2016 Purdue Conferences
23rd Compressor Engineering
16th Refrigeration and Air Conditioning
4th High Performance Buildings

Hosted by
Purdue Center for High Performance Buildings
Ray W. Herrick Laboratories

FINAL PROGRAM

SHORT COURSES & WORKSHOPS: JULY 10, 2016 • CONFERENCE: JULY 11-14, 2016
Stewart Center, Purdue University, West Lafayette, Indiana, USA

ENGINEERING.PURDUE.EDU/HERRICKCONF
FOREWORD

On behalf of the Organizing Committee, the Ray W. Herrick Laboratories, Purdue University, the Co-Sponsoring Organizations and the Endorsing Organizations, it is a great pleasure to present the Final Program of the 23rd International Compressor Engineering Conference, the 16th International Refrigeration and Air Conditioning Conference, and the 4th International High Performance Buildings Conference at Purdue 2016.

The Organizing Committee received more than 650 abstracts and accepted 476 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 any papers published.

I would like to thank the authors for having chosen these 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 conducting 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 as well as Ms. Kim Stockment, our conference secretary, for their tremendous efforts in making our conferences a success.

We hope that you enjoy these conferences and return home with new ideas and professional contacts. The next Purdue Conferences are planned for July 16-19, 2018. We hope that we will see you again at that time.

Yours sincerely,

Eckhard A. Groll
General Chair

ORGANIZING COMMITTEE

General Conference Chair
Eckhard Groll

International Refrigeration and Air Conditioning Conference
Chair: James Braun
Co-Chair: Andrew Hjortland

International Compressor Engineering Conference
Chair: Travis Horton
Co-Chair: Harshad Inamdar

International High Performance Buildings Conference
Chair: Thanos Tzempelikos
Co-Chair: Jason Konstantzos

Short Course Chairs
Orkan Kurtulus – Compressor Short Course
Bill Murphy – Refrigeration Short Course
James Braun – 2016 IBO Workshops
Gregor Henze – 2016 IBO Workshops

Director, Herrick Laboratories
Patricia Davies

Student Organization Committee
Stephen Caskey
Domenique Lumpkin
Vatsal Shah

Student Paper Competition
Neera Jain

Conference Coordinator
Kim Stockment
**Representatives of Cooperating Organizations**

Dr. Karim Amrane  
*Vice President, Regulatory & Research*  
Air-Conditioning, Heating and Refrigeration Institute, USA (AHRI)

Dr. Andreas Athienitis  
*Professor and Concordia Research Chair Tier I*  
Scientific Director of NSERC Solar Buildings Research Network, Concordia University, Canada

Chip Barnaby  
*IBPSA President*  
International Building Performance Simulation Association, USA

Mr. Van D. Baxter  
*Distinguished Research Staff Member, Building Equipment Research, Energy and Transportation Science Division*  
Oak Ridge National Laboratory, USA

Mr. Didier Coulomb  
*Director*  
International Institute of Refrigeration, France (IIR)

Ron Domitrovic  
*Program Manager, Energy Efficiency*  
Electric Power Research Institute, USA

Dr. Ullrich Hesse  
*Professor, Technical University of Dresden, Germany*  
President, Deutscher Kaelte- und Klimatechnischer Verein e. V. (DKV)

Mr. Glenn Hourahan  
*Senior Vice President, Research & Technology*  
Air-Conditioning Contractors of America, USA

Dr. Ji-Hwan Jeong  
*Professor, Pusan National University, South Korea*  
Society of Air-Conditioning and Refrigeration Engineers of Korea (SAREK)

Akio Miyara, D. Eng.  
*Professor, Saga University*  
Japan Society of Refrigerating & Air Conditioning Engineers

Mr. Brendan Owens  
*Vice President, Lead Technical Development*  
U.S. Green Building Research Program, USA

Mr. Michael Vaughn  
*Manager of Research and Technical Services*  
ASHRAE, USA

**Adhoc Members**

Dr. Stefan Bertsch  
*Professor and Head, Institute for Energy Systems*  
Interstate University of Applied Sciences Buchs, Switzerland

Mr. Sergio Bobbo  
*CNR*  
Instituto per le Tecnologie della Construzione, Sezione di Padova, Italy

Mr. Doug Collings  
*Director, N.A. Test Laboratories*  
Tecumseh Products Company, USA

Dr. Rob Comparin  
*Vice President, Research*  
Emerson Climate Technologies, USA

Prof. Cesar J. Deschamps  
*Professor*  
Federal University of Santa Catarina, Brazil

Dr. Ir. Carlos Infante Ferreira  
*Faculty of Mechanical, Maritime & Materials Engineering*  
Delft University of Technology, The Netherlands

Mr. Gene Fields  
*VP of Global Compressor Technologies*  
Johnson Controls, Inc., USA

Dr. Mitsuhiro Fukuta  
*Professor, Department of Mechanical Engineering*  
Shizuoka University, Japan

Dr. Andrea Gasparella  
*Faculty of Science & Technology*  
Libera Universita di Bolzano, Italy

Dr. Andrea Gernemann  
*Director of Advanced Engineering*  
Danfoss Commercial Compressors Division, Germany

Mr. Evandro Francisco Gon  
*R&D Director*  
Embraco S.A., Brazil

Dr. Zhaolin Gu  
*Professor and Executive Dean, School of Human Settlements and Civil Engineering*  
Xi’an Jiaotong University, P.R. of China
Mr. Bill Hooper  
Research & Development Manager  
Kawneer Company, Inc. (Alcoa Building & Construction Systems), USA

Mr. Joseph Karnaz  
Global Technology Leader  
CPI Fluid Engineering, USA

Dr. Vincent Lemort  
Associate Professor  
B49 Thermodynamics Laboratory, University of Liege, Belgium

Dr. Stephen B. Memory  
Director, Thermal & Mechanical Technology  
A.O. Smith Corporate Technology Center, USA

Mr. Kevin Mercer  
Staff Engineer, Thermal Systems Technology Group  
Carrier Corp., United Technologies, USA

Dr. William E. Murphy  
Professor of Mechanical Engineering and Director of Engineering Extended Campus Programs  
University of Kentucky - Paducah, USA

Mr. Andrew Pearson  
Managing Director  
Star Refrigeration Ltd., Scotland

Mr. Gordon Powell  
Compressor Center of Excellence  
Ingersoll Rand - Trane, USA

Dr. Brent Protzman  
Manager - Energy Information and Analytics  
Lutron Electronics, USA

Dr. Joaquim Rigola  
Associate Professor, Heat and Mass Transfer Technological Center  
Technical University of Catalonia, Spain

Dr. Frank Rinne  
Director Application Engineering  
Emerson Climate Technologies, GmbH, Germany

Dr.-Ing. Jurgen Suess  
Leiter Operations (Leader of Operations)  
Efficient Energy GmbH, Germany

Dr. Bob Turney  
Engineering Fellow and Team Lead, Technology and Advanced Development Building Efficiency  
Johnson Controls Inc., USA

Dr. Ruzhu Wang  
Professor and Director, Engineering Research Center for Solar Energy  
Shanghai Jiaotong University, P.R. of China

Mr. John Withouse  
RAC Refrigerants - Sr. Principal Engineer  
Sporlan Division of Parker Hannifin, USA

Mr. Jun Yang  
Department Manager of Product Development, R&D Center  
Shanghai Hitachi Electrical Appliances Co., Ltd., P.R. of China
MONDAY, JULY 11 | 9:30 AM | LOEB THEATRE

Viraj Vithoontien
Program Leader, Montreal Protocol Program, World Bank

“Climate Action driving our future forward, key perspectives on Climate Change and Refrigeration and Air Conditioning linkages from the World Bank Montreal Protocol Program”

Climate Change considerations are transforming both our current and future development trajectory, largely driven by concerted actions taken at the international level. The 2016 International Refrigeration and Air Conditioning Conference is happening during a seminal year of key international decisions that are helping to define future development pathways. This session will present an overview of climate change issues at the international level and discuss the many inter-connections between this and the Refrigeration and Air Conditioning sectors today. The World Bank Montreal Protocol Program operates directly at this nexus, working with developing countries and their industries to help integrate climate change concerns into their industry and national and local development programs through a combination of technical advisory and financial support.

TUESDAY, JULY 12 | 8:30 AM | LOEB THEATRE

Ian Beausoleil-Morrison
Professor, Faculty of Engineering & Design, Carleton University

“Maximizing the use of solar energy to radically reduce the energy needs of housing?”

Heating, cooling, and ventilating the places we live in, and providing the hot water, lighting, and appliance services we need, consumes tremendous amounts of energy; this contributes significantly to environmental and energy security issues. For example, housing accounts for 30% of all electricity and 26% of all natural gas consumed in Canada, and produces 13.5% of the country’s greenhouse gas (GHG) emissions. Although these figures vary from region to region, a similar situation exists in most OECD countries.

If we are to meet ambitious GHG emission reduction targets and reduce dependency on fossil fuels, innovative concepts are required for providing the energy services required by housing; incremental efficiency improvements will not be sufficient.

This talk will demonstrate new techniques aimed at maximizing the use of solar energy to radically reduce housing energy demands. This will include a hybrid active-passive system to increase passive solar gains whilst protecting against overheating. Concepts for the long-term storage of solar thermal energy at the single-house scale will also be explored.
TUESDAY, JULY 12 | 12:00 PM | PURDUE MEMORIAL UNION BALLROOMS

Manpreet Singh
Purdue University Food Science Department

“Refrigeration: A Key Strategy to Global Food Security”

Improved storage and transportation of food is an important aspect that can help in reducing food waste and is a key focus of several food security initiatives worldwide. Not only do transportation mechanisms need to be efficient, but also sustainable to be viable options for use by the industry. Refrigeration and advancing the technology to maintain a cold-chain can play a vital role in tackling the issue of 1.3bn tons of food wasted annually. Extreme weather calls for energy-intensive cooling technologies compared to milder climates, and unfortunately the compounding factor of developing and under-developed countries with weather extremes pose a bigger challenge. Additionally, the demand for chilled and frozen foods is limited due to access to effective refrigeration in developing countries. Therefore, prevention of food loss is a challenge that the food industry is faced with in addition to impact on quality (nutritional and microbial spoilage) and public health risks (due to pathogens).

WEDNESDAY, JULY 13 | 8:30 AM | LOEB THEATRE

Drusilla Hufford
Environmental Protection Agency

“EPA’s SNAP Program: Listing Safer Alternatives and the Climate Action Plan”

In the 1990 Clean Air Act Amendments, Congress tasked EPA with phasing out ozone depleting substances, and in addition, with the task of identifying safer substitutes. In response, EPA created the SNAP program, which in its over twenty years of existence has identified and listed more than 400 alternatives for use in major consumer and industrial uses. The President’s June 2013 announcement of the Climate Action Plan specifically tasked SNAP with an important role in prioritizing listing of lower-global warming potential options, and in reviewing – and possibly prohibiting - options already listed as acceptable in light of the introduction of newer, safer alternatives. We will focus in this talk on EPA’s activities under SNAP to respond to the CAP. In addition, we will focus on how those activities support the broader engagement of the U.S. domestically and internationally in the effort to address rapid growth in the use of hydrofluorocarbons (HFCs). Also a focus of the CAP was the effort to amend the international treaty, the Montreal Protocol to phase down HFCs, and this talk will also update listeners on the status of this effort.

THURSDAY, JULY 14 | 8:30 AM | LOEB THEATRE

Gene Fields
Vice President of Global Compressor Technologies, Johnson Controls

“The Past, Present, and Future of Scroll Compressors”

A colorful tour through the history of this great technology, including the key advancements since the introduction of the mechanism more than a century ago; as well as the many companies and people behind these things. The progress in manufacturing as well as design techniques made this story fascinating; and the Purdue Conference played a major role in the global evolution. From the complex mathematics of involute equations, displacements, volume ratios, and gas forces; to the various applications, including AC, refrigeration, homes/buildings, and automotive; the progress continues to inspire. The basics of simulation models will also be discussed, and how they led the way for very successful scroll products. Finally, future advancements with inverter technology, increased capacities, system integration, and expanders are discussed.
BREAKFAST FOR PRESENTERS, CHAIRPERSONS AND VICE CHAIRPERSONS

A complimentary lunch (on Monday) and breakfast (Tuesday – Thursday) is 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 speaker 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

*NEW Presentations are on a strict time schedule this year. Each presenter gets ONLY 20 minutes total, for both presentation and question/answers. Each presenter is allowed 15 minutes to present and 3-5 minutes for questions. 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.** This means some sessions will indeed end early, while others will run long.

PICTURES AND VIDEOTAPING DURING THE CONFERENCES & PICTURE PHONES

Conference attendees may **NOT** take pictures, videotapes, nor use picture phones 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 16-19, 2018
Short Courses are organized and presented by the faculty of Herrick Laboratories, in cooperation with our sponsoring organizations. Often, speakers from outside organizations and university 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, 2016, and will meet concurrently.

OIL MANAGEMENT COMPRESSORS AND THEIR SYSTEMS
The short course focuses on oil management in hermetic, positive displacement compressors, such as scroll, rotary and reciprocating compressors, and their systems. It consists of eight 50-minute lectures and will provide ample time for discussion. In particular, the following topics will be part of the short course:

- Impact of lubricants on compressor and system performance and reliability.
- Thermodynamic and transport properties of lubricant and HFC/HFO/CO2/NH3/HC refrigerant mixtures, including miscibility, solubility, and viscosity.
- Impact of oil on heat transfer and pressure drop, and oil retention in heat exchangers.
- Review of components used for oil management in vapor compression systems, such as oil separators, accumulators, and filters.
- Oil management in simple and complex vapor compression systems, including supermarket applications using multiple compressors on a rack, air-source heat pump systems, VRF systems, systems with vapor injection, industrial CO2 and NH3 refrigeration systems.
- Performance of liquid-flooded compression with regeneration systems.

FINAL FRONTIERS IN VAPOR COMPRESSION CYCLE EFFICIENCY
The efficiency of vapor compression cycles used for refrigeration and comfort cooling/heating has steadily increased since the US Department of Energy initiated minimum efficiency requirements in the early 1980s. Some current offerings have SEER values that are more than double the initial DOE minimum SEER of 10.0. These efficiency improvements have been the result of better compressor designs, larger and more efficient heat exchangers, better expansion devices, and more efficient motor technology. While efficiencies have risen substantially, they are still just a fraction of the theoretical Carnot efficiency.

The short course speakers will evaluate the various components of the vapor compression cycle to identify all areas that still offer economic opportunities for even higher system efficiencies. Case studies using optimization methods will show how to “invent” new heat exchanger shapes that go beyond tube-fin and microchannel designs, as well as overall system optimization while considering system level performance metrics. In addition, an overview will be provided for other thermodynamic cycles that may hold promise to compete with, or even surpass, the traditional vapor compression cycle that is used in the majority of refrigeration or comfort cooling/heating applications.

2016 INTELLIGENT BUILDING OPERATIONS WORKSHOP
This will be the third (previously held in 2011 and 2013) in a series of workshops that brings together researchers and developers of intelligent building features and systems. The main goals of this one-day workshop are to

1. Review fundamentals of optimal control and automated diagnostics in intelligent buildings,
2. Understand the state-of-the-art in commercialized intelligent building technologies,
3. Identify existing gaps that should be addressed in future research and development.

The format of the workshop will include a review of relevant fundamentals, followed by brief case studies that highlight recent developments and demonstrations of model-predictive controls and automated diagnostics. Ample time will be allotted for open discussion to address what is necessary to move from research to widespread adoption of intelligent building technologies.

A single registration fee will cover participation in both the IBO Workshop and the 2016 Purdue Conferences. Special IBO paper sessions are incorporated within the High Performance Building and Refrigeration and Air Conditioning Conferences where current research critical for achieving scalable and cost effective intelligent building operations will be presented. Participants in the IBO Workshop are strongly encouraged to participate in these conferences.
MONDAY, JULY 11
Reception at the Lafayette Brewing Company
The reception is hosted by UTC Carrier and will be held from 6:00 to 8:00 p.m. Shuttle buses will depart from the Grant Street Parking Garage between 5:30 and 6:00 p.m. transporting attendees and guests to the reception. Attendees may also use CityBus and the Trolleys or walk to the Reception. There will be transportation available after the Reception. You may need to arrange shuttle service with your individual hotels. Some local restaurants and bars are open on Monday evenings in downtown Lafayette and the Purdue campus.

Driving Directions to the Lafayette Brewing Company: From Grant Street Parking Garage: Head south on Andrew Place toward W State Street. Turn right onto W State Street. Turn Right onto N Grant Street. Sharp right onto Northwestern Avenue. Use the two left lanes to turn left onto Wiggins St. Keep left to stay on Wiggins Street. Continue half mile onto Old U.S. 231. Turn right onto N 6th Street. Turn left onto Main street. Lafayette Brewing Company is on the left. Parking is available on the street, or in the lot directly south of the bar that will cost $1 as you exit.

TUESDAY, JULY 12
Luncheon – Purdue Memorial Union, North & South Ballrooms
The buffet luncheon will be held from 12:00 to 1:30 p.m. It is hosted by Danfoss, Inc. There will be a Keynote Address by Purdue University’s Manpreet Singh of the Food Science Department.

WEDNESDAY, JULY 13
Steak BBQ – The Trails Banquet Facility, West Lafayette
The informal steak barbeque will be held from 6 p.m. to dusk and is hosted by Emerson Climate Technologies. Buses will begin departing from the Grant Street Parking Garage entrance across from the Union Club Hotel at 5:45 p.m. The last bus will leave at approximately 6:15 p.m. for the barbeque. There will be games, a beer wagon and a chance to visit outside. The buses will return attendees and guests to the Purdue Memorial Union, University Inn, Holiday Inn and the Hilton Garden Inn after the barbeque. You may also drive your own vehicle to this venue.

Driving Directions to The Trails: From Grant Street Parking Garage, exit on North Street, turn left. Turn right on Grant Street, turn right on Northwestern Avenue (stop light) immediately curve left on Wiggins Street. Follow US 231 (on right) down the hill to State Road 43 North. Turn left on State Road 43 North. Proceed 5-1/2 miles to Burnetts Road, turn right. The Trails will be on your right.

STUDENT EVENTS
Student Paper Competition: Winners of the Student Paper Competition from each conference will be announced and awarded at the Steak BBQ at the Trails. 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 279
Purdue Student Chapter of ASHRAE meeting with ASHRAE President, Tim Wentz. (Open to ALL student ASHRAE members, not just Purdue student members).

Student Mixer – Tuesday, July 12 from 8-10 pm, The Stacked Pickle
Gather with other students from around the world at The Stacked Pickle located at 516 Northwestern Avenue #1700, West Lafayette, IN 47906.
CONFERENCE OFFICE / HOSPITALITY ROOM
Conference Office is located in Stewart Center, Room 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 4:00 p.m.

E-Paper Center
The E-Paper Center is located in Room 302, Stewart Center. Attendees may print up to 10 papers via the computer stations set up in room 302. You may also use the e-stations to print airline boarding passes, check emails, etc. Please be considerate of other guests, and limit time on the computer to 15 minute intervals.

Internet Access
Wireless internet is available to all attendees via the Conference Division/ATT WIFI hotspot. Please choose ATT Wifi as your internet connection. When you open a browser, you will be automatically connected. Your will need to provide your email address and accept terms & conditions. If you have difficulties, please visit the Conference Office, Stewart Center, 306.

Display Center
There will be several tables available in the Conference Hospitality Room, Stewart Center, Room 306. Please check with Conference staff before displaying any material. No commercialism is allowed. There is also a Bulletin Board where messages can be posted for other attendees and the Organizing Committee will post any last minute schedule changes.

PRINTING, COPYING AND FAXING
Attendees may print from a CD/disk/memory stick, make copies, send faxes, and more at The BoilerCopy Maker in the Purdue Memorial Union, Second Floor. Charges vary for different services.

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 near State Road 26.

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 European 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.
PRACTICAL GUIDE

BANKS AND CREDIT UNION LOCATED NEAR THE PURDUE CAMPUS (WITH ATM’S)

REGIONS BANK
Address: Stadium Square Center, 728 Northwestern Avenue, West Lafayette, IN
Telephone: (765) 476-8205
Hours: Monday–Thursday 9:00 a.m. – 5:00 p.m.; Friday 9:00 a.m. – 6:00 p.m.

CHASE BANK
Address: Chauncey Village, 210 West State Street, West Lafayette, IN
Telephone: (765) 423-0412
Hours: Monday – Friday 9:00 a.m. – 6:00 p.m.; Saturday 9:00 a.m. – 2:00 p.m.

PURDUE EMPLOYEES FEDERAL CREDIT UNION
ATMs available at Purdue Memorial Union in the Stewart Center Lobby, Northwestern Avenue and Garfield Streets
Hours: Monday – Friday 9:00 a.m. – 6:00 p.m.; Saturday 9:00 a.m. – 2:00 p.m.

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 will 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’s buses and trolleys will also be available.

TROLLEY ROUTE

HOTEL LOCATIONS ON THE MAP & TELEPHONE CONTACT NUMBERS
B  Hilton Garden Inn ............................................................................................................................(765) 743-2100
C  The Union Club Hotel at Purdue University ....................................................................................(765) 494-8900
D  First Street Towers ..............................................................................................................................(765) 494-0926
G  Holiday Inn -Lafayette City Centre ..................................................................................................(765) 423-1000
Four Points by Sheraton ......................................................................................................................(765) 463-5511
(Located on U.S. 52, West of campus)
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

STAR OF AMERICA
Shuttle service to and from the Indianapolis International Airport
1-800-933-0097 or StarofAmerica.com

EXPRESS AIR COACH
Provides shuttle service to and from the Chicago O’Hare Airport
(765) 743-3120 or expressaircoach.com

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. Guests at the Union Club Hotel can park free. Visitors can purchase “A” garage permits or multiple day passes at the Parking facilities office (494-9494) Monday-Friday 7:30-4:30. Price is $5.00/day and allows parking in any garage EXCEPT Grant Street. Do not park in marked parking spaces or you will be ticketed. We are not able to get your ticket dismissed.

