

CONTENTS

Host Chapter, Officers, and Conferences and Expositions Committee	xiv
State of the Society Address, Sheila J. Hayter, 2018–2019 ASHRAE President	xv
Inaugural Address, Darryl K. Boyce, 2019–2020 ASHRAE President.....	xvii
Technical Program	xx

EXTENDED ABSTRACTS

KC-19-A001	Experimental Investigation of Two-Phase Flow Heat Transfer of R410A and ZnO Nanolubricant Mixture in a Smooth Tube Pratik S. Deokar, Student Member ASHRAE; Lorenzo Cremaschi, PhD, Member ASHRAE	3
KC-19-A002	Heating of Supercritical Carbon Dioxide in Small Channels Saad A. Jajja; Jessa M. Sequeira; Brian M. Fronk, PhD, PE, Associate Member ASHRAE.....	7
KC-19-A003	Permeability and Rate-of-Rise of Additively-Manufactured Wicking Structures Jordan A. Morrow, Student Member ASHRAE; Nhicolas Aponte; Ryan A. Huber, Student Member ASHRAE; Partha P. Chakraborty; G.A. Riley; Melanie M. Derby, Member ASHRAE.....	11
KC-19-A004	Uncertainties on Cooling Energy Based on Computational Indoor Air Modeling in Sports Facilities Samah Ben Ayed, PhD, Associate Member ASHRAE; Donghun Kim, PhD; Jeff Borggaard, PhD; Eugene Cliff, PhD	14
KC-19-A005	IEQ in High-Performance Urban Elementary Schools Emily Oldham, Associate Member ASHRAE; Hyojin Kim, PhD, Member ASHRAE	17
KC-19-A006	Performance of Spiral and Plain Finned-Tube Evaporator Coils for Novel Defrost System in Commercial Freezers Mostafa H. Sharqawy, PhD, PEng; Sameh M. I. Saad, PhD; Punnoose Abraham, Student Member ASHRAE; Kazi K. Ahmed.....	20
KC-19-A007	A Review of Adaptive Thermal Comfort Implementation in International Thermal Comfort Standards Ongun B. Kazanci, PhD, Associate Member ASHRAE; Daniel Coakley, PhD, Associate Member ASHRAE; Bjarne W. Olesen, PhD, Presidential Member, Fellow ASHRAE.....	24
KC-19-A008	WITHDRAWN	
KC-19-A009	Investigation of a Solid Oxide Fuel Cell in a Residential Furnace During Rapid Thermal Cycling Ryan J. Milcarek, PhD, Member ASHRAE; Mengyuan Chu; Jeongmin Ahn, PhD, Member ASHRAE.....	27
KC-19-A010	Effect of Climate Change and Extreme Weather Events on the Thermal Conditions of Canadian Multi-unit Residential Buildings Fuad Mutasim Baba; Hua Ge, PhD, PEng, Member ASHRAE	30
KC-19-A011	Modeling Urban Microclimates of Extreme Weathers by Integrating City Fast Fluid Dynamics and City Building Energy Model Liangzhu (Leon) Wang, PhD, PEng, Member ASHRAE; Ali Katal, Student Member ASHRAE; Mohammad Mortezaazadeh Dorostkar, Student Member ASHRAE.....	34
KC-19-A012	Dimensionless CFD Analysis of Reynolds Independence and Similarity in Urban and Built Environment Airflows Liangzhu (Leon) Wang, PhD, PEng, Member ASHRAE; Chang Shu, Student Member ASHRAE.....	37
KC-19-A013	Effect of Inlet Duct Design on Fan Performance of Indoor Air Handling Unit Md Yeam Hossain, Student Member ASHRAE; Christian Bach, PhD, Associate Member ASHRAE; Omer San, PhD; Ardiyansyah Yatim, PhD, Member ASHRAE	40

