Technology, The Netherlands**2:40pm - 3:00pm ID: 2568***Paper for Refrigeration and Air Conditioning Conference**Battery Cooling Module Optimization Method: Battery Lifetime Prediction Using Temperature*Se Hyeon Ham¹, Dong Soo Jang², Yongchan Kim³¹Graduate School of Mechanical Engineering, Korea University, Anam-ro 145, Seongbuk-gu, Seoul, Korea; ²Engineering Laboratory, National Institute of Standards and Technology, Gaithersburg, MD 20899, USA; ³Department of Mechanical Engineering, Korea University, Anam-ro 145, Seongbuk-gu, Seoul, Korea**R-05: PCM TES Devices****Session Chair:** Haotian Liu**1:00pm - 1:20pm ID: 2121***Design of a Direct-Contact Thermal Energy Storage Heat Exchanger for the NIST Net-Zero Residential Test Facility: Part 1 Flow Observation*

Mark A. Kedzierski, Lingnan Lin

National Institute of Standards and Technology, United States of America

MONDAY • 1:00PM - 3:00PM

1:20pm - 1:40pm **ID: 2122**

Design of a Direct-Contact Thermal Energy Storage Heat Exchanger for the NIST Net-Zero Residential Test Facility: Part 2 Heat Exchanger Design

Mark A. Kedzierski, Lingnan Lin

National Institute of Standards and Technology, United States of America

1:40pm - 2:00pm **ID: 2147**

Development and Validation Of Resistance-Capacitance Model (RCM) For Phase Change Material (PCM) Embedded In 3D Periodic Structures

Tanjebul Alam¹, Giulia Righetti², Daniel Bacellar¹, Vikrant Aute¹, Simone Mancin²

¹University of Maryland, College Park, MD, USA; ²University of Padova, Padova, Italy

2:00pm - 2:20pm **ID: 2493**

Experimental Thermal Characterization of a PCM for Waste Heat Recovery

Giulia Righetti¹, Claudio Zilio¹, Giovanni Antonio Longo¹, Luca Doretti¹, Giuseppe Travaglini², Andrea Dolfi², Simone Mancin¹

¹University of Padova, Italy; ²PETRONAS, GR&T, Turin, Italy

2:20pm - 2:40pm **ID: 2571**

An Experimental Method To Determine The Contact Thermal Resistance Of PCM Materials Undergoing Large Volume Change

Joseph Rendall, Zhenglai Shen, Som Shrestha, Tony Gehl, Jerald Atchley

ORNL, United States of America

2:40pm - 3:00pm **ID: 2421**

Experimental Investigation of a Phase Change Material Charged Finned-Tube Heat Exchanger

Jangho Yang, Jan Muehlbauer, Daniel Bacellar, Jiazhen Ling, Vikrant Aute, Yunho Hwang

University of Maryland, United States of America

C-01: Scroll Compressors

Session Chair: Kirill Ignatiev

1:00pm - 1:20pm **ID: 1181**

Development of Compact and High-efficiency Scroll Compressor Using Shaft-through Hybrid Wrap

Sangbaek Park¹, Cheolhwan Kim¹, Kangwook Lee¹, Yongkyu Choi¹, Jungsun Choi¹, Seheon Choi¹,

Byeongchul Lee¹, Nara Han², Sungchoon Kim²

¹Disruptive Tech. InnovationLab., LG Electronics Inc.; ²Component Solution Division, LG Electronics Inc.

1:20pm - 1:40pm **ID: 1194**

Novel Radial Compliance Mechanism For A Scroll Compressor

Kirill M. Ignatiev, Mikhail Antimonov, Michael Perevozchikov, John Fernandez

Emerson, United States of America

1:40pm - 2:00pm **ID: 1239**

3D Conjugate Heat Transfer Modelling of E-Compressor

Abhishek Ballani, Mingyuan Tao, Chiranth Srinivasan, Haiyang Gao, Dipak Maiti, Sujan Dhar

Simerics, Inc.

2:00pm - 2:20pm ID: 1388*Optimization of the Pre-Outlet and Main-Outlet Bores in Scroll Compressors*

Rico Baumgart, Joerg Aurich

IAV GmbH, Germany

2:20pm - 2:40pm ID: 1436*Lab Testing of a Retrofitted CO₂ Booster Rack with Transcritical Scroll Compressors featuring Dynamic Vapour Injection*Rémi Dickes¹, Cédric De José¹, Javier Vega², Eric Winandy¹¹Emerson Climate Technologies; ²University of Liège**2:40pm - 3:00pm ID: 1545***Modeling, Simulation and Experimental Testing of a Two-phase Scroll Compressor*

Nicolas Leclercq, Vincent Lemort

University of Liège, Belgium

C-02: Modeling Techniques

Session Chair: Manuel Camacho**1:00pm - 1:20pm ID: 1227***Quantitative Comparison of the Performance of Vapor Compression Cycles with Various Means of Compressor Flooding*

Amjid Khan, Craig R. Bradshaw

Center for Integrated Building Systems, Oklahoma State University, Stillwater, Ok 74078

1:20pm - 1:40pm ID: 1260*Mathematical Model for the Mechanical Losses and Validation Experiments*Atakan Oral¹, Ismail Lazoglu¹, Husnu Kerpicci², Seckin Tuysuz²¹Koc University, Turkey; ² Arcelik A.S. Central R&D**1:40pm - 2:00pm ID: 1463***An Improved Mass Flow Rate Prediction Method for Rolling Piston Compressors*Cheng-Yi Lee¹, Yunho Hwang¹, Scott Shaffer²¹ Center for Environmental Energy Engineering, Department of Mechanical Engineering, University of Maryland, 4164 Glenn Martin Hall Bldg., College Park, MD 20742, United States; ² GE Appliances, Appliance Park, Louisville, KY 40225-0001, United States**2:00pm - 2:20pm ID: 1541***Designing a Condense-Air Separator for a Double-Stage Oil Injected Screw Compressor and Verification by Two-Phase Discrete Phase Modelling CFD Analysis*

Buğrahan Bahadır, Hükümrən Selim Ertürk, Sinan Pişirici

Dalgakırın Compressor, Turkey

MONDAY • 3:30PM - 5:00PM

B-02: Building Simulation and Energy Modeling

Session Chair: Huijeong Kim

3:30pm - 3:50pm ID: 3465

Recursive Bayesian Calibration of Data-Driven Archetype Building Energy Models for Residential Sector: Application to a Research House

Seyed Matin Abtahi¹, Andreas K. Athienitis¹, Benoit Delcroix²

¹ Center for Zero Energy Building Studies, Concordia University, Montreal, Canada; ² Hydro Québec Laboratoire des Technologies de l'Energie (LTE), Shawinigan, Canada

3:50pm - 4:10pm ID: 3317

Assessment Of The Accuracy Of Solar Irradiance Models In Mountain Locations: The Case Of Bolzano, Italy

Giovanni Pernigotto¹, Alessandro Prada², Andrea Gasparella¹

¹ Free University of Bozen-Bolzano, Italy; ² University of Trento, Italy

4:10pm - 4:30pm ID: 3498

Performance Modeling and Analysis of a Thermoelectric Building Envelope for Space Heating

Xiaoli Liu¹, Ming Qu¹, Kazuaki Yazawa², Jorge Kohanoff³, Piotr Chudzinski³, Lorenzo Stella³, Brian Norton⁴, Niall Holmes⁴, Ruchita Jani⁴, Hongxi Yin⁵

¹ Lyles School of Civil Engineering, Purdue University West Lafayette, Indiana, USA; ² Birck Nanotechnology Center, Purdue University West Lafayette, Indiana USA; ³ School of Mathematics and Physics, Queen's University Belfast Belfast, United Kingdom; ⁴ School of Civil and Structural Engineering, Technological University Dublin, Dublin, Ireland; ⁵ International Center for Energy, Environment & Sustainability, Washington University in St Louis, St Louis, Missouri, USA

4:30pm - 4:50pm ID: 3341

Cooling Concepts for Residential Buildings: A Comparison Under Climate Change Scenarios

Essam Elnagar, Vincent Lemort

Thermodynamics Laboratory, Aerospace and Mechanical Engineering Department, Faculty of Applied Sciences, Université de Liège, Belgium, Belgium

4:50pm - 5:10pm ID: 3207

District-level validation of a shoeboxing algorithm for Urban Building Energy Modeling

Federico Battini, Giovanni Pernigotto, Andrea Gasparella

Free University of Bozen-Bolzano, Italy

5:10pm - 5:30pm ID: 3470

A Novel Hybrid Modeling Method for Predicting Energy Use of Hydronic Radiant Slab Systems

Lichen Wu¹, Liping Wang¹, James Braun²

¹ University of Wyoming; ² Purdue University

R-06: Thermal Management of Electric Batteries

Session Chair: Justin Weibel

3:30pm - 3:50pm ID: 2125

Enhancement of the Critical Heat Flux During the Cooling of Power Electronics – Part 2

Stefan Wettengel¹, Oliver Ziegler², Andreas Kluge³, Steffen Bernet¹, Lars Lindenmüller¹, Gerd Fischer³

¹ Chair of Power Electronics, TU Dresden, Germany; ² Bitzer-Chair of Refrigeration, Cryogenics and Compressor Technology, TU Dresden, Germany; ³ F&S Prozessautomation GmbH, Dohna (Dresden), Germany

MONDAY • 3:30PM - 5:00PM

3:50pm - 4:10pm **ID: 2138**

Modified Exergy Analysis of a Two-stage Refrigeration System for a Battery Electric Vehicle

George Vegini, Guilherme Ribeiro

Aeronautics Institute of Technology, Brazil

4:10pm - 4:30pm **ID: 2166**

Application of Feedforward Neural Networks in Battery Electric Vehicle Air Conditioning System Simulations

Abhishek Jain¹, Nils Framke², Arpit Tiwari¹, Mihail Spasov¹

¹ Gamma Technologies LLC, United States of America; ² Gamma Technologies GmbH, Stuttgart, Germany

4:30pm - 4:50pm **ID: 2202**

Estimation Of Reversible Entropic Heat Of Lithium Battery Based On Inverse Heat Transfer Analysis and Least-squares Optimization

Ukmin Han, Hoseong Lee

Department of Mechanical Engineering, Korea University, Korea, Republic of Korea

4:50pm - 5:10pm **ID: 2237**

Development Of Novel Hybrid Battery Thermal Management System Coupling With Phase Change Material Under Fast Charging Conditions

Seunghoon Lee¹, Hoseong Lee²

¹ Department of Automotive Convergence, Korea University, Korea, Republic of (South Korea); ² Department of Mechanical Engineering, Korea University, Korea, Republic of (South Korea)

5:10pm - 5:30pm **ID: 2131**

Multi-Objective Optimization of Battery Electric Vehicle Thermal Management System Operation

Tyler J Shelly, Justin A Weibel, Davide Ziviani, Eckhard Groll

Purdue University, United States of America

R-07: CO2 Assessment I

Session Chair: Stefan Elbel

3:30pm - 3:50pm **ID: 2151**

The Role of Internal Heat Exchanger in an R744 Vapor Compression System in the Air-conditioning Mode Under Various Conditions

Wenying Zhang¹, Vladimir Cernicin², Pega Hrnjak^{1,3}

¹ ACRC, University of Illinois, Urbana, Illinois, USA; ² Faculty of Mechanical Engineering, University of Belgrade, Belgrade, Serbia;

³ Creative Thermal Solutions, Inc., Urbana, Illinois, USA

3:50pm - 4:10pm **ID: 2153**

The Role of Internal Heat Exchanger in an R744 Vapor Compression System in the Heat Pump Mode Under Various Conditions

Vladimir Cernicin¹, Wenying Zhang², Pega Hrnjak^{2,3}

¹ Faculty of Mechanical Engineering, University of Belgrade, Serbia; ² ACRC, University of Illinois, Urbana, Illinois, USA; ³ Creative Thermal Solutions, Inc., Urbana, Illinois, USA

MONDAY • 3:30PM - 5:00PM

4:10pm - 4:30pm **ID: 2155**

Study of Heat Reclaim Application of CO₂ Booster System in Low Temperature Environment

Daqing Li, Suresh Shivashankar

Emerson Commercial & Residential Solutions, United States of America

4:30pm - 4:50pm **ID: 2162**

Thermal-Fluid Performance Modelling Of A Transcritical Carbon Dioxide Heat Pump For High Temperature Applications

Martin van Eldik, Philip van Zyl Venter, Michael Botha

North-West University, South Africa

4:50pm - 5:10pm **ID: 2457**

Thermophysical Property Measurements Of A Novel R-744 Blend For Heat Pump Applications

Monika Laura MacNeill, Clare Mary Skae, Robert Elliott Low, Christopher John Seeton,

David Grundy, Christian Ihmels

Koura Global, United Kingdom

R-08: Alternative Air-conditioning, Refrigeration & Heat Pumping I

Session Chair: Piotr Domanski

3:30pm - 3:50pm **ID: 2133**

Integration of Thermoelectric Modules to Vapor Compression Systems

Bo Shen, Kyle Gluesenkamp, Hanlong Wan

Oak Ridge National Lab, United States of America

3:50pm - 4:10pm **ID: 2141**

Studies On Fluid Dynamics And Heat Transfer Characteristics Of Solid-state Caloric Cycles Using New Electric Heating Apparatus

Minwoong Kang¹, Stefan Elbel^{1,2}

1 University of Illinois, United States of America; 2 Creative Thermal Solutions, Inc.

4:10pm - 4:30pm **ID: 2217**

Experimental Investigation of the Effect of Atomizing Electrospray Nozzles on the Cooling and Reduced Humidification of Air.

Gerard Muteba, Lorenzo Cremaschi

Auburn University, United States of America

4:30pm - 4:50pm **ID: 2334**

Performance Evaluation of an Indirect Evaporative Cooler

Alanis Sarah Zeoli, Vincent Lemort

Laboratory of thermodynamics, Aerospace and Mechanical Engineering Department, University of Liege, Belgium

4:50pm - 5:10pm **ID: 2356**

Numerical Study Of Novel Regenerator Design For Solid-state Caloric Cycles

Minwoong Kang¹, Stefan Elbel^{1,2}

1 University of Illinois, United States of America; 2 Creative Thermal Solutions, Inc.

R-09: Automated Fault Detection and Diagnostics for Equipment

Session Chair: Andrew Hjortland

3:30pm - 3:50pm ID: 2218

Modelling and Simulation of the Impact of Soft Faults in a Reversible Air-to-water Propane Heat Pump

Belen Llopis-Mengual, Jose Miguel Corberan, Emilio Navarro-Peris, Francisco Barcelo-Ruescas

Universitat Politecnica de Valencia, Spain

3:50pm - 4:10pm ID: 2278

Comparison of Multiple Fault Impacts on a Heat Pump and an Air Conditioner in Cooling Mode

Yifeng Hu, David P. Yuill

University of Nebraska Lincoln, United States of America

4:10pm - 4:30pm ID: 2339

Field Measurement-Based Validation of Fault Diagnostics for Commercial Building HVAC Systems

Amir Ebrahimiakhar¹, Yuxuan Chen², David P. Yuill², Eliot Crowe³

1 Delos Labs, Delos, New York City, NY, United States of America; 2 University of Nebraska - Lincoln, Architectural Engineering, Omaha, NE, United States of America; 3 Lawrence Berkeley National Laboratory, Building Technology and Urban Systems Division, Berkeley, CA, United States of America

4:30pm - 4:50pm ID: 2342

Electrical Signature Based Fault Detection and Classification Framework for Single-Speed, Unitary Heat Pumps Using an Adaptive Neural Network Approach

David Yuill¹, Andrea Mammoli², Thomas Caudell³, Krish Gomatom², Yifeng Hu¹, Olusegun Showunmi²

1 University of Nebraska - Lincoln, United States of America; 2 Electric Power Research Institute; 3 Electrical and Computer Engineering

4:50pm - 5:10pm ID: 2351

Using Machine Learning for Feature Selection in Automated Fault Detection and Diagnosis of Split System Air Conditioners

Yuxuan Chen¹, Amir Ebrahimiakhar², David P. Yuill¹

1 University of Nebraska - Lincoln, Architectural Engineering, Omaha, NE, United States of America; 2 Delos Labs, Delos, New York City, NY, United States of America

5:10pm - 5:30pm ID: 2429

A Universal Refrigerant Charge Fault Detection and Diagnostics Method Based on Pump Down Operation

Zhenning Li¹, Drew Welch², Bo Shen¹, Kyle Gluesenkamp¹, Brian Butler², Stuart Morgan²

1 Oak Ridge National Laboratory, United States of America; 2 Helix Innovation Center, Emerson, United States of America

R-10: Flammable Refrigerants

Session Chair: Craig Bradshaw

3:30pm - 3:50pm ID: 2232

Compressor Speed, Expansion Valve Opening and Refrigerant Charge Influences on the Propane Unit Design

Zvonimir Jankovic^{1,4}, Branimir Pavkovic², Jaime Sieres³, Marija Zivic¹

1 Department of Energetics, Mechanical Engineering Faculty in Slavonski Brod, University of Slavonski Brod, Trg Ivane Brlić-Mažuranić 2, 35000 Slavonski Brod, Croatia; 2 Department of Thermodynamics and Energy Engineering, Faculty of Engineering, University of Rijeka, Vukovarska 58, 51000 Rijeka, Croatia; 3 Área de Máquinas y Motores Térmicos, Escuela de Ingeniería Industrial, University of Vigo, Campus Lagoas-Marcosende 9, 36310 Vigo, Spain; 4 WSL Refrigeration d.o.o., Sneberska c. 111B, 1260 Ljubljana - Polje, Slovenia

MONDAY • 3:30PM - 5:00PM

3:50pm - 4:10pm ID: 2451

A Numerical Modelling Study on Submerged Condensers for Heat Pump Water Heaters Using Low-GWP Refrigerants
Mingkan Zhang, Bo Shen

Oak Ridge National Laboratory, United States of America

4:10pm - 4:30pm ID: 2461

Fractionation, Release Testing And Flammability Evaluation Of Novel Refrigerants Comprising R-744 And Fluorocarbons

David Charles Grundy, Bob Low, Chris Seeton, Vanessa Webster
Koura, United Kingdom

4:30pm - 4:50pm ID: 2504

Propane As Working Fluid For Heat Pump Water Heaters- Opportunities And Challenges
Kashif Nawaz, Joseph Rendall, Ahmed Elatar, Jian Sun

Oak Ridge National Lab, United States of America

4:50pm - 5:10pm ID: 2527

Lessons Learned from Retrofitting a Psychrometric Facility for Testing of HVAC&R Equipment with Flammable Refrigerants

Parveen Dhillon, Orkan Kurtulus, Changkuan Liang, Vatsal Shah, W. Travis Horton, James E. Braun
Ray W. Herrick Laboratories, Purdue University, United States of America

C-03: Compressor Valves

Session Chair: Joaquim Rigola

3:30pm - 3:50pm ID: 1292

Suction Valve Design Optimization To Improve Reliability
Sehnaz Ektas, Haluk Arda Avci
Arcelik A.S., Turkey

3:50pm - 4:10pm ID: 1299

Optimization of Intermediate Discharge Valve Positions in a Scroll Compressor with Deep Reinforcement Learning
Janggon Yoo, Taekyeong Jeong, Daegyoum Kim
KAIST, Korea, Republic of (South Korea)

4:10pm - 4:30pm ID: 1401

Calculation Of Internal Flow In A Compressor With Valve Motion
Shinichi Kawabata, Ryohei Deguchi, Hideki Matsuura
Daikin Industries, Ltd., Japan

4:30pm - 4:50pm ID: 1407

A Low-cost Photoelectric Based Displacement Measurement System To Quantify Valve Lift Motion In Reciprocating Type Compressors

Anjum Naeem Malik¹, Pooya Pashak¹, İsmail Lazoğlu¹, Çağlar Şahin²

¹ Manufacturing and Automation Research Center, Koç University, Istanbul, Turkey;

² Arcelik A.S. R&D Directorate 34950 Tuzla, Istanbul, Turkey

C-04: Oil & Lubrication

Session Chair: Sarah Kim

3:30pm - 3:50pm ID: 1116

Evaluation of Oil Supply System for Rotary Compressor using Two-phase flow analysis

Joonhyung Kim, Munseong Kwon, Jaewoo Park

SAMSUNG ELECTRONICS Co., Ltd.