CONFERENCE APP
Add the conference agenda on your mobile! Conference4me is a mobile app that facilitates participation in conferences and exhibitions. This app is offered free to conference attendees. Type Conference4me in Google Play / iTunes / WindowsPhone Store or scan the QR code below.
MONDAY, JULY 11

7:00am - 4:00 pm  Conference Registration – East Foyer, Stewart Center

8:00-10:00 am  Welcome Continental Breakfast – West Foyer, Stewart Center – Hosted by Tecumseh

9:30-11:30 am  Opening Session, Welcome and Keynote Address – Loeb Playhouse, Stewart Center
VIRAJ VITHOONTIEN, Program Leader, Montreal Protocol Program, World Bank

11:30-1:00 pm  Lunch Break (on your own)

11:30-1:00 pm  Complimentary Lunch for Chairpersons & Presenting Authors for Monday's Sessions – West Faculty Lounge, Second Floor, Purdue Memorial Union

STEW 214AB  STEW 214CD  STEW 218AB  STEW 218CD  STEW 310  STEW 278  STEW 202  STEW 206


3:00-3:30 pm  Coffee Break – Hospitality Room (STEW 302/306) – Hosted by Tecumseh


5:30-6:00 pm  Bus transportation provided from Grant Street Garage to Lafayette Brewing Company (LBC)

6:00-8:00 pm  Opening Night Reception – Lafayette Brewing Company (LBC) 622 Main Street, Lafayette, IN 47901 – Hosted by UTC Carrier

7:00-8:00 pm  Bus transportation provided from Lafayette Brewing Company (LBC) to Grant Street Garage

TUESDAY, JULY 12

8:00am - 4:00 pm  Conference Registration – East Foyer, Stewart Center

7:15-8:15 am  Complimentary Breakfast for Chairpersons & Presenting Authors for Tuesday's Sessions – West Faculty Lounge, 2nd Floor, Purdue Memorial Union

8:00-10:00 am  Continental Breakfast Available – West Foyer, Stewart Center – Hosted by Highly

8:30-9:30 am  Plenary Session – Loeb Playhouse, Stewart Center
IAN BEAUSOLEIL-MORRISON, Carleton University

9:30-9:45 am  Coffee Break – Hospitality Room (STEW 302/306) – Hosted by Highly

STEW 214AB  STEW 214CD  STEW 218AB  STEW 218CD  STEW 310  STEW 278  STEW 202  STEW 206


12:00-1:15 pm  Conference Luncheon – North and South Ballrooms, Purdue Memorial Union – Hosted by Danfoss (included in registration)
MANPREET SINGH, Purdue University Food Science Department

1:30-3:30 pm  B7: Demand Response & Load Mgmt (IBO)  B8: Building Analysis & Retrofits  R12: Advanced Equipment Controls II (IBO)  R13: Expansion Devices + Two Phase Separators  R14: Heat Exchanger Frost Formation  Student Paper Competition Session C  C7: Expanders I

3:30-4:00 pm  Coffee Break – Hospitality Room (STEW 302/306) – Hosted by Highly

4:00-6:00 pm  B9: Control Oriented Modeling (IBO)  R15: Commercial & Industrial Refrigeration III  R16: Ejector/Injector Analysis & Performance  R17: Heat Exchanger Refrigerant Flow Distribution  Student Paper Competition Session B  C8: Heat Transfer in Compressors II  C9: Linear and Reciprocating Compressors

6:00-8:00  Tours of Herrick Laboratories

7:00-8:30 pm  Conference Advisory Committee Meeting (by invitation only) – Burton Morgan Café, near Herrick Laboratories

8:00-10:00 pm  Student Mixer – The Stacked Pickle (516 Northwestern Ave. #1700, West Lafayette, IN 47906)

*IBO = Intelligent Building Operations Session

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**WEDNESDAY, JULY 13**

7:15-8:15 am  
Complimentary Breakfast for Chairpersons & Presenting Authors for Wednesday's Sessions — West Faculty Lounge, 2nd Floor, Purdue Memorial Union

8:00-10:00 am  
Continental Breakfast Available — West Foyer, Stewart Center — Hosted by Kawneer

8:30-9:30 am  
**Plenary Session — Loeb Playhouse, Stewart Center — DRUSILLA HUFFORD, Environmental Protection Agency**

9:30-9:45 am  
Coffee Break — Hospitality Room (STEW 302/306) — Hosted by Kawneer

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<tr>
<td>12:00-1:00 pm</td>
<td>Lunch Break</td>
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<td>3:00-3:30 pm</td>
<td>Coffee Break — Hospitality Room (STEW 302/306) — Hosted by Kawneer</td>
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<tr>
<td>5:45-6:15 pm</td>
<td>Shuttle buses will transport attendees from the Grant Street Parking Garage to the Steak Barbeque</td>
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<td>6:00-10:00 pm</td>
<td><strong>Steak Barbeque — The Trails (325 Burnetts Rd, West Lafayette, IN 47906) — Hosted by Emerson Climate Technologies</strong></td>
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<tr>
<td>9:30-10:00 pm</td>
<td>Shuttle buses will transport attendees from the Steak Barbeque to the Grant Street Parking Garage and area hotels</td>
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**THURSDAY, JULY 14**

7:15-8:15 am  
Complimentary Breakfast for Chairpersons & Presenting Authors for Thursday's Sessions — West Faculty Lounge, 2nd Floor, Purdue Memorial Union

8:00-10:00 am  
Continental Breakfast Available — West Foyer, Stewart Center — Hosted by Parker Hannifin

8:30-9:20 am  
**Plenary Session — Loeb Playhouse, Stewart Center — GENE FIELDS, Johnson Controls**

9:30-9:45 am  
Coffee Break — Hospitality Room (STEW 302/306) — Hosted by Parker Hannifin

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<tr>
<th>STEW 214AB</th>
<th>STEW 214CD</th>
<th>STEW 218AB</th>
<th>STEW 218CD</th>
<th>STEW 310</th>
<th>STEW 278</th>
<th>STEW 202</th>
<th>STEW 206</th>
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<tbody>
<tr>
<td>12:00-1:00 pm</td>
<td>Lunch Break — Boxed lunches available in the Conference Hospitality Room — Hosted by Rheem</td>
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<td>3:00-3:30 pm</td>
<td>Coffee Break — Hospitality Room (STEW 302/306) — Hosted by Parker Hannifin</td>
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<td>3:30-5:30pm</td>
<td>Conference Advisory Committee Meeting (by invitation only) — STEW 307</td>
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<td>5:30pm</td>
<td>End of Conference</td>
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*IBO = Intelligent Building Operations Session*
B-01: SUPERVISORY CONTROL OPTIMIZATION (IBO) | 214 A&B

Chair: Jie Cai, Purdue University

1:00PM - 1:20PM
ID: 3357
A Multi-Agent Control Approach for Optimization of Central Cooling Plants
Rita C. Jaramillo, James E. Braun, W. Travis Horton
Purdue University, United States of America; rjaramil@purdue.edu

1:20PM - 1:40PM
ID: 3690
Evaluation of Optimal Chiller Plant Control Algorithms in Model-Based Design Platform with Hardware-in-the-Loop
Pengfei Li, Shui Yuan, Keunmo Kang, Hayden Reeve
United Technologies Research Center, United States of America; lip1@utrc.utc.com

1:40PM - 2:00PM
ID: 3194
Closed-Loop Scheduling for Cost Minimization in HVAC Central Plants
Michael J. Risbeck¹, Christos T. Maravelias¹, James B. Rawlings¹, Robert D. Turney²
¹University of Wisconsin--Madison, United States of America; ²Johnson Controls, Inc., United States of America

2:00PM - 2:20PM
ID: 3097
A VOLTTRON based implementation of Supervisory Control using Generalized Gossip for Building Energy Systems
Venkatesh Chinde, Adam Kohl, Zhanhong Jiang, Atul Kelkar, Soumik Sarkar
Iowa State University, United States of America; vchinde@iastate.edu

2:20PM - 2:40PM
ID: 3642
Integrated control of RTUs and refrigeration equipment in convenience stores
Donghun Kim, James Braun
Purdue University, United States of America; kim1077@purdue.edu

2:40PM - 3:00PM
ID: 3191
Model-based Optimal Control of Variable Air Volume Terminal Box
Fuxin Niu, Zheng O'Neill, Xiaohui Zhou, Defeng Qian
The University of Alabama, United States of America; dqian@crimson.ua.edu

B-02: BUILDING ENVELOPE SYSTEMS | 214 C&D

Chair: Ying-Chieh Chan, Purdue University

1:00PM - 1:20PM
ID: 3554
Comparison And Validation Of Modelling Methods For Non-Homogenous Walls Incorporating Vacuum Insulation Panels
Brock Conley¹, Christopher Baldwin¹, Cynthia A. Cruickshank¹, Mark Carver²
¹Carleton University, Canada; ²Natural Resources Canada, Canada; brock.conley@carleton.ca
1:20PM - 1:40PM
ID: 3083
Experimental Study on Thermal Performance Improvement of Envelop Integrated with Phase Change Material in Air-conditioned Room
Yanru Li¹, Xi Meng¹, Suo Wang¹, Enshen Long¹²
¹College of Architecture and Environment, Sichuan University, China; ²Institute of Disaster Management and Reconstruction, Sichuan University-Hong Kong PolyU, China; 429506492@qq.com

1:40PM - 2:00PM
ID: 3646
Analysis of the Measurements Reliability in Dynamic Test of the Opaque Envelope
Nadja Bishara, Alessandro Prada, Giovanni Pernigotto, Marco Baratieri, Andrea Gasparella
Free University of Bozen, Italy; alessandro.prada@unibz.it

2:00PM - 2:20PM
ID: 3494
Cold-Soak Testing Method -Based Evaluation of Thermal Performance of A Typical Residential Dwelling
Minh Nguyen¹, Fumiaki Baba², Anna Sung²
¹Mitsubishi Electric R&D Centre Europe, United Kingdom; ²Mitsubishi Electric Corporation, Advanced Technology R&D Centre, Japan; m.nguyen@uk.merce.mee.com

2:20PM - 2:40PM
ID: 3644
Energy Savings Potential of Phase Change Material Integrated Building Envelope in South Texas
Hui Shen, Xiaoyu Liu
Texas A&M University - Kingsville, United States of America; shen34@purdue.edu

2:40PM - 3:00PM
ID: 3416
Investigation of Dynamic Thermal Parameters of Various Insulation Filled Bricks Exposed to Periodic Thermal Variations for Energy Efficient Stuffed Bricks Design
Ashok Babu Puttaranga Setty Talanki, Saboor Shaik
Mechanical Engineering Department, National Institute of Technology, Karnataka, India; tpashok@rediffmail.com

R-01: COMMERCIAL/INDUSTRIAL REFRIGERATION I | 218 A&B
Chair: Andy Pearson, Star Refrigeration

1:00PM - 1:20PM
ID: 2261
Theoretical and Experimental Analysis of Desiccant Air Conditioning System for Storage of Agricultural Products
Muhammad Hamid Mahmood¹²³, Muhammad Sultan⁴, Takahiko Miyazaki³⁴, Shigeru Koyama³⁴
¹Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Kasuga-koen 6-1, Kasuga-shi, Fukuoka 816-8580, Japan; ²Department of Agricultural Engineering, Faculty of Agricultural Sciences & Technology, Bahauddin Zakariya University, Bosan Road, Multan 60800, Pakistan; ³Faculty of Engineering Sciences, Kyushu University, Kasuga-koen 6-1, Kasuga-shi, Fukuoka 816-8580, Japan; ⁴International Institute for Carbon-Neutral Energy Research (WPI-I2CNER), Kyushu University, 744 Motooka, Nishi-ku, Fukuoka 819-0395, Japan; mahmood@phase.cm.kyushu-u.ac.jp

1:20PM - 1:40PM
ID: 2663
A Trans-critical CO2 Heat Pump System for Waste Heat Utilization in Warm Weather Condition Applied to a Milk Refrigeration Plant
Simarpreet Singh, M.S Dasgupta
Birla Institute of Technology and Science, Pilani, India.; simarpreet.singh@pilani.bits-pilani.ac.in
MONDAY • 1:00-3:00 PM

1:40PM - 2:00PM
ID: 2423
Heat Pump for Energy Efficient Sugarcane Juice Freeze Pre-Concentration
Milind V Rane, Dinesh B Uphade
IIT Bombay, India; dbuphade@iitb.ac.in

2:00PM - 2:20PM
ID: 2282
CO2 Hydrate Slurries For Rapid Chilling Of Fresh Food Products
Steven Lobregt¹, Jan Broeze², Carlos Infante Ferreira³
¹Sparkling Projects, Netherlands, The; ²Wageningen UR, Netherlands, The; ³Technical University Delft, Netherlands, The; sl@sparklingprojects.nl

2:20PM - 2:40PM
ID: 2668
Investigations Of Chinese Cabbage Cold Storage Chamber Operation
Miroslawa Kolodziejczyk, Dariusz Butrymowicz, Jerzy Gagan, Kamil Smierciew
Bialystok University of Technology, ul. Wiejska 42A, Bialystok,15-351, Poland; d.butrymowicz@pb.edu.pl

2:40PM - 3:00PM
ID: 2032
Energy And Exergy Analysis For Low Temperature Refrigeration System For Biogas Upgrading
Joseph Bassila¹,², Denis Clodic¹, Joseph Toubassy¹, Amelie Danlos²
¹Cryopur, France; ²Laboratoire de Chimie Moléculaire, Génie des Procédés Chimiques et Energétique (CNAM), France; joseph.bassila@cryopur.com

R-02: ORGANIC RANKINE CYCLE | 218 C&D
Chair: Abhinav Krishna, Eaton

1:00PM - 1:20PM
ID: 2618
Combined Heat and Power From Low Temperature Heat: HFO-1336mzz(Z) as a Working Fluid for Organic Rankine Cycles
Konstantinos Kontomaris¹, Luke D. Simoni¹, Mattias Nilsson⁰, Tim Hamacher⁴, Harald Nes Rislå⁴
¹Chemours Fluorochemicals, Wilmington, Delaware, United States of America; ²Viking Heat Engines, Kristiansand, Norway; ³Viking Heat Engines, Remscheid, Germany; ⁴Viking Development Group, Kristiansand, Norway; konstantinos.kontomaris@chemours.com

1:20PM - 1:40PM
ID: 2260
Optimal Heat Source Temperature For Supercritical Organic Rankine Cycle
Wei Liu¹, Christoph Wieland¹, Dominik Meinel¹, Hartmut Spleiethoff²
¹Institute for Energy Systems, Faculty of Mechanical Engineering, Technische Universität München, Germany; ²The Bavarian Center for Applied Energy Research (ZAE Bayern), Division ¹Technology for Energy Systems and Renewable Energy, Germany; wei.liu@tum.de

1:40PM - 2:00PM
ID: 2421
Single Stage and Cascaded Organic Rankine Cycles with Screw Expanders Used for Hot Fluids in Oil Refineries and Chemical Plants
Yan Tang
Kaishan Compressor, China; kaishanus1@163.com
2:00PM - 2:20PM  
ID: 2507  
Fundamental Investigation Of Whole-Life Power Plant Performance For Enhanced Geothermal Systems  
Matthew Read, Ian Smith, Nikola Stosic  
City University London, United Kingdom; matthew.read.3@city.ac.uk

R-03: HEAT EXCHANGER DESIGN IMPROVEMENTS  |  310  
Chair: Yunho Hwang, University of Maryland  
1:00PM - 1:20PM  
ID: 2384  
Review of Fractal Heat Exchangers  
Zhiwei Huang, Yunho Hwang, Vikrant Aute, Reinhard Radermacher  
University Of Maryland, United States of America; yhhwang@umd.edu

1:20PM - 1:40PM  
ID: 2305  
Investigation of Evaporator Performance with and without Liquid Overfeeding  
Stefano Bortolin¹, Marco Rossato¹, Stefano Bernardinello², Davide Del Col¹  
¹University of Padova, Italy; ²Blue Box – Swegon, Italy; stefano.bortolin@unipd.it

1:40PM - 2:00PM  
ID: 2015  
Development Of Micro Channel Heat Exchanger For Residential Air-Conditioners  
Gaku Hayase  
SAMSUNG ELECTRONICS CO. LTD, Korea, Republic of (South Korea); gaku.hayase@samsung.com

2:00PM - 2:20PM  
ID: 2275  
Analysis of an Innovative Microchannel Condenser Design for Modular Chillers and Unitary Rooftop Air Conditioners  
Sankaranarayanan Padhmanabhan, Mustafa Yanik  
Danfoss, United States of America; sankar.padhmanabhan@danfoss.com

2:20PM - 2:40PM  
ID: 2381  
Design and Numerical Parametric Study of Fractal Heat Exchanger  
Zhiwei Huang, Jiazhen Ling, Yunho Hwang, Vikrant Aute, Reinhard Radermacher  
University Of Maryland, United States of America; yhhwang@umd.edu

R-04: HEAT PUMP DESIGN AND ASSESSMENT  |  278  
Chair: Stefan Bertsch, NTB University of Applied Sciences of Technology Buchs  
1:00PM - 1:20PM  
ID: 2021  
Multi-Temperature Heat Pumps - A Literature Review  
Cordin Arpagaus¹, Frédéric Bless¹, Stefan Bertsch¹, Jürg Schiffmann²  
¹NTB University of Applied Sciences of Technology Buchs, Institute for Energy Systems, Buchs, Switzerland; ²Ecole Polytechnique Fédérale de Lausanne, Laboratory for Applied Mechanical Design, Neuchâtel, Switzerland; cordin. arpagaus@ntb.ch
Experimental investigation of a two-stage oil-free domestic Air/Water heat pump prototype powered by an oil-free high-speed twin-stage radial compressor rotating on gas bearings

Jean-Baptiste Carré, Daniel Favrat, Jürg Schiffmann
EPFL, Switzerland; jean-baptiste.carre@epfl.ch


Xiaoping Tu¹, Xiangfei Liang¹, Ruiqi Yang², Rong Zhuang²
¹National Engineering Research Center of Green Refrigeration Equipment, China, People’s Republic of; ²Gree Electric Appliances, Inc. of Zhuhai, China, People’s Republic of; liangxf@cn.gree.com

Optimization of a Residential Air Source Heat Pump using Heat Exchangers with Small Diameter Tubes

Mohamed Beshr, Vikrant Aute, Reinhard Radermacher
University of Maryland, United States of America; mbeshr@umd.edu

Heat Pump Clothes Dryer Model Development

Bo Shen, Kyle Gluesenkamp, Pradeep Bansal, David Beers
Oak Ridge National Laboratories, United States of America; shenb@ornl.gov

CFD Analysis of Oil Flooded Twin Screw Compressors

Sham Ramchandra Rane, Ahmed Kovacevic, Nikola Stosic
Centre for Compressor Technology, City University London, United Kingdom; sham.rane@city.ac.uk

Experimental Investigation on the Operating Characteristics of a Semi-hermetic Twin Screw Refrigeration Compressor by Means of p-V Diagram

Xiaokun Wu¹, Zhaorui Zhao¹, Wenging Chen², Ziwen Xing¹
¹Xi’an Jiaotong University; ²Suzhou Academy, Xi’an Jiaotong University; wxiaokun@foxmail.com

Research on Injected Effect and Heat-transfer Characteristics of Narrow-Slit Injection Orifice Used for the Screw Compressor

Jia Xie, Jian Li, Kang Lian, Quanke Feng, Weifeng Wu
Xi’an Jiaotong University, China, People’s Republic of; jiajiawa_1990@163.com

Research on the Performance of a High Pressure 5.3MPa Twin Screw Compressor

Zhaorui Zhao, Xiaokun Wu, Feng Hou, Ziwen Xing
Xi’an Jiaotong University, China, People’s Republic of; smile90613@163.com
C-02: VALVES I | 206

Chair: Cesar J. Deschamps, Federal University of Santa Catarina

1:00PM - 1:20PM
ID: 1055
Linear Compressor Suction Valve Optimization
Rinaldo Puff, Dietmar E. B. Lilie, Marcelo Knies, Marcos G. D. Bortoli
Embraco, Brazil; marcos.g.bortoli@embraco.com

1:20PM - 1:40PM
ID: 1266
Flap-X: Development of a New Compressor Reed Material
Azhar Nawaz1, 2, Alexander Lof2, Chris Millward1
1Research & Development, voestalpine Precision Strip AB, Sweden; 2Research & Development, voestalpine Precision Strip AB, Sweden; azharnawaz@voestalpine.com

1:40PM - 2:00PM
ID: 1011
An Investigation Into The Dynamics Of Self-Acting Compressor Valves
Carsten Möhl, Christiane Thomas, Ullrich Hesse
Technische Universität Dresden, Germany; carsten.moehl@tu-dresden.de

2:00PM - 2:20PM
ID: 1358
Numerical Simulation of a Suction Calve: Comparison between a 3D Complete Model and a 1D Model
José Luiz Gasche1, Allan Demétrio Sales de Lima Dias1, Douglas Domingues Bueno1, Jônatas Ferreira Lacerda2
1UNESP - State University of São Paulo, Department of Mechanical Engineering, Brazil; 2Tecumseh do Brasil, Research and Development Department, Brazil; gasche@dem.feis.unesp.br

2:20PM - 2:40PM
ID: 1498
Fluid-Structure Interaction of a Reed Type Valve
Ignacio Gonzalez1, Oriol Lehmkuhl1, 2, Alireza Naseri1, Joaquim Rigola1, Assensi Oliva1
1Heat and Mass Transfer Technological Center (CTTC) Universitat Politècnica de Catalunya (UPC) - BarcelonaTech ETSEIAT, Colom 11, Terrassa (Barcelona) 08222, Spain; 2Termo Fluids S.L., Avda. Jacquard 97 1-E, Terrassa (Barcelona) 08222, Spain; quim@cttc.upc.edu

2:40PM - 3:00PM
ID: 1143
Transient Experimental and 3D-FSI Investigation of Flapper Valve Dynamics for Refrigerant Compressors
Sven Försterling1, Michael König1, Jakob Hennig1, Nicholas Carsten Lemke1, Jürgen Köhler1
1TU Braunschweig, Germany; 2Volkswagen AG, Germany; s.foersterling@tlk-thermo.de
B-03: MODEL PREDICTIVE CONTROLS (IBO) | 214 A&B

Chair: Robert Turney, Johnson Controls

3:30PM - 3:50PM
ID: 3548
Autonomous Optimization and Control for Central Plants with Energy Storage
Michael J. Wenzel, Robert D. Turney, Kirk H. Drees
Johnson Controls, United States of America; mike.wenzel@jci.com

3:50PM - 4:10PM
ID: 3483
Towards an Automated Tool Chain for MPC in Multi-zone Buildings
Filip Jorissen\textsuperscript{1,2}, Lieve Helsen\textsuperscript{1,2}
\textsuperscript{1}KU Leuven, Belgium; \textsuperscript{2}EnergyVille, Belgium; filip.jorissen@kuleuven.be

4:10PM - 4:30PM
ID: 3484
Comparison of Model Predictive Control Performance using Grey-box and White Box Controller Models
Damien Picard\textsuperscript{1}, Maarten Sourbron\textsuperscript{1}, Filip Jorissen\textsuperscript{1}, Jiří Cigler\textsuperscript{2}, Zdeněk Váňa\textsuperscript{2}, Lukáš Ferkl\textsuperscript{1}, Lieve Helsen\textsuperscript{1,4}
\textsuperscript{1}KU Leuven, Department of Mechanical Engineering, Leuven, Belgium; \textsuperscript{2}Feramat Cybernetics s.r.o., Czech Republic; \textsuperscript{3}University Centre for Energy Efficient Buildings, Czech Technical University in Prague, Czech Republic; \textsuperscript{4}EnergyVille, Waterschei, Belgium; damien.picard@kuleuven.be

4:30PM - 4:50PM
ID: 3654
A Multi-level MPC Simulation Study in a School Building
Vahid Raissi Dehkordi, José Agustín Candanedo
CanmetENERGY-Varennes, Canada; jose.candanedoibarra@canada.ca

4:50PM - 5:10PM
ID: 3684
Reducing Energy Consumption for Buildings under System Uncertainty through Robust MPC with Adaptive Bound Estimator
Hao Huang\textsuperscript{1}, Lei Chen\textsuperscript{2}, Eric Hu\textsuperscript{3}
\textsuperscript{1}The University of Adelaide, Australia; \textsuperscript{2}The University of Adelaide, Australia; \textsuperscript{3}The University of Adelaide, Australia;
lei.chen@adelaide.edu.au

5:10PM - 5:30PM
ID: 3660
A Distributed Model Predictive Control Approach for Optimal Coordination of Multiple Thermal Zones in a Large Open Space
Xiaodong Hou\textsuperscript{1}, Yingying Xiao\textsuperscript{1}, Jie Cai\textsuperscript{1}, Jianghai Hu\textsuperscript{1}, James E. Braun\textsuperscript{2}
\textsuperscript{1}School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, United States; \textsuperscript{2}School of Mechanical Engineering, Purdue University, West Lafayette, IN, United States; hou39@purdue.edu

B-04: NET ZERO ENERGY BUILDINGS | 214 C&D

Chair: Matt Miller, Kawneer Inc.

3:30PM - 3:50PM
ID: 3630
Financial Analysis of University Investments in Solar Photovoltaics
William Arnett, Praneet Arshi, William Hutzel, Brittany Newell, John Piller
Purdue University, United States of America; arnettww@purdue.edu
3:50PM - 4:10PM
ID: 3509
The Potential of Liquid-Based BIPV/T Systems and Ice Storage for High Performance Housing in Canada
Justin Tamasauskas¹, Michel Poireir², Radu Zmeureanu², Martin Kege², Roberto Sunye¹, Eric McDonald¹
¹Natural Resources Canada/CanmetENERGY-Varennes, Canada; ²Department of Building, Civil and Environmental Engineering, Concordia University; justin.tamasauskas@canada.ca

4:10PM - 4:30PM
ID: 3522
Influence Of Building Management On Cost Optimality Definition In Residential Buildings Retrofitting
Paola Penna¹, Alessandro Prada¹, Francesca Cappelletti², Andrea Gasparella¹
¹Free University of Bozen-Bolzano, Italy; ²IUAV University of Venice, Italy; paola.penna@unibz.it

4:30PM - 4:50PM
ID: 3692
Recovery of Waste Thermal Energy in U.S. Residential Appliances
Stephen L. Caskey¹, Eckhard A. Groll¹, Eric J. Bowler²
¹Ray W. Herrick Laboratories, School of Mechanical Engineering, Purdue University, West Lafayette, IN 47907, USA; ²Whirlpool Corporation, Benton Harbor, MI 49022, USA; stephen.l.caskey@gmail.com

4:50PM - 5:10PM
ID: 3309
Net Zero Energy House Evaluation
Meher Taleyarkhan, William Hutzel
Purdue University, United States of America; hutzelw@purdue.edu

5:10PM - 5:30PM
ID: 3395
A Non-Iterative Balancing Method for HVAC Duct System
Haoran Chen¹, Wenjian Cai², Qingguo Wang³
¹EXQUISITUS, Centre for E-City, School of Electronic and Electrical Engineering, Nanyang Technological University, Singapore; ²Institute for Intelligent Systems, the University of Johannesburg; ewjcai@ntu.edu.sg

R-05: COMMERCIAL/INDUSTRIAL REFRIGERATION II | 218 A&B
Chair: Jon Douglas, Lennox

3:30PM - 3:50PM
ID: 2211
Experimental and Numeric Quantitative Evaluation of Thermal Performance in Refrigerated Display Cabinets with Variation of Air Curtain Thickness and Porosity of the Back Panel
Samuel Mariano Nascimento¹, Gustavo Galdi Heidinger¹, Pedro Dinis Gaspar², Pedro Dinho Silva²
¹Eletrofrio Refrigeração, Brazil; ²University of Beira Interior, Portugal; dinis@ubi.pt

3:50PM - 4:10PM
ID: 2209
Experimental Evaluation of the Influence of Consumers’ Passing Velocity on the Thermal Performance of Open Refrigerated Display Cabinets
Samuel Mariano Nascimento¹, Gustavo Galdi Heidinger¹, Pedro Dinis Gaspar², Pedro Dinho Silva², Luís Pinto Andrade³
¹Eletrofrio Refrigeração, Brazil; ²University of Beira Interior, Portugal; ³Polytechnic Institute of Castelo Branco, Portugal; dinis@ubi.pt
4:10PM - 4:30PM  
**ID: 2212**  
**Experimental Analysis of Aerothermodynamics Performance of the Air Curtain Subject to the Systematic Crossing of a Solid Body**  
Samuel Mariano Nascimento¹, Gustavo Galdi Heidinger¹, Pedro Dinis Gaspar², Pedro Dinho Silva²  
¹Eletrofrio Refrigeração, Brazil; ²University of Beira Interior, Portugal; dinis@ubi.pt

4:30PM - 4:50PM  
**ID: 2449**  
**Utilizing Thermal Mass in Refrigerated Display Cases to Reduce Peak Demand**  
Brian Fricke, Teja Kuruganti, James Nutaro, David Fugate, Jibonananda Sanyal  
Oak Ridge National Laboratory, United States of America; frickeba@ornl.gov

4:50PM - 5:10PM  
**ID: 2068**  
**High Efficiency Evaporator Fan Motors for Commercial Refrigeration Applications**  
Bryan Becker¹, Brian Fricke¹  
¹Oak Ridge National Laboratory, United States of America; ²University of Missouri - Kansas City, United States of America; beckerb@umkc.edu