KC-19-A014	A Field Evaluation of the Airflow Performance of Fan-Coil Units Dennis L. O’Neal, PhD, PE, Fellow ASHRAE; Peng Yin, PhD, Associate Member ASHRAE	43
KC-19-A015	Comparison of Hydronic Fan-Coil Unit Energy Consumption with Modulation and On-Off Controls Zahra Sardoueiniasab, Student Member ASHRAE; Peng Yin, PhD, Associate Member ASHRAE; Dennis O’Neal, PhD, PE, Fellow ASHRAE.....	46
KC-19-A016	Empirical Modeling of Variable Air Variable Water Fan Coil Units in Cooling Mode for Building Energy Calculations Peng Yin, PhD, Associate Member ASHRAE; Tanjebul Alam, Student Member ASHRAE; Dennis O’Neal, PhD, PE, Fellow ASHRAE	49
KC-19-A017	Air Leakage Analysis in Parallel Fan-Powered Terminal Units Using EnergyPlus Zahra Sardoueiniasab, Student Member ASHRAE; Peng Yin, PhD, Associate Member ASHRAE; Dennis O’Neal, PhD, PE, Fellow ASHRAE.....	52
KC-19-A018	Automatic Fault Detection and Diagnosis of Air Handling Unit Using an Online Machine Learning Algorithm Majid Karami, Student Member ASHRAE; Liping Wang, Member ASHRAE	56
KC-19-A019	Sensitivity Analysis of Optimal Energy in Buildings to Environment Parameters Samah Ben Ayed, PhD, Associate Member ASHRAE; Jeff Borggaard, PhD; Eugene Cliff, PhD	60
KC-19-A020	Methodology to Evaluate Sensitive Levels of Inputs for U.S. Commercial Building Models Yunyang Ye, Student Member ASHRAE; Kathryn Hinkelman, Student Member ASHRAE; Wangda Zuo, PhD, Member ASHRAE; Gang Wang, PhD, PE, Member ASHRAE	63
KC-19-A021	Model-Based Home Envelope Performance Evaluation: A Use Case of Data from Connected Thermostats Junke Wang, Student Member ASHRAE; Choon Yik Tang, PhD, Li Song, PhD, PE, Member ASHRAE.....	67
KC-19-A022	WITHDRAWN	
KC-19-A023	Solubilities and Diffusivities of HFC and HFO Refrigerants in a Synthetic Polyol Ester Lubricant Oil Ana Rita C. Morais, PhD; Luke D. Simoni, PhD; Aaron M. Scurto, PhD; Mark B. Shiflett, PhD, PE	70
KC-19-A024	Investigating the Thermodynamic and Transport Properties of Hydrofluorocarbon: Ionic Liquid Mixtures with Applications Towards Refrigerant Gas Separations David L. Minnick, PhD; Ana Rita C. Morais, PhD; Mark B. Shiflett, PhD, PE	73
KC-19-A025	Thermodynamic and Kinetic Analysis of Ammonia in Ionic Liquids for Absorption Refrigeration Tugba Turnaoglu; Mark B. Shiflett, PhD, PE	77
KC-19-A026	Two-Objective Genetic Algorithm Optimization of Chilled Water Plant Design Nabil Nassif, PhD, PE, Member ASHRAE; Nihal AIRaees, Student Member ASHRAE; Fouad Al Rifaie, Student Member ASHRAE.....	80
KC-19-A027	Smart Integrated Optimization Technique for Large Chilled Water Systems Mostafa Tahmasebi, Student Member ASHRAE; Nabil Nassif, PhD, PE, Kevin Eaton; Rand Talib, Student Member ASHRAE	83
KC-19-A028	An Approach for Motor Efficiency with Variable Frequency Drives Gang Wang, PhD; Zufen Wang; Zhitao Han, PhD; Li Song, PhD	87
KC-19-A029	The Impacts of Variable Frequency Drives on Drive System Efficiency Zhitao Han, PhD; Zufen Wang; Gang Wang, PhD, PE, Member ASHRAE	90