4:10pm - 4:30pm ID: 1185

Development of Energy-efficient Refrigeration Oil for Refrigerator Using R600a

Tomohiro Takaki, Tatsuki Nakajima, Makoto Ando, Fumiayuki Nara

ENEOS Corporation, Japan

4:30pm - 4:50pm ID: 1204

Mass Flow Rate Optimization of a Reciprocating Inverter Compressors Oil Pump with CFD Simulations

Semih Gürel, Mehmet Onur Dinçer, Melih Özدilek

ARÇELİK A.Ş., Turkey

4:50pm - 5:10pm ID: 1538

Basic Study on Application of Magnetic Nano-oil to Scroll Compressor - Measurement of Friction and Leakage -

Takanobu Kikuchi, Masaaki Motozawa, Mitsuhiro Fukuta

Shizuoka University, Japan

TUESDAY • 9:40AM - 11:40AM

B-03: Smart Sensing, Data Analytics & IEQ

Session Chair: Giovanni Pernigotto

9:40am - 10:00am ID: 3143

Data Analytics for Evaluating Campus Energy Use
Whitman Jerman, Soowon Chang, William Hutzel
Purdue University, United States of America

10:00am - 10:20am ID: 3438

Investigating the Quality of the Correlation Between Indoor Environmental Factors and Human Perception
Ilaria Pittana¹, Federica Morandi², Francesca Cappelletti¹, Andrea Gasparella²
¹ Iuav University of Venice, Italy; ² Free University of Bozen-Bolzano, Italy

10:20am - 10:40am ID: 3246

Developing Learning-Based Models for Occupant Centric Control
Richard Lamont Kimball¹, Jin Wen¹, Zheng O'Niell², Tao Yang², Yicheng Li¹
¹ Drexel University, United States of America; ² Texas A&M University, United States of America

10:40am - 11:00am ID: 3370

Development of a Camera-based Tool to Monitor Non-binary Occupants' Interaction with Windows and Shadings
Julian Donges¹, Federica Morandi¹, Alessandro Prada², Francesca Cappelletti³, Andrea Gasparella¹
¹ Faculty of Science and Technology, Free University of Bozen-Bolzano, Italy; ² Dept. of Civil, Environmental and Mechanical Engineering, University of Trento, Italy; ³ Department of Architecture and Arts, Iuav University of Venice, Italy

11:00am - 11:20am ID: 3315

Preliminary Analysis On The Sensitivity To The Four Comfort Domains Of People With Autism Spectrum Condition
Arianna Marzi, Luca Zaniboni, Marco Caniato, Andrea Gasparella
Free University of Bozen - Faculty of Science and Technologies

R-11: Frost and Defrost Characterization and Modeling

Session Chair: Christian Bach

9:40am - 10:00am ID: 2123

A Review Of The Effects And Mitigation Of Frost With Focus On Air-Source Heat Pump Applications
Amirarsalan Mashhadian, Tauseef Ismail, Christian K. Bach, Aaron Alexander
Oklahoma State University, United States of America

10:00am - 10:20am ID: 2149

The Effects of the Orientation of Outdoor Microchannel Heat Exchanger on the Performance of a Transcritical R744 Heat Pump During Frosting and Defrosting
Wenying Zhang¹, Pega Hrnjak^{1,2}
¹ A CRC, University of Illinois, Urbana, Illinois, USA; ² Creative Thermal Solutions, Inc., Urbana, Illinois, USA

10:20am - 10:40am ID: 2150

The Experimental Study of Defrosting Energy of an Air-source Heat Pump System Under Various Conditions
Wenying Zhang¹, Pega Hrnjak^{1,2}
¹ ACRC, University of Illinois, Urbana, Illinois, USA; ² Creative Thermal Solutions, Inc., Urbana, Illinois, USA

TUESDAY • 9:40AM - 11:40AM

10:40am - 11:00am ID: 2308

Critical Impact of Fin Thermal Conductivity in the Modeling of Evaporator Under Frost Conditions

Antoine M. Parthoens, Samuel Gendebien, Vincent Lemort

University of Liège, Belgium

11:00am - 11:20am ID: 2586

Improving Robustness of Transient Heat Exchanger Models with Non-uniform Frost Formation

Jiacheng Ma¹, Donghun Kim², James E. Braun¹

¹Ray W. Herrick Laboratories, School of Mechanical Engineering, Purdue University West Lafayette, IN, U.S.; ²Building Technology & Urban Systems Division, Lawrence Berkeley National Laboratory Berkeley, CA, U.S.A.

R-12: Advanced System Control

Session Chair: Roy Crawford

9:40am - 10:00am ID: 2135

Adaptive Reinforcement Learning PI Controllers for Vapor Compression Cycle Control

Tech Logg Ding, Stuart Norris, Alison Subiantoro

The University of Auckland, New Zealand

10:00am - 10:20am ID: 2382

On the Feasibility of Model-Based Design and Optimal Control of Industrial Air-Conditioning System

Noma Park, Han Won Park, Soo Kyung Kim, Zhe Quan Jin, Hyuk Min Kwon, Jin Min Cho, Yoon Jei Hwang, Sai Kee Oh

LG Electronics, Korea, Republic of (South Korea)

10:20am - 10:40am ID: 2411

Rapid Energy Optimization Of Vapor Compression Systems Using Probabilistic Machine Learning And Extremum Seeking Control

Ankush Chakrabarty¹, Daniel J. Burns¹, Martin Guay², Christopher R. Laughman¹

¹Mitsubishi Electric Research Labs, Cambridge, MA, USA; ²Department of Chemical Engineering, Queen's University, ON, Canada

10:40am - 11:00am ID: 2484

Nonlinear Model Predictive Control for Integrated Thermal Management of Electric Vehicle Battery and Cabin Environment

Chao Pan, Yaoyu Li

University of Texas at Dallas, United States of America

11:00am - 11:20am ID: 2508

Simulation of a PCM Integrated Heat Pump Using Time-of-Use Utility Structure based Control Strategy for Demand Response

Zhenning Li¹, Juan Catano², Kyle Gluesenkamp¹, Bo Shen¹, Tim LaClair¹, Rob Comparin², Drew Welch²

¹Oak Ridge National Laboratory, United States of America; ²The Helix Innovation Center, Emerson, United States of America

11:20am - 11:40am ID: 2511

Hybrid Heat Pump Controls: Conventional Dual Fuel versus Seamlessly Fuel Flexible Heat Pump

Zhenning Li, Kyle Gluesenkamp, Bo Shen, Jeffrey Munk, Helia Zandi, Praveen Cheekatamarla, Steve Kowalski

Oak Ridge National Laboratory, United States of America

TUESDAY • 9:40AM - 11:40AM

R-13: Advance Equipment Sensing

Session Chair: David Yuill

9:40am - 10:00am ID: 2152

Development of a Remote Refrigerant Leakage Detection System for VRFs and Chillers

Shunsuke Kimura, Michio Moriwaki, Manabu Yoshimi, Shohei Yamada, Takeshi Hikawa, Shinichi Kasahara
Daikin Industries, Ltd., Japan

10:00am - 10:20am ID: 2282

Effect Of Heat Exchanger Size On Subcooling Control In Residential Air Conditioning Systems

Bruno Yuji Kimura de Carvalho¹, Pega Hrnjak^{1,2}

1 University of Illinois at Urbana-Champaign; 2 Creative Thermal Solutions, Inc.

10:20am - 10:40am ID: 2283

Evaluation Of Subcooling Control In Residential Heat Pumps Through Experimental And Model Analysis

Bruno Yuji Kimura de Carvalho¹, Pega Hrnjak^{1,2}

1 University of Illinois at Urbana-Champaign; 2 Creative Thermal Solutions, Inc.

10:40am - 11:00am ID: 2450

Accumulator Liquid-Level Estimator to Enable Zero-Superheat and Active Charge Control in Vapor-Compression Systems

Haopeng Liu, Jie Cai

University of Oklahoma, United States of America

R-14: Alternative Refrigerants Modeling and Test II

Session Chair: Chad Bowers

9:40am - 10:00am ID: 2233

Modular Data Center Direct Expansion HPAC Solutions – Application of R466A as Replacement for R410A

Zvonimir Jankovic¹, Jaime Sieres², Branimir Pavkovic³, Antun Barac¹

1 Department of Energetics, Mechanical Engineering Faculty in Slavonski Brod, University of Slavonski Brod, Trg Ivane Brlić-Mažuranić 2, 35000 Slavonski Brod, Croatia; 2 Área de Máquinas y Motores Térmicos, Escuela de Ingeniería Industrial, University of Vigo, Campus Lagoas-Marcosende 9, 36310 Vigo, Spain; 3 Department of Thermodynamics and Energy Engineering, Faculty of Engineering, University of Rijeka, Vukovarska 58, 51000 Rijeka, Croatia

10:00am - 10:20am ID: 2262

R468C as a Low-GWP Replacement of R410A in Fin-and-Tube Evaporators

Matin Ghadiri, Christian K. Bach, Craig R. Bradshaw

Oklahoma State University, United States of America

10:20am - 10:40am ID: 2305

Refrigerant Replacement from HFC to HC in a Medical Ultra-low Temperature Appliance: Experimental and Simulation Approach

Daniel Hense, Jackson Karnopp

Nidec GA, Brazil

10:40am - 11:00am ID: 2362

Experimental Study Of Falling Film Evaporation Of R1234ze(E) And R134a In An Innovative Shell-And-Tube Heat Exchanger

Giuseppe Censi, Andrea Padovan

Onda S.p.A.

11:00am - 11:20am ID: 2547

Experimental Investigation of R454C as a Replacement for R410A in a Residential Heat Pump Split System

Weigang Hou¹, Hafez Raeisi Fard², Larry Burns², Eckhard A. Groll¹, Davide Ziviani¹, James E. Braun¹

¹ Ray W. Herrick Laboratories, Purdue University, USA; ² Carrier Corporation, Indianapolis, USA

11:20am - 11:40am ID: 2193

R1234ze(E) as a Low-GWP Replacement of R410A in Fin-and-Tube Evaporators

Saad Saleem¹, Craig R. Bradshaw², Christian K. Bach²

¹ Energy, Sustainability & Infrastructure (ES&I) segment, Guidehouse, Burlington, MA 01803, USA; ² Center for Integrated Building Systems, Oklahoma State University, Stillwater, OK 74078, USA

C-05: Compressor Testing and Evaluation I

Session Chair: Michael Perevozchikov

9:40am - 10:00am ID: 1126

Gas Leakages Measurement Method on Hermetic Reciprocating Compressor

Aykut Bacak, Hüsnü Kerpicci, Çağlar Şahin

Arçelik A.Ş, Turkey

10:00am - 10:20am ID: 1211

Advanced Analysis of MEMS Accelerometers for Monitoring Reciprocating Refrigerant Compressors

Franz Joseph Pal¹, Robin Langebach¹, Miroslav Andjelkovic¹, Tobias Pfliehinger¹, Ulf Ahrend¹, Ullrich Hesse²

¹ University of Applied Sciences Karlsruhe, Endowed professorship for compressor technology, Institute for Refrigeration, Air Conditioning and Environmental Technology, Germany; ² Technical University of Dresden, BITZER professorship for refrigeration, cryogenics and compressor technology, Germany

10:20am - 10:40am ID: 1220

Reed Valves' Impact Velocity Measurements on Working Compressors

Paulo Victor Ribeiro Martins

Secop Austria GmbH, Austria

10:40am - 11:00am ID: 1328

Improving Lifetime of Domestic Compressor Subjected To Repetitive Internal Stresses

Seongwoo Woo¹, Dennis O'Neal², Yimer Mohammed Hassen¹

¹ Ethiopian Technical University, Ethiopia; ² Baylor University, USA

11:00am - 11:20am ID: 1564

Experimental Quantification of the Thermodynamic and Mechanical Losses of an oil-injected and economized 4/6 twin-screw compressor

Abhignan Saravana, Haotian Liu, Eckhard A. Groll, Ziviani Davide

Ray W. Herrick Laboratories, School of Mechanical Engineering, Purdue University

TUESDAY • 9:40AM - 11:40AM

C-06: Screw Compressors I

Session Chair: Gordon Powell

9:40am - 10:00am ID: 1136

Experimental Investigation Of Screw Compressor Clearance Monitoring Techniques

Thibault Tam¹, Ahmed Kovacevic¹, William J Milligan², Tong Sun³, Kenneth Grattan³, Matthias Fabian³, Thibaud Plantegenet¹, Brijeshkumar Patel¹, Sankhyabrata Bandyopadhyay³

1 Thermo-Fluids Research Centre - City, University of London, UK; 2 Howden Compressors, Glasgow UK; 3 Research Centre for Photonics and Instrumentation - City, University of London, UK

10:00am - 10:20am ID: 1285

Experimental Investigation of a Screw Spindle Vacuum Pump at Sub-Atmospheric Discharge Pressures

Thomas Werner Moesch, Paul Gustav Lemke, Konrad Klotsche, Ullrich Hesse

Technische Universität Dresden, Institute of Power Engineering, Bitzer-Chair of Refrigeration, Cryogenics and Compressor Technology, Dresden, Germany

10:20am - 10:40am ID: 1306

Development of Experimental Test Rig for Internally Geared Screw Compressors

Aleksander Krupa, Ahmed Kovacevic, Matthew Read

City, University of London, United Kingdom

10:40am - 11:00am ID: 1442

Experimental Investigation of the Effect of Oil Injection Flow Rate on the Performance of Oil-Injected Twin-Screw Compressor

Sagar Prabhakar Dundagekar, Suraj Kuber Abdan, Ashish Ramchandra Munde, Neeraj Asati, Sumit Jagannath Patil

Kirloskar Pneumatic Company Limited, India

11:00am - 11:20am ID: 1446

Training Neural Networks to Predict the Energy Efficiency of Screw Rotor Profiles

Sumit Patil^{1,2}, Sathiskumar Ponnusami¹, Ahmed Kovacevic¹, Neeraj Asati²

1 City, University of London, UK; 2 Kirloskar Pneumatic Company Limited, India

11:20am - 11:40am ID: 1560

Transient Analysis Of Startup Characteristics Of A Water-lubricated Twin-screw Air Compressor System

Yishuang Liu, Chuang Wang, Xinzhang Liao, Ziwen Xing

School of Energy and Power Engineering, Xi'an Jiaotong University, China, People's Republic of China

R-Student Paper Competition

Session Chair: Bill Murphy

9:40am - 10:00am ID: 2174

Enhancing Membrane-Based Air Dehumidification Through Non-Isothermal Operation

Andrew Fix, James Braun, David Warsinger

Purdue University, United States of America

TUESDAY • 9:40AM - 11:40AM

10:00am - 10:20am ID: 2492

How to Measure and Evaluate Refrigerant Cycles – in a Representative, Reproducible Manner? An Experimental Case Study for Water-to-Water Heat Pumps

Stephan Göbel¹, Christian Vering¹, Dirk Müller¹, André Wachau²

¹RWTH Aachen University, Institute for Energy Efficient Buildings and Indoor Climate, Aachen, Germany; ²Federal Institute for Materials Research and Testing (BAM), Berlin, Germany

10:20am - 10:40am ID: 2524

Validation of a Load-Based Testing Methodology for Residential Heat Pump Performance Characterization in Heating Mode

Parveen Dhillon¹, Drew Welch², Brian Butler², W. Travis Horton¹, James E. Braun¹

¹Ray W. Herrick Laboratories, Purdue University, United States of America; ²The Helix Innovation Center, Emerson, Dayton, United States of America

10:40am - 11:00am ID: 2190

Dynamic Modeling of Air Source Heat Pumps under Reverse-cycle Defrosting

Jiacheng Ma¹, Donghun Kim², James E. Braun¹

¹Ray W. Herrick Laboratories, School of Mechanical Engineering, Purdue University, West Lafayette, IN, U.S.; ²Building Technology & Urban Systems Division, Lawrence Berkeley National Laboratory, Berkeley, CA, U.S.

11:00am - 11:20am ID: 2512

Salt Hydrate Eutectic Mixtures for Near Ambient Thermal Energy Storage Applications

Damilola Akamo^{1,3}, Jason Hirshey², Tugba Turnaoglu³, Tim LaClair³, Kyle Gluesenkamp³, Monojoy Goswami³, Orlando Rios⁴

¹The Bredesen Center for Interdisciplinary Research and Graduate Education, University of Tennessee, Knoxville, TN.; ²George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA.; ³Oak Ridge National Laboratory, Buildings and Transportation Science Division, Oak Ridge, TN.; ⁴Department of Material Science and Engineering, University of Tennessee, Knoxville, TN.