5:10PM - 5:30PM  
**ID: 2669**  
**Application Of Single Blow Technique For Heat Transfer Measurement In Packed Bed Of Vegetables**  
Dariusz Butrymowicz, Adam Lapinski, Jerzy Gagan, Kamil Smierciew  
Bialystok University of Technology, ul. Wiejska 42A, Bialystok, 15-351, Poland; d.butrymowicz@pb.edu.pl

5:30PM - 5:50PM  
**ID: 2580**  
**Design, Build-up, and Commissioning of 350 kW Refrigeration Test Facility for Experimental Investigation of Large Cold Chain Equipment**  
Mario Wenzel¹, Stefan Elbel¹,², Pega Hrnjak¹,²  
¹Creative Thermal Solutions, Inc., USA; ²Air Conditioning and Refrigeration Center, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, 1206 West Green Street, Urbana, IL 61801, USA; mario.wenzel@creativethermalsolutions.com

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**R-06: LUBRICANT DEVELOPMENTS AND ASSESSMENTS | 218 C&D**  
*Chair: Christopher Seeton, Shrieve Chemical Products*

3:30PM - 3:50PM  
**ID: 2399**  
**Development of Polyol Ester Refrigeration Oils for HFO Refrigerants**  
Akira Tada, Takeshi Okido, Yuya Mizutani, Yohei Shono, Kiyomi Sakamoto  
JX Nippon Oil & Energy Corporation, Japan; tada.akira@jxgr.com

3:50PM - 4:10PM  
**ID: 2526**  
**POE Lubricant Candidates For Low GWP Refrigerants**  
Yu-kai Chen, Jung-Tsung Hung, Hsu-Hua Tang, Jeng-Shiang Tsaih  
Patech Fine Chemicals Co., Ltd., Taiwan, Republic of China; yukai@patechfc.com.tw

4:10PM - 4:30PM  
**ID: 2127**  
**Emerging Technologies in Metal Working Fluids and Compatibility with Refrigeration Systems**  
Richard Butler¹,²,³, Mike Foster²,³  
¹Chemtool, Inc., United States of America; ²CPI Fluid Engineering; ³Lubrizol; rbutler@chemtool.com
4:30PM - 4:50PM
ID: 2131
**On the Effect of Lubricant on Pool Boiling Heat Transfer Performance**
Ting-Yang Chen¹, Shou-Ren Sheng¹, Jung-Tsung Hung², Yu-Kai Chen², Chi-Chuan Wang¹
¹Department of Mechanical Engineering, National Chiao Tung University, Hsinchu 300, Taiwan; ²Patech Fine Chemicals Co., Ltd., Changhua County 50741, Taiwan; tzung@patechfc.com.tw

4:50PM - 5:10PM
ID: 2457
**Evaluation of Friction and Wear on PVE Refrigeration Lubricants for HFC Refrigerants**
Tomoya Matsumoto¹, Masato Kaneko¹, Yasuhiro Kawaguchi²
¹Idemitsu Kosan Co., Ltd., Lubricants Research Laboratory, Japan; ²Idemitsu Kosan Co., Ltd., Lubricants Department, Japan; tomoya.matsumoto@idemitsu.com

5:10PM - 5:30PM
ID: 2274
**Systematic Study of the Solution Properties of Low Global Warming Potential R-404A Replacement Refrigerant Blends with Various Polyol Ester Lubricants**
Edward Hessell, Roberto Urrego
Industrial Performance Products Division, Chemtura Corporation, United States of America; ed.hessell@chemtura.com

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**R-07: HEAT EXCHANGER DESIGN OPTIMIZATION | 310**
*Chair: Christiane Sabine Thomas, Technische Universitat Dresden*

3:30PM - 3:50PM
ID: 2117
**Novel Airside Heat Transfer Surface Designs Using an Integrated Multi-Scale Analysis with Topology and Shape Optimization**
Daniel Bacellar, Vikrant Aute, Zhiwei Huang, Reinhard Radermacher
University of Maryland, United States of America; dfbace@umd.edu

3:50PM - 4:10PM
ID: 2193
**Performance Evaluation Criteria & Utility Function for Analysis of Compact Air-to-Refrigerant Heat Exchangers**
Daniel Bacellar, Vikrant Aute, Reinhard Radermacher
University of Maryland, United States of America; dfbace@umd.edu

4:10PM - 4:30PM
ID: 2118
**Airside Performance Correlations and Optimal Heat Pump Heat Exchanger Designs Based on 0.5mm-2mm Finless Round Tube Bundles**
Daniel Bacellar, Vikrant Aute, Reinhard Radermacher
University of Maryland, United States of America; dfbace@umd.edu

4:30PM - 4:50PM
ID: 2119
**Wavy Fin Profile Optimization Using NURBS for Air-To-Refrigerant Tube-Fin Heat Exchangers with Small Diameter Tubes**
Daniel Bacellar, Vikrant Aute, Reinhard Radermacher
University of Maryland, United States of America; dfbace@umd.edu
4:50PM - 5:10PM
ID: 2070
Sunil Mehendale\(^1\), Zhenning Li\(^2\), Vikrant Aute\(^2\)
\(^1\)Michigan Technological University, Houghton, MI, United States of America; \(^2\)University of Maryland, College Park, MD, United States of America; ssmehe\(@\)mtu.edu

5:10PM - 5:30PM
ID: 2092
Numerical Study on the Design of Microchannel Evaporators for Ejector Refrigeration Cycles
Neal Lawrence\(^1\), Stefan Elbel\(^1,2\)
\(^1\)Air Conditioning and Refrigeration Center, University of Illinois at Urbana-Champaign, United States of America; \(^2\)Creative Thermal Solutions, Inc., United States of America; ndlawre2\(\lbrack\)illinois.edu

R-08: VAPOR COMPRESSION CYCLE ENHANCEMENTS | 278
Chair: Hung M. Pham, Emerson Climate Technologies

3:30PM - 3:50PM
ID: 2095
Performance Analysis of a Vapor Injection Cycle with Flash Tank Using a Low-GWP Inorganic Blend Refrigerant
Jose Vicente Hallak Dangelo\(^1\), Hugo Valenca de Araujo\(^1\), Jiazhen Ling\(^2\), Vikrant Aute\(^2\), Reinhard Radermacher\(^2\)
\(^1\)University of Campinas, Brazil; \(^2\)University of Maryland, USA; dangelo\(\lbrack\)feq.unicamp.br

3:50PM - 4:10PM
ID: 2425
Thermodynamic Cycle Analysis and Experimental Investigate on a Two-stage Vapor Injection Low Temperature Air Source Heat Pump with a Variable Displacement Ratio Rotary Compressor
Hui Huang\(^1,2\), Xiangfei Liang\(^1,2\), Bo Zheng\(^1\), Boliang Huang\(^2\), Jinsheng Fang\(^2\), Rong Zhuang\(^2\)
\(^1\)National Engineering Research Center of Green Refrigeration Equipment, China, People's Republic of; \(^2\)Gree Electric Appliances, Inc. of Zhuhai, China, People's Republic of; liangxf\(\lbrack\)cn.gree.com

4:10PM - 4:30PM
ID: 2323
Comparative Analysis Of CO2 Cycle Enhancements: Ejector Vs. Vapor Injection
Kirill M. Ignatiev
Emerson Climate Technologies, Inc., United States of America; Kirill.Ignatiev\(\lbrack\)Emerson.com

4:30PM - 4:50PM
ID: 2460
Experimental Investigation on the Influence of the Oil Return Hole on the Performance of R-32 Wet Compression Cycle
Bo Zheng\(^1,2\), Xiangfei Liang\(^1,2\), Rong Zhuang\(^2\)
\(^1\)National Engineering Research Center of Green Refrigeration Equipment, China, People's Republic of; \(^2\)Gree Electric Appliances, Inc. of Zhuhai, China, People's Republic of; liangxf\(\lbrack\)cn.gree.com

4:50PM - 5:10PM
ID: 2694
Experimental Results on a New Prototype Packaged Heat Pump System Retrofitted with Oil Flooded Compression and Regeneration Technology
Damien Schyns, Bin Yang, Jim E. Braun, W. Travis Horton, Eckhard Groll
Purdue University, School of Mechanical engineering, Ray W. Herrick Laboratories, West Lafayette, IN, USA; damien.schyns\(\lbrack\)gmail.com
5:10PM - 5:30PM
ID: 2366
Performance Comparison of Air-source Heat Pumps Using Economizer Vapor Injection and Internal Heat Exchanger in Cold Regions
Lei Jin, Xiang Yin, Shengchen Pan, Dongfang Yang, Feng Cao
Xi’an Jiaotong University, China, People’s Republic of; jinlei19880106@stu.xjtu.edu.cn

C-03: NOVEL COMPRESSORS | LOCATION: 202
Chair: Margaret Mathison, Iowa State University

3:30PM - 3:50PM
ID: 1336
An Integrated Model for an Oil Free Carbon Dioxide Compressor Using Sanderson-Rocker Arm Motion Mechanism
Bin Yang, Orkan Kurtulus, Eckhard Groll
Purdue University, United States of America; yang62@purdue.edu

3:50PM - 4:10PM
ID: 1478
Research of Variable Volume and Gas Injection DC Inverter Air Conditioning Compressor
Weimin Xiang, Bin Gao, Hualong Wu, Yangbo Yu
Guangdong Meizhi Compressor CO., LTD., China, People’s Republic of; gaob@chinagmcc.com

4:10PM - 4:30PM
ID: 1377
Updated Performance and Operating Characteristics of a Novel Rotating Spool Compressor
Craig R Bradshaw¹, Greg Kemp¹, Joe Orosz¹, Eckhard A Groll²
¹Torad Engineering, United States of America; ²Purdue University, United States of America; joe.orosz@toradengineering.com

4:30PM - 4:50PM
ID: 1495
Theoretical Study of Seal Spring in a Wankel Compressor
De-lou Zhang, Yu-ting Wu, Jing-fu Wang, Chun-xu Du, Xia Chen, Rui Ma, Chong-fang Ma
Beijing University of Technology, China, People’s Republic of; zhangdelou@163.com

5:10PM - 5:30PM
ID: 1378
Dynamic Modeling of a Poppet Valve for use in a Rotating Spool Compressor
Nathaniel Wood¹, Craig R Bradshaw¹, Joe Orosz¹, Greg Kemp¹, Eckhard A. Groll²
¹Torad Engineering, United States of America; ²Ray W. Herrick Laboratories, Purdue University, West Lafayette, IN; craig.bradshaw@toradengineering.com
C-04: HEAT TRANSFER IN COMPRESSORS I  |  LOCATION: 206
Chair: Vincent Lemort, University of Liege

3:30PM - 3:50PM
ID: 1210
Experimental And Numerical Investigation Of The Heat Transfer Inside A Hollow Piston Rod
Konrad Klotsche, Christiane Thomas, Ullrich Hesse
TU Dresden, Germany; konrad.klotsche@tu-dresden.de

3:50PM - 4:10PM
ID: 1215
Thermal Analysis of a Hermetic Reciprocating Compressor Using Numerical Methods
Stefan Posch1, Johann Hopfgartner1, Martin Heimel1, Erwin Berger1, Raimund Almbauer1, Stefan Stangl2
1Institute for Internal Combustion Engines and Thermodynamics, Austria; 2Secop Austria GmbH, Austria; almbauer@ivt.tugraz.at

4:10PM - 4:30PM
ID: 1492
CFD Approach to Evaluate Heat Transfer in Reciprocating Compressors
Jônatas Ferreira Lacerda1, Celso Kenzo Takemori2
1Tecumseh Products Company, Brazil; 2Vibroacústica Desenvolvimento e Pesquisa Ltda., Brazil; jonatas.lacerda@tecumseh.com

4:30PM - 4:50PM
ID: 1373
Experimental Investigation of Heat Transfer in Components of a Hermetic Reciprocating Compressor under Thermal Transient
Gustavo Luiz Macedo da Silva, Thiago Dutra, Cesar Jose Deschamps
POLO/Federal University of Santa Catarina, Brazil; dutra@polo.ufsc.br

4:50PM - 5:10PM
ID: 1374
Experimental Determination of Correlations for Heat Transfer Coefficients in the Suction Muffler of a Hermetic Reciprocating Compressor
Eduardo Arceno, Thiago Dutra, Cesar Jose Deschamps
POLO/Federal University of Santa Catarina, Brazil; dutra@polo.ufsc.br

5:10PM - 5:30PM
ID: 1508
On the Use of a Parallel Object-Oriented Code for Solving the Heat Transfer in Hermetic Reciprocating Compressors
Lopez Mas1, Rigola Joaquim1, Lehmkuhl Oriol 1,2, Oliva Assensi3
1UPC, Spain; 2Termo Fluids S.L.; quim@cttc.upc.edu
B-05: BUILDING DATA ANALYTICS AND DIAGNOSTICS (IBO) | 214 A&B
Chair: John House, Johnson Controls

9:45AM - 10:05AM
ID: 3361
Assisted Point Mapping to Enable Cost-effective Deployment of Intelligent Building Applications
Francesco Leonardi¹, Hayden Reeve¹, Timothy Wagner¹, Ziyou Xiong¹, June Park¹
¹United Technologies Research Center, United States of America; ²Carnegie Mellon University, United States of America; leonarf@utrc.utc.com

10:05AM - 10:25AM
ID: 3674
Automated Fault Diagnostics for AHU-VAV Systems: A Bayesian Network Approach
Adam Regnier, Jin Wen
Drexel University, United States of America; ar626@drexel.edu

10:25AM - 10:45AM
ID: 3223
Current Based HVAC Systems Air Filter Diagnostics and Monitoring
Fadi M. Alsaleem¹, Michael Munroe², Mostafa RAFAIE Rafaie¹
¹Wichita State University, United States of America; ²Emerson Climate Technologies,United States of America; fadi.alsalemewichita.edu

10:45AM - 11:05AM
ID: 3029
A Probabilistic Framework To Diagnose Faults in Air Handling Units.
Debashis Dey, Bing Dong, Zhaoxuan Li
University of Texas at San Antonio, United States of America; Zhaoxuan.Li@utsa.edu

11:05AM - 11:25AM
ID: 3182
Improving the Performance of PCA-Based Chiller Sensor Fault Detection by Sensitivity Analysis for the Training Data Set
Yunpeng Hu, Jianli Liu, Li Zhou, Yang Liu, Qingling Qiu
Wuhan Buziness University, China, People’s Republic of; YunpengHu@hust.edu.cn

11:25AM - 11:45AM
ID: 3017
Low Refrigerant Algorithm Detection for Cooling Systems Relying on Trending and Data Analysis
Fadi M. Alsaleem, Amro Quedan
Wichita State University, United States of America; fadi.alsaleem@wichita.edu

B-06: FACADES, LIGHTING AND SOLAR RADIATION | 214 C&D
Chair: Andrea Gasparella, University of Bozen-Bolzano

9:45AM - 10:05AM
ID: 3607
Daylight Glare Evaluation When the Sun is Within the Field of View Through Window Shades
Iason Konstantzos¹, Athanasios Tsempelikos¹,², Nicole M. Murchison³, Robert W. Proctor³
¹School of Civil Engineering, Purdue University; ²Ray W. Herrick Laboratories, School of Mechanical Engineering, Purdue University; ³Psychological Sciences, Purdue University; ikonsta@purdue.edu
Solar Irradiance Modelling And Uncertainty On Building Hourly Profiles Of Heating And Cooling Energy Needs
Giovanni Pernigotto¹, Alessandro Prada², Paolo Baggio², Andrea Gasparella¹, Ardeshir Mahdavi³
¹Free University of Bozen-Bolzano, Faculty of Science and Technology, Bolzano, Italy; ²University of Trento, Department of Civil Environmental and Mechanical Engineering, Trento, Italy; ³Vienna University of Technology, Department of Building Physics and Building Ecology, Vienna, Austria; giovanni.pernigotto@unibz.it

On The Representation Of The Thermal And Visual Behavior Of A Roller Shade Material: Comparison Between Different Simulation Models
Anna Maria Atzeri¹, Francesca Cappelletti², Andrea Gasparella¹, Athanasios Tzempelikos³
¹Free University of Bolzano/Bozen, Faculty of Science and Technology, Bolzano, Italy; ²University IUAV of Venezia, Dpt. of Design and Planning in Complex Environments, Venezia, Italy; ³Purdue University School of Civil Engineering and Ray W. Herrick Labs, West Lafayette, Indiana (USA); annamaria.atzeri@unibz.it

The Effect of the Configuration of the Absorber on the Performance of Flat Plate Thermal Collector
Moyu Yan¹, Ming Qu¹, Steve Peng²
¹Purdue University, Department of Civil Engineering, West Lafayette, IN, United States of America; ²California State University, College of Business and Economics, East Bay, CA, United States of America; yan170@purdue.edu

A New Interactive Web-based Tool to Evaluate The Efficiency of Solar Protection Devices
Ying-Chieh Chan¹, Iason Konstantzos¹, Athanasios Tzempelikos¹, Matthew Miller²
¹Purdue University; ²Kawneer Company Inc.; ychan@purdue.edu

R-09: ADVANCED EQUIPMENT CONTROLS I (IBO) | 218 A&B
Chair: Christopher Reed Laughman, Mitsubishi Elec Research Lab

Distributed Extremum Seeking Control for a Variable Refrigerant Flow System
Yang Zhu¹, Yaqiu Li¹, Liujia Dong¹, Timothy I. Salsbury², John M. House²
¹University of Texas at Dallas, United States of America; ²Johnson Controls, Inc.; zhuyang19881218@163.com

Proportional-Integral Extremum Seeking for Optimizing Power of Vapor Compression Systems
Daniel J Burns¹, Christopher R. Laughman¹, Martin Guay²
¹Mitsubishi Electric Research Laboratories, United States of America; ²Queen’s University, Ontario, Canada; burns@merl.com

Automatic Mode Switching for A Multi-functional Variable Refrigerant Flow System
Liujia Dong¹, Yaqiu Li¹, Timothy I. Salsbury², John M. House²
¹The University of Texas at Dallas, United States of America; ²Johnson Controls, Inc.; lxd122030@utdallas.edu
10:45AM - 11:05AM
ID: 2574
Experimental Performance Investigation of Cooling or Heating Coil Valves and Their Impact on Temperature Controls
Jie Cai, Orkan Kurtulus, James E. Braun
Ray W. Herrick Laboratories, Purdue University, United States of America; cai40@purdue.edu

11:05AM - 11:25AM
ID: 2577
Self-learning Backlash Inverse Control of Cooling or Heating Coil Valves Having Backlash Hysteresis
Jie Cai, James E. Braun
Ray W. Herrick Laboratories, Purdue University, United States of America; cai40@purdue.edu

R-10: ALTERNATIVE COOLING/HEATING TECHNOLOGIES | 218 C&D
Chair: Reinhard Radermacher, University of Maryland

9:45AM - 10:05AM
ID: 2447
Preliminary Analysis of a Fully Solid State Magnetocaloric Refrigeration
Mingkan Zhang, Ayyoub Meh dizadeh Momen, Omar Abdelaziz
Oak Ridge National Laboratory, United States of America; zhangm1@ornl.gov

10:05AM - 10:25AM
ID: 2136
The Optimization Model of Effective Thermal Conductivity for Metal Hydride Heat Pump of Refrigeration Cycle
Heyinan Zheng1, Kuan-Ting Lin1, Sang-chul Bae2, Masafumi Katsuta3
1Department of Modern Mechanical Engineering, Waseda University, Tokyo, Japan; 2Environmental Research Institute, Waseda University, Saitama, Japan; zhenghe@fuji.waseda.jp

10:25AM - 10:45AM
ID: 2385
Experimental Evaluation of Compressive Elastocaloric Cooling System
Suxin Qian1,2, Yi Wang1, Yunlong Geng1, Jiazhen Ling1, Yunho Hwang1, Jan Muehlbauer1, Reinhard Radermacher1, Ichiro Takeuchi1
1University Of Maryland, United States of America; 2Xi’an Jiaotong Universit; yhhwang@umd.edu

10:45AM - 11:05AM
ID: 2430
Operation Analysis on Refrigeration System Combined with Heat Pipe
Haixia He, Wen Wang, Zhaoqiang Qi, Rui Zhuan, Qifan Gu
Shanghai Jiao Tong University, China, People’s Republic of; wenwang@sjtu.edu.cn

11:05AM - 11:25AM
ID: 2510
Experimental Performance of Solar Collector cum Regenerator for Coupling with a Liquid Desiccant Cooling System
Gezahegn Habtamu Tafesse, Subhash Chandra Mullick, Sanjeev Jain Jain
Indian Institute of Technology Delhi (IIT Delhi), India; gezisha@yahoo.com

11:25AM - 11:45AM
ID: 2291
Numerical Simulation on Forced Convection Cooling of Horizontal Ionic Wind with Multi-electrodes
Rong Li1,2, Yijian He1,2, Guangming Chen1,2, Fengshuo Wen1,2
1Key Laboratory of Refrigeration and Cryogenic Technology of Zhejiang Province; 2Institute of Refrigeration and Cryogenics, Zhejiang University, Hangzhou 310027, China; 21427058@zju.edu.cn
R-11: AIR-SIDE HEAT TRANSFER CHARACTERIZATION AND ENHANCEMENT | 310
Chair: Lorenzo Cremaschi, Auburn University

9:45AM - 10:05AM
ID: 2595
Dynamic Contact Angle on a Surface with Gradient in Wettability
Xiaofei Wang¹, Longfei Wang¹,², Rong Yu¹
¹University of Illinois, United States of America; ²Harbin Institute of Technology, Harbin, P R China; wangxf@illinois.edu

10:05AM - 10:25AM
ID: 2120
CFD-Based Correlation Development for Air Side Performance of Wavy Fin Tube Heat Exchangers using Small Diameter Tubes
Daniel Bacellar, Vikrant Aute, Reinhard Radermacher
University of Maryland, United States of America; dfbace@umd.edu

10:25AM - 10:45AM
ID: 2363
CFD-Based Airside Heat Transfer and Pressure Drop Correlation Development for Small Diameter (3 mm to 5 mm) Louver Fin Heat Exchangers
Shekhar Sarpotdar¹, Dennis Nasuta¹, Vikrant Aute¹,²
¹Optimized Thermal Systems, 7040 Virginia Manor Road, Beltsville, MD, 20705; ²Center for Environmental Energy Engineering Department of Mechanical Engineering, University of Maryland College Park, MD, 20742; nasuta@optimizedthermalsystems.com

10:45AM - 11:05AM
ID: 2362
CFD Based Comparison of Slit Fin and Louver Fin Performance for Small Diameter (3mm to 5 mm) Heat Exchangers
Shekhar Sarpotdar¹, Dennis Nasuta¹, Vikrant Aute¹,²
¹Optimized Thermal Systems, 7040 Virginia Manor Road, Beltsville, MD, 20705; ²Center for Environmental Energy Engineering Department of Mechanical Engineering, University of Maryland College Park, MD, 20742; nasuta@optimizedthermalsystems.com

11:05AM - 11:25AM
ID: 2587
Method for Determining Air Side Convective Heat Transfer Coefficient Using Infrared Thermography
Scott S. Wujek¹, Wayne L. Staats¹, Stefan W. Elbel¹, Jeffrey P. Koplow², H. Arthur Kariya¹, Predrag S. Hrnjak¹
¹Creative Thermal Solutions, United States of America; ²Sandia National Laboratory, United States of America; scott.wujek@creativethermalsolutions.com

11:25AM - 11:45AM
ID: 2555
Numerical Simulation (CFD) to Explore Optimal Vortex Generator Array Configurations in Air Cooled Condensers
Mei Yung Wong, Gregory D Hardy, Anthony M Jacobi, Predrag Hrnjak
University of Illinois at Urbana Champaign, United States of America; mwong17@illinois.edu

R-STUDENT PAPER COMPETITION | 278
Chair: William E. Murphy, University of Kentucky

9:45AM - 10:05AM
ID: 2454
Design and Modeling of 3D-Printed Air-Cooled Heat Exchangers
Rachel Ann Felber, Gregory Nellis, Natalie Rudolph
University of Wisconsin-Madison, United States of America; rfelber@wisc.edu
10:05AM - 10:25AM
ID: 2424
Thermodynamic Analysis of an Electrochemically Driven Chemical Looping Heat Pump
Nelson A James, James E Braun, Eckhard A Groll, W Travis Horton
Ray W. Herrick Laboratories, Purdue University, United States of America; najames@purdue.edu

10:25AM - 10:45AM
ID: 2629
Development and Evaluation of an Automated Virtual Refrigerant Charge Sensor Training Kit
Akash Patil, Andrew L. Hjortland, James E. Braun, Orkan Kurtulus, W. Travis Horton
Purdue University - Ray W. Herrick Laboratories, United States of America; ahjortla@purdue.edu

10:45AM - 11:05AM
ID: 2569
Experimental and Numerical Study of a Mobile Reversible Air Conditioning-Heat Pump System
Lili Feng, Pega Hrnjak
University of Illinois at Urbana-Champaign, United States of America; lfeng8@illinois.edu

11:05AM - 11:25AM
ID: 2271
Hydrodynamic Considerations for Optimal Thermal Compressor Design
Marcel A. Staedter, Srinivas Garimella, Khoudor Keniar
Georgia Institute of Technology, United States of America; m.staedter@gmail.com

11:25AM - 11:45AM
ID: 2420
Online, Non-Intrusive Composition Measurements Of Circulating Co2 Based Mixtures In An Experimental Heat Pump By Means Of Infra-Red Spectroscopy.
Paul Bouteiller¹, Marie-France Terrier¹, Maria Isabel Barba-Garrancho², Pascal Tobaly¹
¹CNAM, IFFI, case 2D3P21, 292 rue saint martin 75003 Paris, France; ²CREVER, Universitat Rovira I Virgili, Avinguda Paisos Catalans, 26 (Campus Sescelades) - 43007 Tarragona, Spain; paul.bouteiller@cnam.fr