KC-19-A030	Algorithmically Generated Chiller Performance Curves for Building Energy Simulation Jeremy Lerond, Affiliate Member ASHRAE.....	93
KC-19-A031	Barriers to Energy Controls Delivering Real Savings Reid Hart, PE, Member ASHRAE; Michael Rosenberg, Fellow ASHRAE	96
KC-19-A032	Enhancing Traditional Building Energy Model Calibration with Physics-Based Inverse Models Han Li, Associate Member ASHRAE; Tianzhen Hong, PhD, PE, Member ASHRAE; Marina Sofos, PhD	99
KC-19-A033	Influence of Source Location and Ventilation Rates on Contaminant Dispersion Pattern in an Aircraft Cabin James Bennett, Member ASHRAE; Veronica Dos Santos Teixeira; Yanhui Zhang; Shamia Hoque, Associate Member ASHRAE	102
KC-19-A034	Particle and Chemical Emissions from 3D Printers and Their Potential Health Impacts Qian Zhang, PhD; Aika Davis, PhD; Marilyn Black, PhD, Fellow ASHRAE; Rodney Weber, PhD.....	106
KC-19-A035	A Study of Chemical Exposure from Consumer Products Used in Residential Environments Aika Davis, PhD, Member ASHRAE; Debra Harris, PhD; Marilyn Black, PhD, Fellow ASHRAE	109
KC-19-A036	WITHDRAWN	
KC-19-A037	A Desiccant Wheel Application with Condenser Water Cooling and Low-Grade Geothermal Energy in Humid Climates Jiajun Liao, Student Member ASHRAE; David E. Claridge, PhD, PE, Fellow/Life Member ASHRAE.....	112
KC-19-A038	Real-Time Optimization of Energy Efficiency for Cold Climate Heat Pumps with Extremum Seeking Control Wenyi Wang; Yaoyu Li, Member ASHRAE	115
KC-19-A039	Identifying Models of HVAC Systems Using ARIMAX Fan Feng, Student Member ASHRAE; Zheng O'Neill, PhD, PE, Member ASHRAE	118
KC-19-A040	Break-Point Statistical Formulations for Whole Building Heating Hot Water Consumption Modeling Hongxiang Fu, Student Member ASHRAE; Juan-Carlos Baltazar, PhD, PE; David E. Claridge, PhD, PE, Fellow ASHRAE.....	121
KC-19-A041	Inferring Occupant Counts from Wi-Fi Data through Random Forest Zhe Wang, PhD; Tianzhen Hong, Member ASHRAE.....	124
KC-19-A042	Experimental Test Chamber for Testing Innovative PCM Building Envelope Assemblies in Full Scale Applications Sajith Wijesuriya, Student Member ASHRAE; Paulo Cesar Tabares-Velasco, PhD, Associate Member ASHRAE	127
KC-19-A043	Window Enhancements in Prototype Buildings Chitra Nambiar, Associate Member ASHRAE; Supriya Goel, Associate Member ASHRAE; Michael Rosenberg, Fellow ASHRAE; Jian Zhang, PhD, Member ASHRAE.....	131

CONFERENCE PAPERS

KC-19-C001	Development of a New Prototype Energy Model for Data Centers Kaiyu Sun, Member ASHRAE; Tianzhen Hong, PhD, PE, Member ASHRAE; Xuan Luo.....	137
KC-19-C002	Improving Data Center and Telecommunication System HVAC Design from Lessons Learned in Retro-Commissioning Richard Pavlak, PE, Fellow ASHRAE; Nick Pavlak, Member ASHRAE.....	145