11:20am - 11:40am ID: 2353

Techno-economic Analysis for Early-Stage Assessment of Chemical Looping Heat Pump Technology

Junyoung Kim, James E. Braun, Eckhard A. Groll, Davide Ziviani

Ray W. Herrick Laboratories, School of Mechanical Engineering, Purdue University

TUESDAY • 1:30PM - 3:50PM

B-04: MPC & Smart Building Controls

Session Chair: Yunho Hwang

1:30pm - 1:50pm **ID: 3419**

A Heuristic Model Predictive Control Method to Activate the Energy Flexibility of School Buildings

Navid Morovat¹, Andreas K Athienitis¹, José Agustín Candanedo^{1,2}

¹C oncordia University, Centre for Zero Energy Building Studies, Montréal, Québec, Canada; ² CanmetENERGY, Varennes, Québec, Canada

1:50pm - 2:10pm **ID: 3489**

Hybrid Modeling Approach For Better Identification Of Building Thermal Network Model And Improved Prediction

Sang woo Ham, Donghun Kim

Building Technologies and Urban Systems Division, Energy Technologies Area, Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley, CA, USA

2:10pm - 2:30pm **ID: 3223**

Generalized Disjunctive Programming-based, Mixed Integer Linear MPC Formulation for Optimal Operation of a District Energy System for PV Self-consumption and Grid Decarbonization: Field Implementation

Donghun Kim, Tianzhen Hong, Mary Ann Piette

Building Technology & Urban Systems Division, Lawrence Berkeley National Laboratory, United States of America

2:30pm - 2:50pm **ID: 3543**

Optimal Load Shifting for Multiple ON/OFF Air Conditioning Units: How to Avoid Unnecessary Peak for Precooling?

Donghun Kim¹, James Braun²

¹ Lawrence Berkeley National Laboratory, United States of America; ² Ray Herrick Laboratories, Mechanical Engineering, Purdue University

2:50pm - 3:10pm **ID: 3535**

Peak Demand Limiting Packaged Rooftop HVAC Unit Coordination

Joshua Devenezia, Todd Rossi, Michael Muller

Rutgers University, United States of America

R-15: Oil and Lubrication I

Session Chair: Joe Karnaz

1:30pm - 1:50pm **ID: 2265**

Transient Oil-refrigerant Mixture Migration and Change of Properties at Compressor Shutdown

Xin Wang¹, Syed Angkan Haider¹, Pega Hrnjak^{1,2}, Stefan Elbel^{1,2}

¹ University of Illinois at Urbana-Champaign, Department of Mechanical Science and Engineering, Air Conditioning and Refrigeration Center, 1206 West Green Street, Urbana, IL 61801, USA; ² Creative Thermal Solutions, Inc., 2209 North Willow Road, Urbana, IL 61802, USA

1:50pm - 2:10pm **ID: 2266**

Transient Migration of Oil at Compressor Discharge and Suction during Startup

Xin Wang¹, Syed Angkan Haider¹, Pega Hrnjak^{1,2}, Stefan Elbel^{1,2}

¹ University of Illinois at Urbana-Champaign, Department of Mechanical Science and Engineering, Air Conditioning and Refrigeration Center, 1206 West Green Street, Urbana, IL 61801, USA; ² Creative Thermal Solutions, Inc., 2209 North Willow Road, Urbana, IL 61802, USA

TUESDAY • 1:30PM - 3:50PM

2:10pm - 2:30pm **ID: 2300**

Comparison of Fresh and Used Refrigerator Compressor Oil Properties with GC-MS, GC-SIMDIS and ICP-MS Analysis

Gizem Balkız

Arçelik A.Ş., Turkey

2:30pm - 2:50pm **ID: 2195**

Effect of Lubricating Oil on the Refrigerant Heat Transfer Performance during Spray Evaporation on Tube Bundles

Jerin Robins Ebanesar, Lorenzo Cremaschi

Auburn University, United States of America

2:50pm - 3:10pm **ID: 2212**

Oil Circulation Rate Measurements with Flow-through and Evacuated Type Sampling Cylinders

Syed Angkan Haider¹, Xin Wang¹, Stefan Elbel^{1,2}

¹ Air Conditioning and Refrigeration Center, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, 1206 West Green Street, Urbana, IL 61801, USA, United States of America; ² Creative Thermal Solutions, Inc., 2209 North Willow Road, Urbana, IL 61802, USA

3:10pm - 3:30pm **ID: 2214**

Effects of Orientation and Valve Opening Speed on Oil Circulation Rate Measurements Using an Evacuated Type Sampling Cylinder

Syed Angkan Haider¹, Xin Wang¹, Stefan Elbel^{1,2}

¹ Air Conditioning and Refrigeration Center, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, 1206 West Green Street, Urbana, IL 61801, USA, United States of America; ² Creative Thermal Solutions, Inc., 2209 North Willow Road, Urbana, IL 61802, USA

3:30pm - 3:50pm **ID: 2249**

Dynamic Modeling of Oil Transport in Vapor Compression Systems

Hongtao Qiao, Christopher Laughman

Mitsubishi Electric Research Laboratories, United States of America

R-16: Alternative Refrigerants Properties

Session Chair: Brian Fricke

1:30pm - 1:50pm **ID: 2114**

New Thermodynamic Mixture Models for HFO-containing blends

Ian Bell

National Institute of Standards and Technology, United States of America

1:50pm - 2:10pm **ID: 2115**

Review of Lower GWP Refrigerants For Retrofitting R-410A Applications

Michael Petersen, Steve Kujak

Trane Technologies, United States of America

2:10pm - 2:30pm **ID: 2170**

A Fundamental Equation of State for trans-1,1,4,4-Hexafluoro-2-butene [R1336mzz(E)]

Ryo Akasaka¹, Luke D. Simoni², Eric W. Lemmon³

¹ Kyushu Sangyo University, Japan; ² The Chemours Company, USA; ³ National Institute of Standards and Technology, USA

TUESDAY • 1:30PM - 3:50PM

2:30pm - 2:50pm ID: 2375

Thermal Conductivity Measurements for Trans-1,3,3,3-Tetrafluoropropene (R1234ze(E)) in Liquid Phase

Mauro Scattolini, Giovanni Ferrarini, Laura Fedele, Stefano Rossi, Sergio Bobbo

CNR ITC, National Research Council, Construction Technologies Institute, Padova, Italy

2:50pm - 3:10pm ID: 2330

Chemical Stability Investigations of Ultra-Low GWP Refrigerants R-1336mzz(Z), R-1336mzz(E), R-514A, R-1233zd(E), and R-1224yd(Z) with Lubricants

Stephen Kujak, Morgan Herried-Leehey, Cameron Robaczewski

Trane Technologies, United States of America

3:10pm - 3:30pm ID: 2332

Chemical Stability Investigations of Low GWP Refrigerants R-1234ze(E), R-450A, R-515B, R-1234yf, R-513A and R-516A with Lubricants with Lubricants.

Stephen Kujak, Morgan Herried-Leehey, Cameron Robaczewski

Trane Technologies, United States of America

3:30pm - 3:50pm ID: 2333

Chemical Stability Investigations of Low GWP Refrigerants R-454B, R-454C, R-455A, R-468A, R-466A with Lubricants

Stephen Kujak, Morgan Herried-Leehey, Cameron Robaczewski

Trane Technologies, United States of America

R-17: Heat Pump Applications (Dryers & Water Heater)

Session Chair: Kevin Mercer

1:30pm - 1:50pm ID: 2172

Performance Analysis of an R410A Air-to-Water Heat Pump for Different Fan and Compressor Speed Combinations

Ignacio Ortega¹, Jaime Sieres¹, Fernando Cerdeira¹, José M. Santos¹, Estrella Álvarez²

¹Área de Máquinas y Motores Térmicos, Escuela de Ingeniería Industrial, University of Vigo, Campus Lagoas-Marcosende 9, 36310 Vigo, Spain; ²Chemical Engineering Department, Escuela de Ingeniería Industrial, University of Vigo, Campus Lagoas-Marcosende 9, 36310 Vigo, Spain

1:50pm - 2:10pm ID: 2256

Model Of Heat Pump Water Heater Operating On A New Storage Heat Pump Cycle To Achieve Higher Operating Range

Purav Patel¹, Stefan Elbel^{1,2}

¹University of Illinois at Urbana-Champaign, Department of Mechanical Science and Engineering, Air Conditioning and Refrigeration Center, 1206 West Green Street, Urbana, IL 61801, USA; ²Creative Thermal Solutions, Inc., 2209 North Willow Road, Urbana, IL 61802, USA

2:10pm - 2:30pm ID: 2270

Modeling and Simulation of Air-Source CO₂ Heat Pump Water Heater

Zhiming Gao, Keith Rice, Kashif Nawaz

Oak Ridge National Laboratory, United States of America

2:30pm - 2:50pm ID: 2296

Field Performance Of Domestic Heat Pumps For Heating And Hot Water In Switzerland – Insights And Analysis

Ralph Kuster, Manuel Prinzing, Matthias Berthold, Mick Eschmann, Stefan Bertsch

OST Eastern Switzerland University of Applied Sciences, Switzerland

TUESDAY • 1:30PM - 3:50PM

2:50pm - 3:10pm **ID: 2459**

Performance Modeling Of A Thermoelectric Heat Pump Clothes Dryer With Very High Air Flow

Philip Boudreux, Viral Patel, Kyle Gluesenkamp, Chris Hall, Steve Karman, Dean Ellis

ORNL, United States of America

3:10pm - 3:30pm **ID: 2468**

CFD Modeling Of Very High Air Flow In A Residential Clothes Dryer To Investigate Pressure Loss And Flow Through The Air Flow Path

Christopher Lawrence Hall, Steve Karman, Philip Boudreux, Viral Patel, Kyle Gluesenkamp, Dean Ellis

Oak Ridge National Laboratory, United States of America

3:30pm - 3:50pm **ID: 2486**

Carnot Analysis of Heat Pump Drying: Ideal Efficiency and Dry Time

Kyle R Gluesenkamp, Viral Patel

Oak Ridge National Laboratory, United States of America

R-18: Heat Exchanger Design

Session Chair: Yunho Hwang

1:30pm - 1:50pm **ID: 2124**

Improved Airside Modeling of Heat Exchangers for 1D Refrigeration Cycle Simulation through the Experimental Determination of Factors of Influence

Kevin Wimmer, Jan Kummer, Christoph Zainer, Lukas Dür, Michael Lang, Raimund Almbauer

Graz University of Technology, Austria

1:50pm - 2:10pm **ID: 2134**

Aeroacoustics Noise Characterization of Shape-Optimized Non-Round Tube Bundles in Cross-Flow Configuration

James Tancabel, Vikrant Aute, Jiazen Ling

University of Maryland, United States of America

2:10pm - 2:30pm **ID: 2192**

Effects of Air-Side Flow Maldistribution on the Heat Transfer Performance of Polymeric

Air-Coupled Heat Exchangers

Daniel B. Boman, Bataung Mohapi, Jason S. Wexler

Gradient, United States of America

2:30pm - 2:50pm **ID: 2427**

On the Pressure Drop of Various Hydraulic Pipes Including 90-Degree Bends and T-Shape

Manifolds: 1-D and 3-D Analyses

Hyun Jin Kwon¹, Yeong Jun Yun², Se-Myong Chang³, Yong Cho⁴

¹ Department of Mechanical Engineering, Kunsan National University, Korea, Republic of (South Korea); ² Department of Mathematics, Kunsan National University, Korea, Republic of (South Korea); ³ School of Mechanical Convergence System Engineering, Kunsan National University, Korea, Republic of (South Korea); ⁴ K-water Institute, Korea Water Resources Cooperation, Korea, Republic of (South Korea)

2:50pm - 3:10pm **ID: 2460**

Analysis of Droplet Motion – Sliding On and Detaching From a Vertical Surface

Haoyang Zou, Hongqing Jin, Sophie Wang

University of Illinois at Urbana-Champaign, United States of America

TUESDAY • 1:30PM - 3:50PM

3:10pm - 3:30pm **ID: 2188**

Droplet Behavior and Condensation Heat Transfer Performance on Silica Nanospring Coated Surfaces

Andrew Dillman, Adam Vuth, Giancarlo Corti, Andrew Sommers

Dept. of Mechanical & Manufacturing Engineering, Miami University, Oxford, OH USA

3:30pm - 3:50pm **ID: 2381**

Using Local Entropy Generation Rate in Air-Side Heat Exchanger Design

Max Friestad, Anthony M. Jacobi

University of Illinois at Urbana-Champaign, United States of America

C-07: Novel Compressors I

Session Chair: Ken Monnier

1:30pm - 1:50pm **ID: 1119**

Updated Performance and Operating Characteristics of a Novel Rotating Spool Compressor

Joe Orosz¹, Greg Kemp¹, Craig Bradshaw², Eckhard Groll³

1 TORAD Engineering LLC, United States of America; 2 Center for Integrated Building Systems, Oklahoma State University;

3 Ray W. Herrick Laboratories, Purdue University

1:50pm - 2:10pm **ID: 1201**

Lessons Learned from the Modelling of a Novel Compressor-Expander

Andy Pearson¹, Jon Fenton², Joe Subert²

1 Star Refrigeration Ltd, United Kingdom; 2 FeTu Ltd, United Kingdom

2:10pm - 2:30pm **ID: 1210**

Development and Experimental Validation of a Mechanistic Chamber Model of a Novel Peristaltic Compressor

Mazharul Islam, Jeffery Nicholas, Craig R Bradshaw

Oklahoma State University, United States of America

2:30pm - 2:50pm **ID: 1379**

Optimum Spool Compressor Aspect Ratio for R134a and R1234ze(E)

M. Mohsin Tanveer¹, Craig R. Bradshaw¹, Joe Orosz², Greg Kemp²

1 Center for Integrated Building Systems, Oklahoma State University, Stillwater, Oklahoma 74078;

2 Torad Engineering LLC, Cumming, GA 30040

2:50pm - 3:10pm **ID: 1444**

Initial Design and Experimental Results of a Novel Near-Isothermal Compressor for Heat Pump Applications

Stephen Kowalski¹, Joseph Rendall¹, Praveen Cheekatamarla¹, Ahmad Abu-Heiba¹, Gehl Anthony¹, Ayyoub

Momen², Kashif Nawaz¹

1 Oak Ridge National Laboratory, United States of America; 2 Ultrasonic Technology Solutions, United States of America

3:10pm - 3:30pm **ID: 1518**

Near Isothermal Steam Compressor for Jaggery Making

Milind Rane, Arun M Jha, Aditya M Rane

IIT Bombay, India

3:30pm - 3:50pm **ID: 1552**

Epitrochoidal Gerotor Profiles with Asymmetric Lobes

Matthew Read

City, University of London, United Kingdom

C-08: Compressor Modeling II

Session Chair: Ahmed Kovacevic

1:30pm - 1:50pm ID: 1160

Simulation technology of Oil circulation rate with Moving particle for Scroll Compressors

Tsutomu Nozaki¹, Kazuyuki Matsunaga²

¹ Hitachi, Japan; ² Hitachi-Johnson Controls Air Conditioning, Japan

1:50pm - 2:10pm ID: 1163

A Statistical Machine Learning Performance Modelling Approach For A Carbon Dioxide Variable Speed Compressor

Philip van Zyl Venter, Martin van Eldik, Roelof Coetzer

North-West University, South Africa

2:10pm - 2:30pm ID: 1180

Mechanistic Chamber Models: A Review of Geometry, Mass Flow and Heat Transfer Sub-Models and an Outlook to Future Research

Muhammad Mohsin Tanveer¹, Craig R. Bradshaw¹, Xin Ding², Davide Ziviani²

¹ Center for Integrated Building Systems, Oklahoma State University, Stillwater, Oklahoma, 74078;

² PURDUE University, School of Mechanical Engineering, R. W. Herrick Laboratories, West Lafayette, IN, 47907

2:30pm - 2:50pm ID: 1298

Cfd Approach To Optimize Discharge Flow Line Of A Reciprocating Compressor

Sehnaz Ektas¹, Murat Piri²

¹Arcelik A.S., Turkey; ²Manisa Uretim ve Teknoloji A.S.

2:50pm - 3:10pm ID: 1559

Dynamic Simulation and Anti-Surge System Design of a Demethanizer Compression Unit

Mahshid Zaresharif¹, Jafar Hooshmand²

¹Dublin City University, Dublin, Ireland; ² HATCO Compression & Separation, Tehran, Iran

C-Student Paper Competition

Session Chair: Bruce Harley

1:30pm - 1:50pm ID: 1111

Infrared-Thermography And Numerical Investigation Of Conjugate Heat Transfer In Roots Blower

Brijeshkumar Patel, Sham Rane, Ahmed Kovacevic

City university of London (SMCSE), United Kingdom

1:50pm - 2:10pm ID: 1200

Semi-empirical Scroll Compressor Model with Optional Vapor-injection

Jan Christ^{1,2}, Fabian Schmid¹, Konstantinos Stergiaropoulos², Stefan Bertsch³

¹ Robert Bosch GmbH, Germany; ² University of Stuttgart, Germany; ³ Eastern Switzerland University of Applied Sciences, Switzerland

2:10pm - 2:30pm ID: 1289

Numerical Investigation of Pressure Losses and its Effect During Intake in a Steam Wankel Expander

Auronil Mukherjee, Satyanarayanan Seshadri

Energy and Emissions Research Group, Indian Institute of Technology Madras Chennai- 600036, Tamil Nadu, India

TUESDAY • 1:30PM - 3:50PM

2:30pm - 2:50pm **ID: 1307**

A Novel Experimental Rig to Investigate the Effect of the Refrigerant on the Oil Supply of a Variable Capacity Reciprocating Compressor

Vitor M Braga, Cesar J Deschamps

Federal University of Santa Catarina, Brazil

2:50pm - 3:10pm **ID: 1318**

Evaluation And Quantification Of Semi-Empirical Compressor Model Predictive Capabilities Under Modulation And Extrapolation Scenarios

Kalen S. Gabel, Craig R. Bradshaw

Center for Integrated Building Systems, Oklahoma State University, Stillwater, OK 74078

3:10pm - 3:30pm **ID: 1566**

Rotordynamic and Fatigue Analyses of a Twin-Screw Compressor with 4-6 Configuration and Internal Cooling Channels

Abhignan Saravana¹, Eckhard A. Groll¹, Ziviani Davide¹, James Collins², Nicholas Able², Haotian Liu¹

¹*Ray W. Herrick Laboratories, School of Mechanical Engineering, Purdue University, West Lafayette, United States of America;*

²*Ingersoll Rand, United States of America*

TUESDAY • 4:20PM - 6:20PM

R-19: Load Based Testing I

Session Chair: Andrew Hjortland

4:20pm - 4:40pm **ID: 2127**

Introduction to ASHRAE 205 – A New Standard for HVAC&R Performance Maps

Ralph T. Muehleisen¹, Charles S. Barnaby², Neal Kruis³, Timothy P. McDowell⁴

¹*Argonne National Laboratory; 2 Consultant; 3 Big Ladder Software; 4 Thermal Energy System Specialists, LLC*

4:40pm - 5:00pm **ID: 2340**

Load-based Testing of Heating and Cooling Equipment Informed by Detailed Energy Models

Aleksandr Fridlyand, Alejandro Baez Guada, Navin Kumar, Abbas Ahsan, Tim Kingston, Paul Glanville

GTI Energy, United States of America

5:00pm - 5:20pm **ID: 2522**

Thermostat Environment Emulator Design Update and Assessment for Load-Based Testing Methodology