C-05: TRIBOLOGY AND LUBRICATION I | 202
Chair: Joseph Karnaz, CPI Engineering

9:45AM - 10:05AM
ID: 1026
Surface Tension Of Low-viscous Lubricants In High Pressure Carbon Dioxide Atmospheres
Tobias Göpfert, Christiane Thomas, Ullrich Hesse
Technische Universität Dresden, Germany; tobias.goepfert@tu-dresden.de

10:05AM - 10:25AM
ID: 1190
The Evolution of Polymer Bearing Processing for Scroll Compressor Performance and Life Enhancement
Michael R. Kim, Derek Marsella, Benoit Sidot
GGB Bearing Technologies, United States of America; michael.kim@ggbearings.com

10:25AM - 10:45AM
ID: 1239
Evaluating Lubricants For Lower GWP Refrigerant Compressor Operations
Joseph Karnaz
CPI Fluid Engineering, United States of America; joe.karnaz@gmail.com
10:45AM - 11:05AM
ID: 1436
LGWP & HC Refrigerants Solubility Tests Performed in Running Scroll Compressor
Pierre Ginies, Guillaume Rebiere, Julie Mandon, Jean Guillaume Cheurlin
Danfoss Commercial Compressors, France; p.ginies@danfoss.com

11:05AM - 11:25AM
ID: 1111
Numerical Modeling of Capillary Compensated Aerostatic Bearing Applied to Linear Reciprocating Compressor
Emilio Rodrigues Hulse¹, Alvaro Toubes Prata²
¹Embraco - R&D, Brazil; ²POLO Research Laboratories for Emerging Technologies in Cooling and Thermophysics, Federal University of Santa Catarina, Brazil; emilio.r.hulse@embraco.com

11:25AM - 11:45AM
ID: 1054
Evaluation of Wettability of Solid Surface with Oil/Refrigerant Mixture
Mitsuhiro Fukuta¹, Junki Sumiyama², Masaaki Motozawa¹, Akifumi Hyodo², Tadashi Yanagisawa¹
¹Shizuoka University, Japan; ²Graduate school of engineering, Shizuoka University; hyodo.akifumi.15@shizuoka.ac.jp

C-06: SCROLL COMPRESSORS I | 206
Chair: Gene Fields, Johnson Controls

9:45AM - 10:05AM
ID: 1177
Numerical Simulation Of The Flow Inside A Scroll Compressor
Alain Picavet, Brian Angel
Danfoss Commercial Compressors, France; a.picavet@danfoss.com

10:05AM - 10:25AM
ID: 1314
A Heat Transfer Correlation for the Suction and Compression Chambers of Scroll Compressors
Evandro L.L. Pereira, Cesar J. Deschamps
Federal University of Santa Catarina, Brazil; evandro.l.lange@embraco.com

10:25AM - 10:45AM
ID: 1370
The Improvement of Motor Cooling Through Stator Profile Optimization using CFD Analysis in Hermetic Scroll Compressors
Weiping Tang, Liu Wang, Li Yao, Jiangbo Lin
Danfoss (Tianjin) Ltd., China, People’s Republic of; yaoli@danfoss.com

10:45AM - 11:05AM
ID: 1499
Empirical Calculation Method of Bypass Leakage in Scroll Compressors
Noriaki Ishii¹, Takuma Tsuji², Eiji Nonoguchi³, Keiko Anami³, Atsushi Sakuda⁴, Charles William Knisely⁵
¹Osaka Electro-Communication University, Japan; ²Mayekawa Mfg. Co., Ltd, Japan; ³Ashikaga Institute of Technology, Japan; ⁴Panasonic Corporation Appliances Company, Japan; ⁵Bucknell University, USA; ishii@isc.osakac.ac.jp

11:05AM - 11:25AM
ID: 1515
CFD Simulation of a Dry Scroll Vacuum Pump Including Leakage Flows
Jan Hesse, Rainer Andres
CFX Berlin Software GmbH, Germany; jan.hesse@cfx-berlin.de
B-07: DEMAND RESPONSE AND LOAD MANAGEMENT (IBO)  |  214 A&B
Chair: William Hutzel, Purdue University

1:30PM - 1:50PM
ID: 3648
A Multi-objective Approach to Optimal Battery Storage in The Presence of Demand Charges
Reza Kamyar, Matthew Monnig Peet
Arizona State University, United States of America; rkamyar@asu.edu

1:50PM - 2:10PM
ID: 3128
Assessing the Potential for Reduction in Peak Residential Electrical Loads Using a Heat Pump and Thermal Storage Systems
Christopher Baldwin, Cynthia A. Cruickshank
Carleton University, Ottawa, Canada; christopher.baldwin@carleton.ca

2:10PM - 2:30PM
ID: 3269
Simulation Based Design and Testing of a Supervisory Controller for Reducing Peak Demand in Buildings
James Nutaro, Ozgur Ozmen, Jibonananda Sanyal, David Fugate, Teja Kuruganti
Oak Ridge National Laboratory, United States of America; nutarojj@ornl.gov

2:30PM - 2:50PM
ID: 3511
Load Modulation Strategies Of Residential Heat Pumps For Demand-Response Programs With Different Thermal Storage Options
Emeline Georges, Vincent Lemort
Université de Liège, Belgium; emeline.georges@ulg.ac.be

2:50PM - 3:10PM
ID: 3653
Control-oriented Modelling of Thermal Zones in a House: a Multi-level Approach
Jennifer Date¹, José Agustín Cananedo², Andreas K. Athienitis¹
¹BCEE Department, Concordia University; ²CanmetENERGY-Varennes, Canada; jose.canaledoibarra@canada.ca

B-08: BUILDING ANALYSIS AND RETROFFITS  |  214 C&D
Chair: Francesca Cappelletti, University of Venice

1:30PM - 1:50PM
ID: 3645
Characteristics of Energy Consumption by Building Type of a U.S. Navy Installation in Hot and Humid Climate
Xiaoyu Liu, Ahmed Al-Barwani, Hui Shen
Texas A&M University - Kingsville, United States of America; shen34@purdue.edu

1:50PM - 2:10PM
ID: 3677
Airflow Based Model to Estimate Commercial Building HVAC Energy Use: Analysis to Determine Principal Factors for Different Climate Zones
Stefan Gunnsteinsson, Rebecca Kahn, Michael Gevelber
Boston University, United States of America; gevelber@bu.edu
TUESDAY • 1:30-3:30 PM

2:10PM - 2:30PM
ID: 3187
Building Energy Efficiency Assessment of Renewable and Cogeneration Energy Efficiency Technologies for the Canadian High Arctic
Eric McDonald, Martin Kegel, Justin Tamasauskas
Natural Resources Canada/CanmetENERGY, Varennes, QC, Canada; eric.mcdonald@canada.ca

2:30PM - 2:50PM
ID: 3551
HVAC Solutions for Small- and Medium-sized Commercial Building Retrofit Opportunities
BongGil Jeon, W. Travis Horton
Purdue University, United States of America; jeonb@purdue.edu

2:50PM - 3:10PM
ID: 3485
The Value of Price Risk Reduction in Energy Efficiency Improvements in Buildings
Pekka Tuominen¹, Tuomas Seppänen²
¹VTT Technical Research Centre of Finland; ²OP Financial Group; Pekka.Tuominen@vtt.fi

R-12: ADVANCED EQUIPMENT CONTROLS II (IBO) | 218 A&B
Chair: John House, Johnson Controls

1:30PM - 1:50PM
ID: 2386
Review of Temperature and Humidity Control Technology for Heat Pump and Air Conditioning Systems
Xiaojie Lin, Hoseong Lee, Yunho Hwang, Reinhard Radermacher
University Of Maryland, United States of America; yhhwang@umd.edu

1:50PM - 2:10PM
ID: 2571
Dynamic Charge Management for Vapor Compression Cycles
Christopher R. Laughman, Hongtao Qiao, Daniel J. Burns, Scott A. Bortoff
Mitsubishi Electric Research Laboratories, United States of America; laughman@merl.com

2:10PM - 2:30PM
ID: 2433
Cooling Capacity Control for Multi-Evaporator Vapor Compression Systems
Daniel J. Burns, Scott A. Bortoff
Mitsubishi Electric Research Laboratories, United States of America; burns@merl.com

2:30PM - 2:50PM
ID: 2496
Optimisation Of Expansion Device Control In Cold Appliance Cooling Systems
Marcel van Beek, Hans de Jong
Re/genT, Netherlands, The; marcel.van.beek@re-gent.nl

2:50PM - 3:10PM
ID: 2365
Development Of An Adaptive PID Controller For Superheating Control Employing Artificial Bee Colony Algorithm
Nathalie Martins Panoiero¹, Ricardo Nicolau Nassar Koury², Luiz Machado², Antonio Augusto Torres Maia²
¹M.Sc. candidate - Programa de pós-graduação em Engenharia Mecânica - Universidade Federal de Minas Gerais, Brazil; ²Programa de pós-graduação em Engenharia Mecânica - Universidade Federal de Minas Gerais, Brazil; nathaliemp@gmail.com
R-13: EXPANSION DEVICES + TWO PHASE SEPARATORS | 218 C&D
Chair: Ullrich Hesse, Technische Universität Dresden

1:30PM - 1:50PM
ID: 2062
Theoretical and Experimental Analysis of Expansion Devices for Meso-Scale Cooling Systems
Claudio Melo, João Fabio Parise Lara, Joel Boeng
Federal University of Santa Catarina, Brazil; melo@polo.ufsc.br

1:50PM - 2:10PM
ID: 2009
Noise Effects In Capillary Tubes Caused By Refrigerant Flow
Thomas Tannert, Ullrich Hesse
Bitzer-Stiftungsprofessur für Kältetechnik, Kryotechnik und Kompressorentecnik / Technische Universität Dresden, Germany; thomas.tannert@tu-dresden.de

2:10PM - 2:30PM
ID: 2426
Experimental Research and Theoretical Analysis on Throttling Characteristics of Electronic Expansion Valve in Series with Capillary Tube
Xiangfei Liang¹, Jinheng Fang², Bo Zheng¹, Youlin Zhang²
¹National Engineering Research Center of Green Refrigeration Equipment, China, People’s Republic of; ²Gree Electric Appliances, Inc. of Zhuhai, China, People’s Republic of; liangxf@cn.gree.com

2:30PM - 2:50PM
ID: 2276
Experimental Study of Two-phase Separators for Vapor Compression Systems in Household Appliances
Jessica Alvarado, Junge Brent, Andrea Kelecy
General Electric Appliances, United States of America; jessica.alvarado@ge.com

2:50PM - 3:10PM
ID: 2549
Performance Testing of Unitary Split-System Heat Pump with an Energy Recovery Expansion Device
Nicholas Czapla, Harshad Inamdar, Nicholas Salts, Eckhard Groll
Purdue University, United States of America; nczapla@purdue.edu

R-14: HEAT EXCHANGER FROST FORMATION | 310
Chair: Lorenzo Cremaschi, Auburn University

1:30PM - 1:50PM
ID: 2643
Computationally Efficient Modeling Approach for Evaporator Performance under Frost Conditions
Donghun Kim, Sugirdhalakshmi Ramaraj, James Braun
Purdue University, United States of America; kim1077@purdue.edu

1:50PM - 2:10PM
ID: 2195
Performance Evaluation Of Peripheral-Finned Tube Evaporators Under Frosting Conditions
Marco Timmermann, Jader Barbosa
Federal University of Santa Catarina, Brazil; marcoat@polo.ufsc.br
Experimental Investigation of Frost Formation in a Finned-Tube Evaporator under Simulated Real Operation Conditions
Ergin Bayrak1,2, Akın Çağlayan1, Alper Şevki Konukman2
1Research and Development Department, Friterm Inc, Istanbul, 34957, TURKEY; 2Energy Systems Division, Department of Mechanical Engineering, Gebze Technical University, 41400, Kocaeli, TURKEY; ergin.bayrak@yandex.com.tr

Assessing Defrosting Performance on Hydrophilic, Hydrophobic, and Micro-Patterned Heat Transfer Surfaces
Nickolas C. Schmiesing, Andrew D. Sommers
Miami University, Oxford, OH, United States of America; sommerad@miamioh.edu

Frost Growth Investigation and Temperature Glide Refrigerants in a Fin-and-Tube Heat Exchanger
Elie Keryakos1,2, Georges Descombes2, Denis Clodic1, Joseph Toubassy1
1CRYOPUR, France; 2Cnam (Conservatoire National des Arts et Metiers), laboratoire chimie Moléculaire, Génie des Procédés Chimiques et Energétiques (CMGPCE)-EA 7341, France; elie.keryakos@cryopur.com

Improvement of the Efficiency of Twin-Screw Refrigeration Compressors by means of Dual Lead Rotors
Matthias Utri, Andreas Brümmer
Chair of Fluidics, TU Dortmund University, Germany; matthias.utri@tu-dortmund.de

Performance Testing of a Vapor Injection Scroll Compressor with R407C
Thomas W. Moesch1, Ammar M. Bahman2, Eckhard A. Groll2
1Institut fuer Energietechnik Bitzer-Stiftungsprofessur fuer Kaelte-, Kryo- und Kompressorenteknik, Technische Universität Dresden, Germany; 2Ray W. Herrick Laboratories, Purdue University, United States of America; thomas.moesch@tu-dresden.de

Analysis of Indicator Diagrams of a Water Injected Twin-shaft Screw-type Expander
Alexander Nikolov, Andreas Brümmer
Chair of Fluidics, TU Dortmund University; alexander.nikolov@tu-dortmund.de

Performance Investigation on Electrochemical Compressor with Ammonia
Ye Tao, Hoseong Lee, Yunho Hwang, Reinhard Radermacher
University Of Maryland, United States of America; yhhwang@umd.edu
TUESDAY • 1:30-3:30 PM

2:50PM - 3:10PM
ID: 1226
3D-CFD Design Study And Optimization Of A Centrifugal Turbo Compressor For The Operation In A Hybrid Sorption/Compression Heat Pump Cycle
Thomas Eckert, Leo Dostal, Martin Helm, Christian Schweigler
University of Applied Sciences Munich, Germany; teckert@hm.edu

3:10PM - 3:30PM
ID: 1486
Mechanistic Model Of An Oil-Flooded Single-Screw Expander
Davide Ziviani¹, Ian H. Bell², Michel De Paepe¹, Martijn van den Broek¹
¹Ghent University, Belgium; ²University of Liege; davide.ziviani@ugent.be

C-07: EXPANDERS I | 206
Chair: Martijn van den Broek, Ghent University

1:30PM - 1:50PM
ID: 1334
Theoretical and Experimental Analysis of Scroll Expander
Bin Peng¹,², Bingguo Zhu¹,², Vincent Lemort¹
¹School of Mechanical and Electronical Engineering, Lanzhou University of Technology; ²Wenzhou Pump&Valve Engin. Research Institute, Lanzhou University of Technology; ³University of Liege, Energy Systems Research Unit, Liege; pengb2000@163.com

1:50PM - 2:10PM
ID: 1539
Modelling and Preliminary Design of a Variable-BVR Rotary Valve Expander with an Integrated Linear Generator
Sergei Gusev, Davide Ziviani, Martijn van den Broek
Ghent University, Belgium; sergei.gusev@ugent.be

2:10PM - 2:30PM
ID: 1488
CFD Approaches Applied To A Single-Screw Expander
Davide Ziviani¹, Alessio Suman², Jacopo Gabrielloni², Michele Pinelli², Michel De Paepe¹, Martijn van den Broek¹
¹Ghent University, Belgium; ²University of Ferrara; davide.ziviani@ugent.be

2:30PM - 2:50PM
ID: 1512
CFD Simulation of a Twin Screw Expander including Leakage Flows
Rainer Andres¹, Jan Hesse¹, Haris Babic¹, Uwe Salecker¹, Andreas Spille-Kohoff¹, Alexander Nikolov², Andreas Brümmer²
¹CFX Berlin Software GmbH, Germany; ²TU Dortmund University, Germany; rainer.andres@cfx-berlin.de

2:50PM - 3:10PM
ID: 1480
Felipe A Accorsi, Nelson A James, Eckhard Groll, William T Horton, James E Braun
Herrick lab student, United States of America; faccorsi@purdue.edu
B-09: CONTROL-ORIENTED MODELING (IBO) | 214 A&B

Chair: José Agustín Candanedo, Natural Resources Canada

4:00PM - 4:20PM
ID: 3583
System Identification for Model Predictive Control of Building Region Temperature
Matthew J Ellis, Michael J Wenzel, Robert D Turney
Johnson Controls, United States of America; matthew.j.ellis@jci.com

4:20PM - 4:40PM
ID: 3389
Experiment Design and Training Data Quality of Inverse Model for Short-term Building Energy Forecasting
Liang Zhang¹, Jin Wen¹, Can Cui¹, Xiwang Li³, Teresa Wu²
¹Drexel University, Department of Civil, Architectural and Environmental Engineering; ²Arizona State University, School of Computing, Informatics, Decision Systems Engineering; ³Harvard University, Graduate School of Design; lz356@drexel.edu

4:40PM - 5:00PM
ID: 3647
Load and Electricity Rates Prediction for Building Wide Optimization Applications
Mohammad N ElBsat, Michael J Wenzel
Johnson Controls, United States of America; mohammad.elbsat@jci.com

5:20PM - 5:40PM
ID: 3682
Evaluation of an Extremum Seeking Control Based Optimization and Sequencing Strategy for a Chilled-water Plant
Zhongfan Zhao¹, Yaoyu Li¹, Baojie Mu¹, Timothy I. Salsbury², John M. House²
¹University of Texas at Dallas, United States of America; ²Johnson Controls Inc.; zxz124130@utdallas.edu

5:40PM - 6:00PM
ID: 3673
A Study of the Effect of Zone Design Parameters on Frequency Domain Transfer Functions for Radiant and Convective Systems
Ali Saberi Derakhtenjani, Andreas K. Athienitis
Concordia University, Montreal, Quebec, Canada; ali.saberi.mech@gmail.com

R-15: COMMERCIAL/INDUSTRIAL REFRIGERATION III | 218 A&B

Chair: Brian Fricke, Oak Ridge National Laboratory

4:00PM - 4:20PM
ID: 2556
Conversion of cold beverage dispenser’s refrigeration system to R744 refrigerant
Matej Visek¹, Stefan Elbel¹, Stefan Elbel¹, Pega Hrnjak¹,²
¹Creative Thermal Solutions, United States of America; ²University of Illinois at Urbana-Champaign, United States of America; matej.visek@creativethermalsolutions.com
4:20PM - 4:40PM
ID: 2220
Challenges on Converting an Upright Ice-Cream Freezer from R404a to R290 Complying with 150g Refrigerant Charge Restriction
Murilo Augusto Moreira Favaro, Jackson Henrique Kruger, Fernando Luis de Borba
EMBRACO, R&D; jackson.h.kruger@embraco.com

4:40PM - 5:00PM
ID: 2388
Testing of HFO Refrigerant with Less Than 150 GWP in a Commercial Freezer
Barbara Haviland Minor1, Sonali Shah2, Luke Simon3
1The Chemours Company, United States of America; 2The Chemours Company, United States of America; 3The Chemours Company, United States of America; barbara.h.minor@chemours.com

5:00PM - 5:20PM
ID: 2561
Use of Blends in Commercial Refrigeration Systems: Fractionation characteristics and material compatibility of R448A
Michael Petersen, Gustavo Pottker, Gregory L. Smith, Samuel F. Yana Motta, Ankit Sethi
Honeywell International, United States of America; michael.petersen4@honeywell.com

5:20PM - 5:40PM
ID: 2286
Laboratory Evaluation of a Commercial CO2 Booster Refrigeration System
Brian Fricke1, Shitong Zha1, Vishal Sharma1, Jeff Newel2
1Oak Ridge National Laboratory, United States of America; 2Hillphoenix, United States of America; sharmav@ornl.gov

5:40PM - 6:00PM
ID: 2281
Simulation Model of an Automatic Commercial Ice Machine
Haithem Murgham1, David Myszka1, Vijay Bahel, Rajan Rajendran, Kurt Knapke, Suresh Shivashankar, Kyaw Wynn
1University of Dayton, United States of America; 2Emerson Climate Technologies; dmyszka@udayton.edu

R-16: EJECTOR/INJECTOR ANALYSIS AND PERFORMANCE | 218 C&D
Chair: Stefan Elbel, Creative Thermal Solutions, Inc.

4:00PM - 4:20PM
ID: 2666
Development Of Numerical Modelling Of Isobutane Vapor Ejector
Kamil Smierciew1, Dariusz Butrymowicz1, Jerzy Gagan, Slawomir Pietrowicz2
1Bialystok Technical University, Wiejska 45C, Bialystok, 15-351, Poland; 2Wroclaw University of Technology, Wybrzeze Wyspianskiego 27, Wroclaw, 50-370, Poland; j.gagan@pb.edu.pl

4:20PM - 4:40PM
ID: 2012
Coupled Thermodynamic And CFD Approaches Applied To A Supersonic Air Ejector
Sergio Croquer, Sébastien Poncet, Nicolas Galanis
Université de Sherbrooke, Canada; sergio.croquer@usherbrooke.ca

4:40PM - 5:00PM
ID: 2155
Visualization research of ejector in CO2 refrigeration cycle
Zhang Yazhou1, Deng Jianqiang1, He Yang2
1School of Chemical Engineering and Technology Xi’AN JIAO TONG UNIVERSITY; 2State Key Laboratory of Multiphase Flow in Power Engineering, Xi’an Jiaotong University; asiago@stu.xjtu.edu.cn
Investigations Of Low Pressure Two-Phase Steam – Water Injector
Roman Kwidziński¹, Dariusz Butrymowicz², Jaroslaw Karwacki¹, Marian Trela¹, Kamil Smierciew²
¹Institute of Fluid-Flow Machinery Polish Academy of Sciences, ul. Gen. J. Fiszera 14, Gdańsk, 80-231, Poland; ²Bialystok University of Technology, Faculty of Mechanical Engineering, Wiejska 45C, Białystok, Poland; d.butrymowicz@pb.edu.pl

Investigations Of Heat And Momentum Transfer in Vapor-Liquid Isobutane Injector
Kamil Smierciew¹, Dariusz Butrymowicz¹, Tomasz Przybylinski²
¹Białystok Technical University, Wiejska 45C, Białystok, 15-351, Poland; ²The Szewalski Institute of Fluid-Flow Machinery of Polish Academy of Sciences, Fiszera 14, Gdansk, 80-231, Poland; k.smierciew@pb.edu.pl

A New Control Mechanism for Two-Phase Ejector in Vapor Compression Cycles Using Adjustable Motive Nozzle Inlet Vortex
Jingwei Zhu¹, Stefan Elbel¹²
¹ACRC, University of Illinois at Urbana-Champaign; ²CTS – Creative Thermal Solutions, Inc. Urbana IL; jzhu50@illinois.edu

A Critical Assessment of Two-Phase Flow Distribution in Microchannel Heat Exchangers
Karthik Panghat, Sunil S Mehendale
Michigan Technological University, United States of America; ssmehend@mtu.edu

Effect of Channel Geometries on Flow Reversal in Microchannel Evaporators
Huize Li, Pega Hrnjak
University of Illinois at Urbana-Champaign, United States of America; huizeli@illinois.edu

Oil Effects On Distribution Of Refrigerant In MAC Heat Exchangers
Xuan Liu¹, Pega Hrnjak¹²
¹ACRC, the University of Illinois, United States of America; ²CTS – Creative Thermal Solutions, Inc. Urbana IL; liuxuanuiuc@gmail.com

CFD Simulation of R134a and R410A Two-Phase Flow in the Vertical Header of Microchannel Heat Exchanger
Yang Zou¹, Pega Hrnjak¹²
¹University of Illinois at Urbana-Champaign; ²Creative Thermal Solutions; yang.zou@creativethermalsolutions.com
5:20PM - 5:40PM
ID: 2290
Refrigerant Distribution Characteristics in Vertical Header of Flat-Tube Heat Exchanger
Kazuhiro Endoh
Hitachi, Ltd., Japan; kazuhiro.endo.un@hitachi.com

5:40PM - 6:00PM
ID: 2248
Separation of Liquid and Vapor in Header of MCHE
Jun Li¹, Pega Hrnjak¹,²
¹ACRC, University of Illinois at Urbana-Champaign, United States of America; ²Creative Thermal Solution, Inc., Urbana IL, United States of America; junli9@illinois.edu

B-STUDENT PAPER COMPETITION | 278
Chair: Panagiota Karava, Purdue University

4:00PM - 4:20PM
ID: 3641
Model Predictive Control of a Radiant Floor Cooling System in an Office Space
Jaewan Joe¹,³, Panagiota Karava¹,³, Xiaodong Hou²,³, Jianghai Hu²,³
¹School of Civil Engineering, Purdue University, West Lafayette, Indiana 47907, USA; ²School of Electrical and Computer Engineering, Purdue University, West Lafayette, Indiana 47907, USA; ³Center for High Performance Buildings, Ray W. Herrick Laboratories, West Lafayette, Indiana, USA 47907; jjoe@purdue.edu

4:20PM - 4:40PM
ID: 3481
From Energy Signature To Cluster Analysis: An Integrated Approach
Lorenza Pistore¹, Giovanni Pernigotto¹, Francesca Cappelletti², Piercarlo Romagnoni², Andrea Gasparella¹
¹Free University of Bozen-Bolzano, Faculty of Science and Technology, Bolzano, Italy; ²University Iuav of Venice, Italy; lorenza.pistore@natec.unibz.it

4:40PM - 5:00PM
ID: 3661
A Bayesian Approach for Learning and Predicting Personal Thermal Preference
Seungjae Lee¹,², Ilias Bilionis¹, Panagiota Karava¹,², Athanasios Tzempelikos¹,²
¹Lyles School of Civil Engineering, Purdue University, West Lafayette, Indiana USA; ²Center for High Performance Buildings, Ray W. Herrick Laboratories, Purdue University, West Lafayette, Indiana USA; ³School of Mechanical Engineering, Purdue University, USA; lee1904@purdue.edu