KC-19-C003	First Steps to Maintain a Large Fleet of Building Energy Models Daniel L. Villa, PE, Member ASHRAE; Joshua R. New, PhD, Member ASHRAE; Mark Adams, Member ASHRAE; Aaron Garrett, PhD; Gerald R. Gallegos, PE, Member ASHRAE	153
KC-19-C004	Simulation Based Fault Impact Analysis for the Secondary School in the U.S. Yanfei Li, Student Member ASHRAE; Zheng O'Neill, PhD, PE, Member ASHRAE	162
KC-19-C005	WITHDRAWN	
KC-19-C006	Three-Dimensional Computations for Forced Convection of Air in Offset-Strip Fin Channels: Effects of Fin Offset Length D. Shi, Student Member ASHRAE; K.-T. Lin; M.A. Jog, PhD; R.M. Manglik, PhD, Fellow ASHRAE	172
KC-19-C007	Personalized Thermal Demand Prediction Algorithm Based on Wrist Temperature and Heart Beat Linhao Li, Chenlu Zhang	181
KC-19-C008	WITHDRAWN	
KC-19-C009	Air Conditioner Control Strategy Based on Thermal Comfort Improvement Model Guan-Wen Chen; Hung-Wen Lin, PhD, Member ASHRAE; Chung-Inn Yong; Deqing Moo; Yin-Chun Tsai	189
KC-19-C010	Study of Heat Exchanger Inlet Air Velocity Distribution for Ducted Tests in a Psychrometric Chamber Abraham J. Lee, Student Member ASHRAE; Christian K. Bach, PhD, Associate Member ASHRAE; Craig R. Bradshaw, PhD, Member ASHRAE	198
KC-19-C011	Potency of Cyclic Degradation Coefficient in Characterizing Dynamic Air Conditioner Operation Rohit Dhumane, Student Member ASHRAE; Jiazhen Ling, PhD, Associate Member ASHRAE; Vikrant Aute, PhD, Member ASHRAE; Reinhard Radermacher, PhD, Fellow ASHRAE; Allen Chad Kirkwood, Member ASHRAE; Jack Esformes, Member ASHRAE	206
KC-19-C012	Improvement of Unitary Equipment and Heat Exchanger Testing Methods Md Yeam Hossain, Student Member ASHRAE; Romit Maulik; Hyunjin Park, Student Member ASHRAE; Mansoor Ahmed; Christian K. Bach, PhD, Associate Member ASHRAE; Omer San, PhD	214
KC-19-C013	Integrated Sizing Methodology for a hybridGEOTABS Building Mohsen Sharifi; Rana Mahmoud; Eline Himpe, PhD; Jelle Laverge, PhD	222
KC-19-C014	Radiant Ceiling Panels: An Analysis of Load Shifting, Energy Use, and Comfort in a Laboratory House Setting James Haile, PE; David Springer, Member ASHRAE	231
KC-19-C015	Impact of Microclimate and Macroclimate on Building Energy Consumption Carlo Bianchi, PhD, Student Member ASHRAE; Jermy Thomas, Student Member ASHRAE; Amanda D. Smith, PhD, Associate Member ASHRAE	239
KC-19-C016	City-Scale High-Resolution WRF-UCM Urban Weather Predictions Compared to a Dense Network of Ground-Based Weather Station Data for Assessment of Urban Building Energy Consumption Elham Jahani, Student Member ASHRAE; Soham Vanage, Student Member ASHRAE; David Jahn, PhD; William Gallus, PhD; Kristen Cetin, PhD, PE, Member ASHRAE	248
KC-19-C017	The Influence of Role Models on the Sustainability of the Engineering Profession in the UK: A Case Study Ina Colombo, PhD; Ollie Folayan, PhD; Nike Folayan, PhD; Reneth Mckenzie-Schoetz	257
KC-19-C018	Examination of a Novel R410A Replacement Kenneth Schultz, PhD, Member ASHRAE; Steve Kujak, Member ASHRAE	264