Dohyeon Kim, Parveen Dhillon, W. Travis Horton, James E. Braun

Ray W. Herrick Laboratories, Purdue University, United States of America

5:20pm - 5:40pm **ID: 2523**

Effect of a Thermostat Environment Emulator on Load-Based Test Results for a Residential Heat Pump

Parveen Dhillon, Dohyeon Kim, W. Travis Horton, James E. Braun

Ray W. Herrick Laboratories, Purdue University, United States of America

R-20: Heat Pump Design and Applications I

Session Chair: Stefan Bertsch

4:20pm - 4:40pm ID: 2435

A Platform-Based Product Family Design Method Using Standardized Models with Physical Similarity Law and Its Application to Room Air Conditioners

Takashi Kobayashi¹, Shingo Hamada², Naoki Nakagawa², Hajime Ikeda¹, Hironori Hattori¹, Takuya Kodama¹, Xingfa Zhou³, Yun Lu³, Hironori Nagai²

¹Design Systems Engineering Center, Mitsubishi Electric Corp. Japan; ²Shizuoka Works, Mitsubishi Electric Corp. Japan;

³Shanghai Mitsubishi Electric & Shangling Air-conditioner and Electric Appliance Co.Ltd. China

4:40pm - 5:00pm ID: 2502

Cold Climate Integrated Heat Pump

Bo Shen, Jeffrey Munk, Kyle Gluesenkamp

Oak Ridge National Lab, United States of America

5:00pm - 5:20pm ID: 2157

Carnot -Equivalent Air Cycle Heat Pump Leveraging Isentropic and Isothermal Compression and Expansion Principles – A Theoretical Analysis

Daniel Bacellar, Selorm Tsikata, Reinhard Radermacher

University of Maryland, United States of America

5:20pm - 5:40pm ID: 2178

Comparison Study of a Traditional Ducted Heat Pump and a Multi Split Heat Pump

Manoj Bhandari, Nelson Fumo

The University of Texas at Tyler, United States of America

R-21: Experimental Characterization of Two-phase Flow I

Session Chair: Leon Brendel

4:20pm - 4:40pm ID: 2409

Optical Measurements Of Liquid Film Thickness During Condensation In A Small Diameter Tube

Arianna Berto¹, Pascal Lavieille², Marco Azzolin¹, Stefano Bortolin¹, Marc Miscevic², Davide Del Col¹

¹Department of Industrial Engineering, University of Padova;

²Université Toulouse III - Paul Sabatier, Laboratoire Plasma et Conversion d'Énergie

4:40pm - 5:00pm ID: 2408

Condensation Heat Transfer Coefficient Measurements and Flow Pattern Visualizations of R515B and R450A Inside a 3.4 mm Diameter Channel

Marco Azzolin, Arianna Berto, Stefano Bortolin, Nicolò Mattiuzzo, Davide Del Col

Department of Industrial Engineering, University of Padova, Italy

5:00pm - 5:20pm ID: 2373

Experimental Study on Condensation Heat Transfer of R454B inside Small Diameter Microfin Tube

Afdhal Kurniawan Mainil¹, Hakimatul Ubudiyah¹, Naoki Sakamoto¹, Keishi Kariya², Akio Miyara^{2,3}

¹Graduate School of Science and Engineering, Saga University, Japan; ²Department of Mechanical Engineering, Saga University, Japan;

³International Institute for Carbon-Neutral Energy Research, Kyushu University, Japan

TUESDAY • 4:20PM - 6:20PM

5:20pm - 5:40pm ID: 2350

Enhanced Pool Boiling Of Low-Pressure Refrigerants On Round Tubes- An Experimental Evaluation

Cheng-Min Yang¹, William Asher², Matthew Sandlin³, Kashif Nawaz¹

¹ Oak Ridge National Lab, United States of America; ² Gas Technology Institute (GTI), United States of America;

³ Heliogen, United States of America

5:40pm - 6:00pm ID: 2349

Flow Boiling Heat Transfer Characteristics Of Water For Metal-Foam-Filled Horizontal Tube

Cheng-Min Yang, Kashif Nawaz, Anthony Gehl

Oak Ridge National Laboratory, United States of America

6:00pm - 6:20pm ID: 2272

Pressure Drop of Low GWP Refrigerant Mixture of R1234yf and R32 inside Small Diameter Horizontal Microfin Tube

Hakimatul Ubudiyah¹, Afdhal Kurniawan Mainil¹, Kazuki Sadakata¹, Keishi Kariya², Akio Miyara^{2,3}

¹ Graduate School of Science and Engineering, Saga University, Saga, 840-8502, Japan; ² Department of Mechanical Engineering, Saga University, Saga, 840-8502, Japan; ³ International Institute for Carbon-Neutral Energy Research, Kyushu University, Fukuoka, 819-0395, Japan

R-22: Systems Integrated with PCMBbased TES

Session Chair: Zhenning Li

4:20pm - 4:40pm ID: 2177

Model-based Co-Simulation of Heat Pump Water Heater with Embedded Phase Change Materials

Thermal Energy Storage

Jian Sun, Kashif Nawaz, Joe Rendall, Jamieson Brechtl, Ahmed Elatar

Oak Ridge National Laboratory, United States of America

4:40pm - 5:00pm ID: 2146

Design of Phase-change Thermal Storage Device in a Heat Pump for Building Electric Peak Load Shaving

Ransisi Huang, Allison Mahvi, Eric Kozubal, Jason Woods

National Renewable Energy Lab, United States of America

5:00pm - 5:20pm ID: 2241

Experimental Results Of Density Controlled Phase Change Material Capsules For Increased First Hour

Rating For Heat Pump Water Heaters

Joseph Rendall¹, Will Asher², Jamieson Brechtl¹, Kai Li¹, Cheng-Min Yang¹, Jian Sun¹, Kashif Nawaz¹, Tony Gehl¹

¹ ORNL, United States of America; ² GTI, United States of America

5:20pm - 5:40pm ID: 2302

Two-phase Loop Thermosiphon Coupled With Latent Heat Storage For Electronics Cooling

Björn Albertsen^{1,2}, Arne Speerforck²

¹Nordex SE, Germany; ²Hamburg University of Technology, Germany

5:40pm - 6:00pm ID: 2496

Innovative Organic Thermal Energy Storage for Building Heating

Simone Mancin¹, Claudio Zilio¹, Domenico Feo²

¹ University of Padova, Italy; ² Sunservice srl, Italy

6:00pm - 6:20pm ID: 2499*Optimal Operating Temperatures for a Variable-Temperature Thermal Energy Storage System*

Patrick Krane, Davide Ziviani, James Braun, Neera Jain, Amy Marconnet

Purdue University, United States of America

C-09: Reciprocating Compressors I**Session Chair:** Matt Cambio**4:20pm - 4:40pm ID: 1528***Study of High-Performance Engineering Polymers Applied in Reciprocating Hermetic Refrigeration Compressors – Part 2: Extension to New Components & Experimental Validation*Mohammad Qasim Shaikh¹, Patrick Kunc¹, Roger Nelson¹, Laurent Hazard¹, Philippe Martin¹, Celso Kenzo Takemori², Edmar Baars², Luis Miguel Valdes Lopez², Gustavo Rafael Bernardes²¹Solvay Materials, Alpharetta, GA, United States of America; ²Vibroacustica Research and Development, Joinville, SC, Brazil**4:40pm - 5:00pm ID: 1261***Numerical And Experimental Investigation Of The Cylinder Inlet Temperatures For Different Designs Of The Suction Line Of A Hermetic Reciprocating Compressor*Julian Gräf¹, Jan Tuhovcak², Ricardo Brancher²¹University of Applied Sciences FH Joanneum GmbH, Austria; ²Secop GmbH, Austria**5:00pm - 5:20pm ID: 1267***Experimental Investigation of Liquid Slugging in the Suction Mufflers of Hermetic Reciprocating Compressors*Teo B Balconi¹, Tadeu T Rodrigues², Cesar J Deschamps¹¹Federal University of Santa Catarina, Brazil; ²Nidec-GA, Brazil**5:20pm - 5:40pm ID: 1314***A Critical Analysis of the Characterization of Reciprocating Compressors Energy Consumption*Javier Marchante¹, Jose Miguel Corberan¹, Emilio Navarro Peris¹, Som Shrestha²¹Universitat Politècnica de Valencia, Spain; ²Oak Ridge National Laboratory**C-10: NVH I****Session Chair:** Patricia Davies**4:20pm - 4:40pm ID: 1164***The Optimisation of the Inlet Diameter and the Filter of the Muffler of the Hermetic Compressors*

Semih Gürel, Sarper Maraşlı, İsmail Yeşilaydın

ARÇELİK A.Ş., Turkey

4:40pm - 5:00pm ID: 1187*Reducing Compressor Vibrations by Load Torque Compensation from Acoustic Perspective*Anja Christine Thielecke¹, Jürgen Herbst¹, Johannes Hübel¹, Wolfgang Friede¹, Stefan Becker²¹Bosch Thermotechnik GmbH, Germany;²Lehrstuhl für Prozessmaschinen und Anlagentechnik, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

TUESDAY • 4:20PM - 6:20PM

5:00pm - 5:20pm ID: 1189

Virtual Prototyping Methodology: Predicting Start Stop Movement of Pump Unit by Simulation

Blaz Terlevic, Norbert Nerpel, Denis Nikitin, Mattias da Silva Castro

SECOP Austria GmbH, Austria

5:20pm - 5:40pm ID: 1219

3D Printed Turbine-like Inserts As An Effective Pressure Pulsation Dampers In Positive-displacement Compressors Manifolds

Przemyslaw Mlynarczyk, Damian Brewczynski, Joanna Krajewska-Spiewak, Paweł Lempa, Jarosław Bladek, Kamil Chmielarczyk

Cracow University of Technology, Faculty of Mechanical Engineering, Poland

5:40pm - 6:00pm ID: 1434

A Sound Reduction Solution of Rotary Compressor by Experimental Source Analysis

Masaya Ichihara¹, Takeshi Chinen¹, Takuya Hirayama¹, Hisataka Kato²

¹ Toshiba Carrier Corporation, Core Technology Center, Tadehara 336, Fuji City, Shizuoka Prefecture, Japan 416-8521;

² Toshiba Carrier Corporation, Compressor Design Department, Tadehara 336, Fuji City, Shizuoka Prefecture, Japan 416-8521

B-Student Paper Competition

Session Chair: Ming Qu

4:20pm - 4:40pm ID: 3347

Comparison Study Of High-performance Rule-based HVAC Control With Deep Reinforcement Learning-based Control In A Multi-zone VAV System

Xing Lu¹, Yangyang Fu¹, Shichao Xu², Qi Zhu², Zheng O'Neill¹, Zhiyao Yang¹

¹ Texas A&M University, College Station, Texas, USA; ² Northwestern University, Evanston, USA

4:40pm - 5:00pm ID: 3488

A Luminance-based Approach For Inferring Personal Daylight Preferences Using A New Composite Similarity Index

Dongjun Mah^{1,2}, Jie Xiong³, Athanasios Tzempelikos^{1,2}

¹Purdue University, United States of America; ²Center for High Performance Buildings, Ray W. Herrick Laboratories, Purdue University, United States of America; ³National Renewable Energy Laboratory, United States of America

5:00pm - 5:20pm ID: 3209

Building Energy Model Calibration with Functional Inputs and Outputs for Performance Monitoring

Thomas Cerbelaud^{1,2}, Bruno Duplessis², Riad Ziour¹, Pascal Stabat²

¹ OpenEnergy R&D, France; ² Mines Paris, PSL Research University, CES - Centre for Energy Efficiency of Systems

5:20pm - 5:40pm ID: 3363

Smart Low-cost Thermal Imaging Acquisition Towards Personal Comfort Prediction

Ati Soleimani Javid, Iason Konstantzos

Durham School of Architectural Engineering & Construction, University of Nebraska - Lincoln, USA

TUESDAY • 4:20PM - 6:20PM

5:40pm - 6:00pm ID: 3326

Energy Model of an Air Source Heat Pump to Explore Performance Improvements under Cold Conditions: a Python Framework

Conrado Ermel^{1,2}, Marcus V.A. Bianchi¹, Paulo S. Schneider²

¹ National Renewable Energy Laboratory, United States of America; ² Federal University of Rio Grande do Sul, Brazil

6:00pm - 6:20pm ID: 3476

Model Predictive Control for a Grid-interactive Efficiency Thermal-storage-integrated Heat Pump System

Liang Shi¹, Ming Qu¹, Xiaobing Liu², Jin Dong², Borui Cui², Lingshi Wang²

¹ Purdue University, United States of America; ² Oak Ridge National Laboratory, United States of America

WEDNESDAY • 9:40AM - 12:00PM

B-05: Building Performance Monitoring, Energy Management & FDD

Session Chair: Marcus Bianchi

9:40am - 10:00am ID: 3562

Assessing EMIS Benefits: A New Field Evaluation Protocol Offers Rigor and Flexibility

Guanjing Lin, Eliot Crowe, Valerie Nibler, Jessica Granderson

Lawrence Berkeley National Lab, United States of America

10:00am - 10:20am ID: 3337

Field-test performance of Solid Oxide Fuel Cells (SOFC) for residential cogeneration applications

Nicolas Paulus, Vincent Lemort

ULiege, Belgium

10:20am - 10:40am ID: 3182

Lagged-kNN Based Data Imputation Approach for Multi-Stream Building Systems Data

Ojas Pradhan¹, David Hälleberg², Zhelun Chen¹, Jin Wen¹, Teresa Wu³, K. Selcuk Candan³, Zheng O'Neill⁴

¹ Drexel University, Philadelphia, PA, USA; ² KTH Royal Institute of Technology, Stockholm, Sweden;

³ Arizona State University, Tempe, AZ, USA; ⁴ Texas A&M University, College Station, TX, USA

10:40am - 11:00am ID: 3478

Modeling Air Handling Units to Create a Diverse Fault Dataset for FDD Innovation: Lessons Learned and Recommendations

Armando Casillas¹, Guanjing Lin¹, Yimin Chen¹, Jessica Granderson¹, Sen Huang², Zhelun Chen³

¹ Lawrence Berkeley National Laboratory, United States of America; ² Pacific Northwest National Laboratory, United States of America;

³ Drexel University, United States of America

11:00am - 11:20am ID: 3234

Numerical Investigation of Solar and Geothermal Powered Desiccant Assisted Air Conditioning in Full-Year Operation

Peter Niemann, Arne Speerforck

Hamburg University of Technology, Germany

WEDNESDAY • 9:40AM - 12:00PM

11:20am - 11:40am ID: 3490

Fault Detection and Diagnostic Method Based on Evolving Data-driven Model for Radiant Heating and Cooling Systems

Sujit Dahal¹, Liping Wang¹, James Braun²

¹ University of Wyoming; ² Purdue University

R-23: Absorption Technology

Session Chair: Kyle Gluesenkamp

9:40am - 10:00am ID: 2235

Performance Analysis of a Novel Ejector-assisted Non-cascading Compression-absorption-resorption Refrigeration System

Anil Kumar, Anish Modi

Department of Energy Science and Engineering, Indian Institute of Technology Bombay, Powai, Mumbai 400076, Maharashtra, India

10:00am - 10:20am ID: 2284

Experimental Studies on a Bubble Absorber with Swirl Entry of Refrigerant Vapour

Narashimareddy Sanikommu¹, Mani A², Shaligram Tiwari³

¹ Indian Institute of Technology Madras, India; ² Indian Institute of Technology Madras, India; ³ Indian Institute of Technology Madras, India

10:20am - 10:40am ID: 2474

Sensitivity Study To An Absorption System Performance Considering Heat And Mass Transfer Enhancements

Jian Zheng, Jesús Castro, Giorgos Papakokkinos, Oliva Assensi

Universitat Politècnica de Catalunya, Spain

10:40am - 11:00am ID: 2481

Experimental Study of an Energy-efficient Sorption-based Clothes Dryer

Masoud Ahmadi¹, Behnam Ahmadi¹, Kyle Gluesenkamp², Kashif Nawaz², Sajjad Bigham¹

¹ Department of Mechanical Engineering-Engineering Mechanics, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931-1295, USA; ² Building Technologies Research and Integration Center, Oak Ridge National Laboratory, One Bethel Valley Road, P.O. Box 2008, MS-6070, Oak Ridge, TN 37831- 6070, USA

11:40am - 12:00pm ID: 2594

Double-Lift Ammonia/Water Compression-Resorption Heat Pump for Simultaneous Industrial Process Heating and Refrigeration Applications

Dereje S. Ayou, Alberto Coronas

Universitat Rovira i Virgili, Department of Mechanical Engineering, CREVER-Group of Applied Thermal Engineering, Av. Països Catalans 26, 43007 Tarragona, Spain

R-24: Vapor Compression System Modeling I

Session Chair: Jiazen Ling

9:40am - 10:00am ID: 2243

Influence of the High-outdoor Temperature on an Air conditioner Operation: Second-Law Analysis for Low-GWP Refrigerant Fluids

Leonardo Franco, Izabela Henriques, Guilherme Ribeiro

Aeronautics Institute of Technology, Brazil

10:00am - 10:20am ID: 2321

Low-Carbon District Heating: Performance Modeling of Hybrid Solar, Heat Pump and Thermal Storage Systems for District Thermal Energy in the United States

Jordan Tracy Cox¹, Gustavo Campos¹, Paul Armatis¹, Scott Belding¹, Travis Lowder¹, Andreas Zourellis²

¹ National Renewable Energy Laboratory, United States of America; ² Aalborg CSP

10:20am - 10:40am ID: 2323

Optimal Refrigerant Charge Determination based on SCOP Maximization with IMST-ART Simulation Tool

Luis Sánchez-Moreno Giner, Francisco Bárcelo Ruescas, José González Maciá

Instituto de Ingeniería Energética. Universitat Politècnica de València, Spain

10:40am - 11:00am ID: 2371

Simulation Research On Variable Speed Air Conditioner Under Extreme Conditions

Lei Zhang, Chunhui Liu

Shanghai Highly Electrical Appliances CO. LTD, China, People's Republic of China

11:00am - 11:20am ID: 2386

Physics Informed Machine Learning Based Reduced Order Model of Unitary Equipment

Shahzad Yousaf, Craig Bradshaw, Rushikesh Kamalapurkar, Omer San

Center For Integrated Buildings Systems, Oklahoma State University, Stillwater 74078

11:20am - 11:40am ID: 2574

Development of a Standardized Refrigerant Evaluation Tool for Air Conditioning and Refrigeration Equipment Using a General-Purpose Energy-Analysis Simulator

Niccolo Giannetti¹, Kiyoshi Saito², Koji Yamashita³, Shigeharu Taira³

¹ Waseda Institute for Advanced Study, Waseda University, Japan; ² Department of Applied Mechanics and Aerospace, Waseda University, Japan; ³ The Japan Refrigeration and Air Conditioning Industry Association, Japan