5:00PM - 5:20PM
ID: 3236
Design and Application of Distributed Economic Model Predictive Control for Large-Scale Building Temperature Regulation
Nishith R. Patel¹, James B. Rawlings¹, Michael J. Wenzel¹, Robert D. Turney²
¹University of Wisconsin-Madison, Madison, WI; ²Johnson Controls, Milwaukee, WI; nishith.patel@wisc.edu

5:20PM - 5:40PM
ID: 3685
Adaptive Personalized Shading Control Strategies To Maximize Occupant Satisfaction While Reducing Lighting Energy Use In Buildings
Jie Xiong¹,², Seungjae Lee¹,², Athanasios Tzempelikos¹,², Panagiota Karava¹,²
¹Lyles School of Civil Engineering, Purdue University, West Lafayette, Indiana USA; ²Center for High Performance Buildings, Ray W. Herrick Laboratories, Purdue University, West Lafayette, Indiana USA; xiong29@purdue.edu
Air Cleaning Performance of a Biowall for Residential Applications  
Osama Alraddadi, Hannes Leuner, Brandon Boor, Bhargav Rajkhowa, William Hutzels, Michael Dana  
School of Engineering Technology, Purdue University, United States of America; osa@purdue.edu

C-08: HEAT TRANSFER IN COMPRESSORS II  |  202

Chair: Joe Orosz, Torad Engineering, LLC

4:00PM - 4:20PM
ID: 1152
Transient Thermal and Structural Analysis of Cylinder and Bolted Joints on BOG Compressor During Starting Process  
Lingxiao Wei1, Yi Yan1, Yun Li1, Xueqiang Feng2  
1School of Chemical Engineering and Technology, Xi’an Jiaotong University, China; 2Zhejiang Qiangsheng Compressor Manufacturing Co., Ltd. China; yanyi_xjtu@qq.com

4:20PM - 4:40PM
ID: 1113
An Investigation Of The Heat Transfer Characteristics Of The Induction Motor Inside The Hermetic Reciprocating Compressor  
Haşim Otunç1, Ahmet Refik Özdemia, Prof. Dr. Hasan Güneş2  
1ARCELIK A.S., Turkey; 2Istanbul Technical University, Mechanical Eng. Department, Turkey; ahmetrefik.ozdemir@arcelik.com

4:40PM - 5:00PM
ID: 1330
Performance Analysis of a Reciprocating Compressor under Typical Transients of Refrigeration Systems  
Marco Carrilho Diniz, Cesar Jose Deschamps  
POLO - UFSC, Brazil; marcodiniz@polo.ufsc.br

5:00PM - 5:20PM
ID: 1091
Integral and Differential Model of Hermetical Compressor Heat Losses Including Experimental Validation  
Maria Goossens1,2, Philippe Riviere1, Odile Cauret1, Cedric Teuillieres1, Dominique Marchio2  
1EDF R&D, Energy in Buildings and Territories Department (ENERBAT), France; 2Centre for Energy efficiency of Systems (CES), MINES ParisTech, PSL Research University, France; maria.niznik@mines-paristech.fr

5:20PM - 5:40PM
ID: 1108
Heat Transfer Analysis in the Cylinder of Reciprocating Compressor  
Ján Tuhovčák, Jiří Hejčík, Miroslav Jiča  
Brno University of Technology, Czech Republic; jan.tuhovcak@vutbr.cz
C-09: LINEAR AND RECIPROCATING COMPRESSORS  |  206
Chair: Craig Bradshaw, Torad Engineering

4:00PM - 4:20PM
ID: 1392
A 3-D Transient CFD Model of a Reciprocating Piston Compressor with Dynamic Port Flip Valves
Sujan Dhar¹, Hui Ding¹, Jonatas Lacerda²
¹Simerics, Inc., Bellevue, WA, USA; ²Tecumseh Products Company, São Carlos, SP, Brazil; sd@simerics.com

4:20PM - 4:40PM
ID: 1658
Modeling Reciprocating Compressors Using A Cartesian Cut-Cell Method With Automatic Mesh Generation
David Henry Rowinski, Kenneth Edward Davis
Convergent Science, Inc., United States of America; david.rowinski@convergecfd.com

4:40PM - 5:00PM
ID: 1523
Study of Valve Motion in Reciprocating Refrigerator Compressors based on the 3-D Fluid–structure Interaction Model
Weifeng Wu¹, Zhifang Jian¹, Mingyi Song¹, Zhao Zhang¹, Zhi Li¹
¹Xi’an Jiaotong University, China, People’s Republic of China; ²Faculty of Engineering and Architecture – Department of Industrial System and Product Design/Ghent University, Graaf Karel de Goedelaan 5, B-8500 Kortrijk, Belgium; weifengwu@mail.xjtu.edu.cn

5:00PM - 5:20PM
ID: 1047
Linear Compressor Discharge Manifold Design For High Thermal Efficiency
Dietmar E. B. Lilie, Rinaldo Puff, Marcos G. D. Bortoli
Embraco, Brazil; marcos.g.bortoli@embraco.com

5:20PM - 5:40PM
ID: 1445
Numerical Simulation for the Internal Flow Analysis of the Linear Compressor with Improved Muffler
Hyunjoo Oh, Sungchul Kong, Wonsik Oh, Kyeong-bae Park
LG electronics, Korea, Republic of (South Korea); bluevenus985@gmail.com
B-10: OCCUPANT BEHAVIOR AND PREDICTIVE MODELS (IBO) | 214 A&B
Chair: Athanasios Tzempelikos, Purdue University

9:45AM - 10:05AM
ID: 3466
Sensitivity Analysis for the PMV Thermal Comfort Model and the Use of Wearable Devices to Enhance Its Accuracy
Mohammad H. Hasan, Fadi M. Alsaleem, Mostafa Rafaie
Wichita State University, United States of America; fadi.alsaleem@wichita.edu

10:05AM - 10:25AM
ID: 3542
Stochastic Modeling of Short-term Occupancy for Energy Efficient Buildings
Jin Dong¹, Chris Winstead¹, Seddik M. Djouadi¹, James J. Nutaro², Teja Kuruganti²
¹University of Tennessee, Knoxville, United States of America; ²Oak Ridge National Laboratory, Oak Ridge, TN, United States of America; jdong@vols.utk.edu

10:25AM - 10:45AM
ID: 3073
A Bayesian Approach for Modeling Occupants’ Use of Window Shades
Seyed Amir Sadeghi¹, Nimish M Awalgaonkar¹, Panagiota Karava¹, Ilias Bilionis²
¹Lyles School of Civil Engineering, Purdue University, West Lafayette, Indiana 47907, USA; ²Department of Mechanical Engineering, Purdue University, West Lafayette, Indiana 47907, USA; sadeghis@purdue.edu

10:45AM - 11:05AM
ID: 3233
The Rebound Effect after the Energy Refurbishment of Residential Buildings towards High Performances
Vincenzo Corrado, Ilaria Ballarini, Simona Paduos, Elisa Primo
DEPARTMENT OF ENERGY, POLITECNICO DI TORINO, Italy; simona.paduos@polito.it

11:05AM - 11:25AM
ID: 3300
Evacuation Hazards in Crowded Subway Stations
M.K. Ho, C.Y. Ku, W.K. Chow
The Hong Kong Polytechnic University, Hong Kong S.A.R. (China); beelize@polyu.edu.hk

B-11: THERMAL STORAGE AND HEAT PUMPS | 214 C&D
Chair: Marco Baratieri, University of Bozen-Bolzano

9:45AM - 10:05AM
ID: 3349
Carolina Carmo¹²³, Olivier Dumont⁴, Mads P. Nielsen¹, Brian Elmegaard³
¹Aalborg University; ²Insenergi; ³DTU; ⁴Univ. Liège; cca@et.aau.dk

10:05AM - 10:25AM
ID: 3296
Operation of Cool Thermal Energy Storage to Increase Renewable Energy Utilization
Amy Van Asselt, Douglas T. Reindl, Gregory F. Nellis
University of Wisconsin, United States of America; avanasselt@wisc.edu
10:25AM - 10:45AM
ID: 3543
Dynamic Modeling and Performance Analysis of Sensible Thermal Energy Storage Systems
Austin Lee Nash, Neera Jain
Purdue University, United States of America; nash@purdue.edu

10:45AM - 11:05AM
ID: 3491
Optimization of Air Source Heat Pump Systems over the Heating Season through the Use of Renewable Energy Sources
Elena Bee, Alessandro Prada, Paolo Baggio
DICAM – Dept. of Civil, Environmental and Mechanical Engineering – Univ. of Trento – Via Mesiano 77 - 38123 Trento (Italy); paolo.baggio@unitn.it

11:05AM - 11:25AM
ID: 3652
Investigation on A Ground Source Heat Pump System Integrated With Renewable Sources
Defeng Qian, Fuxin Niu, Steven Kavanaugh, Zheng O'Neill
the University of Alabama, United States of America; dqian@crimson.ua.edu

11:25AM - 11:45AM
ID: 3308
Heat Pump Assisted Solar Thermal System
David Lotz, William Hutzel, William Arnett, Duane Dunlap, Chris Foreman
School of Engineering Technology, Purdue University, U.S.A.; dlotz@purdue.edu

R-18: ROOFTOP UNIT DIAGNOSTICS (IBO) | 218 A&B
Chair: David Yuill, University of Nebraska

9:45AM - 10:05AM
ID: 2364
A Prediction Method for Overall Economic Value of Fault Detection and Diagnostic Tools for Rooftop and Split Systems
David Yuill¹, James Braun²
¹University of Nebraska - Lincoln, United States of America; ²Purdue University, United States of America; dyuill@unl.edu

10:05AM - 10:25AM
ID: 2627
The Effectiveness of using Total System Power for Fault Detection in Rooftop Units
Andrew L. Hjortland¹, James E. Braun², Mikhail Gorbounov²
¹Purdue University - Herrick Laboratory, United States of America; ²United Technologies Research Center, East Hartford, CT, United States of America; ahjortla@purdue.edu

10:25AM - 10:45AM
ID: 2069
Lab and Field Evaluations of FDD for Advanced RTUs
Jinliang Wang¹, Mikhail Gorbounov¹, Yasar Murat¹, Hayden Reeve¹, Andrew L Hjortland², James E Braun²
¹UTRC, United States of America; ²School of Mechanical Engineering, Purdue University; gorboumb@utrc.utc.com
10:45AM - 11:05AM  
ID: 2074  
**Fault Diagnosis of Refrigerant Charge Based on PCA and Decision Tree for Variable Refrigerant Flow Systems**  
Jiangyan Liu¹, Huanxin Chen¹, Jiangyu Wang¹, Guannan Li³, Haorong Li², Wenju Hu³  
¹Huazhong University of Science and Technology, Wuhan 430074, Hubei, China; ²University of Nebraska-Lincoln, Lincoln, 68182, NE, USA; ³Beijing Key Lab of Heating, Gas Supply, Ventilating and Air Conditioning Engineering, Beijing University of Civil Engineering and Architecture 100044, Beijing, China; liujiangyan@hust.edu.cn

11:05AM - 11:25AM  
ID: 2379  
**Embedded RTU FDD using Open-Source Monitoring and Control Platform**  
Andrew L. Hjortland, James E. Braun  
Purdue University - Herrick Laboratory, United States of America; ahjortla@purdue.edu

11:25AM - 11:45AM  
ID: 2465  
**Generalized Effect Of Condenser Fouling And Refrigerant Charge On Operating Parameters Of Vapor Compression Air Conditioning Systems**  
Mehdi Mehrabi, David Yuill  
University Of Nebraska-Lincoln, Architectural Engineering, Omaha, NE, US; mmehrabi@unomaha.edu

**R-19: TRANSIENT SYSTEM MODELING | 218 C&D**  
Chair: Donghun Kim, Purdue University  

9:45AM - 10:05AM  
ID: 2031  
**A Modeling Study on the Operational Stability of a Variable Speed Direct Expansion Air Conditioning System**  
Yudong Xia, Shiming Deng  
Department of Building Services Engineering, The Hong Kong Polytechnic University, Hong Kong S.A.R. (China); edomxia@gmail.com

10:05AM - 10:25AM  
ID: 2157  
**Simulink Based Transient Modeling of a Flash Tank vapor Injection System and Experimental Validation**  
Viren Bhanot, Jiazhen Ling, Vikrant Aute, Reinhard Radermacher  
University of Maryland, College Park; jiazhen@umd.edu

10:25AM - 10:45AM  
ID: 2144  
**Transient Modeling of a Thermosiphon based Air Conditioner with Compact Thermal Storage: Modeling and Validation**  
Rohit Dhumane, Yilin Du, Jiazhen Ling, Vikrant Aute, Reinhard Radermacher  
University of Maryland, United States of America; dhumane@umd.edu

10:45AM - 11:05AM  
ID: 2302  
**Transient Multiphysics Modeling of a Robotic Personal Air-conditioning Device**  
Rohit Dhumane¹, Jiazhen Ling¹, Vikrant Aute¹, Reinhard Radermacher¹, Aravind Mikkilineni², Philip Bingham²  
¹University of Maryland, United States of America; ²Oak Ridge National Laboratory, United States of America; dhumane@umd.edu
11:05AM - 11:25AM
ID: 2027
Experimentally Validated Model of Transient Heat Transfer between a Magnetocaloric Packed Particle Bed and Stagnant Interstitial Fluid
Michael Goodman Schroeder1,2, Ellen Brehob2, Michael Benedict1,3
1General Electric, United States of America; 2University of Louisville, United States of America; 3University of Florida, United States of America; michael.schroeder2@ge.com

11:25AM - 11:45AM
ID: 2224
Analysis of Dynamic Stability of Ejector Expansion Refrigeration System
Jianqiang Deng, Lixing Zheng, Fei Wang
School of Chemical Engineering and Technology, Xian Jiaotong University, China.; dengjq@mail.xjtu.edu.cn

11:45AM - 12:05PM
ID: 2441
A Novice Method for Calibrating the Transient Model of an Automotive HVAC System
Zhiyu Yang1, Junye Shi1, Jianmin Li2, Jiangping Chen1
1Shanghai Jiao Tong University, People’s Republic of China; 2Anhui Jianghuai Automobile Co. Ltd, People’s Republic of China; zhiyuyang@sjtu.edu.cn

R-20: EVALUATION OF R410A ALTERNATIVES | 310
Chair: Barbara Haviland Minor, Chemours

9:45AM - 10:05AM
ID: 2402
Interim And Long-Term Low-GWP Refrigerant Solutions For Air Conditioning
Hung M. Pham, Ken Monnier
Emerson Climate Technologies, United States of America; hung.m.pham@emerson.com

10:05AM - 10:25AM
ID: 2205
Experimental Assessment on Performance of a Heat Pump Cycle Using R32/R1234yf and R744/R32/R1234yf
Sho Fukuda1, Hedeki Kojima1, Chieko Kondou1, Nobuo Takata1, Shigeru Koyama1
1Kyushu Univ., Japan; 2Nagasaki Univ., Japan; fukuda@phase.cm.kyushu-u.ac.jp

10:25AM - 10:45AM
ID: 2459
Research on Optimization of Heat exchanger in Heat pump using R32 and HFO-mixed Refrigerant
Toshimitsu Kamada, Tomoyuki Haikawa, Shigeharu Taira
Daikin Industries, LTD., Japan; toshimitsu.kamada@daikin.co.jp

10:45AM - 11:05AM
ID: 2409
Evaluation of Performance of Heat Pump using R32 and HFO-mixed Refrigerant by System simulation and Loss analysis
Shigaharu Taira1, Tomoyuki Haikawa2, Tomoatsu Minamida1
1Japan; 2Japan; 3Japan; tomoyuki.haikawa@daikin.co.jp

11:05AM - 11:25AM
ID: 2333
Assessment Of DR-55 As A Drop-In Replacement For R410A
Bo Shen, Omar Abdelaziz, Lane Liudahl
Oak Ridge National Laboratories, United States of America; shenb@ornl.gov
Testing of Low GWP Replacements for R-410A in Stationary Air Conditioning
Joshua Hughes, Sonali Shah
The Chemours Company, United States of America; joshua.hughes@chemours.com

Behavior of R410A Low GWP Alternative Refrigerants DR-55, DR-5A, and R32 in the Components of a 4-RT RTU
Kenneth Schultz
Ingersoll Rand, United States of America; kschultz@trane.com

Researces on The Heat Pump System Using Rotary Compressor in Electric Vehicles
Jun-ye Shi¹, Tian-yuan Gao¹, Bing-qing Lu¹, Wan-yong Li¹, Zi-qi Zhang¹, Bo-wei Cai¹, Jiang-ping Chen¹, Le-yan Pan¹,², Tian-ying Wang²; Rui-dong Yan¹
¹shanghai jiao tong university, Shanghai, People's Republic of China; ²SAIC Motor Co., Ltd.,Shanghai, People's Republic of China; ³Changan Automobile (Group) Co., Ltd.,Shanghai, People's Republic of China; jyshi@sjtu.edu.cn

Impact of a 12-volt Lead Acid Battery State-of-Charge on the Performance of an Automotive Air Conditioning System
Santanu Prasad Datta¹, Prasanta Kumar Das², Siddhartha Mukhopadhyay³
¹Birla Institute of Technology & Science Pilani, Hyderabad Campus, India; ²Indian Institute of Technology Kharagpur, 721302, India; spdatta@hyderabad.bits-pilani.ac.in

LCCP Analysis of Energy-Saving Effect of Defaulting to Recirculated Cabin Air in EV Mobile Air Conditioning System
Ziqi Zhang, Xiaoning Chen, Cichong Liu, Wanyong Li, Junye Shi, Jiangping Chen
Shanghai Jiao Tong University, China, People's Republic of; sheen986@61.com

Simulation of a VRF System Applied in Electric Buses in Taiwan
Anne Liebold¹, Po-Hsu Lin², Bernhard Vetsch¹, Cordin Arpagaus¹, Stefan S. Bertsch¹
¹Interstate University of Applied Sciences of Technology NTB, Switzerland; ²Automotive Research & Testing Center, Taiwan; anne.liebold@ntb.ch

Modelling Of An Automotive Multi-Evaporator Air-Conditioning System
Thomas Gillet¹,², Emmanuelle Andrès¹, Amin El-Bakkali¹, Gérard Olivier¹, Vincent Lemort², Romuald Rullière³, Philippe Haberschill³
¹Renault SAS, 1, avenue du Golf, 78288 Guyancourt, France; ²Laboratoire de Thermodynamique et Énergétique de l’Université de Liège, 17, allée de la Découverte, 4000 Liège, Belgique; ³CETHIL UMR5008, Université de Lyon, CNRS, INSA-Lyon, Univ. Lyon 1, F-69621, Villeurbanne, France; thomas.gillet@doct.ulg.ac.be
11:25AM - 11:45AM
ID: 2199
Oil Effects On Performance Of Automobile A/C System
Xuan Liu¹, Pega Hrnjak¹²
¹ACRC, the University of Illinois, United States of America; ²CTS – Creative Thermal Solutions, Inc. Urbana IL; liuxuanuiuc@gmail.com

C-10: NOISE, VIBRATION & HARSHNESS I | 202
Chair: Stuart Bolton, Purdue University
9:45AM - 10:05AM
ID: 1315
Mechanical Impact Noise Analysis of Rotary Compressor
Jinquan Zhang, Peizhen Que, Yusheng Hu, Rongting Zhang, Yuanjie Shang
GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI, China, People’s Republic of; popway@163.com

10:05AM - 10:25AM
ID: 1322
Research On Low Frequency Vibration Of Rotary Compressor
Zhiming Wen, Rongting Zhang, Yaosi Zhang, Huanhuan Gu, Yusheng Hu
GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI, China, People’s Republic of; madicus@163.com

10:25AM - 10:45AM
ID: 1346
Rotary Compressor Noise Analysis Using Mechanisms and Electromagnetics Coupled Approach
Jinah Chung¹, Uiyoon Lee¹, Jeongbae Lee¹, Unseop Lee¹, Eunsil Han², Jinhwan Yoon²
¹Samsung ElectronicsCo.Ltd, Korea, Republic of (South Korea); ²Taesung S&E, Inc Republic of (South Korea); jinah.chung@samsung.com

10:45AM - 11:05AM
ID: 1391
Stick-Slip Squeal in a Dry Scroll Vacuum Pump
John Calhoun¹, James Moore², Ronald Forni³
¹Agilent Technologies Vacuum Products Division, Lexington, Mass., USA; ²Acentech Incorporated, Cambridge, Mass., USA; john.calhoun@agilent.com

11:05AM - 11:25AM
ID: 1538
Investigation of the Effects of Coil Spring on Discharge Tube
Ergin Tasdelen, Atilla Kaya
ARCELIK AS, Turkey; ergin_tasdelen@arcelik.com

11:25AM - 11:45AM
ID: 1084
Analysis of Vibration Isolators for Hermetic Compressors
Carlos Eduardo Vendrami, Claudio Pellegrini
Embraco, Brazil; carlos.vendrami@embraco.com

11:45AM - 12:05PM
ID: 1255
Study on Vibrations of Inverter Refrigerator Compressor
Shoufei Wu, Jun Luo, Yuqian Li
Jiaxipera Compressor Co,. Ltd, China, People’s Republic of; shoufei.wu@qq.com
WEDNESDAY • 9:45 AM - 12:00 PM

C-11: COMPRESSOR MODELING  |  206
Chair: Craig R Bradshaw, Torad Engineering, LLC

9:45AM - 10:05AM
ID: 1354
A Calibration Procedure for Compressor Simulation Models using Evolutionary Algorithm
Ernane Silva, William M. Ferreira, Cesar J. Deschamps
Federal University of Santa Catarina, Brazil; ernane@polo.ufsc.br

10:05AM - 10:25AM
ID: 1168
Structural Analysis Of Reciprocating Compressor Manifold
Marcos Giovani Dropa Bortoli
Embraco, Brazil; marcos.g.bortoli@embraco.com

10:25AM - 10:45AM
ID: 1335
Refrigeration Cycle And Compressor Performance For Various Low GWP Refrigerents
Jit Guan Edwin Ong, Kim Tiow Ooi
Nanyang Technological University, Singapore; a140003@e.ntu.edu.sg

10:45AM - 11:05AM
ID: 1331
Comparative Analysis of Two Types of Positive Displacement Compressors for Air Conditioning Applications
Marco Carrilho Diniz, Cesar Jose Deschamps
POLO - UFSC, Brazil; marcodiniz@polo.ufsc.br

11:05AM - 11:25AM
ID: 1376
Design Methodology Improvements of a Rotating Spool Compressor using a Comprehensive Model
Craig R Bradshaw¹, Greg Kemp¹, Joe Orosz¹, Eckhard A Groll²
¹Torad Engineering, United States of America; ²Purdue University, United States of America; craig.bradshaw@toradengineering.com

11:25AM - 11:45AM
ID: 1506
Systematic Calculation of the Piston Rod Unit
Vasillaq Kacani
Leobersdorfer Maschinenfabrik GmbH, Austria; vasillaq.kacani@lmf.at

11:45AM - 12:05PM
ID: 1010
Investigation of High Pressure Fluid Circuit Gas Flow Dynamics in a Hermetic Compressor Using CFD to Improve Qualitative Flow Understanding
David Neal Halbrooks
Bristol Compressors, United States of America; davidhalbrooks@gmail.com
B-12: BUILDING SIMULATION AND OPTIMIZATION  |  214 A&B
Chair: Hui Shen, Texas A&M - Kingsville

1:00PM - 1:20PM
ID: 3415
Energy and Economic Performance Analysis of Heat Recovery Devices Under Different Climate Conditions
Stefanie Tafelmeier1, Giovanni Antonio Longo2, Andrea Gasparella1
1Free University of Bolzano, Faculty of Science and Technology, Bolzano, Italy; 2University of Padova, Department of Management and Engineering, Vicenza, Italy; stefanie.tafelmeier@natec.unibz.it

1:20PM - 1:40PM
ID: 3446
Gradient-Based Estimation of Air Flow and Geometry Configurations in a Building Using Fluid Dynamic Adjoint Equations
Runxin He, Humberto Gonzalez
Department of Electrical and Systems Engineering, Washington University in Saint Louis, United States of America; runxinhe@email.wustl.edu

1:40PM - 2:00PM
ID: 3025
Bayesian Calibration - What, Why And How
Ralph T Muehleisen, Joshua Bergerson
Argonne National Laboratory, United States of America; rmuehleisen@anl.gov

2:00PM - 2:20PM
ID: 3458
An Efficient and Accurate Building Optimization Strategy Using Singular Value Decomposition
Yeonjin Bae, W. Travis Horton
Purdue University, United States of America; ybae@purdue.edu

2:20PM - 2:40PM
ID: 3679
State-Space Modeling of Thermal Spaces in a Multi-Zone Building
Vahid Raissi Dehkordi, José Agustín Candanedo
CanmetENERGY - Natural Resources Canada, Canada; jose.candanedoibarra@canada.ca

2:40PM - 3:00PM
ID: 3535
Parallel Object-Oriented Algorithms for Building Performance Simulation. Application to an existing dwelling
Lopez Joan, Capdevila Roser, Souaihi Oussama, Rigola Joaquim, Oliva Assensi
UPC, Spain; quim@cttc.upc.edu

R-22: ABSORPTION/ADSORPTION TECHNOLOGY  |  214 C&D
Chair: Srinivas Garimella, Georgia Institute of Technology

1:00PM - 1:20PM
ID: 2043
CFD Heat and Mass Transfer Studies in a R134a-DMF Bubble Absorber with Swirl Flow Entry of R134a Vapour
Annamalai Mani1, Santosh Kumar Panda1
1Indian Institute Of Technology Madras, India; 2Indian Institute Of Technology Madras, India; mania@iitm.ac.in
WEDNESDAY • 1:00 - 3:00 PM

1:20PM - 1:40PM
ID: 2159
Experimental Study On a Solar Chemisorption Refrigeration System Based On the Strontium Chloride-Ammonia Reaction
Si Wu, Ting Xian Li, Ting Yan, Ru Zhu Wang
Institute of Refrigeration and Cryogenics, Shanghai Jiao Tong University, China, People's Republic of; ws_sjtu@163.com

1:40PM - 2:00PM
ID: 2285
Screening Criteria for ILs used in NH3 Based Absorption Heat Pump Systems
Meng Wang, Carlos A. Infante Ferreira
Process and Energy Department, Delft University of Technology, The Netherlands; m.wang-2@tudelft.nl

2:00PM - 2:20PM
ID: 2479
Theoretical and Experimental Investigation on Dewatering Performance from Aqueous Lithium Bromide Solution Stream confined by Hollow Fiber Membrane
Sung Joo Hong, Chaobin Dang, Eiji Hihara
University of Tokyo, Japan; gatorhong@gmail.com

2:20PM - 2:40PM
ID: 2467
A Novel Model Considered Mass and Energy Conservation for Both Liquid and Vapor in Adsorption Refrigeration System.
Tsung Yi Lin, Chien Chang Wu, Tsung Lin Chen
Department of Mechanical Engineering, National Chiao Tung University, Hsinchu 30010, Taiwan.; tsunglin@mail.nctu.edu.tw

R-23: ANALYSIS OF SYSTEMS WITH EJECTORS | 218 A&B
Chair: Stefan Elbel, Creative Thermal Solutions, Inc.