KC-19-C019	Performance of Displacement Ventilation for Hospital Patient Rooms with Varying Cooling Loads Kishor Khankari, PhD, Fellow ASHRAE	272
KC-19-C020	Designing Simplified Airborne Infection Isolation Rooms to Reduce Infection Rate in Future Pandemics Merethe C. Lind; Hannu Koskela; Bård Venås, Anders Welde Vikan; Petri Kalliomäki; Trond Thorgeir Harsem, Member ASHRAE	280
KC-19-C021	Infectious Passenger Isolation System for Aircraft Ian Darrah; James S. Bennett, Member ASHRAE; Byron W. Jones, Fellow Member ASHRAE; Mohammad H. Hosni, Fellow ASHRAE	288
KC-19-C022	Codes, Standards, and OSHA Regulations Impacting Occupant Health and Safety in Buildings Stephen W. Duda, PE, HFDP, HBDP, BEAP, Fellow ASHRAE	297
KC-19-C023	A Real-Time Platform for Assessment of Chiller-Side Demand Response Strategies Fan Feng, Student Member ASHRAE; Zhengwei Li, PhD; Zheng O'Neill, PhD, PE, Member ASHRAE	305
KC-19-C024	Modelling Moisture Sources Due to Air Leakage with the HAMT Extension for EnergyPlus Florian Antretter, Member ASHRAE; Simon Pallin, PhD, Member ASHRAE	313
KC-19-C025	Ventilation Design Considerations for Occupant Health in Aircraft Painting Facilities Under OSHA Requirements James S. Bennett, PhD, Member ASHRAE	321
KC-19-C026	Development of a Semi-Empirical Model for Predicting the Pressure Drop of Nanofiber Air Filters Ye Bian; Li Zhang, PhD; Chun Chen, PhD, Associate Member ASHRAE	330
KC-19-C027	Long-Term Monitoring and Simulation of a Vertical Closed-Loop Ground Source Heat Pump System Used in the Cold Climate of the U.S. Rui Miao, Student Member ASHRAE; Yao Yu, PhD, Associate Member ASHRAE; Xiaou Hu, Student Member ASHRAE; Todd Sirotiak, PhD, PE	337
KC-19-C028	Design and Construction of a Geothermal CO ₂ Air Conditioner Paul Kalinowski, Associate Member ASHRAE; Dennis Nasuta, Associate Member ASHRAE; Cara Martin, BEMP, Associate Member ASHRAE	346
KC-19-C029	Machine Learning in a Model Predictive Controller for the Management of Domestic Hot Water Systems Louis-Gabriel Maltais, Student Member ASHRAE; Louis Gosselin, PEng, PhD, Member ASHRAE	355
KC-19-C030	Bio-Sensing and Reinforcement Learning Approaches for Occupant-Centric Control Chenlu Zhang; Zhiang Zhang; Vivian Loftness	364
KC-19-C031	Defining Typical Occupancy Schedules and Behaviors in Residential Buildings Using the American Time Use Survey Debrudra Mitra, Student Member ASHRAE; Yiyi Chu, Student Member ASHRAE; Nicholas Steinmetz, Student Member ASHRAE; Kristen Cetin, PhD, PE, Member ASHRAE; Paul Kremer, Associate Member ASHRAE; Jayde Lovejoy, Student Member ASHRAE	372
KC-19-C032	Data-Driven Leakage Detection in Air-Handling Units on a University Campus Megan K. McHugh, Student Member ASHRAE; Travis Isakson, PE; Zoltan Nagy, PhD, Member ASHRAE	381
KC-19-C033	An Interactive Building Control for the Integrative HVAC System Featuring Personalized Cooling in Office Buildings Siliang Lu, PhD, Student Member ASHRAE; Erica Cochran Hameen, PhD; Yue Zou, PhD, Member ASHRAE	389