R-25: Heat Exchangers Testing

Session Chair: Vikrant Aute

9:40am - 10:00am ID: 2159

3 and 5mm Copper Tube Fin Heat Exchangers: Continued Testing and Frost Developing Characteristics

Dennis Michael Nasuta¹, Song Li¹, Regina Hong²

¹ Optimized Thermal Systems; ² OTS Energy

WEDNESDAY • 9:40AM - 12:00PM

10:00am - 10:20am ID: 2231

Experimental Evaluation of Separation Efficiency in the Intermediate Header of a MC Condenser

Jun Li^{1,2}, Pega Hrnjak^{1,3}

1 ACRC, the University of Illinois, Urbana, Illinois, USA; 2 Department of Materials Science and Engineering, University of Michigan, Ann Arbor, Michigan, USA; 3 Creative Thermal Solutions, Inc., Urbana, Illinois, USA

10:20am - 10:40am ID: 2269

The Effect of Corrosion Protection Methods on The Thermal-Hydraulic Performance of Aluminum Microchannel Heat Exchangers

Yupeng Wang¹, Hui Zhao^{1,2}, Pega Hrnjak^{1,2}

1 University of Illinois at Urbana-Champaign; 2 Creative Thermal Solution, Inc.

10:40am - 11:00am ID: 2273

Differential Mass Evacuation Sampling Method for Measuring Refrigerant Charge in Round Tube Plate Fin Heat Exchangers (ASHRAE RP-1785)

Abraham J Lee, Christian K Bach, Craig R Bradshaw

Oklahoma State University, United States of America

11:00am - 11:20am ID: 2329

Toward Optimal Secondary Furnace Heat Exchanger: Acquisition of Heat Transfer Correlations

Simon B Devlin, Christian K Bach, Aaron S Alexander, Hyunjin Park, James Cook, Tien Nguyen, Aaron Board

Oklahoma State University, United States of America

11:20am - 11:40am ID: 2355

Evaporator Flooding upon Compressor Start-up as a Function of Heat Exchanger Geometry and Refrigerant

Smrithi Pranatharthi Haran, Leon P. M. Brendel, Haotian Liu, James E. Braun, Eckhard A. Groll

School of Mechanical Engineering, Purdue University

11:40am - 12:00pm ID: 2397

Experimentally Validated Correlations for Heat Transfer and Pressure Drop for Single-phase Flow in Frame-and-Plate Heat Exchanger

Abdel-Rahman Farraj¹, Pega Hrnjak^{1,2}

1 ACRC, University of Illinois at Urbana-Champaign, USA; 2 Creative Thermal Solutions, Inc., Urbana, Illinois, USA

R-26: Domestic and Light-Commercial Refrigeration

Session Chair: Brian Fricke

9:40am - 10:00am ID: 2145

Three-Dimensional Modeling of the Solidification Front in Ice Cubes

Guilherme Berno, Fernando Knabben, Christian Hermes

Department of Mechanical Engineering, Federal University of Santa Catarina

10:00am - 10:20am ID: 2175

Cycle Architectures for Two-Door Refrigerators: Performance Breakdown

Vitor Liston¹, Guilherme Santos¹, Gustavo Montagner², Christian Hermes¹

1 Department of Mechanical Engineering, Federal University of Santa Catarina, Florianópolis, SC, Brazil;

2 Nidec Global Appliance, Joinville, SC, Brazil

WEDNESDAY • 9:40AM - 12:00PM

10:20am - 10:40am ID: 2179

Multi-Objective Optimization of a Vapor Compression Portable Cooler

Diego Marchi, Vitor Alves, Christian Hermes

Department of Mechanical Engineering, Federal University of Santa Catarina

10:40am - 11:00am ID: 2225

Modeling of Ice Harvest and Dispensing Processes of Domestic Icemaker Systems Using DEM

Elizabeth Wohlers¹, Lucilla Coelho de Almeida², Vinicius Daroz²

1 Sub-Zero Group, United States of America; 2 ESSS, Brazil

11:00am - 11:20am ID: 2259

Characteristics and Control of Popping Noise in a Refrigerator Using R600a

Yingyue Zhang¹, Stefan Elbel^{1,2}

1 University of Illinois at Urbana-Champaign, United States of America; 2 Creative Thermal Solutions, Inc.

11:20am - 11:40am ID: 2519

Cold Storage in India for Small Farmers - Current Status and Challenges

Arunendra Kumar Tiwari, Harischander Harischander, Milind V Rane

IIT Bombay, India

11:40am - 12:00pm ID: 2578

Performance Evaluation Of R471A In Refrigerated Display Cabinet And Walk-In-Cooler

Kaimi Gao, Nilesh Purohit, Elizabeth Vera Becerra, Ronald Vogl, Ryan Hulse, Ankit Sethi

Honeywell, United States of America

R-27: Oil and Lubrication II

Session Chair: Chris Seeton

9:40am - 10:00am ID: 2215

Impact of Lubricant in the Evaporator as a function of Oil Circulation Rate in Variable Speed Heat Pumps working with R290

Ruben Ossorio¹, Emilio Navarro Peris¹, Riley Barta², Alejandro Lopez-Navarro¹

1 Universitat Politècnica de Valencia, Spain; 2 Technische Universität Dresden, Germany

10:00am - 10:20am ID: 2248

What's Important When Designing For A New Refrigerant? Lubricant Perspective

Joseph Anthony Karnaz

Shrieve Chemical Products, LLC, United States of America

10:20am - 10:40am ID: 2288

Development Of Refrigeration Oils With High Electric Resistivity For New Energy Vehicles

Satoshi Goto, Tatsuki Nakajima, Yasushi Onumata

ENEOS Corporation

10:40am - 11:00am ID: 2431

Surface Tension, Oil Level and Density Measurement of Oil/Refrigerant Mixture by Maximum Bubble Pressure Method

Guanting Lee¹, Mitsuhiro Fukuta², Masaaki Motozawa², Ryota Kimura¹, Ryo Tsujita¹

1 Graduate School of Integrated Science and Technology, Shizuoka University, Hamamatsu, 432-8561, Japan;

2 Department of Mechanical Engineering, Shizuoka University, Hamamatsu, 432-8561, Japan

WEDNESDAY • 9:40AM - 12:00PM

11:00am - 11:20am ID: 2432

1,1-Difluoroethylene Thermal Stability, Material Compatibility and Refrigerant/Lubricant Interactions Study

Rusul Al-rubaay, Robert E. Low, Christopher J. Seeton

Koura Global

11:20am - 11:40am ID: 2433

R1234ze(E) Specialized Refrigeration Lubricant in HFO Blend Application

Yu-Kai Chen, Yu-Hsiang Wang, Jung-Tsung Hung

Patech Fine Chemicals, Taiwan

11:40am - 12:00pm ID: 2455

On the Lubricant Pathway in Rotary Compressors

Puyuan Wu¹, Jun Chen¹, Paul Sojka¹, Yang Li², Hongjun Cao²

¹ School of Mechanical Engineering, Purdue University, United States of America; ² Guangdong Meizhi Compressor Co., Ltd., China

C-11: Compressor Testing and Evaluation II

Session Chair: Jan Muehlbauer

9:40am - 10:00am ID: 1186

Terminal Arcing Forced Failure Test Design

Tugba Cetinturk¹, Ozan Kirdar², Muslum Sinan Kok²

¹ TU-WIS Consulting, Training, Organization Industry and Trade Limited Company; ² ARCELIK A.S. KOMPRESOR ISLETMESI, Turkey

10:00am - 10:20am ID: 1263

Design Of A Two-phase Reciprocating Expansion Test-rig For Model Validation

Xander van Heule, Elias Vieren, Michel De Paepe, Steven Lecompte

Ghent University, Belgium

10:20am - 10:40am ID: 1294

Comparison of Low-Cost Detection Methods for Liquid Refrigerant Flow at Compressor Inlet

Robin Langebach, Miroslav Andjelkovic, Tobias Pfliehinger, Franz Joseph Pal

Karlsruhe University of Applied Sciences, Germany

10:40am - 11:00am ID: 1391

A Proposal of Graphing Methods for Improved Compressor Test Data Evaluation

Lars Sjoholm, YoungChan Ma, Bruce Wynn

Thermo King / Trane Technologies

11:00am - 11:20am ID: 1404

Health Management System for Compressors in Hydrogen Refueling Stations Based on Nondestructive Fault Diagnosis Method

Xueying Li¹, Xueyuan Peng^{1,2}, Da Chen¹, Xiaohan Jia¹

¹ School of Energy and Power Engineering, Xi'an Jiaotong University, Xi'an 710049, China; ² State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, Xi'an 710049, China

11:20am - 11:40am ID: 1544

Development and Application of Accelerated Life Test Cycles for Performance Degradation Study on Water-cooled Variable-speed Screw Compressor Chillers

Andreas J Hoess, Davide Ziviani, James E Braun, Eckhard A Groll

Purdue University, United States of America

C-12: Compressors for Alternative Refrigerants

Session Chair: Takashi Kobayashi

9:40am - 10:00am ID: 1129

Compressor Design Vs. Refrigerants Properties: What Affects Compressor Efficiency More?

Dennis Roskosch¹, Cordin Arpagaus², Stefan Bertsch², André Bardow¹

¹ Energy and Process Systems Engineering Lab, ETH-Zürich, Switzerland; ² Institute for Energy Systems, Eastern Switzerland University of Applied Sciences, Switzerland

10:00am - 10:20am ID: 1290

Modeling and Performance Evaluation of Rotary Compressor and Air-Conditioning System using Low GWP Refrigerants

Hana Sano, Eriko Urasaki, Tao Lyu, Jongsoo Jeong, Kenji Tojo, Yonezo Ikumi, Hiroo Nakamura, Seiichi Yamaguchi, Kiyoshi Saito

Faculty of Science and Engineering, Waseda University, Japan

10:20am - 10:40am ID: 1437

Performance Evaluation of Swing and Scroll Compressors Using Low GWP Refrigerant

Daisuke Okamoto, Hideki Matsuura, Yohei Nishide

DAIKIN INDUSTRIES, LTD., Japan

10:40am - 11:00am ID: 1483

Coupled Design of High-Speed Motor Drive and Shaped Optimized Compressor Systems

Xin Ding, Matthew Dickerson, Carlos Castillo, Haotian Liu, Steven Pekarek, Davide Ziviani

Purdue University, United States of America

11:00am - 11:20am ID: 1452

Development Of Twin-screw Steam Compressor with Water Sealing

Bin Hu¹, Hong Cai¹, Di Wu², Junyu Liang³, R.Z. Wang¹

¹ Institute of Refrigeration and Cryogenics, Research Center of Solar Power & Refrigeration (MOE China), Shanghai Jiao Tong University, Shanghai 200240, China; ² Shanghai Nuotong New Energy Technology Co., Ltd., Shanghai 200240, China; ³ Yunnan Electric Power Research Institute, Yunnan Power Grid Co., Ltd., Kunming, 650217, China

WEDNESDAY • 1:00PM - 3:00PM

B-06: IAQ, Disinfection & Air Cleaning

Session Chair: Paul Hoertz

1:00pm - 1:20pm ID: 3293

Contagion Risk Assessment For COVID-19 Variants With A Dynamic Approach For A Multizone Building Model Of University Classrooms

Riccardo Albertin, Giovanni Pernigotto, Andrea Gasparella

Free University of Bozen-Bolzano, Italy

1:20pm - 1:40pm ID: 3480

Evaluation of a Gaseous Hydrogen Peroxide Generating Device

Paul Gerard Hoertz¹, Stephen Anthony Kujak¹, Kathleen Owen²

1 Trane Technologies, United States of America; 2 Owen Air Filtration Consulting LLC, United States of America

1:40pm - 2:00pm ID: 3479

Evaluation of a Graphene Enhanced Photocatalytic Oxidation Device

Paul Gerard Hoertz¹, Stephen Anthony Kujak¹, Kathleen Owen²

1 Trane Technologies, United States of America; 2 Owen Air Filtration Consulting LLC, United States of America

2:00pm - 2:20pm ID: 3236

Experimental Study of Electrospray for Exhaust Gas Treatment

Soyeon Kim¹, Minkyu Jung¹, Sanghun Jeong¹, Donik Ku¹, Soojin Bae¹, Gijeong Seo², Minsung Kim^{1,2}

1 Department of Intelligent Energy and Industry, Chung-Ang University, Korea, Republic of (South Korea);

2 School of Energy Systems Engineering, Chung-Ang University, Korea, Republic of (South Korea)

2:20pm - 2:40pm ID: 3250

Object Tracking-based Droplet Characterization on High Flowrate Electrospray for PM Removal

Minkyu Jung¹, Soyeon Kim¹, Donik Ku¹, Sanghun Jeong¹, Soojin Bae¹, Gijeong Seo², Minsung Kim^{1,2}

1 Department of Intelligent Energy and Industry, Chung-Ang University, Korea, Republic of (South Korea);

2 School of Energy Systems Engineering, Chung-Ang University, Korea, Republic of (South Korea)

2:40pm - 3:00pm ID: 3491

Outdoor Comfort in Public Spaces, a Critical Review

Mingliang Li¹, Hongxi Yin¹, Ming Qu², Ian Trivers¹

1 Washington University in St. Louis, United States of America; 2 Purdue University, United States of America

R-28: Advanced HX and Manufacturing

Session Chair: Ammar Bahman

1:00pm - 1:20pm ID: 2158

Advanced Copper Heat Exchangers from Low-Cost Additive Manufacturing Techniques

Dennis Michael Nasuta, Austin Halota, Angelina Zhao, Max Mzhen

Optimized Thermal Systems

1:20pm - 1:40pm ID: 2258

Frequency Distribution Control for Flow-induced Noise Mitigation Near Expansion Device

Yingyue Zhang¹, Stefan Elbel^{1,2}

1 University of Illinois at Urbana-Champaign, United States of America; 2 Creative Thermal Solutions, Inc.

WEDNESDAY • 1:00PM - 3:00PM

1:40pm - 2:00pm ID: 2324

Experimental Investigation of Additively Manufactured Microchannel Evaporator Performance Using Low-GWP Refrigerants Compared to Conventional Air Cooling in Electronics Cooling

Theresa Kramer¹, Kevin Lemberg², Riley B. Barta¹, Mario Raddatz², Ullrich Hesse¹

¹ Technische Universität Dresden, BITZER-Chair of Refrigeration, Cryogenics and Compressor Technology, Germany;

² Technische Universität Dresden, Chair of Thermal Power Machinery and Plants, Germany

2:00pm - 2:20pm ID: 2495

Additive Manufacturing For Thermal Management Applications: From Experimental Results To Numerical Modeling

Giacomo Favero^{1,2}, Massimiliano Bonesso¹, Pietro Rebesan¹, Razvan Dima¹, Adriano Pepato¹, Simone Mancin^{1,2}

¹ University of Padova, Italy; ² I.N.F.N. - Sezione di Padova, Italy

2:20pm - 2:40pm ID: 2344

Review of Triply Periodic Minimal Surface (TPMS) based Heat Exchanger Designs

Lalith Kannah Dharmalingam, Vikrant Aute, Jiazen Ling

University of Maryland at College Park, United States of America

2:40pm - 3:00pm ID: 2453

A Computational Fluid Dynamic Study on Polymer Heat Exchangers

Mingkan Zhang, Kashif Nawaz, Kai Li, Tyler Smith

Oak Ridge National Laboratory, United States of America

R-29: Vapor Compression System Modeling II

Session Chair: Bo Shen

1:00pm - 1:20pm ID: 2154

Refrigerant Charge Optimization of a Variable Speed Residential Heat Pump with an Expander/Separator

Alhussain Othman^{1,2}, Ammar Bahman^{2,3}, Riley Barta^{3,4}, Davide Ziviani⁴, Eckhard Groll⁴

¹ Center for Environmental Energy Engineering, Department of Mechanical Engineering, University of Maryland; ² Mechanical Engineering Department, College of Engineering and Petroleum, Kuwait University; ³ Bitzer Chair for Refrigeration, Cryogenics and Compressor Technology, Institute for Energy Technologies, Technische Universitaet Dresden; ⁴ Center for High Performance Buildings, Ray W. Herrick Laboratories, Purdue University

1:20pm - 1:40pm ID: 2226

Approximate Calculation Of On-off Vapor Refrigeration Cycle Efficiency Through A Pseudo-stationary Models

Vinicio Akyo Matsuda¹, Eduardo Postigel Falcetti^{2,1}, Cristiano Bigonha Tibiriça¹, Luben Cabezas Gomes¹

¹ Department of Mechanical Engineering, São Carlos School of Engineering, University of São Paulo, São Carlos, Brazil;

² Tecumseh Products Company, São Carlos, Brazil

1:40pm - 2:00pm ID: 2352

Application of Mixed Integer Nonlinear Programming (MINLP) Optimization through GAMS for Component Selection in Vapor Compression Refrigeration

Leon Philipp Martin Brendel, James E. Braun, Eckhard A. Groll

Purdue University, United States of America

WEDNESDAY • 1:00PM - 3:00PM

2:00pm - 2:20pm **ID: 2383**

A White-box Modelling Methodology for Electronic Expansion Valve by Considering Choked Flow

Zhequan Jin, Noma Park, Byeong Hwi Lee, Yoonjei Hwang, Sim Won Chin, Saikee Oh

Home Appliance & Air Solution Company, LG electronics

2:20pm - 2:40pm **ID: 2585**

Performance Assessment of High-temperature Heat Pump in an Integrated Energy System

P. Ganesan¹, Signe Truyen Ryssda¹, Trygve M. Eikevik¹, Ruzhu Wang², Bin Hu²

¹Department of Energy and Process Engineering, Norwegian University of Science and Technology, Trondheim, Norway.;

²Institute of Refrigeration and Cryogenics, Shanghai, Jiao Tong University, Shanghai, China

2:40pm - 3:00pm **ID: 2501**

Dynamic Modeling and Validation of a Triple-Evaporator Domestic Refrigerator/Freezer with R-600a

Changkuan Liang, James E. Braun, Eckhard A. Groll, Davide Ziviani

Ray W. Herrick Laboratories, Purdue University Mechanical Engineering West Lafayette, IN, 47906, USA

R-30: Application of Ejectors

Session Chair: Riley Barta

1:00pm - 1:20pm **ID: 2274**

Design Optimization of R744 Ejector for Compressor Oil Pumping

Md Muntasir Alam¹, Stefan Elbel^{1,2}

¹Air Conditioning and Refrigeration Center, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, 1206 West Green Street, Urbana, IL 61801, USA; ²Creative Thermal Solutions, Inc., 2209 North Willow Road, Urbana, IL 61802, USA

1:20pm - 1:40pm **ID: 2277**

Utilization of Ejector for Decrease of Compressor Discharge Pressure in HVAC&R Applications