1:00PM - 1:20PM
ID: 2396
Thermodynamic Analysis On A Novel Gas-gas Ejector Enhanced Autocascade Refrigeration Cycle
Jiaheng Chen, Jianlin Yu, Gang Yan
Xi'an Jiaotong University, China, People's Republic of; chenjiaheng2009@126.com

1:20PM - 1:40PM
ID: 2667
Assessment Of Refrigerant Selection For Ejection System Driven By Low-Grade Heat
Kamil Smierciew, Dariusz Butrymowicz, Jerzy Gagan
Bialystok Technical University, Wiejska 45C, Bialystok, 15-351, Poland; j.gagan@pb.edu.pl

1:40PM - 2:00PM
ID: 2665
Performance Model Of Co2 Two-Phase Ejector For Subcritical Conditions
Kamil Smierciew1, Dariusz Butrymowicz1, Piotr Baj2
1Bialystok Technical University, Wiejska 45C, Bialystok, 15-351, Poland; 2Star Refrigeration, Wincanton Close, Ascot Drive, DE24 8NB, Derby, United Kingdom; k.smierciew@pb.edu.pl
2:00PM - 2:20PM  
ID: 2689  
**Experimental Investigations of Low-temperature Driven Ejector for Isobutane**  
*Mark Bergander¹, Dariusz Butrymowicz², Kamil Smierciec³, Jerzy Gagan⁴, Sarken D. Kapayeva⁵*  
¹Magnetic Development, Inc, Madison, CT, USA; ²Bialystok University of Technology, Bialystok, 15-351, Poland; ³Eastern Kazakhstan Technical University, Ust Kamenogorsk, Kazakhstan; mark@mdenergy.com

2:20PM - 2:40PM  
ID: 2045  
**Experimental And Numerical Investigations of Ejector Jet Refrigeration System With Primary Stream Swirl**  
*Annamalai Mani⁶, Jiautheen Parveen Banu⁷, Jawali Maharudrappa Mallikarjuna⁸*  
⁶⁷⁸Indian Institute of Technology Madras, India; ⁸Indian Institute of Technology Madras, India; mania@iitm.ac.in

2:40PM - 3:00PM  
ID: 2368  
**Modeling of Initially Subcooled Flashing Vortex Flow in the Nozzle for Possible Applications in the Control of Ejector Cooling Cycles**  
*Jingwei Zhu⁹, Stefan Elbel¹⁰,¹¹*  
⁹¹¹ACRC, University of Illinois at Urbana-Champaign; ¹⁰¹¹CTS – Creative Thermal Solutions, Inc. Urbana IL; jzhu50@illinois.edu

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**R-24: BOILING HEAT TRANSFER ENHANCEMENTS | 218 C&D**

Chair: Kenneth Schultz, Trane

1:00PM - 1:20PM  
ID: 2513  
**Continuous vs. Pulsating Flow Boiling. Part 1: Experimental Comparison and Visualization**  
*Martin Ryhl Kærn¹, Brian Elmegaard¹, Knud Erik Meyer¹, Björn E Palm²*  
¹Technical University of Denmark, Denmark; ²Royal Institute of Technology, Sweden; pmak@mek.dtu.dk

1:20PM - 1:40PM  
ID: 2514  
**Continuous vs. Pulsating Flow Boiling. Part 2: Statistical Comparison using Response Surface Methodology**  
*Martin Ryhl Kærn¹, Brian Elmegaard¹, Knud Erik Meyer¹, Björn E Palm², Jørgen Holst³*  
¹Technical University of Denmark, Denmark; ²Royal Institute of Technology, Sweden; ³Danfoss Drives A/S, Denmark; pmak@mek.dtu.dk

1:40PM - 2:00PM  
ID: 2098  
**Effect of Nanoparticles Aspect Ratio on the Two Phase Flow Boiling Heat Transfer Coefficient and Pressure Drop of Refrigerant and Nanolubricants Mixtures in a 9.5 mm Micro-fin Tube.**  
*Pratik Shashikant Deokar¹, Lorenzo Cremaschi³, Thiam Wong¹, Gennaro Criscuolo³*  
¹Auburn University, Department of Mechanical Engineering, Auburn, AL, USA; ³Polytechnic University of Milan, Department of Energy Engineering, Milan, Italy; ³Oklahoma State University, School of Mechanical and Aerospace Engineering, Stillwater, OK, USA; pratik.deokar@auburn.edu

2:00PM - 2:20PM  
ID: 2340  
**A Comparison Between Recent Experimental Results and Existing Correlations for Microfin Tubes for Refrigerant and Nanolubricants Mixtures Two Phase Flow Boiling**  
*Andrea A. M. Bigi, Lorenzo Cremaschi*  
Auburn University, United States of America; aab0059@auburn.edu
2:20PM - 2:40PM
ID: 2129
Wettability Change by Pool Boiling of Nanofluids and Its Impact on Heat Transfer
Feini Zhang, Anthony Jacobi
University of Illinois at Urbana Champaign, United States of America; fzhang8@illinois.edu

2:40PM - 3:00PM
ID: 2264
R134a Flow Boiling Heat transfer on an Electrically Heated Carbon/Carbon Surface
Luca Doretti¹, Simone Mancin², Claudio Zilio³, Giovanni A. Longo³
¹Dept. of Civil, Architectural and Environmental Engineering, University of Padova, Italy; ²Dept. of Management and Engineering, University of Padova, Italy; luca.doretti@unipd.it

R-25: DOMESTIC REFRIGERATION I | 310
Chair: Claudio Melo, Federal University of Santa Catarina

1:00PM - 1:20PM
ID: 2056
An Experimental Study on the Effect of a new Defrosting Strategy on the Energy Consumption of Household Refrigerators
Fernando Testoni Knabben, Claudio Melo
Federal University of Santa Catarina, Brazil; melo@polo.ufsc.br

1:20PM - 1:40PM
ID: 2401
Optimized On-Off Controller For Energy Saving In A Household Refrigerator
Ulisses Carvalho de Elian Saffar, Antônio Augusto Torres Maia
Universidade Federal de Minas Gerais, Brazil; ulissessaffar@hotmail.com

1:40PM - 2:00PM
ID: 2058
A Methodology for Measuring the Air Infiltration Rates into Refrigerated Compartments
Paula do Vale Pereira, Claudio Melo
Federal University of Santa Catarina, Brazil; melo@polo.ufsc.br

2:00PM - 2:20PM
ID: 2063
An Experimental Study on the Use of Vaccum Insulation Panels in Household Refrigerators
Susan Thiessen, Claudio Melo, Fernando Testoni Knabben, Joaquim Manoel Gonçalves
Federal University of Santa Catarina, Brazil; melo@polo.ufsc.br

2:20PM - 2:40PM
ID: 2145
Observation of R600a Flow at Subcooled Temperature Conditions in a Vapor Compression Refrigeration System
Ji Hwan Jeong, Joonyoung Seo, DaeSig Shin
Pusan National University, Korea, Republic of (South Korea); jihwan@pusan.ac.kr
R-26: HEAT EXCHANGER DESIGN, MANUFACTURING, AND OPERATIONAL IMPACTS | 278

Chair: Christian Bach, Oklahoma State University

1:00PM - 1:20PM
ID: 2438
Accelerated Fatigue Testing of Aluminum Refrigeration Press Fittings for HVAC & R Applications
Stefan Elbel1,2, Michael Duggan1, Tony LaGrotta1, Sharat Raj2, Pega Hrnjak1,2
1University of Illinois at Urbana-Champaign, United States of America; 2Creative Thermal Solutions, United States of America; hui.zhao@creativethermalsolutions.com

1:20PM - 1:40PM
ID: 2545
A Study of Microchannel Heat Exchanger Performance Associated with the Manufacturing Process
Hui Zhao1, Sharat Raghunandan1, Stefan Elbel1,2, Pega Hrnjak1,2
1Creative Thermal Solutions, Inc., United States of America; 2University of Illinois at Urbana-Champaign, United States of America; hui.zhao@creativethermalsolutions.com

1:40PM - 2:00PM
ID: 2289
Manufacturing & Testing of Air-to-Refrigerant Heat Exchangers Based on 0.8mm Diameter Tubes
Yoram Shabtay1, Zhiwei Huang2, Vikrant Aute2, Vishaldeep Sharma2, Reinhard Radermacher2
1Heat Transfer Technologies, United States of America; 2University of Maryland, United States of America; yoram@heattransfertechnologies.com

2:00PM - 2:20PM
ID: 2532
An Evaluation of a Pressure Expansion Method for the Manufacturing of Copper Tube Heat Exchangers
Roger Tetzloff1, Vikrant Aute2, Song Li3, Cara Martin3
1Burr Oak Tool, Inc., Sturgis, MI, USA; 2Center for Environmental Energy Engineering, University of Maryland College Park; 3Optimized Thermal Systems, Inc., United States of America; cmartin@optimizedthermalsystems.com

2:20PM - 2:40PM
ID: 2234
A Literature Review On Heat Exchanger Air Side Fouling In Heating, Ventilation And Air-conditioning (HVAC) Applications
Omer Sarfraz, Christian Bach
Oklahoma State University, United States of America; sarfraz@okstate.edu

C-12: EXPANDERS II | 202

Chair: Jason Hugenroth, InvenTherm, LLC

1:00PM - 1:20PM
ID: 1240
Integral Compressor/Generator/Fan Unitary Structure
Nelik Dreiman
Consultant, United States of America; ndreiman@frontier.com
1:20PM - 1:40PM
ID: 1341
Study on Gas-liquid Two-phase Flow Patterns and Pressure Drop in a Helical Channel with Complex Section
Cai B1, Xia G D2
1BEIJING UNIVERSITY OF TECHNOLOGY, China, People’s Republic of; 2BEIJING UNIVERSITY OF TECHNOLOGY, China, People’s Republic of; caibo2014@mails.bjut.edu.cn

1:40PM - 2:00PM
ID: 1343
Development Of A General Numerical Methodology For CFD Analyses In Sliding Vane Machines And Application On A Mid-Size Oil Injected Air Compressor
Giuseppe Bianchi1,2, Sham Rane2, Ahmed Kovacevic2, Roberto Cipollone1, Stefano Murgia3, Giulio Contaldi3
1University of L’Aquila, Italy; 2City University London, United Kingdom; 3Ing. Enea Mattei S.p.A., Italy; giuseppe.bianchi@univaq.it

2:00PM - 2:20PM
ID: 1432
Thermodynamic Modeling of Screw Expander in a Trilateral Flash Cycle
Hanushan Vasuthevan, Andreas Brümmer
Chair of Fluidics, TU Dortmund University, Germany; hanushan.vasuthevan@tu-dortmund.de

2:20PM - 2:40PM
ID: 1550
Theoretical Analysis of the Impact of an Energy Recovery Expansion Device in a CO2 Refrigeration System
Nicholas Joseph Czapla, Harshad Inamdar, Nicholas Salts, Eckhard Groll
Purdue University, United States of America; nczapla@purdue.edu

C-13: SCROLL COMPRESSORS II | 206
Chair: Bryce Shaffer, Air Squared, Inc.

1:00PM - 1:20PM
ID: 1081
High Efficiency Inverter Scroll Compressors
Yasuhiro Murakami, Hiroshi Kitaura, Kazuhiko Matsukawa, Katsumi Katou, Yoshitomo Tsuka, Yasuo Mizushima
DAIKIN INDUSTRIES, LTD., Japan; yasuhiro.murakami@daikin.co.jp

1:20PM - 1:40PM
ID: 1482
Development of The Compact and High-efficient Scroll Compressor with The Novel Bearing Structure
Sungyong Ahn1, Junchul Oh1, Junghoon Park1, Seheon Choi1, Byeongchul Lee1, Hyunwoong Cho2, Jeonghun Kim2
1Air Conditioning Compressor Team, LG Electronics Inc.; 2Air Conditioning Compressor Development Team, LG Electronics Inc.; sungyong.ahn@lge.com

1:40PM - 2:00PM
ID: 1616
CFD Simulation of An Oil Flooded Scroll Compressor Using VOF Approach
Hui Ding, Yu Jiang
Simerics Inc., United States of America; hd@simerics.com
B-13: VENTILATION, PASSIVE COOLING AND IAQ | 214 A&B
Chair: Brandon E. Boor, Purdue University

3:30PM - 3:50PM
ID: 3163
The Air Distribution Around Nozzles Based On Active Chilled Beam System
Bingjie Wu¹, Wenjian Cai², Qinguo Wang¹, Can Chen², Chen Lin², Haoran Chen²
¹Energy Research Institute @ NTU (ERI@N), Interdisciplinary Graduate School, Nanyang Technological University, Singapore; ²School of Electrical and Electronic Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore, 639798; ³Institute for Intelligent Systems, the University of Johannesburg, South Africa; BWU006@e.ntu.edu.sg

3:50PM - 4:10PM
ID: 3231
Performance Evaluation of a Passive Chilled Beam System and Comparison with a Conventional Air System
Janghyun Kim¹, James E. Braun¹, Athanasios Tzempelikos¹,², W. Travis Horton¹,²
¹Ray W. Herrick Laboratories, School of Mechanical Engineering, Purdue University, 140 S. Martin Jischke Dr., West Lafayette, IN 47907, USA; ²School of Civil Engineering, Purdue University, 550 Stadium Mall Dr., West Lafayette, IN 47907, USA; kim1302@purdue.edu

4:10PM - 4:30PM
ID: 3310
Demand Controlled Heat Recovery for Residential Applications
Zhen Li, William Hutzel
School of Engineering Technology, Purdue University, United States of America; li2215@purdue.edu

4:30PM - 4:50PM
ID: 3676
Temperature, Relative Humidity, and Carbon-Dioxide Modulation in a Near-Zero Energy Efficient Retrofit House
Saurabh Sudhakaran, Mark Shaurette
Purdue University, United States of America; sudhakas@purdue.edu

R-27: ABSORPTION TECHNOLOGY II | 214 C&D
Chair: Srinivas Garimella, Georgia Institute of Technology

3:30PM - 3:50PM
ID: 2142
Investigations on Performance of an Auto-Cascade Absorption Refrigeration System Operating with the Mixed Refrigerant
Shengjian Le, Qin Wang, Dahong Li, Xiaohong Han, Guangming Chen
Key Laboratory of Refrigeration and Cryogenic Technology of Zhejiang Province; Institute of Refrigeration and Cryogenics, Zhejiang University, China, People’s Republic of; qtxz1234567890@126.com

3:50PM - 4:10PM
ID: 2273
Experimental Evaluation of a Small-capacity, Direct-fired Ammonia-water Absorption Chiller
Anurag Goyal, Marcel A. Staedter, Dhruv C. Hoysall, Mikko J. Ponkala, Srinivas Garimella
Georgia Institute of Technology, United States of America; anurag.goyal@gatech.edu
4:10PM - 4:30PM
ID: 2270
Investigation of Air-Cooled Condensers for Ammonia-Water Absorption Chillers
Subhrajit Chakraborty, Victor C. Aiello, Srinivas Garimella
Georgia Institute of Technology, United States of America; schakraborty38@gatech.edu

4:30PM - 4:50PM
ID: 2603
A Preliminary Study on Innovative Absorption Systems that Utilize Low-Temperature Geothermal Energy for Air-Conditioning Buildings
Xiaobing Liu, Zhiyao Yang, Kyle R. Gluesenkamp, Ayyoub M. Momen
Oak Ridge National Laboratory, United States of America; yangz2@ornl.gov

4:50PM - 5:10PM
ID: 2552
Regional Climate Zone Modeling of a Commercial Absorption Heat Pump Hot Water Heater
Patrick Geoghegan¹, Bo Shen¹, Christopher Keinath², Michael Garrabrant²
¹Oak Ridge National Laboratory; ²Stone Mountain Technologies, Inc.; geogheganpj@ornl.gov

R-28: HEAT EXCHANGER MODELING AND CHARACTERIZATION | 218 A&B
Chair: Hongtao Qiao, Mitsubishi Electric Research Laboratories

3:30PM - 3:50PM
ID: 2534
A Review of State of the Art in Modeling of Air-to-Refrigerant Heat Exchangers for HVAC&R Applications
Vikrant C. Aute
University of Maryland, United States of America; vikrant@umd.edu

3:50PM - 4:10PM
ID: 2672
Experimental Investigations Of Propane Minichannel Condenser And Evaporator
Dariusz Butrymowicz, Jerzy Gagan, Teodor Skiepko, Adam Dudar, Michał Łukaszuk, Kamil Smierciew
Bialystok University of Technology, Wiejska 45C, Bialystok, 15-351, Poland; j.gagan@pb.edu.pl

4:10PM - 4:30PM
ID: 2474
Round-Tube and Microchannel Heat Exchanger Modeling at Wet Air Condition
Yang Zou¹, Huize Li², Ke Tang³, Pega Hrnjak¹²
¹University of Illinois at Urbana-Champaign; ²Creative Thermal Solutions; yang.zou@creativethermalsolutions.com

4:30PM - 4:50PM
ID: 2137
Development and Validation of a Minichannel Evaporator Model under Different Dehumidifying Conditions
Abdelrahman Hussein Hassan¹, José González-Maciá¹, Santiago Martínez-Ballester¹, José R. García-Cascales²
¹Institute for Energy Engineering, Universitat Politècnica de València, Spain; ²DITF, ETSII, Universidad Politécnica de Cartagena, Spain; jgonzalv@ter.upv.es

4:50PM - 5:10PM
ID: 2298
Modeling of Finned-Tube Heat Exchangers: A Novel Approach to the Analysis of Heat and Mass Transfer under Cooling and Dehumidifying Conditions
Hongtao Qiao, Christopher R. Laughman
Mitsubishi Electric Research Laboratories, United States of America; qiao@merl.com
5:10PM - 5:30PM
ID: 2453
Internal Heat Exchanger Performance Quantification and Comparison Testing Methods Including Exploration of the Effects of Location of Measurements and Oil in Circulation
Andrew Musser¹, Stefan Elbel¹,², Pega Hrnjak¹,²
¹Creative Thermal Solutions, Inc., United States of America; ²University of Illinois at Urbana-Champaign, United States of America; musser@gmail.com

R-29: DESICCANT AND OTHER HEAT/MASS TRANSFER STUDIES | 218 C&D
Chair: Carlos Infante Ferreira, Delft University of Technology

3:30PM - 3:50PM
ID: 2096
Adsorption and Desorption Isotherms Of Desiccants for Dehumidification Applications: Silica Aerogels and Silica Aerogel Coatings on Metal Foams
Kashif Nawaz¹, Shelly J. Schmidt¹, Anthony M. Jacobii
¹Department of Aerospace and Mechanical Engineering, University of Oklahoma, Norman, OK, 73071; ²Department of Food Science and Human Nutrition, University of Illinois at Urbana Champaign, Urbana, IL, 61801; nawaz1@illinois.edu

3:50PM - 4:10PM
ID: 2125
Parametric Evaluation of Governing Heat and Mass Transfer Resistances in Membrane Based Heat and Moisture Exchangers
Paul D. Armatis, Brian M. Fronk
Oregon State University, United States of America; armatisp@oregonstate.edu

4:10PM - 4:30PM
ID: 2670
Numerical Modelling Of Heat And Mass Transfer Processes In Chinese Cabbage Cold Storage Chamber
Miroslawa Kolodziejczyk, Dariusz Butrymowicz, Kamil Smierciew, Jerzy Gagan
Bialystok University of Technology, ul. Wiejska 42A, Bialystok,15-351, Poland; k.smierciew@pb.edu.pl

4:30PM - 4:50PM
ID: 2262
Investigation Of Hydrate Growth Rate On The Interface Between Liquid and Solid Film
Hongxia Zhou, Carlos Infante Ferreira
Technology University of Delft, The Netherlands; h.zhou-1@tudelft.nl

R-30: DOMESTIC REFRIGERATION II | 310
Chair: Joaquim Rigola, Technical University of Catalonia

3:30PM - 3:50PM
ID: 2057
The Influence of Non-Condensable Gases on the Thermal-Acoustic Behavior of Household Refrigerators
Rodolfo da Silva Espíndola, Fernando Testoni Knabben, Claudio Melo
Federal University of Santa Catarina, Brazil; melo@polo.ufsc.br
Performance Characteristics of a Refrigerator-Freezer with Parallel Evaporators using a Linear Compressor
Byungchae Min1, Sangjin Song1, Kiyoul Noh1, Geonwoo Kim1, Teaseung Yoon1, Sangkyung Na1, Sanghoon Song2, Jangsik Yang3, Gyungmin Choi4, Duckjool Kim4
1Graduate School of Mechanical Engineering, Pusan National University, Korea, Republic of (South Korea); 2Engineering Design Department, Refrigeration Division, LG Electronics, Korea, Republic of (South Korea); 3Rolls-Royce University Technology Centre, Pusan National University, Korea, Republic of (South Korea); 4Department of Mechanical Engineering, Pusan National University, Korea, Republic of (South Korea); tsluv89@pusan.ac.kr

Virtual Household Refrigerators at Steady-state and Transient Conditions. Numerical Model and Experimental Validation
Nicolas Ablanque, Carles Oliet, Joaquim Rigola, Carlos-David Pérez-Segarra
Heat and Mass Transfer Technological Center - POLYTECHNIC UNIVERSITY OF CATALONIA, Spain; quim@cttc.upc.edu

A Numerical and Experimental Study on Skin Condensers Applied to Household Refrigerators
Elias Gava Colombo, Rodolfo da Silva Espíndola, Fernando Testoni Knabben, Claudio Melo
Federal University of Santa Catarina, Brazil; melo@polo.ufsc.br

Numerical Simulation of the 3d Transient Temperature Evolution Inside a Domestic Single Zone Wine Storage Cabinet With Forced Air Circulation
Johann Hopfgartner1, Martin Heimel1, Stefan Posch1, Erwin Berger1, Raimund Almbauer1, Stephan Schlemmer2
1TU Graz, Austria; 2Liebherr-Hausgeräte Lienz GmbH; hopfgartner@ivt.tugraz.at

Calibration Strategies And Limitations Of Cycle Simulations Representing Complex Domestic Cooling Devices
Martin Heimel1, Erwin Berger1, Stefan Posch1, Johann Hopfgartner1, Stephan Schlemmer2, Raimund Almbauer1
1Graz University of Technology, Austria; 2Liebherr-Hausgeräte Lienz GmbH; Hopfgartner@ivt.tugraz.at

Method of Measuring the Vapor Pressure and Concentration of Fluids using VLE and Vibrating Tube Densitometer Apparatuses
Momin Elhadi Abdalla1, Siddharth Pannir2
1University of Khartoum, Sudan; 2Purdue University; siddharth.pannir@gmail.com

Density of the Refrigerant Fluids of R365mfc and R152a: Measurement and Prediction
Momin Elhadi Abdalla1, Siddharth Pannir2
1University of Khartoum, Sudan; 2Purdue University; siddharth.pannir@gmail.com
4:10PM - 4:30PM
ID: 2283
Measurements of Thermodynamic Properties for R1123 and R1123+R32 Mixture
Yukihiro Higashi¹, Ryo Akasaka²
¹Kyushu University, ²CNER, Japan; imufeehigashi@mac.com

4:30PM - 4:50PM
ID: 2448
Hot Surface Ignition Testing of Low GWP 2L Refrigerants
Mary Koban, Barbara Minor, Nina Gray, Patrick Coughlan
Chemours Fluoroproducts, United States of America; barbara.h.minor@chemours.com

4:50PM - 5:10PM
ID: 2122
Compositional Fractionation Studies of R410A Alternative R452B or DR55 and Their Impact on Flammability Behavior and Safety Implications
Steve Kujak, Ken Schultz
Ingersoll Rand, United States of America; skujak@irco.com

5:10PM - 5:30PM
ID: 2318
Use of Nanoparticles In Refrigeration Systems: A Literature Review Paper
Amey Majgaonkar
Kirloskar Pneumatic Co. Ltd, India; amey.majgaonkar@gmail.com

C-14: TRIBOLOGY AND LUBRICATION II | 202
Chair: Michael Perevozchikov, Emerson Climate Technologies

3:30PM - 3:50PM
ID: 1213
A Numerical Investigation of the Oil Pump Suction Behaviour in a Hermetic Reciprocating Compressor
Stefan Posch¹, Johann Hopfgartner¹, Martin Heimel¹, Erwin Berger¹, Raimund Almbauer¹, Peter Schöllauer²
¹Institute for Internal Combustion Engines and Thermodynamics, Austria; ²Secop Austria GmbH, Austria; almbauer@ivt.tugraz.at

3:50PM - 4:10PM
ID: 1214
A Numerical Friction Loss Analysis of the Journal Bearings in a Hermetic Reciprocating Compressor
Stefan Posch¹, Johann Hopfgartner¹, Martin Heimel¹, Erwin Berger¹, Raimund Almbauer¹, Peter Schöllauer²
¹Institute for Internal Combustion Engines and Thermodynamics, Austria; ²Secop Austria GmbH, Austria; almbauer@ivt.tugraz.at

4:10PM - 4:30PM
ID: 1124
Effect of Refrigerant Gases (HFC134a and R600a) on the Tribological Behaviour of a Multifunctional DLC Coating
Marcio Silverio¹, Roberto Binder¹, Jose Daniel Biasoli De Mello¹, Emilio Rodrigues Hulse⁴
¹Embraco, Brazil; ²Embraco, Brazil; ³Federal University of Santa Catarina, Brazil; ⁴Embraco, Brazil; emilio.r.hulse@embraco.com

4:30PM - 4:50PM
ID: 1617
Lubrication Analysis of Journal Bearings in R410A Rotary Compressor
Yongjun Fu, Xingbiao Zhou, Hong Guo, Peipei Mei
Guangdong Meizhi Compressor Limited, China, People’s Republic of; zhouxb3@chinagmcc.com
Oil Flow Measurement at the Compressor Discharge
Jiu Xu¹, Pega Hrnjak¹,²
¹Air Conditioning and Refrigeration Center, University of Illinois at Urbana-Champaign; ²Creative Thermal Solutions Inc., Urbana, Illinois; jiuxu@illinois.edu

Study on Flow Characteristics of Oil Viscosity Pump for Refrigerant Compressors
Kiyoshi Sawai¹, Doi Manabu¹, Noriaki Ishii², Noboru Iida³, Kenji Kinjo³
¹Hiroshima Institute of Technology, Japan; ²Osaka Electro-Communication University, Japan; ³Panasonic Corporation, Japan; iida.noboru@jp.panasonic.com

Performance Comparison of Single–stage and Two–stage Hermetic Rotary CO2 Compressor
Li Zhang, Min Yang, Xiaolong Huang
R&D Center, Shanghai Hitachi Electrical Appliances Co., Ltd.; zhangli@shec.com.cn

CFD Analysis and Experiment Study of the Rotary Two-Stage Inverter Compressor with Vapor Injection
Liying Deng, Shebing Liang, Jia Xu, Yusheng Hu
Compressor and Motor Institute of Gree Electric Appliances, Inc. of Zhuhai, China, People’s Republic of; haitunsai@163.com

Comparative Research on Air Conditioner with Gas-injected Rotary Compressor through Injection Port on Blade
Liu Xingru, Wang Baolong, Shi Wenxing
Tsinghua university, China, People’s Republic of; liuxr11@yeah.net

Development of a New Dual-Cylinder Rotary Compressor for VI System
Guoyong Yang, Cheng Zhang, Yanping Wu, Siqing Liao
Guangdong Meizhi Compressor Limited, China, People’s Republic of; yangguoy@chinagmcc.com

Prediction of Leakage Flow of Radial Clearance in a Rolling Piston Rotary Compressor
Geon-woo Kim¹, Ki-youl Noh¹, Byung-chae Min¹, Sang-jin Song¹, Sang-kyung Na¹, Tae-seung Yoon¹, Kenichiro Teshima², Jang-sik Yang³, Gyung-min Choi⁴, Duck-jool Kim⁵
¹Graduate School of Mechanical Engineering, Pusan National University, Busan, Republic of (South Korea); ²Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Fukuoka, Japan; ³Rolls-Royce University Technology Centre, Pusan National University, Busan, Republic of (South Korea); ⁴Department of Mechanical Engineering, Pusan National University, Busan, Republic of (South Korea); ⁵bcmin@pusan.ac.kr

The Influence of Main Bearing Parameters on The Bearing Wear in Rotary Compressor
Lingchao Kong, Qingfu Zhao, Liping Ren, Jia Xu, Xiaotong Cheng, Yusheng Hu
Compressor and Motor Institute of Gree Electric Appliances, Inc. of Zhuhai, China, People’s Republic of; klc03@163.com
R-32: EQUIPMENT PERFORMANCE MEASUREMENTS AND MODELING | 214 A&B

Chair: Reinhard Radermacher, University of Maryland

9:45AM - 10:05AM
ID: 2382
Harmonization of Life Cycle Climate Performance (LCCP) Methodology
Sarah Troch, Hoseong Lee, Yunho Hwang, Reinhard Radermacher
University Of Maryland, United States of America; yhhwang@umd.edu

10:05AM - 10:25AM
ID: 2067
Steady State Modeling of Advanced Vapor Compression Systems with Multiple Air and Refrigerant Loops
Mohamed Beshr, Vikrant Aute, Reinhard Radermacher
University of Maryland, United States of America; mbeshr@umd.edu

10:25AM - 10:45AM
ID: 2328
Second-Law Analysis to Improve the Energy Efficiency of Environmental Control Unit
Ammar M. Bahman, Eckhard A. Groll
Ray W. Herrick Laboratories, Purdue University, United States of America; abahman@purdue.edu

10:45AM - 11:05AM
ID: 2052
Steady-State Numerical Simulation Of A Vapor Compression Heat Pump System As An Effective Method To Predict Its Performance
Zvonimir Janković*, Jaime Sieres*, Fernando Cerdeira*, Branimir Pavković*

1Department of Energetics, Mechanical Engineering Faculty in Slavonski Brod, University of Osijek; 2University of Vigo, Spain; 3Faculty of Engineering in Rijeka; jsieres@uvigo.es

11:05AM - 11:25AM
ID: 2109
Automated Optimization of Air Conditioning Systems using Geometry based Simulation Models
Joerg Aurich, Rico Baumgart, Eric Tomoscheit
IAV GmbH, Germany; joerg.aurich@iav.de

11:25AM - 11:45AM
ID: 2235
Development Of Operating Envelope Limits For Equipment Tested In A Wind Tunnel
Omer Sarfraz, Christian Bach
Oklahoma State University, United States of America; sarfraz@okstate.edu

11:45AM - 12:05PM
ID: 2102
Oil Return Measurements In A Unitary Split System Air Conditioner Using Different Refrigerant Mixtures
Gabriel A. Feichter*, Eckhard A. Groll*, Orkan Kurtulus*, Ben Meng*

*Interstate University of Applied Sciences of Technology NTB, Switzerland; 2Purdue University, United States of America; 3BMP International Inc., United States of America; gabriel.feichter@ntb.ch
R-33: EVALUATION OF NATURAL REFRIGERANTS | 214 C&D
Chair: Frank Rinne, Emerson Climate Technologies

9:45AM - 10:05AM
ID: 2615
Conversion of Platelet Incubator Refrigeration System to R600a and Performance Optimization
Matej Visek1, Stefan Elbel1,2, Pega Hrnjak1,2, Brian Hoaglan3, Chengzhi Tang1, Dennis Smith2
1Creative Thermal Solutions, United States of America; 2University of Illinois at Urbana-Champaign, USA; 3Helmer Scientific, USA; matej.visek@creativethermalsolutions.com

10:05AM - 10:25AM
ID: 2530
Experimental Comparison of a Cascade Refrigeration System Operating with R744/R134a and R744/R404a
Marcus Vinicius Almeida Queiroz1, Victor Hugo Panato1, Arthur Heleno Pontes Antunes1, Jose Alberto Reis Parise2, Enio Pedone Bandarra Filho1
1University Federal of Uberlandia, Brazil; 2Pontific University Catholic of Rio de Janeiro, Brazil; bandarra@mecanica.ufu.br

10:25AM - 10:45AM
ID: 2429
A Fair Comparison of CO2 and Propane used in Light Commercial Applications Featuring Natural Refrigerants
Stefan Elbel1,2, Matej Visek2, Pega Hrnjak1,2
1University of Illinois at Urbana-Champaign, United States of America; 2Creative Thermal Solutions, United States of America; elbel@illinois.edu

10:45AM - 11:05AM
ID: 2008
Modelling of an R-290/POE ISO 22 Variable Speed Air Conditioner System under SEER Conditions
Guilherme Borges Ribeiro1, Jader Riso Barbosa Jr.2
1Aerospace Science and Technology Department, Brazil; 2Federal University of Santa Catarina, Brazil; jrb@polo.ufsc.br

11:05AM - 11:25AM
ID: 2049
Performance Comparison of R32, R410A and R290 Refrigerant in Inverter Heat pumps application.
Supharuek Konghuayrob, Kornvalee Khositkullaporn
Siam Compressor Industry, Thailand; supharuekk@siamcompressor.com

11:25AM - 11:45AM
ID: 2105
CO2 As An Alternative Refrigerant For Applications Below -50°C
Robin Langebach, Ullrich Hesse
TU Dresden, Germany; robin.langebach@tu-dresden.de

11:45AM - 12:05PM
ID: 2202
Development of a Refrigerant to Refrigerant Heat Exchanger for High Efficiency CO2 Refrigerant Cycle
Ryuhei Kaji, Shun Yoshioka, Hirokazu Fujino
Daikin Industries, LTD, Japan; ryuuhei.kaji@daikin.co.jp
R-34: FLOW BOILING | 218 A&B

Chair: Claudio Zilio, University of Padova

9:45AM - 10:05AM
ID: 2417
Experimental Investigation on Upflow Boiling of Low GWP Refrigerant in Aluminum Multi-port Extruded Tubes
Jiyang Li, Chaobin Dang, Eiji Hihara
Department of Human and Engineered Environmental Studies, The University of Tokyo; lijiyangxjtu@gmail.com

10:05AM - 10:25AM
ID: 2371
Flow Boiling Heat Transfer Characteristics of R32 inside a Horizontal Small-diameter Microfin Tube
Daisuke Jige, Kentaro Sagawa, Norihiro Inoue
Tokyo University of Marine Science and Technology, Japan; djige00@kaiyodai.ac.jp

10:25AM - 10:45AM
ID: 2251
An Experimental Investigation of Convective Boiling Heat Transfer Using Alternative and Natural Refrigerants Inside Horizontal Microchannels
Nguyen-Ba Chien, Pham-Quang Vu, Kwang-II Choi, Jong-Taek Oh
Chonnam National University, Korea, Republic of (South Korea); ohjt@chonnam.ac.kr

10:45AM - 11:05AM
ID: 2265
R134a Flow Boiling inside a 4.3 mm ID Microfin Tube
Simone Mancin1, Claudio Zilio1, Giulia Righetti1, Luca Doretti2, Giovanni A. Longo1
1Dept. of Management and Engineering, University of Padova, Italy; 2Dept. of Civil, Architectural and Environmental Engineering, University of Padova, Italy; claudio.zilio@unipd.it

11:05AM - 11:25AM
ID: 2167
HFO1234ze(E) And HFC134a Flow Boiling Inside a 4mm Horizontal Smooth Tube
Giovanni A. Longo, Simone Mancin, Giulia Righetti, Claudio Zilio
University of Padova, Italy; giuliarighetti@gmail.com

11:25am - 11:45am
ID: 2166
HFO1234ze(E) Boiling Inside a Brazed Plate Heat Exchanger
Giovanni A. Longo, Simone Mancin, Giulia Righetti, Claudio Zilio
University of Padova, Italy; simone.mancin@unipd.it

11:45AM - 12:05PM
ID: 2244
Comparison on Evaporation Heat Transfer between R32/R1234yf and R32/R1234ze(E) Flowing in Horizontal Microfin Tubes
Shingo Nakamura1, Chieko Kondou2, Shigeru Koyama1
1Kyushu university, Japan; 2Nagasaki university, Japan; ckondou@nagasaki-u.ac.jp
R-35: RESIDENTIAL HEAT PUMPS | 218 C&D

Chair: Bo Shen, Oak Ridge National Laboratory

9:45AM - 10:05AM
ID: 2035
Experimental Evaluation of Low-Cost Gas Heat Pump Prototypes for Building Space Heating
Michael Garrabrant1, Roger Stout1, Christopher Keinath1, Paul Glanville2
1Stone Mountain Technologies, Inc.; 2Gas Technologies Institute; ckeinath@stonemtnttechnologies.com

10:05AM - 10:25AM
ID: 2505
Experimental Evaluation of High Performance Integrated Heat Pump
William A. Miller1, Robert Berry2, Neal Durfee1, Van D. Baxter1
1Oak Ridge National Laboratory, United States of America; 2Unico, Inc., United States of America; vdb@ornl.gov

10:25AM - 10:45AM
ID: 2586
Laboratory Performance Evaluation Of Residential Scale Gas Engine Driven Heat Pump
Ahmad Abu-Heiba1, Isaac Y. Mahderekal1, Ayyoub Momen2
1Oak Ridge Associated Universities, United States of America; 2Oak Ridge National Laboratory; 3IntelliChoice Energy; momena@ornl.gov

10:45AM - 11:05AM
ID: 2171
Techno-Economic Analysis of a Novel Solar Thermal and Air-Source Heat Pump System
Stefano Poppi1,2, Chris Bales1
1Dalarna University, Falun; 2KTH, Energy Technology, Stockholm; spo@du.se

11:05AM - 11:25AM
ID: 2442
Research on the Operating Characteristics of Floor Heating System with Residential EVI Air Source Heat Pump in China
Xiaoning Chen, Ziqi Zhang, Junye Shi, Zhiyu Yang, Jiangping Chen
Shanghai Jiao Tong University, China, People’s Republic of; chenxn0731@163.com

11:25AM - 11:45AM
ID: 2103
Evaluation of R-410A Refrigerant Alternatives in a Residential Reversible Air to Water Heat Pump
Pierre Pardo, Louis Charbonnier, Michèle Mondot
CETIAT, Centre Technique des Industries Aérauliques et Thermiques, Villeurbanne, France; pierre.pardo@cetiat.fr

11:45AM - 12:05PM
ID: 2408
Shigeharu Taira1, Tomoyuki Haikawa2, Tomoatsu Minamida3, Fumio Ota4
1Japan; 2Japan; 3Japan; 4Japan; tomoatsu.minamida@daikin.co.jp

R-36: PROPERTY MEASUREMENTS, MODELING, AND ASSESSMENTS II | 310

Chair: Barbara Haviland Minor, Chemours

9:45AM - 10:05AM
ID: 2287
Viscosity Correlations for Refrigerants and Other Working Fluids from Residual Entropy Scaling
Ian Bell, Arno Laesecke
National Institute of Standards and Technology, United States of America; ian.bell@nist.gov
THURSDAY • 9:45 AM - 12:00 PM

10:05AM - 10:25AM
ID: 2297
A Helmholtz Energy Equation of State for Trifluoroethylene (R-1123)
Ryo Akasaka1, Masato Fukushima2, Eric W. Lemmon3
1Kyushu Sangyo University, Japan; 2ASAHI GLASS CO., LTD., Japan; 3National Institute of Standards and Technology, USA; ryo-a@ip.kyusan-u.ac.jp

10:25AM - 10:45AM
ID: 2176
Comparison of Models for Calculation of the Thermodynamic Properties of NH3-CO2-H2O Mixture
Vilborg Gudjonsdottir, Carlos Infante Ferreira
Delft University of Thecnology, Section Engineering Thermodynamics, Netherlands; v.gudjonsdottir-1@tudelft.nl

10:45AM - 11:05AM
ID: 2288
Psychrometric Properties of Humid Air from Multi-Fluid Helmholtz-Energy-Explicit Models
Ian Bell, Eric Lemmon, Allan Harvey
National Institute of Standards and Technology, United States of America; ian.bell@nist.gov

11:05AM - 11:25AM
ID: 2204
The Viscosity Characteristics for the Mixed Refrigerant HFO-1234yf + HFC-152a
Zhangzhang Yang1, Xuehui Wang1, Yibo Fang1, Xiaohong Han1, Xiaogang Qiao2, Guangming Chen1
1Institute of Refrigeration and Cryogenics, State Key Laboratory of Clean Energy Utilization, Zhejiang University,Hangzhou ,Zhejiang, China; 2Zhejiang College of Construction, Hangzhou, Zhejiang, China; yzhangzhang@126.com

11:25AM - 11:45AM
ID: 2151
Thermodynamic Properties of Low-GWP Refrigerant for Centrifugal Chiller
Masato Fukushima, Hiroki Hayamizu, Mai Hashimoto
AGC Chemicals, ASAHI GLASS Co.,Ltd, Japan; mai-hashimoto@agc.com

R-37: PLATE HEAT EXCHANGERS | 278
Chair: Vikrant C. Aute, University of Maryland

9:45AM - 10:05AM
ID: 2279
An Improved Approach for Modeling Plate Heat Exchangers Based on Successive Substitution in Alternating Flow Directions
Radia Eldeeb, Vikrant Aute, Reinhard Radermacher
University of Maryland, United States of America; radiame@umd.edu

10:05AM - 10:25AM
ID: 2338
Shenghan Jin1, Pega Hrnjak1,2
1University of Illinois, United States of America; 2Creative Thermal Solutions, Inc. (CTS), Urbana IL, USA; sjin8@illinois.edu
THURSDAY • 9:45 AM - 12:00 PM

10:25AM - 10:45AM
ID: 2600
Local Heat Transfer Characteristics of the R1234ze(E) Two Phase Flow Inside a Plate Heat Exchanger
Keishi Kariya, Mohammad Sultan Mahmud, Akitoshi Kawazoe, Akio Miyara
Saga university, Saga, Japan; kariya@me.saga-u.ac.jp

10:45AM - 11:05AM
ID: 2278
Investigation of Thermal-Hydraulic Characteristics of Pillow Plate Heat Exchangers Using CFD
Radia Eldeeb, Vikrant Aute, Reinhard Radermacher
University of Maryland, United States of America; radiame@umd.edu

11:05AM - 11:25AM
ID: 2337
Effect of End Plates on Heat Transfer of Plate Heat Exchanger
Shenghan Jin¹, Pega Hrnjak¹,²
¹University of Illinois, United States of America; ²Creative Thermal Solutions, Inc. (CTS), Urbana IL, USA; sjin8@illinois.edu

11:25AM - 11:45AM
ID: 2106
Experimental Results For Hydrocarbon Refrigerant Vaporization In Brazed Plate Heat Exchangers at High Pressure
Adriano Desideri¹, Jorrit Wronski², Torben Schmidt Ommen¹, Sylvain Quoilin¹, Vincent Lemort¹, Fredrik Haglind³
¹University of Liege, Belgium; ²IPU, Denmark; ³Technical University of Denmark; adesideri@ulg.ac.be

11:45AM - 12:05PM
ID: 2609
Single Phase Pressure Drop and Flow Distribution in Brazed Plate Heat Exchangers
Wenzhe Li¹, Pega Hrnjak¹,²
¹Air-Conditioning and Refrigeration Center (ACRC), University of Illinois Urbana-Champaign, United States of America; ²CTS – Creative Thermal Solutions, Inc. Urbana IL; liwz310@illinois.edu

C-16: TESTING AND MEASUREMENT | 202
Chair: Stefan Bertsch, NTB University of Applied Sciences of Technology Buchs

9:45AM - 10:05AM
ID: 1100
Design And Realization Of An Automated Test-Stand For Variable Capacity Household Compressors
Bernhard Vetsch¹, Gabriel Feichter¹, Adrian Bachmann¹, Stefan S. Bertsch¹
¹Interstate University of Applied Sciences of Technology NTB, Switzerland; ²V-ZUG COOLING TECHNOLOGY LTD, Switzerland; bernhard.vetsch@ntb.ch

10:05AM - 10:25AM
ID: 1216
Experimental Study on the Thermal Behavior of a Domestic Refrigeration Compressor during Transient Operation in a Small Capacity Cooling System
Johann Hopfgartner¹, Martin Heimel¹, Stefan Posch¹, Erwin Berger¹, Raimund Almbauer¹, Stefan Stangl²
¹TU Graz, Austria; ²Secop Austria; hopfgartner@ivt.tugraz.at

10:25AM - 10:45AM
ID: 1185
A Methodology for Characterization of Vapor-injection Compressors
Fernando M. Tello Oquendo, Emilio Navarro-Peris, José González-Maciá
Institute for Energy Engineering, Universitat Politècnica de València, Spain; emilio.navarro@iie.upv.es
10:45AM - 11:05AM
ID: 1533
Characterization and Performance Testing of Two-Stage Reciprocating Compressors using a Hot-Gas Load Stand with Carbon Dioxide
Xinye Zhang¹, Bin Yang¹, Andres Osorio², Dylan Bethel³, Orkan Kurtulus⁴, Eckhard Groll⁵
¹Purdue University, United States of America; ²BlackPak Inc; zhan1600@purdue.edu

11:05AM - 11:25AM
ID: 1531
Characterization and Performance Testing of Two-Stage Reciprocating Compressors during the Dynamic Charging of a Tank with Air
Xinye Zhang¹, Bin Yang¹, Andres Osorio², Dylan Bethel³, Orkan Kurtulus⁴, Eckhard Groll⁵
¹Purdue University, United States of America; ²BlackPak Inc; zhan1600@purdue.edu

11:25AM - 11:45AM
ID: 1348
A Comprehensive Evaluation of Regression Uncertainty and the Effect of Sample Size on the AHRI-540 Method of Compressor Performance Representation
Vikrant Aute¹, Cara Martin²
¹Center for Environmental Energy Engineering, University of Maryland, College Park; ²Optimized Thermal Systems, Inc., Beltsville, MD, USA; cmartin@optimizedthermalsystems.com

C-17: CENTRIFUGAL COMPRESSORS | 206
Chair: Christian Bach, University of Oklahoma

9:45AM - 10:05AM
ID: 1393
Experimental Study on Noise Characteristic of Centrifugal Compressor Surge
Qichao Yang, Yuanyang Zhao, Yue SHU, Xiaosa LI, Liansheng LI
Hefei General Machinery Research Institute, Hefei, P.R. China; qichaoyang@163.com

10:05AM - 10:25AM
ID: 1048
The Effects of Blade Fillets on Aerodynamic Performance of a High Pressure Ratio Centrifugal Compressor
Justin Jongsik Oh
Danfoss Turbocor, United States of America; jongsik.oh@danfoss.com

10:25AM - 10:45AM
ID: 1456
Experimental Research on Surge and Stability Enhancement of Centrifugal Compressor
Yuanyang Zhao, Qichao Yang, Liansheng Li, Jun Xiao, Guangbin Liu, Le Wang
Hefei General Machinery Research Institute, China, People's Republic of; yuanyangzhao@163.com

10:45AM - 11:05AM
ID: 1181
Performance Gain for Multiple Stage Centrifugal Compressor by using non-Equal Impeller Configuration
Yuanjie Wu, Chris Thilges, Philippe Guillerot
Ingersoll Rand -Trane Company, United States of America; JIM.WU@IRCO.COM

11:05AM - 11:25AM
ID: 1088
Design of Oil-Free Turbocompressors for a Two-Stage Industrial Heat Pump under Variable Operating Conditions
Adeel Javed¹, Cordin Arpagaus², Stefan Bertsch², Jürg Schiffmann³
¹École Polytechnique Fédérale de Lausanne, Switzerland; ²NTB University of Applied Sciences of Technology Buchs, Switzerland; jurg.schiffmann@epfl.ch
R-38: HVAC EQUIPMENT PERFORMANCE ENHANCEMENTS | 214 A&B

Chair: Roy Crawford, Ingersoll Rand

1:00PM - 1:20PM
ID: 2387
Isentropic Mixtures and Their Application in Heat Pumps in Cold Climate Region
Nan Zheng1,2, Hoseong Lee1, Yunho Hwang1, Reinhard Radermacher1, Li Zhao2
1University Of Maryland, United States of America; 2Tianjin University, China; yhhwang@umd.edu

1:20PM - 1:40PM
ID: 2606
Reduction Of Energy Consumption in Air-conditioning Systems employing direct evaporative pre-cooling of Condenser air
Theodore Aganachi Ndukaife1,2, A.G Agwu Nnanna1,2
1Mechanical Engineering department, Purdue University NorthWest; 2Purdue University Water Institute, United States of America; tndukaif@purduecal.edu

1:40PM - 2:00PM
ID: 2101
Two-Stage Heat Pump using Oil-Free Turbocompressors - System Design and Simulation
Cordin Arpagaus1, Stefan Bertsch1, Adeel Javeed1, Jürg Schiffmann1
1NTB University of Applied Sciences of Technology Buchs, Institute for Energy Systems, Buchs, Switzerland; 2Ecole Polytechnique Fédérale de Lausanne, Laboratory for Applied Mechanical Design, Neuchâtel, Switzerland; cordin.arpagus@ntb.ch

2:00PM - 2:20PM
ID: 2528
An Integrated Solution for Commercial AC Chillers Using Variable Speed Scroll Compressors
Stephane Bertagnolio, Eric Winandy, Dina Koepke
Emerson Climate Technologies, Aachen, Germany; stephane.bertagnolio@emerson.com

2:20PM - 2:40PM
ID: 2123
Modelling And Simulation Of A R744 Based Air Conditioning Unit
Mihir Mouchum Hazarika, Maddali Ramgopal, Souvik Bhattacharyya
IIT Kharagpur, India; mihirbesu2011@gmail.com

2:40PM - 3:00PM
ID: 2140
Cost Optimization of Thermoelectric Sub-Cooling in Air-cooled CO2 Air Conditioners
Kazuaki Yazawa1, Yefeng Liu2, Orkan Kurtulus2, Eckhard A. Groll2
1Birck Nanotechnology Center / Purdue University, United States of America; 2Department of Mechanical Engineering / Purdue University, United States of America; kyazawa@purdue.edu