Md Muntasir Alam¹, Stefan Elbel^{1,2}

¹Air Conditioning and Refrigeration Center, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, 1206 West Green Street, Urbana, IL 61801, USA; ²Creative Thermal Solutions, Inc., 2209 North Willow Road, Urbana, IL 61802, USA

1:40pm - 2:00pm **ID: 2279**

Numerical Analysis of Hybrid Heat Driven Ejector System Based on the Ejector Performance Map Approach

Tokitaka Yoshida¹, Stefan Elbel^{2,3}

¹Fuji Electric Co., Ltd, Japan; ²University of Illinois at Urbana-Champaign, Department of Mechanical Science and Engineering, Air Conditioning and Refrigeration Center, USA; ³Creative Thermal Solutions, Inc., USA

2:00pm - 2:20pm **ID: 2320**

Variable Mixing Chamber Waste-Heat Driven Ejector Cycle For Commercial Refrigeration

Egoi Ortego Sampedro

Mines PSL, France

2:20pm - 2:40pm **ID: 2394**

Effect of Fractionation on Ejector and System Performance in R1234yf/R32 Refrigeration System

Muhammad Haider¹, Stefan Elbel^{1,2}

¹University of Illinois Urbana-Champaign, United States of America; ²Creative Thermal Solutions, Inc. Urbana, IL, USA

WEDNESDAY • 1:00PM - 3:00PM

2:40pm - 3:00pm ID: 2572

Booster Ejector Enhanced Vapor Compression Cycle Performance For Industrial Refrigerating Facilities
Olexiy Buyadgie^{1,2}, Dmytro Buyadgie^{1,3}, Oleksii Drakhnia¹

1Wilson Engineering Technologies, Inc, United States of America; 2V.S. Martynovsky Institute of Refrigeration, Cryogenic Technologies and Eco Energetics, Ukraine; 3Wilson, Ejector Technology Laboratory, Ukraine

R-31: Power and Co-generation Equipment I

Session Chair: Steven Lecompte

1:00pm - 1:20pm ID: 2100

Feasibility of High Yield Biomass Fuel for Regenerative Gas Turbine Power Plants in Sudan

Aya Mohammed Hassan Mahjob¹, Siddharth Pannir², Momin Elhadi Abdalla³

1 University of Khartoum, Chemical Engineering Department, Sudan; 2 GenH Inc, Charlestown, Massachusetts, United States;

3 University of Khartoum, Chemical Engineering Department

1:20pm - 1:40pm ID: 2102

Performance and Efficiency of Combined Cycle Power Plants

Momin Elhadi Abdalla¹, Siddharth Pannir², Aya Mohammed Hassan Mahjob³

1 University of Khartoum, Chemical Engineering Department, Sudan; 2 GenH Inc, Charlestown, Massachusetts, United States;

3 University of Khartoum, Chemical Engineering Department

1:40pm - 2:00pm ID: 2103

Energy Analysis of Biomass Integrated Air Gasification Regenerative Gas Turbine Power Plants

Chol Jacob Reu¹, Siddharth Pannir², Momin Elhadi Abdalla³

1 Ministry of Petroleum, South Sudan; 2 GenH Inc, Charlestown, Massachusetts, United States;

3 University of Khartoum, Chemical Engineering Department, Sudan

2:00pm - 2:20pm ID: 2104

Power Technologies for Sustainable Energy: Impact on Energy, Economics, Environment and Equity

Praveen Cheekatamarla

ORNL, United States of America

2:20pm - 2:40pm ID: 2105

Modeling of Syngas Integrated Regenerative Gas Turbine Power Plants

Reu Chol Jacob¹, Siddharth Pannir², Momin Elhadi Abdalla³

1 University of Khartoum, Chemical Engineering Department, Sudan; 2 GenH Inc, Charlestown, Massachusetts, United States;

3 University of Khartoum, Chemical Engineering Department, Sudan

2:40pm - 3:00pm ID: 2142

The Role of Heat-to-Power Technologies in Building Decarbonization

Praveen Cheekatamarla, Kyle Gluesenkamp, LaClair Timothy, Abuheieba Ahmad

Oak Ridge National Laboratory, United States of America

WEDNESDAY • 1:00PM - 3:00PM

C-13: Novel Compressors II

Session Chair: Niccolo Giannetti

1:00pm - 1:20pm ID: 1198

Comparative Experimental Analysis Of Different Compressor Capacity Modulation Strategies In R410A Chiller With Focus On Seasonal Performance

Sugun Tej Inampudi¹, Francesco Botticella², Stefan Elbel^{1,2}

1 University of Illinois at Urbana-Champaign, Department of Mechanical Science and Engineering, Air Conditioning and Refrigeration Center, 1206 West Green Street, Urbana, IL 61801, USA; 2 Creative Thermal Solutions, Inc., 2209 North Willow Road, Urbana, IL 61802, USA

1:20pm - 1:40pm ID: 1199

Study Of Charge Optimization And Compressor Modulation Strategies Effect On The Seasonal Performance In A R410A Chiller

Sugun Tej Inampudi¹, Stefan Elbel^{1,2}

1 University of Illinois at Urbana-Champaign Department of Mechanical Science and Engineering Air Conditioning and Refrigeration Center, 1206 West Green Street, Urbana, IL 61801, USA; 2 Creative Thermal Solutions, Inc., 2209 North Willow Road, Urbana, IL 61802, USA ()Corresponding author: elbel@illinois.edu*

1:40pm - 2:00pm ID: 1312

A Novel Screw Compressor with a Shunt Enhanced Decompression and Pulsation Trap (SEDAFT)

Paul Xiubao Huang¹, Sean Yonkers², James Willie³

1Hi-Bar MC Tech LLC, United States of America; 2Hi-Bar Blowers, Inc, United States of America; 3CVS Engineering GmbH, Germany

2:00pm - 2:20pm ID: 1439

Swing Compressor with Injection Mechanism That Realizes High Heating Capacity at Low Outside Air Temperatures

Ryosuke Wada, Emu Tokuda, Kouichi Irikawa, Yuya Sunahara, Yukihiro Inada, Chihiro Endo,

Masanori Yanagisawa

DAIKIN INDUSTRIES, LTD., Japan

2:20pm - 2:40pm ID: 1128

Quasi 1D Modelling of Conical Rotary Compressors

Yang Lu, Hoang Khoi, David Noake, Nicol Low

Vert Technologies

C-14: Compressor Modeling III

Session Chair: Vincent Lemort

1:00pm - 1:20pm ID: 1140

Modeling a Spool Compressor Using a Coupled Fluid And Solid Solver With Cut-Cell Based CFD Methodology With Adaptive Mesh Refinement

Ameya Waikar¹, David Rowinski¹, Greg Kemp², Joe Orosz², Craig Bradshaw³

1 Convergent Science Inc., Madison,WI, USA; 2 Torad Engineering LLC, Alpharetta, Georgia, USA;

3 Oklahoma State University, Stillwater, OK USA

WEDNESDAY • 1:00PM - 3:00PM

1:20pm - 1:40pm **ID: 1191**

CFD Study of the Internal Leakage of a Four-Intersecting-Vane Expander

Anarghya Ananda Murthy, Alison Subiantoro

The University of Auckland, New Zealand

1:40pm - 2:00pm **ID: 1222**

Computational Model Of Start-up Process for Reciprocating Compressors

Eduardo Postigel Falcetti¹, Luben Cabezas Gomez², Tiago Fernando Botega¹

1 Tecumseh Products Company, São Carlos, Brazil; 2 Department of Mechanical Engineering, São Carlos School of Engineering, University of São Paulo, São Carlos, Brazil

2:00pm - 2:20pm **ID: 1357**

Hermetic Reciprocating Compressor Simulation Using a Multi-Physics Platform

Maite C de Araujo^{1,2}, Jan Tuhovcak¹, Ricardo D Brancher¹, Thiago Dutra²

1 SECOP Austria GmbH; 2 TEG Thermofluids Engineering Group, Federal University of Santa Catarina

WEDNESDAY • 3:30PM - 5:00PM

R-32: Heat Exchanger Modeling

Session Chair: Harshad Inamdar

3:30pm - 3:50pm **ID: 2228**

A Low-Order Model for Nonlinear Dynamics of Heat Exchangers

Hongtao Qiao, Christopher Laughman

Mitsubishi Electric Research Laboratories, United States of America

3:50pm - 4:10pm **ID: 2230**

Extraction as a Way to Improve the Performance of Microchannel Condensers Using R134a

Jun Li^{1,2}, Pega Hrnjak^{1,3}

1 ACRC, the University of Illinois, Urbana, Illinois, USA; 2 Department of Materials Science and Engineering, University of Michigan, Ann Arbor, USA; 3 Creative Thermal Solutions, Inc., Urbana, Illinois, USA

4:10pm - 4:30pm **ID: 2287**

Effect of the Contained Refrigerant Mass on the Efficiency and Effectiveness of Two-phase Heat Exchangers

Christoph Zainer, Kevin Wimmer, Michael Lang, Raimund Almbauer

Graz University of Technology, Austria

4:30pm - 4:50pm **ID: 2331**

Design of 5 mm Copper Tube Heat Exchangers for Display Cabinets with R404A

Frank Gao¹, Kerry Song¹, Yoram Shabtay²

1 International Copper Association; 2 Heat Transfer Technologies

4:50pm - 5:10pm **ID: 2361**

Thermal systems Oriented Two-Phase Heat Exchanger Models. Focus on Numerical Robustness and Calibration

Nicolás Ablanque, Santiago Torras, Carles Oliet, Joaquim Rigola

Universitat Politècnica de Catalunya, Spain

WEDNESDAY • 3:30PM - 5:00PM

5:10pm - 5:30pm ID: 2396

Developing Computationally Efficient Artificial Neural Network Model of R744 Microchannel Evaporator from Experimental Data for Component Selection Analysis of an Ejector System

Muhammad Haider¹, Stefan Elbel^{1,2}

¹ University of Illinois Urbana Champaign, United States of America; ² Creative Thermal Solutions, Inc. Urbana, IL, USA

R-33: Commercial and Industrial HVAC&R

Session Chair: Andy Pearson

3:30pm - 3:50pm ID: 2144

Effect of the Freezing Rate on the Quality of Frozen Strawberries

Diogo Da Silva¹, Alessandro Silveira², Adriano Ronzoni³, Christian Hermes²

¹ Mobility Engineering Department, Federal University of Santa Catarina;

² Mechanical Engineering Department, Federal University of Santa Catarina; ³ Nidec Global Appliance

3:50pm - 4:10pm ID: 2244

Performance Improvements in Low Temperature Blast Freezing Systems

Eric Alar, Douglas Reindl, Gregory Nellis

University of Wisconsin - Madison, United States of America

4:10pm - 4:30pm ID: 2369

Effect Of Compressor Speeds On Performance Of Industrial Waste Water Treatment System Driven By Heat Pump Based On Humidification-Dehumidification Principle

Qingqing Wu

Shanghai Highly Electrical Application Co., Ltd, China, People's Republic of China

4:30pm - 4:50pm ID: 2520

Rotating Contacting Device based Improved Cooling Tower - Concept along with Demonstration Results

Milind V Rane, Aditya M Rane

IIT Bombay, India

R-34: Alternative Technologies for Sensible and Latent Load Management

Session Chair: Jason LeRoy

3:30pm - 3:50pm ID: 2101

Experimental Investigation of Hybrid Air-Conditioning System with Desiccant-Coated Heat Exchanger Using CO2 Refrigerant

Tomohiro Higashi¹, Kohei Tokunaga², Li Zhang¹, Michiyuki Saikawa¹, Chaobin Dang³, Eiji Hihara⁴

¹ Central Research Institute of Electric Power Industry, Japan; ² The University of Tokyo, Japan; ³ University of Fukui, Japan;

⁴ National Institution for Academic Degrees and Quality Enhancement of Higher Education, Japan

3:50pm - 4:10pm ID: 2110

Modeling And Experiments On A Dedicated Outdoor Air System Using Liquid Desiccant Heat And Mass Exchangers

Jason Woods¹, Eric Kozubal¹, Peter Luttik², David Fox², Jason Warner²

¹ National Renewable Energy Laboratory, United States of America; ² Emerson Climate Technologies

WEDNESDAY • 3:30PM - 5:00PM

4:10pm - 4:30pm ID: 2310

Review Of Liquid Desiccant Air Dehumidification Systems Coupled With Heat Pump: System Configurations, Component Designs, and Performance

Tomas Pablo Venegas¹, Ming Qu¹, Lingshi Wang², Xiaobing Liu²

¹ Purdue University, United States of America; ² Oak Ridge National Laboratory, United States of America

4:30pm - 4:50pm ID: 2506

Impact of Cycle Parameters on Moisture Removal Rate of a Sorption-based Dehumidification System

Behnam Ahmadi¹, Masoud Ahmadi¹, Kashif Nawaz², Kyle Gluesenkamp², Sajjad Bigham¹

¹ Department of Mechanical Engineering-Engineering Mechanics, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931-1295, USA; ² Building Technologies Research and Integration Center, Oak Ridge National Laboratory, One Bethel Valley Road, P.O. Box 2008, MS-6070, Oak Ridge, TN 37831- 6070, USA

R-35: Energy Storage

Session Chair: Rebecca Ciez

3:30pm - 3:50pm ID: 2171

Experimental Investigation Of A Thermally Integrated Carnot Battery Using A Reversible Heat Pump/Organic Rankine Cycle: Influence Of System Charge On Performance Of The Reversible Scroll Compressor/Expander And Global Performance

Robin Tassenoy^{1,2}, Olivier Dumont³, Vincent Lemort³, Michel De Paepe^{1,2}, Steven Lecompte^{1,2}

¹ Department of Electromechanical, Systems and Metal Engineering, Ghent University, Ghent, Belgium;

² FlandersMake@UGent - Core lab EEDT-MP, Leuven, Belgium; ³Thermodynamics Laboratory, University of Liège, Liège, Belgium

3:50pm - 4:10pm ID: 2238

Water-Based Thermal Energy Storage for Heating and Air-Conditioning Applications in Residential Buildings: Review and Preliminary Study

Khaled I. Alghamdi, Christian K. Bach, Jeffrey D. Spitler

Oklahoma State University, Mechanical and Aerospace Engineering School, Stillwater, OK 74074, USA

4:10pm - 4:30pm ID: 2257

Study Of A Conventional Heat Pump Water Heater System For Implementation Of A New Storage

Heat Pump Concept

Purav Patel¹, Stefan Elbel^{1,2}

¹ University of Illinois at Urbana-Champaign, Department of Mechanical Science and Engineering, Air Conditioning and Refrigeration Center, 1206 West Green Street, Urbana, IL 61801, USA; ² Creative Thermal Solutions, Inc., 2209 North Willow Road, Urbana, IL 61802, USA

4:30pm - 4:50pm ID: 2469

Effect of Metal Foam Integration on The Thermal Regulation Performance of Salt Hydrate-Based Heat Sink

Amr Kotb, Sophie Wang

Department of Mechanical Science and Engineering, University of Illinois at Urbana- Champaign, Urbana, Illinois 61801, United States

C-15: NVH II

Session Chair: Yangfan Liu

3:30pm - 3:50pm ID: 1183

High Frequency Aerodynamic Noise Improvement of Variable Speed Scroll Compressor by Transient CFD Analysis

Jiangbo Lin, Kang Zheng, Qingqing Rong, Liu Wang

Danfoss (Tianjin) Ltd, China, People's Republic of China

WEDNESDAY • 3:30PM - 5:00PM

3:50pm - 4:10pm ID: 1418

Numerical Prediction of Gas Pulsation in a Scroll Compressor Using 1-D Modeling: A Validation Study Based on AHRI Standard 530-2011

Srinivasan Ramalingam¹, Adam D'Amico¹, Miles Strand¹, Michael Rutan¹, Gautham Ramchandran²

¹ Emerson Commercial & Residential Solutions, Sidney, Ohio, USA; ² Gamma Technologies LLC, Westmont, Illinois, USA

4:10pm - 4:30pm ID: 1542

Vibration Mount Optimization of Two-Stage Screw Compressors with Harmonic Analysis

Hükümrən Selim Ertürk, Buğrahan Bahadır, Sinan Pişirici

Dalgakıran Compressor, Turkey

4:30pm - 4:50pm ID: 1415

Numerical Study of the Aerodynamic Noise and Vibration Due to Pulsive Discharge Gas Jet in Hermetic Compressors

Dazhuang He, Yangfan Liu, Davide Ziviani, Yidan Cui

Purdue University, United States of America

4:50pm - 5:10pm ID: 2591

Circuit Techniques for Thermodynamic Analysis

Noori Kim¹, Jont B. Allen²

¹ Newcastle University Singapore, Electrical Electronic Department Singapore; ² University of Illinois at Urbana Champaign, Electrical and Computer Engineering Urbana-Champaign, IL, 61820, USA

5:10pm - 5:30pm ID: 1393

Experimental Study on Fluid-induced Noise Generated by the Gas Pulsation at Discharge Valve of a Hermetic Compressor

Yidan Cui, Dazhuang He, Davide Ziviani, Yangfan Liu

Ray W. Herrick Laboratories, Purdue University Mechanical Engineering, USA

C-16: Tribology

Session Chair: Joe Karnaz

3:30pm - 3:50pm ID: 1281

Numerical Analysis of Journal Bearing in Rotary Compressor

Jeongbae Lee

SAMSUNG Elec., Korea, Republic of (South Korea)

3:50pm - 4:10pm ID: 1291

The Effect Of The Thickness Of The Lower Raceway, The Thickness And Material Of The Third Raceway Of The Bearing Set On The Efficiency Of A Reciprocating Compressor

Umar Ul Haque, Tolga Çetin, Özgür Yalçın

Arçelik, Turkey

4:10pm - 4:30pm ID: 1364

Evaluation of the Lubrication Regime for Rotary Compressors. Influence of Thermal Expansions on the Minimum Film Thickness.

Jordi Vera¹, Eugenio Schillaci², Joaquim Rigola¹

¹ CTTC UPC, Spain; ² Termofluids, S.L.