R-39: ALTERNATIVE REFRIGERANT EVALUATION METHODS AND RESULTS | 214 C&D

Chair: Andy Pearson, Star Refrigeration

1:00PM - 1:20PM
ID: 2649
Low GWP Refrigerants for Air Conditioning and Chiller Applications
Ankit Sethi, Elizabet Vera Becerra, Joshua Close, Michael Petersen, Samuel Yana Motta
Honeywell, United States of America; ankit.sethi@honeywell.com
1:20PM - 1:40PM
ID: 2064
AHRI Low Global Warming Potential Alternative Refrigerants Evaluation Program (Low-GWP AREP) – Summary of Phase II Testing Results
Xudong Wang, Karim Amrane
Air-Conditioning, Heating, and Refrigeration Institute, United States of America; xwang@ahrinet.org

1:40PM - 2:00PM
ID: 2614
Analysis of the Drop-in Operation of a Refrigeration System by the Response Surface Methodology
Victor Hugo Panato, Marcus Almeida Queiroz, Luís Manoel Paiva Souza, Arthur Heleno Pontes Antunes, Enio Pedone Bandarra Filho
Federal University of Uberlandia, Brazil; vpanato@hotmail.com

2:00PM - 2:20PM
ID: 2071
R-32 As An Alternative To Ammonia In Industrial Refrigeration
Andy Pearson
Star Refrigeration Ltd, United Kingdom; apearson@star-ref.co.uk

2:20PM - 2:40PM
ID: 2332
Novel Reduced GWP Refrigerant Compositions To Replace R-134a in Stationary Air-conditioning and Refrigeration
Laurent Abbas¹, Sarah Kim¹, Kenneth Schultz²
¹ARKEMA Inc, United States of America; ²Ingersoll Rand, United States of America; laurent.abbas@arkema.com

2:40PM - 3:00PM
ID: 2450
Multi-Year Evaluation of R-449A as a Replacement for R-22 in Low Temperature and Medium Temperature Refrigeration Applications
Andrew Pansulla¹, Charles Allgood²
¹Chemours, United States of America; ²Chemours, United States of America; andrew.r.pansulla@chemours.com

R-40: REFRIGERANT HEAT TRANSFER AND PRESSURE DROP I | 218 A&B
Chair: Harshad Vijay Inamdar, Purdue University

1:00PM - 1:20PM
ID: 2077
A New Flow Map and Flow Characterization of Condensation in Smooth Round Tube from Superheated Vapor
Jiange Xiao¹, Pega Hrnjak¹,²
¹ACRC, the University of Illinois; ²CTS – Creative Thermal Solutions, Inc. Urbana IL; jxiao10@illinois.edu

1:20PM - 1:40PM
ID: 2078
Heat Transfer of Condensation in Smooth Round Tube from Superheated Vapor
Jiange Xiao¹, Pega Hrnjak¹,²
¹ACRC, the University of Illinois; ²CTS – Creative Thermal Solutions, Inc. Urbana IL; jxiao10@illinois.edu

1:40PM - 2:00PM
ID: 2053
Condensation Of Superheated R134a Inside A Vertical Tube
Jaime Sieres¹, José Antonio Martínez-Suárez¹, Elena Martín²
¹Área de Máquinas y Motores Térmicos, Escuela de Ingeniería Industrial, University of Vigo, Spain; ²Área de Mecánica de Fluidos, Escuela de Ingeniería Industrial, University of Vigo, Spain; jsieres@uvigo.es
**Heat Transfer and Visualization in Large Flattened-Tube Condensers with Variable Inclination**

William A. Davies¹, Yu Kang¹, Pega Hrnjak¹,², Anthony M. Jacobi¹

¹ACRC, University of Illinois, United States of America; ²CTS - Creative Thermal Solutions, Inc. Urbana IL; daviesi2@illinois.edu

**Literature review of condensation and evaporation of R290**

Cichong Liu, Ziyang Sun, Ziqi Zhang, Junye Shi, Jiangping Chen

Shanghai JiaoTong University, China, People's Republic of; lcc_sjtu@163.com

**Effect of Inclination on Condensation Pressure Drop in Large Flattened-Tube Condensers**

Yu Kang¹, William A. Davies¹, Pega Hrnjak¹,², Anthony M. Jacobi¹

¹ACRC, University of Illinois, United States of America; ²CTS – Creative Thermal Solutions, Inc. Urbana, IL; yukang2@illinois.edu

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**R-41: HEAT PUMP WATER HEATERS | 218 C&D**

Chair: Van D. Baxter, Oak Ridge National Laboratory

**High Efficiency Heat Pump with Subcooling for Sanitary Hot Water Production Working with Propane**

Miquel Pitarch-Mocholi, Emilio Navarro-Peris, José Gonzalvez-Maciá, José Miguel Corberán

Instituto de Ingenieria Energética, Universitat Politècnica de València, Spain; enava@ter.upv.es

**Investigation, Analysis and Solution of Higher Noise of Heat Pump Water Heater**

Bo Huang, Weiyan Chu, Yinxiao Lu

Shanghai Hitachi Electrical Appliances Co., Ltd, China, People's Republic of; chuwy@shc.com.cn

**“Heat Pump Driven by a Gas engine for Heating and Domestic Hot Water Generation”**

Amine Mekdache¹,², Assaad Zoughaib⁰, Denis Clodic³

¹Ecole des Mines de Paris / Centre efficacité énergétique des systèmes, France; ²Engineering Research Innovation for Energy (EREiE), France; amine.mekdache@mines-paristech.fr

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**Fifteen Years of Dehumidification Results from Heat Pump Water Heaters**

William E. Murphy

Retired - University of Kentucky, United States of America; william.murphy@uky.edu

**Modeling and Experimental Study of a Heat Pump Water Heater Cycle**

Kevin Ruben Deutz¹,², Odile Cauret¹, Romuald Rullière³, Philippe Haberschill²

¹Electricité De France, EDF, France; ²Institut National des Sciences Appliquées de Lyon, INSA Lyon; kevin-ruben.deutz@edf.fr
2:40PM - 3:00PM  
ID: 2134  
Experimental Investigation on the Influence of Refrigerant Charge on the Performance of Trans-critical CO2 Water-Water Heat Pump  
Ze Zhang\textsuperscript{1,2}, Rong Xue\textsuperscript{2}, Shuangtao Chen\textsuperscript{2}, Shijie Song\textsuperscript{2}, Yu Hou\textsuperscript{1,2}  
\textsuperscript{1}State Key Laboratory of Multiphase Flow in Power Engineering, Xi’an Jiaotong University, Xi’an 710049, China;  
\textsuperscript{2}School of Energy and Power Engineering, Xi’an Jiaotong University, Xi’an 710049, China; zhangze@163.com  

R-42: THERMAL STORAGE | 310  
Chair: Gerhard Schmitz, Hamburg University of Technology  

1:00PM - 1:20PM  
ID: 2192  
Integrated Thermal Energy Storage  
William L. Kopko  
Johnson Controls, United States of America; william.kopko@jci.com  

1:20PM - 1:40PM  
ID: 2141  
Ruixin Zhou, Bei Guo, Xiaole Chen, Yang Lu  
School of Energy and Power Engineering, Xi’an Jiaotong University, China; zhouruixin@stu.xjtu.edu.cn  

1:40PM - 2:00PM  
ID: 2018  
Design and Performance of Thermal Energy Storage Module using High Thermal Conductivity Phase Change Composite Material for Building Cooling Applications  
Yoram Shabtay\textsuperscript{1}, Siddique Khateeb\textsuperscript{2}  
\textsuperscript{1}Heat Transfer Technologies, United States of America;  \textsuperscript{2}NetEnergy, United States of America; yoram@heattransferttechnologies.com  

2:00PM - 2:20PM  
ID: 2221  
Experimental Analysis of Latent Heat Storages integrated into a Liquid Cooling System for the Cooling of Power Electronics  
Thomas Bezerra Helbing, Gerhard Schmitz  
Institute of Thermo-Fluid Dynamics, Hamburg University of Technology, Germany; thomas.helbing@tuhh.de  

2:20PM - 2:40PM  
ID: 2170  
Experimental Comparison Of Different Composite Latent Heat Storage Devices With Spatially Non-Constant Heat Loads  
Henrik Veelken, Gerhard Schmitz  
Institute of Thermo-Fluid Dynamics, Hamburg University of Technology, Germany; henrik.veelken@tuhh.de
C-18: NOISE, VIBRATION & HARSHNESS II | 202
Chair: Patricia Davies, Purdue University

1:00PM - 1:20PM
ID: 1158
Vertical-Vibration Suppressing Design of Accumulator with New Vibration-Measuring Method
Hikaru Wada, Hideki Matsuura, Satoru Takanezawa, Ayumi Ogawa
DAIKIN INDUSTRIES, LTD, Japan; hikaru.wada@daikin.co.jp

1:20PM - 1:40PM
ID: 1254
Study on the Contribution of Compressor noise to Refrigerator Overall Noise
Shoufei Wu, Jiayou Song, Gaowei Shen
Jiaxipera Compressor Co., Ltd, China, People’s Republic of; shoufei.wu@qq.com

1:40PM - 2:00PM
ID: 1259
Analysis And Control Of Severe Vibration Of A Screw Compressor Outlet Piping System
Ying Zhao¹, Bin Zhao¹, Qiang Zhou¹, Xiaohan Jia¹,², Jianmei Feng¹,², Xueyuan Peng¹,²
¹Xi’an Jiaotong University, China, People’s Republic of; ²National Engineering Research Center of Fluid Machinery and Compressors, China, People’s Republic of; zy18706704461@stu.xjtu.edu.cn

2:00PM - 2:20PM
ID: 1121
Prediction of Compressor Muffler Frequency Response Function using CFD
Tadeu Tonheiro Rodrigues, Cristiano Stumpf, Ricardo Mikio Doi
Embraco, Brazil; tadeu.t.rodrigues@embraco.com

2:20PM - 2:40PM
ID: 1503
3D Compressible Simulation Of a Muffler With Pseudosound Prediction Levels
Jesus Ruano¹, Joan Lopez¹, Oriol Lehmkuhl¹,², Joaquim Rigola¹, Carles David Pérez Segarra¹
¹CTTC, Universitat Politècnica de Catalunya, Spain; ²TermoFluids, Spain; jesusr@cttc.upc.edu

2:40PM - 3:00PM
ID: 1022
Gas Pulsation Control by a Shunt Pulsation Trap with Perforated Tubes and an Optional Absorptive Silencer
Paul Xiubao Huang, Sean Yonkers, David Hokey
Hi-Bar MC Tech. LLC, United States of America; paulxbh@yahoo.com

C-19: ROTARY COMPRESSORS II | 206
Chair: Margaret Mathison, Iowa State University

1:00PM - 1:20PM
ID: 1037
Development of a Novel Structure Rotary Compressor for Separate Sensible and Latent Cooling Air-Conditioning System
Chunhui Liu, Haifeng Zhang, Lei Zhang, Jin Pan
Shanghai Hitachi Electrical Appliance Co., Ltd, People’s Republic of China; liuchh@shec.com.cn
1:20PM - 1:40PM
ID: 1104
A Study on High Efficiency Wing-vane Compressor - Part 1: A Simulation Analysis of Dynamic Model
Raito Kawamura, Shin Sekiya, Tatsuya Sasaki, Hideaki Maeyama, Shinichi Takahashi, Kanichiro Sugiura
Mitsubishi Electric Corporation, Japan; Kawamura.Raito@cj.MitsubishiElectric.co.jp

1:40PM - 2:00PM
ID: 1085
A Study on High Efficiency Wing-vane Compressor - Part 2: Lubrication Characteristic of The Partial Arc Guide Bearing
Tatsuya Sasaki, Shin Sekiya, Raito Kawamura, Hideaki Maeyama, Shinichi Takahashi, Kanichiro Sugiura
Mitsubishi Electric Corporation, Japan; Sasaki.Tatsuya@ea.MitsubishiElectric.co.jp

2:00PM - 2:20PM
ID: 1293
A Study on High Efficiency Wing-vane Compressor - Part 3: Experimental Evaluation of the Prototype
Raito Kawamura, Shin Sekiya, Tatsuya Sasaki, Hideaki Maeyama, Shinichi Takahashi, Kanichiro Sugiura
Mitsubishi Electric Corporation, Japan; Kawamura.Raito@cj.MitsubishiElectric.co.jp

2:20PM - 2:40PM
ID: 1468
Optimal Structural Design of Swing Double-Vane Compressor
Junjie Ma, Xiang Chen, Xu Yang, Zongchang Qu
Xi’an Jiaotong University, China, People’s Republic of; amazing_ma@163.com

2:40PM - 3:00PM
ID: 1596
Modeling And Testing The Thermal Effect Of Lubricating Oil Sprayed In Sliding-Vane Air Compressors Using Pressure-Swirl Nozzles
Gianluca Valenti¹, Stefano Murgia², Ida Costanzo³, Giulio Contaldi², Alessandro Valenti³
¹Politecnico di Milano, Italy; ²Ing. Enea Mattei S.p.a.; ³Valenti Energie S.r.l.; gianluca.valenti@polimi.it
R-43: AIR CONDITIONING EQUIPMENT ASSESSMENTS | 214 A&B

3:30PM - 3:50PM
ID: 2227
Conversion Factors for Comparing the Performance of Variable Refrigerant Flow Systems
Emi Matsui¹, Shigeki Kametani¹, Tatsuo Nobe²
¹Tokyo University of Marine Science and Technology, Japan; ²Kogakuin University, Japan; m164026@edu.kaiyodai.ac.jp

3:50PM - 4:10PM
ID: 2541
Cooling Season Full and Part Load Performance Evaluation of Variable Refrigerant Flow (VRF) system using an Occupancy Simulated Research Building
Piljae Im, Malhotra Mini, Jeffrey D Munk
Oak Ridge National Laboratory, United States of America; imp1@ornl.gov

4:10PM - 4:30PM
ID: 2439
Design Integration of Dedicated Outdoor Air System with Variable Refrigerant Flow System
Milind Vishwanath Rane, Deepa M Vedartham, Niranjan Bastakoti
IIT Bombay, India; ranemv@iitb.ac.in

4:30PM - 4:50PM
ID: 2138
A Study of High Efficiency CO2 Refrigerant VRF Air Conditioning System Adopting Multi-stage Compression Cycle
Tetsuya Okamoto, Kazuhiro Furusho, Ikuhiro Iwata, Eiji Kumakura, Ryuhei Kaji
Daikin Industries, Ltd.; tetsuya.okamoto@daikin.co.jp

4:50PM - 5:10PM
ID: 2303
Simulation of a R410A Residential Air-Conditioning System with Round-Tube and/or Microchannel Evaporators and Condensers under both Dry and Wet Air Conditions
Yang Zou¹, Huize Li¹, Pega Hrnjak¹²
¹University of Illinois at Urbana-Champaign; ²Creative Thermal Solutions; yang.zou@creativethermalsolutions.com

5:10PM - 5:30PM
ID: 2563
Low GWP Refrigerants Modelling Study for a Room Air Conditioner Having A Microchannel Evaporator
Bo Shen¹, Mahabir Bhandari¹, Milind Rane², Deep Mota²
¹Oak Ridge National Laboratories, United States of America; ²Mechanical Engineering Department, Indian Institute of Technology Bombay, India; shenb@ornl.gov

5:30PM - 5:50PM
ID: 2472
Experimental Study on Microchannel and Round Tube Plate Fin Evaporators in a Residential Air Conditioning System
Huize Li¹, Pega Hrnjak¹²
¹University of Illinois at Urbana-Champaign, United States of America; ²Creative Thermal Solutions; huizeli2@illinois.edu
R-44: ELECTRONICS/THERMOELECTRIC COOLING  |  214 C&D
Chair: Orkan Kurtulus, Purdue University

3:30PM - 3:50PM
ID: 2263
Loop Heat Pipes and mini-Vapour Cycle System for Helicopter Avionics Electronic Thermal Management
Claudio Zilio¹, Simone Mancin¹, Romain Hodot², Claude Sarno², Vincent Pomme³, Bertrand Truffart³
¹Dept. of Management and Engineering, University of Padova, Italy; ²Thales avionics, France; ³Airbus Helicopter, France; simone.mancin@unipd.it

3:50PM - 4:10PM
ID: 2196
Compact Refrigeration System For Electronics Cooling Based on a Novel Two-Phase Jet Impingement Heat Sink
Pablo de Oliveira, Jader Barbosa
Federal University of Santa Catarina, Brazil; jrb@polo.ufsc.br

4:10PM - 4:30PM
ID: 2473
The Transient Supercooling Enhancement For A Pulsed Thermoelectric Cooler (TEC)
Jia-ni Mao, Jun-yan Du, Shi-fei Wang, Jing-wei Zhou, Yu-gang Wang
Department of Energy and Power Engineering, China JiLiang University, Hangzhou 310018, People’s Republic of China; 18767160440@163.com

4:30PM - 4:50PM
ID: 2623
Thermoelectric Multi-Utility Water Heater
Milind Vishwanath Rane¹, Dinesh B Uphade¹, Adittyar Rane²
¹IIT Bombay, India; ²Vishwakarma Institute of Technology, Pune, INDIA; adittyarane@gmail.com

4:50PM - 5:10PM
ID: 2567
Experimental Evaluation and Thermodynamic System Modeling of Thermoelectric Heat Pump Clothes Dryer
Viral K. Patel, Dakota Goodman, Kyle Gluesenkamp, Anthony Gehl
ORNL, United States of America; patelvk@ornl.gov

R-45: REFRIGERANT HEAT TRANSFER AND PRESSURE DROP II  |  218 A&B
Chair: Pega Hrnjak, University of Illinois

3:30PM - 3:50PM
ID: 2189
Two-Phase Evaporation Pressure Drop Experimental Results for Low Refrigerant Mass Flux
Anna Fenko, Ellen Brehob, Andrea Kelecy
GE Appliances, United States of America; anna.fenko@ge.com

3:50PM - 4:10PM
ID: 2394
Evaporation Heat Transfer and Pressure Drop of R32 inside Small-diameter 4.0 mm Tubes
Norihito Inoue, Daisuke Jige, Kentaro Sagawa
Tokyo University of Marine Science and Technology; inoue@kaiyodai.ac.jp
4:10PM - 4:30PM  
ID: 2133  
Heat Transfer and Pressure Drop during Evaporation in Microchannel Tubes  
Houpei Li¹, Pega Hrnjak¹²  
¹ACRC, the University of Illinois; ²Creative Thermal Solutions, Inc. Urbana IL; hli84@illinois.edu

4:30PM - 4:50PM  
ID: 2602  
Experimental Study on Boiling and Condensation Heat Transfer in a Horizontal Mini Channel  
Yasuhiro Kudou, Kyosuke Nakaiso, Keishi Kariya, Akio Miyara  
Saga university, Saga, Japan; 13575007@edu.cc.saga-u.ac.jp

4:50PM - 5:10PM  
ID: 2437  
Flow Boiling Pressure Drop for R410A and RL32H in Multi-channel Tube  
Xiu Wei Yin, Wen Wang, Vikas Patnaik, Jin Sheng Zhou, Xiang Chao Huang  
Ingersoll Rand, China, People's Republic of; xwyin@trane.com

5:10PM - 5:30PM  
ID: 2044  
Falling Film Evaporation On A Thermal Spray Metal Coated Vertical Corrugated Plate Conduits  
Annamalai Mani², Ebenezar Jerin Robins¹  
¹Indian Institute Of Technology Madras, India; ²Indian Institute Of Technology Madras, India; mania@iitm.ac.in

R-46: GEOTHERMAL/GROUND SOURCE HEAT PUMPS  |  218 C&D  
Chair: Ron Domitrovic, EPRI

3:30PM - 3:50PM  
ID: 2351  
Improvement Of Thermal Conductivity Of Grout Mixture For Geothermal Heat Pump Systems  
Chantal Maatouk  
Saint Joseph University, Lebanon (Lebanese Republic); chantal.maatoukriachi@usj.edu.lb

3:50PM - 4:10PM  
ID: 2601  
Experimental Performance Estimations of Horizontal Ground Heat Exchangers for GSHP System  
Md. Hasan Ali, Salsuwanda Bin Selamat, Keishi Kariya, Akio Miyara  
Saga university, Saga, Japan; mhakuet@yahoo.com

4:10PM - 4:30PM  
ID: 2207  
Heat Pumps Architecture Optimization For Enhanced Medium Temperature Geothermal Heat Use in District Heating  
Matthildi Apostolou¹², Sahar Salame¹, Stéphanie Barrault¹, Assaad Zoughaib¹  
¹MINES ParisTech, PSL Research University, CES - Center for energy Efficiency of Systems, France; ²EDF R&D Division, EDF Lab Les Renardières, France; assaad.zoughaib@mines-paristech.fr

4:30PM - 4:50PM  
ID: 2412  
Experimental Investigation on the Performance of Ground-source Heat Pump with the Refrigerant R410A  
Junhao Niu¹, Huagen Wu¹, Yunda Dong²  
¹School of Energy and Power Engineering,Xi’an Jiaotong University.P.R. China; ²Waterfurnace Shenglong HVACR Climate Solutions Co., Ltd; 824805525@qq.com
4:50PM - 5:10PM  
ID: 2284  
**Characterization of Nanofluids Formed by Fumed Al2O3 in Water for Geothermal Applications**  
*Sergio Bobbo, Laura Colla, Antonella Barizza, Stefano Rossi, Laura Fedele*  
Istituto per le Tecnologie della Costruzione – Consiglio Nazionale delle Ricerche, Italy; laura.fedele@itc.cnr.it

**C-20: VALVES II | 202**  
*Chair: Akash Bhatia, Tecumseh Products Company*

3:30PM - 3:50PM  
ID: 1267  
**Flap-X: Investigations of Residual Stresses and Tumbling**  
Azhar Nawaz¹,², Alexander Lof³, Chris Millward¹  
¹Research & Development, voestalpine Precision Strip AB, Sweden; ²Research & Development, voestalpine Precision Strip AB, Sweden; azhar.nawaz@voestalpine.com

3:50PM - 4:10PM  
ID: 1355  
**Analysis of Viscous Slip at the Wall in Gas Flows of R134a and R600a through Metallic Microtubes**  
Ernane Silva¹, Murilo F. Nicoluzzi¹, Marcos Rojas-Cardenas¹, Cesar J. Deschamps¹  
¹Federal University of Santa Catarina, Brazil; ²Université Fédérale Toulouse Midi-Pyrénées, France; ernane@polo.ufsc.br

4:10PM - 4:30PM  
ID: 1228  
**Experimental Investigation of Damping Coefficient for Compressor Reed Valves**  
Sergio Koerich Lohn¹, Evandro Luiz Lange Pereira¹, Cesar Jose Deschamps¹, Humberto Ferreira Camara¹  
¹Embraco, R&D; ²POLO Research Labs for Emerging Technologies in Cooling and Thermophysics; evandro.l.lange@embraco.com

4:30PM - 4:50PM  
ID: 1313  
**A Combined Experimental-Numerical Procedure to Estimate Leakage Gap of Compressor Valves**  
Gustavo C. Rezende, Ernane Silva, Cesar J. Deschamps  
Federal University of Santa Catarina, Brazil; deschamps@polo.ufsc.br

4:50PM - 5:10PM  
ID: 1238  
**Integrating Numerical Models for Efficient Simulation of Compressor Valves**  
Ajay Parihar¹, David Myszka², Benjamin Robinet³, Thomas Hodapp¹  
¹Emerson Climate Technologies; ²University of Dayton, United States of America; dmyszka@udayton.edu

**C-21: SCROLL III | 206**  
*Chair: Kirill M. Ignatiev, Emerson Climate Technologies*

3:30PM - 3:50PM  
ID: 1079  
**Experimental Investigations On The Performance Improvement Of Oil-gas Separator In Electric Driven Scroll Compressor For Eco-friendly Vehicles**  
Donglim Nam¹,², Poyoung Lee¹, Seungbin Jung¹, Geonho Lee², Yunki Kwon³, Jinho Lee⁴  
¹R&D Center of Doowon Heavy Industrial Co., Ltd., Korea, Republic of (South Korea); ²Department of Building Engineering Services, Doowon Technical University College; ³Department of Computer Aided Design, Doowon Technical University College; ⁴School of Mechanical Engineering, Yonsei University; dlnam@doowonhi.com
Influencing Factors Study of the Variable Speed Scroll Compressor with EVI Technology
Xiaoli Kang, Yusheng Hu, Caixia Shan, Yun Liu, Xiaojun Gao, Gang Lv
GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI, China, People's Republic of; jidianyihao@163.com

Noriaki Ishii¹, Eiji Nonoguchi¹, Keiko Anami², Atsushi Sakuda³, Yusuke Imai³, Kiyoshi Sawai⁴, Charles William Knisely⁵
¹Osaka Electro-Communication University, Japan; ²Ashikaga Institute of Technology, Japan; ³Panasonic Corporation Appliances Company; ⁴Hiroshima Institute of Technology; ⁵Bucknell University, USA; ishii@isc.osakac.ac.jp

Visualization and Simulation of Oil Flow in a Scroll Compressor Plenum
Jiu Xu³, Pega Hrnjak³-²
³Air Conditioning and Refrigeration Center, University of Illinois at Urbana-Champaign; ²Creative Thermal Solutions Inc., Urbana, Illinois; jiuxu³@illinois.edu

Numerical Simulation and Experimental Examination on a Failure Oldham Coupling
Hang Ye¹, Zhigang Huang¹, Jinduo Ye²
¹Danfoss (Tianjin) R&D, Tianjin, PR. China; ²School of Mechanical, Tianjin University of Technology, Tianjin, PR.China; weissen@sohu.com