R-36: Load Based Testing II

Session Chair: Jim Braun

9:40am - 10:00am ID: 2458

Development of an Emulator-Based Assessment Method for Representative Evaluation of the Dynamic Performance of Air Conditioners

Niccolo Giannetti¹, Hifni Ariyadi², Yoichi Miyaoka³, Jongsoo Jeong⁵, Kiyoshi Saito⁴

¹ Waseda Institute for Advanced Study, Waseda University, Japan; ² Department of Mechanical and Industrial Engineering, Universitas Gadjah Mada, Indonesia; ³ Research Organization for Open Innovation Strategy, Waseda University, Japan; ⁴ Department of Applied Mechanics and Aerospace, Waseda University, Japan; ⁵ Research Institute for Science and Engineering, Waseda University, Japan

10:00am - 10:20am ID: 2477

CSA EXP07: Ongoing Progress, Lessons Learned, And Future Work In Load-based Testing of Residential Heat Pumps

Bruce Harley¹, Gary Hamer², Christopher Dymond³, Mark Alatorre⁴

¹Bruce Harley Energy Consulting, LLC, United States of America; ²BC Hydro; ³Northwest Energy Efficiency Alliance; ⁴Pacific Gas & Electric

10:20am - 10:40am ID: 2525

Repeatability and Reproducibility Assessment of Residential Heat Pump Performance Evaluation Methodologies based on CSA EXP07 and AHRI 210/240

Parveen Dhillon¹, Xudong Wang², W. Travis Horton¹, James E. Braun¹

¹ Ray W. Herrick Laboratories, Purdue University, United States of America; ² Air Conditioning, Heating, and Refrigeration Institute, Arlington, VA, United States of America

R-37: Alternative Refrigerants Modeling and Test II

Session Chair: Eric Berg

9:40am - 10:00am ID: 2440

ASHRAE Guideline 38 Methodology Material Compatibility Testing of R-473A

Rusul Al-rubaay, Christopher J. Seeton, Robert E. Low, Ira Saxena

Koura Global, United Kingdom

10:00am - 10:20am ID: 2456

Charging And Recovery Techniques For Low GWP Refrigerant Blends

Monika Laura MacNeill, Christopher John Seeton, Robert Elliott Low

Koura Global, United Kingdom

10:20am - 10:40am ID: 2565

Critical Analysis of Replacements for R410A in Heat Pump Applications

Zhenning Li, Samuel Fortunato Yana Motta, Bo Shen, Brian Fricke, Hanlong Wan

Oak Ridge National Laboratory, United States of America

10:40am - 11:00am ID: 2581

Overview of novel GWP 1 HFO Refrigerant 1132E and the Mixture of 1132E and R-1234yf

Ivan Rydkin¹, Tsubasa Nakae², Kenji Gobou², Alvaro Leon²

¹ Daikin America, Inc.; ² Daikin Industries Ltd.

THURSDAY • 9:40AM - 11:40AM

R-38: CO₂ Assessment II

Session Chair: Remi Dicke

9:40am - 10:00am ID: 2430

Performance Evaluation of a Hybrid Air Conditioning System Based on Transcritical CO₂ Cycle

Sobiya Maqbool, Ramgopal Maddali

Indian Institute of Technology Kharagpur, India

10:00am - 10:20am ID: 2464

Fractionation Testing For Low Critical Temperature Blends

Vanessa Webster, Ira Saxena, Robert Elliott Low, Christopher Seeton

Koura Global

10:20am - 10:40am ID: 2546

Experimental Study and Modelling of a 2-Stage Compression R744 refrigeration System with Vapor Injection and Inter-Cooling

Javier Ignacio Vega Benavente, Samuel Gendebien, Vincent Lemort

University of Liège, Belgium

10:40am - 11:00am ID: 2583

Introduction of an Ejector for Industrial Scale CO₂ Systems

Florian Simon, Julian Pfaffl, Oliver Javerschek

BITZER Kuehlmaschinenbau GmbH, Peter-Schaufler-Strasse 3, 72108 Rottenburg-Ergenzingen, Germany

11:00am - 11:20am ID: 2247

Thermodynamic Analysis of a Transcritical CO₂ Heat Pump Integrating a Vortex Tube

Ahmed Mansour¹, Sébastien Poncet¹, Hakim Nesreddine²

¹Université de Sherbrooke; ²Hydro-Québec

R-39: Alternative Air-conditioning, Refrigeration and Heat Pumping

Session Chair: Abhinav Krishna

9:40am - 10:00am ID: 2366

Investigation of Electrochemical Looping Heat Pump Technology in Heating Mode

Elias N. Pergantis, James E. Braun, Eckhard A. Groll, Davide Ziviani

Ray W. Herrick Laboratories, School of Mechanical Engineering, Purdue University, West Lafayette, 47907-2099, USA

10:00am - 10:20am ID: 2405

Experimental Study to Enhance the Performance of Li-Fe-Co-Si Active Magnetic Regenerator for Room Temperature Cooling Applications

Priya Singh¹, Kavita Srikanti², Manish Chandra¹, R Gopalan², Satyanarayanan Seshadri¹

¹Energy and Emissions Research Group (EnERG Lab), Department of Applied Mechanics, Indian Institute of Technology Madras, Chennai, India; ²Centre for Automotive Energy Materials, International Advanced Research Centre for Powder Metallurgy and New Materials, Chennai, Tamil nadu-113, India

10:20am - 10:40am ID: 2445

Thermodynamic Evaluation of a Magnetic Air Conditioner

Guilherme Peixer, Maria Cláudia Silva, Anderson Lorenzoni, Gislaine Hoffmann, Diego dos Santos, Sergio Dutra, Higor Teza, Elias Pagnan, Bernardo Vieira, Alan Nakashima, Jaime Lozano, Jader Barbosa Jr Polo, Brazil

THURSDAY • 9:40AM - 11:40AM

10:40am - 11:00am ID: 2536

Thermodynamic Assessment of Air-Cycles for Ultra-Low-Temperature Refrigerated Container Applications

John Kevin Brehm, Elias N. Pergantis, Abd Alrhman M. Bani Issa, Eckhard A. Groll, Davide Ziviani

Purdue University, United States of America

11:00am - 11:20am ID: 2582

Cooling Technologies in Datacom Facilities: An Overview and Perspectives

Amin Isazadeh¹, Davide Ziviani², David E. Claridge¹

¹Energy Systems Laboratory, Texas A&M Engineering Experiment Station and J. Mike Walker '66 Department of Mechanical Engineering, Texas A&M University, College Station, TX 77843, USA; ²Ray W. Herrick Laboratories, School of Mechanical Engineering, Purdue University, West Lafayette, 47907-2099, USA

11:20am - 11:40am ID: 2112

Effect Of Pressure Convection On The Energy Separation In Air Vortex Tube: Dimensional Analysis And Numerical Investigation

Junior Lagrandeur, Sergio Croquer, Sébastien Poncet

Université de Sherbrooke, Canada

R-40: Power and Co-generation Equipment II

Session Chair: Vincent Lemort

9:40am - 10:00am ID: 2173

Field Testing of a Transcritical Organic Rankine Cycle (ORC) Engine Coupled with Concentrating Photovoltaic Thermal Collectors

Jera Van Nieuwenhuyse¹, Anastasios Skiadopoulos², Dimitris Manolakos², Steven Lecompte^{1,3}, Michel De Paepe^{1,3}

¹Ghent University, Department of Electromechanical, Systems and Metal Engineering, Ghent, Belgium; ²Agricultural University of Athens, Department of Natural Resources and Agricultural Engineering, Athens, Attica, Greece; ³FlandersMake@UGent - Core lab EEDT-MP

10:00am - 10:20am ID: 2184

Experimental Investigation On Organic Rankine Cycle In Off-Design Conditions For The Development Of A Fully Deterministic Simulation Model

Jinwoo Oh, Hoseong Lee

Korea University, Korea, Republic of (South Korea)

10:20am - 10:40am ID: 2360

Potential of Power and Heat Prosumers for Climate-Neutral Energy Systems

Benedikt Gregor Bederna, Riley Bradley Barta

Technische Universität Dresden, Bitzer-Professur für Kälte-, Kryo- und Kompressorentechnik, Germany

10:40am - 11:00am ID: 2390

Experimental Investigation of a Micro-CHP Unit Driven by Natural Gas for Residential Buildings

Camila Davila, Nicolas Paulus, Vincent Lemort

University of Liège, Belgium

11:00am - 11:20am ID: 2561

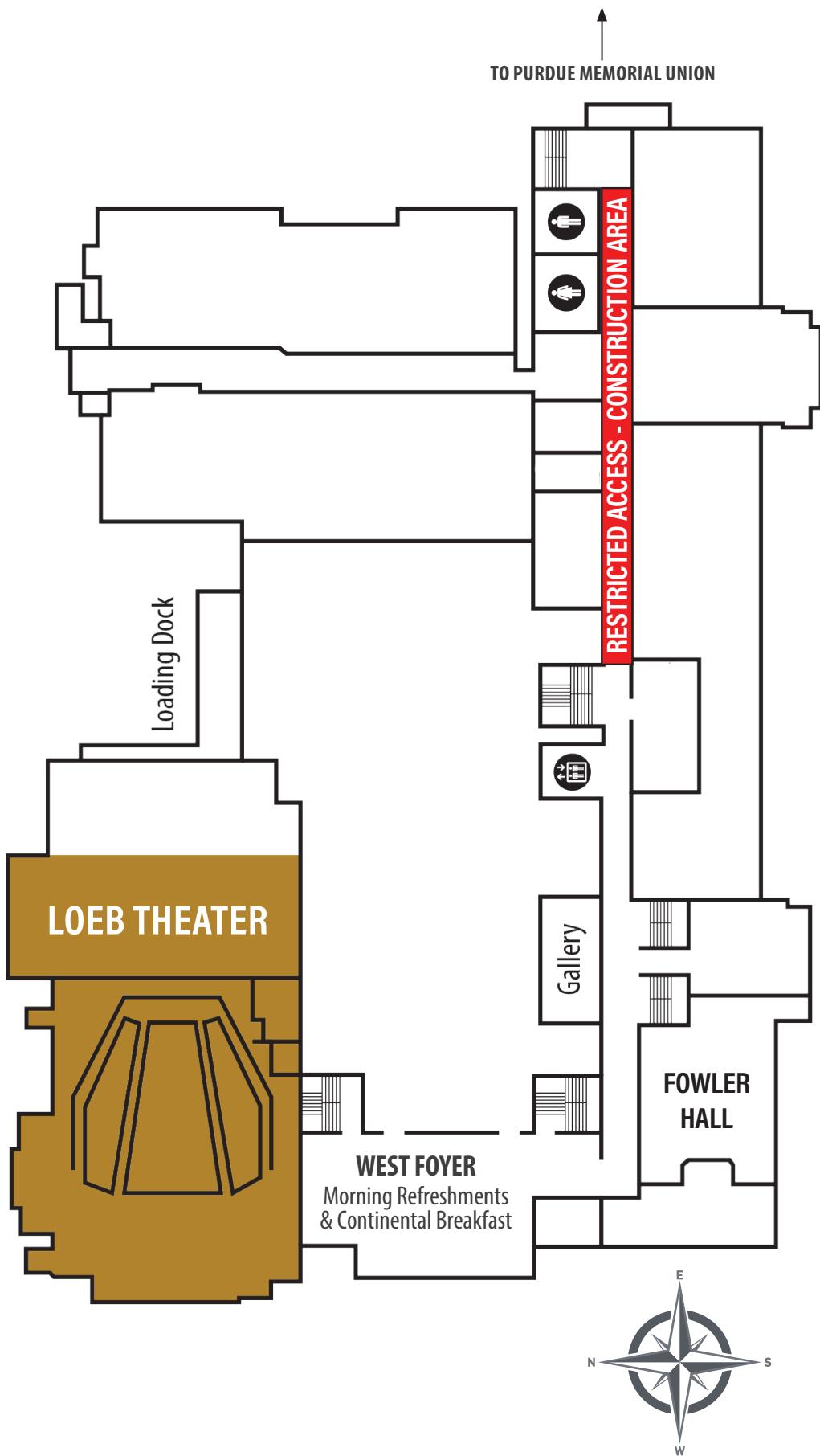
Energetic Assessment of Syngas Fuel for Regenerative Gas Turbine Power Plants

Chol Jacob Reu¹, Siddhrtha Pannir², Momin Elhadi Abdalla³, Momin Elhadi Abdalla⁴

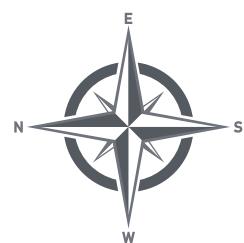
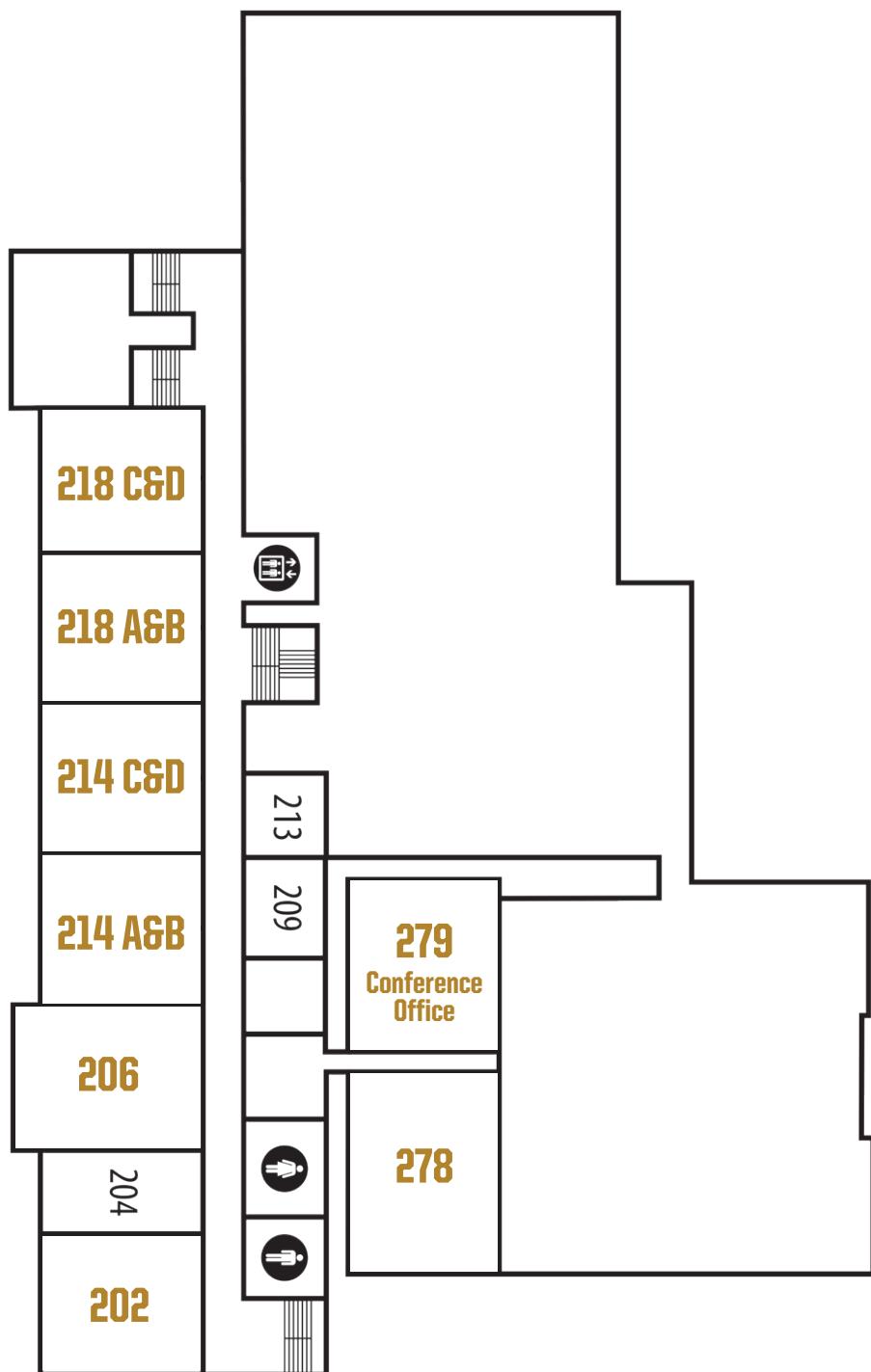
¹Ministry of Petroleum, South Sudan; ²GenH Inc, Charlestown, Massachusetts, United States;

³University of Khartoum, Chemical Engineering Department, Sudan; ⁴University of Khartoum, Sudan

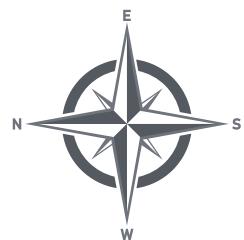
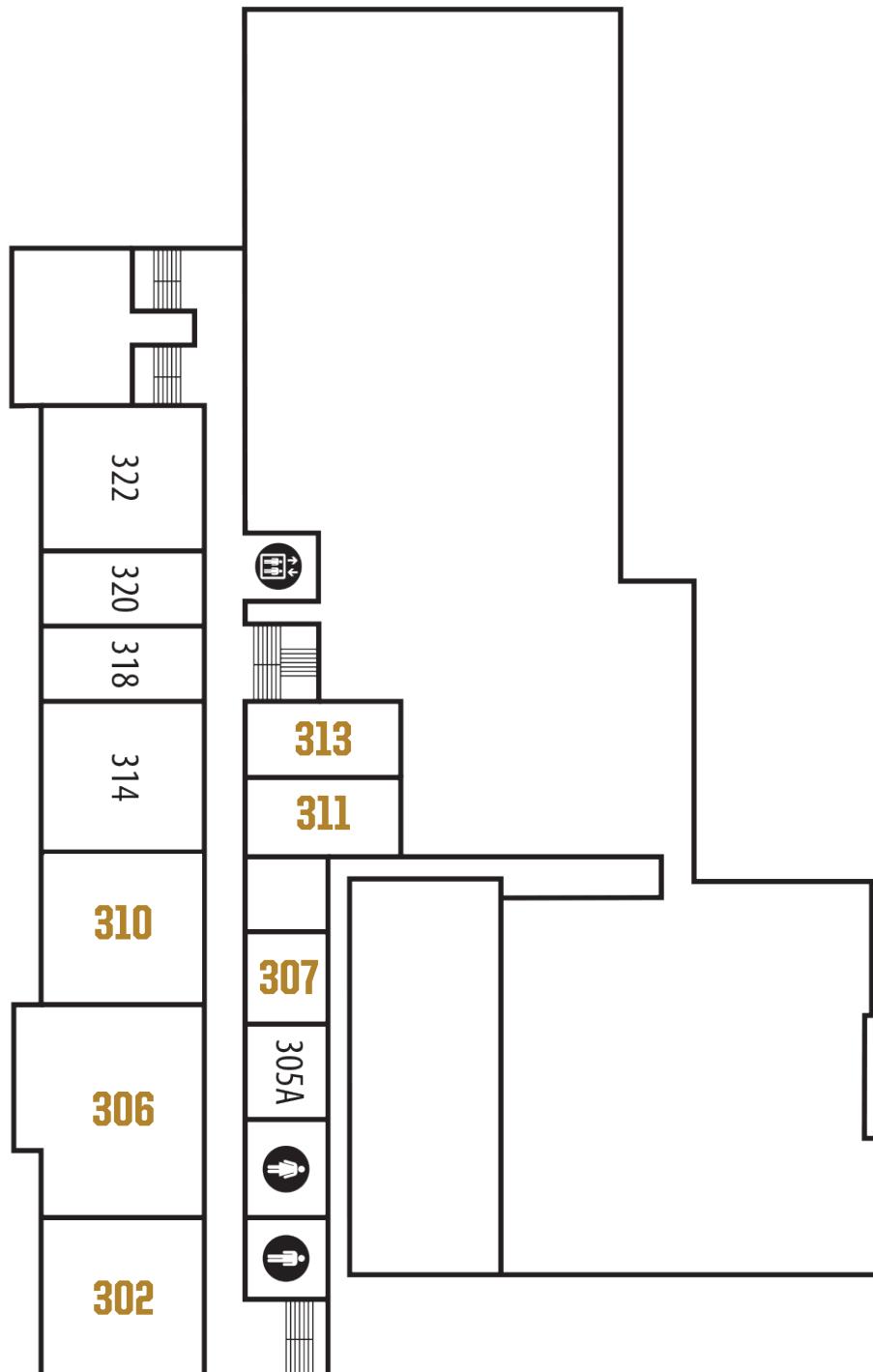
STEWART CENTER MAP: MAIN LEVEL



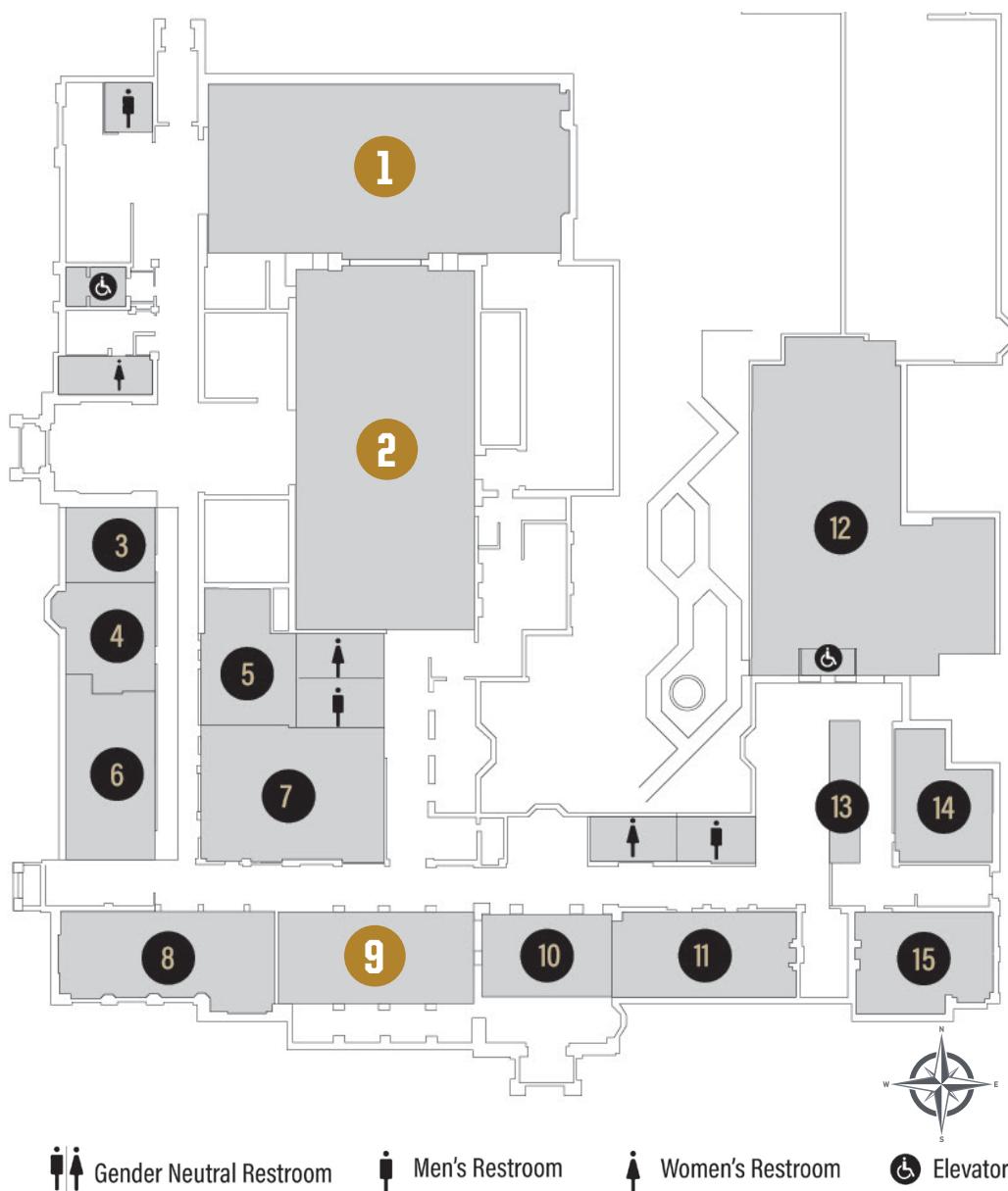
STEWART CENTER MAP: SECOND FLOOR



STEWART CENTER MAP: THIRD FLOOR



PURDUE MEMORIAL UNION MAP: FIRST FLOOR



EVENT VENUES

- 1** North Ballroom
- 2** South Ballroom
- 8** West Main Lounge
- 9** East Main Lounge
- 10** Great Hall (Info Desk)
- 11** 118 Lounge
- 12** Union Club Hotel Lobby

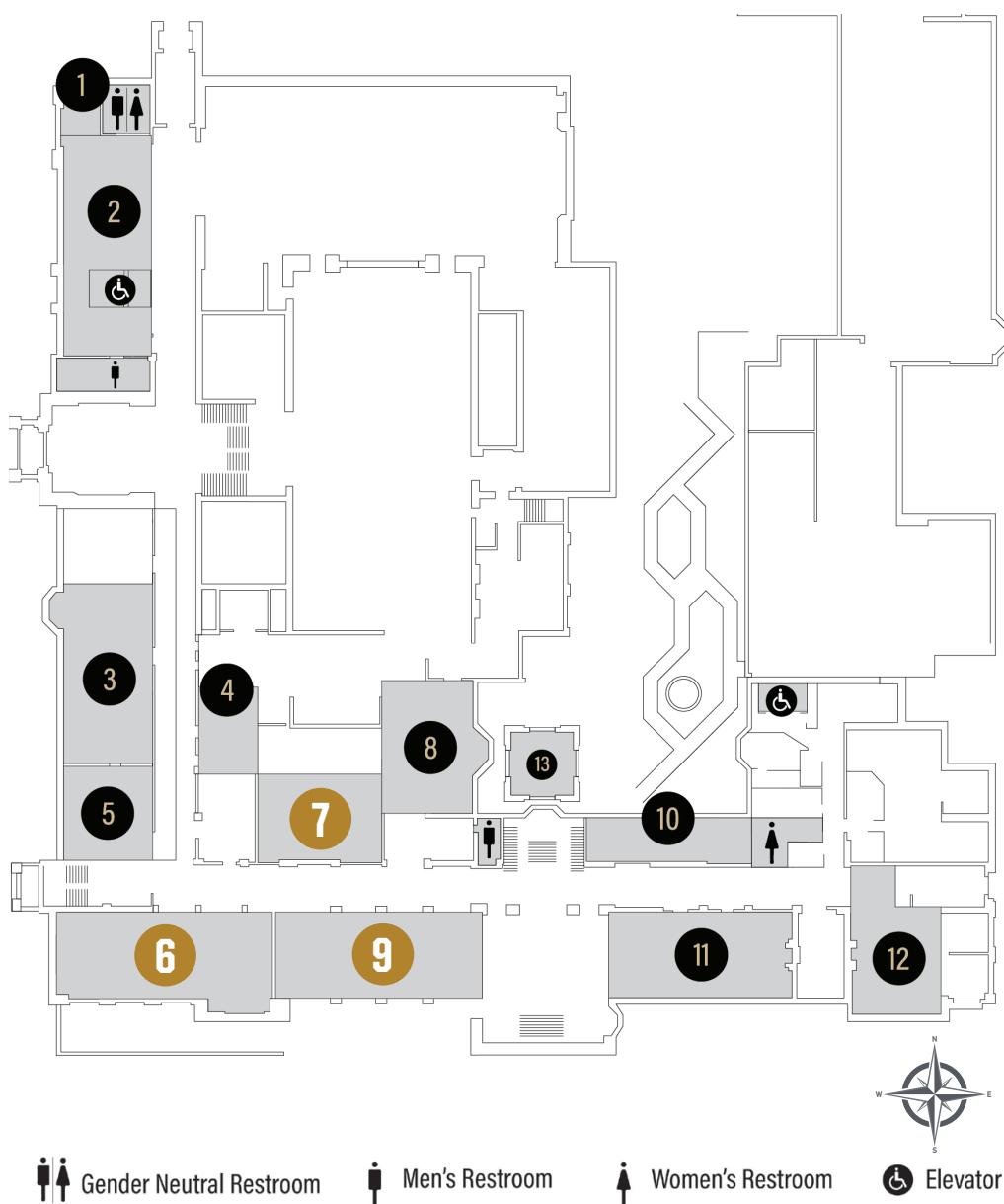
FOOD VENUES

- 13** Leaps Coffee
- 14** Boiler Up Bar
- 15** 8Eleven Modern Bistro

RETAIL TENANTS

- 3** UPS Store
- 4** Fidelity Investments
- 5** Purdue Federal Credit Union
- 6** Evans, Piggot and Finney Eye Care
- 7** Amazon @ Purdue

PURDUE MEMORIAL UNION MAP: SECOND FLOOR



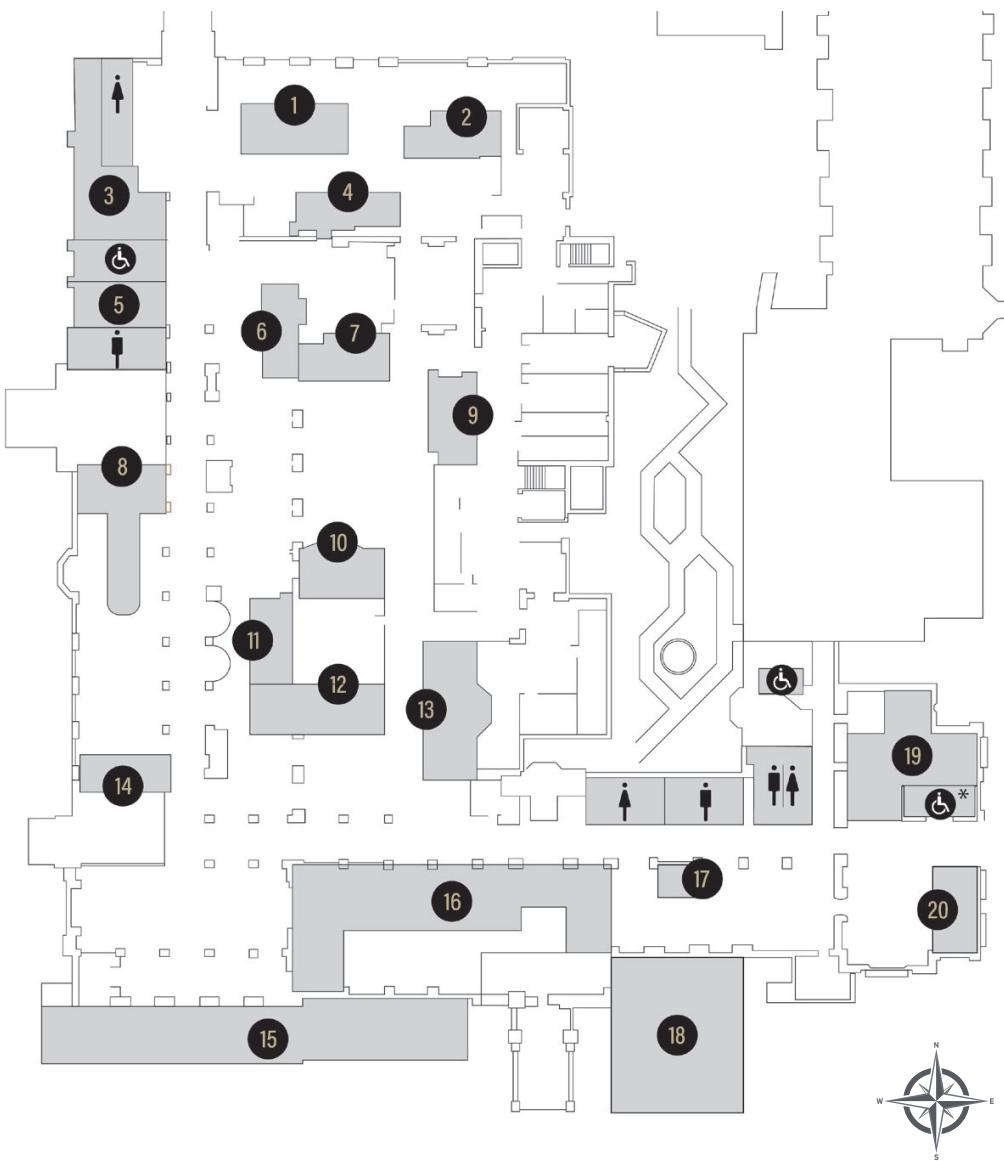
EVENT VENUES

- 1 288 Meeting Room
- 4 263 Meeting Room
- 5 256/258/260 Meeting Rooms
- 6 **West Faculty Lounge**
- 7 **Director's Room**
- 8 Sagamore Meeting Room
- 9 **East Faculty Lounge**
- 12 Anniversary Drawing Room
- 13 South Tower

OFFICE SUITES

- 2 Veteran Success Center
- 3 Purdue Student Union Board
- 10 Administration Office
- 11 UCH Sales & Event Services

PURDUE MEMORIAL UNION MAP: GROUND FLOOR



Gender Neutral Restroom

Men's Restroom

Women's Restroom

Elevator
*to Rack & Roll only

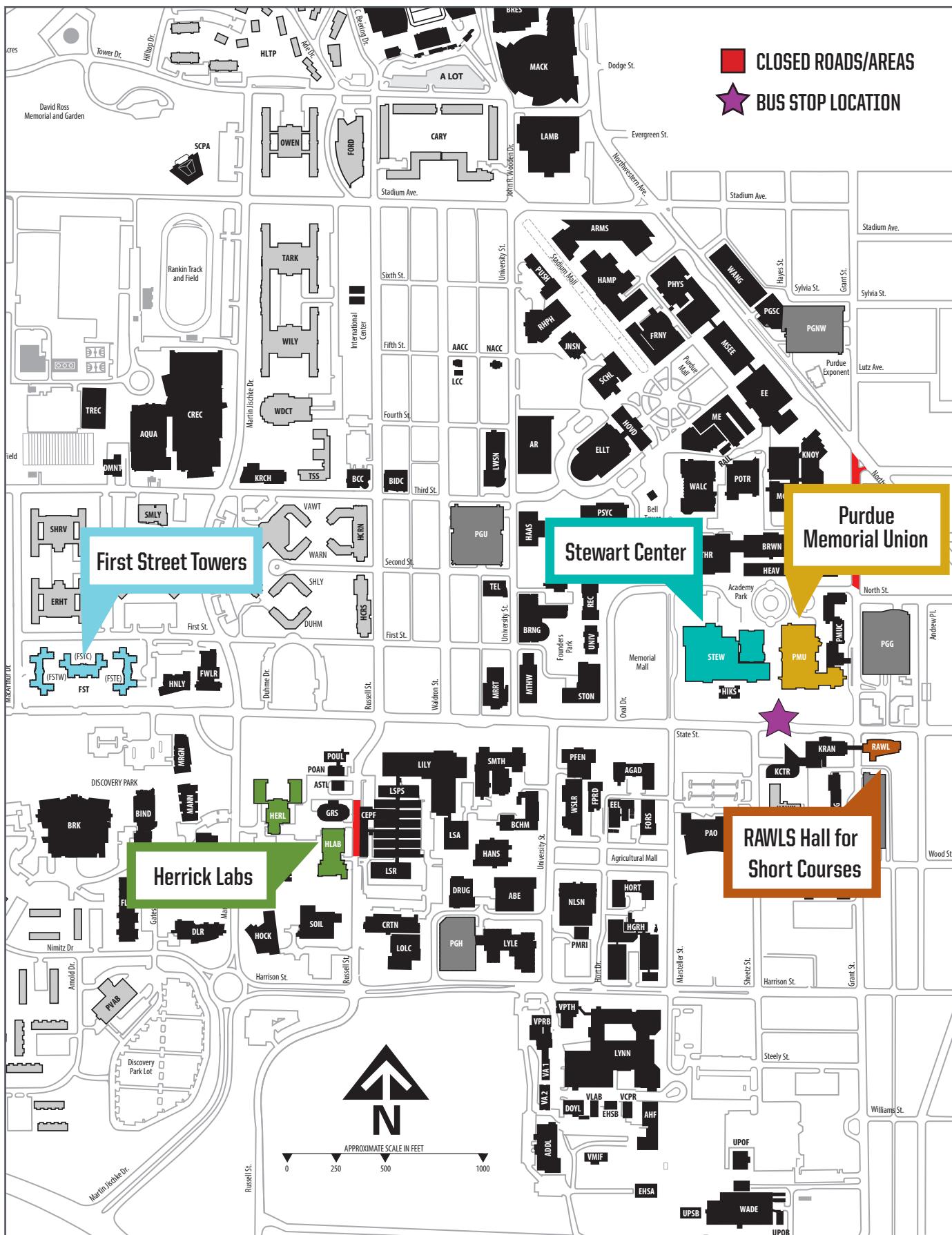
FOOD VENUES

- 1 BBQ District
- 2 Fresh Fare
- 4 Latin Inspired
- 6 Sol Toro
- 7 Pizza & Parm
- 8 Starbucks
- 9 Zen
- 10 Sushi Boss
- 11 Chef Bill Kim's
- 12 Aatish
- 16 Walk-Ons
- 19 Boilermaker Market

EVENT VENUES

- 3 G083 Meeting Room
- 5 G077 Meeting Room
- 13 Fireside Lounge
- 14 Hail Purdue Stage
- 15 West Terrace
- 17 Ever True Stage
- 18 East Terrace
- 20 1869 Meeting Room

PURDUE CAMPUS MAP





Ray W. Herrick Laboratories

Ray W. Herrick Laboratories
177 South Russell Street
West Lafayette, IN 47907-2099

PURDUE UNIVERSITY

FOR 50 YEARS

Purdue University has played host to the International Compressor Engineering Conference (beginning in 1972), the International Refrigeration and Air Conditioning Conference (added in 1986) and the International High Performance Buildings Conference (added in 2010). These conferences provide a perfect venue to present research and development work, as well as network with top experts in the field.

The conferences technical sessions run simultaneously enabling attendees to attend sessions of interest from any conference. Conference registration includes online access to the conference schedule, presented papers and all social networking events. The conferences will be conducted in English.

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CELEBRATING 50 YEARS OF INNOVATION

MULTIPHYSICS MODELING MACHINE LEARNING