KC-19-C034	Using Text Analytics on Operator Logbooks for Performance Benchmarking: A Case Study Saptak Dutta, Student Member ASHRAE; Burak Gunay, PhD, Member ASHRAE; Scott Bucking, PhD, Member ASHRAE.....	398
KC-19-C035	Model Predictive Control of Cool Thermal Energy Storage Under Different Electricity Rate Structures Amy Van Asselt, PhD, Associate Member ASHRAE.....	407
KC-19-C036	Modeling and Analysis of Compact Evacuated Tube with PCM for a Tank-Less Solar Water Heating System Mohamed Osman; Mohamed Abokersh; Omar Huzayyin, PhD, Member ASHRAE; Mohamed Elmorsi, PhD, Member ASHRAE.....	415
KC-19-C037	Best Practices for Full-Scale Testing and Energy Savings, Daylighting and Visual Comfort Evaluation of Dynamic Shading Niraj Kunwar, Student Member ASHRAE; Kristen S. Cetin, PhD, PE, Member ASHRAE; Ulrike Passe, Associate Member ASHRAE.....	423
KC-19-C038	Occupant Window Usage and Cooling Energy Consumption: A Case Study Jayson Bursill, Student Member ASHRAE; William O'Brien, PhD, Associate Member ASHRAE; Ian Beausoleil-Morrison, PhD, PEng, Member ASHRAE.....	431
KC-19-C039	Unmanned Aerial Vehicles Application in Building Envelope Thermal Energy Assessment in Saudi Arabia Ayman Youssef, PE, Member ASHRAE; Ahmed Alawfi; Faisal Al Musa; Muhammad Elias	440

TECHNICAL PAPERS

KC-19-001	Uncertainty Analysis of a Numerical Performance Model for an Inflatable Fabric Evaporative Cooling Tower S. Duong; R. Craven; S. Garner; S. Idem, PhD, Member ASHRAE	451
KC-19-002	Achieving Health and Comfort in High-Rise Residential Buildings by Using a Dynamic-Hybrid Air Permeable Ceiling (DHAPC) Mohd Firrdhaus Mohd Sahabuddin, Student Member ASHRAE; Cristina Gonzalez-Longo, PhD	463
KC-19-003	Fire Hazard Analysis of Energy-Saving, High-Volume Low-Speed (HVLS) Fan Systems in Large Spaces Xiaolei Chen, PhD; Frank Wang, PE.....	476
KC-19-004	Analysis on Applicability and Feasibility of Popularizing the Naphthalene Sublimation Technique in Island-Reef Areas Y.P. Cui; J.C. Xie, PhD; P. Xue, PhD; J.P. Wang	493
KC-19-005	Load Forecasting and Equipment Sequencing in a Central Heating and Cooling Plant: A Case Study H. Burak Gunay, PhD, Member ASHRAE; Araz Ashouri, PhD; Weiming Shen, PhD, PEng.....	503
KC-19-006	A Preliminary Analysis on the Use of Low-Cost Data Streams for Occupant-Count Estimation H. Burak Gunay, PhD, Member ASHRAE; Araz Ashouri, PhD; Weiming Shen, PhD, PEng; Guy Newsham, PhD; William O'Brien, PhD, PEng, Associate Member ASHRAE	514
KC-19-007	Development of a Unified Tool for Analysis of Room Loads and Conditions (RP-1766) Charles S. Barnaby, BEMP, Fellow/Life Member ASHRAE; Peter Simmonds, PhD, Fellow ASHRAE	532
KC-19-008	A New Algorithm to Measure the Convergence of PSO with an Application to Hydronic Design in Buildings Ramiro H. Bravo PhD, PE, Member ASHRAE; Forrest W. Flocker, PhD, PE.....	539

KC-19-009	Performance Evaluation of a Three-Fluid Liquid Desiccant Membrane Air-Conditioning System Devin Storle, Associate Member ASHRAE; Mohamed R.H. Abdel-Salam, PhD, PEng, LEED GA, Member ASHRAE; Carey J. Simonson, PhD, PEng, Fellow ASHRAE	548
KC-19-010	Geothermal Heat Pumps—Simply Efficient Lisa Meline, PE, Member ASHRAE; Steve Kavanaugh, PhD, Fellow/Life Member ASHRAE	566
KC-19-011	Chronological Variations in ASHRAE Handbook Refrigerant Thermodynamic and Transport Properties from 1981 to 2017 Paul H. Nagy, Student Member ASHRAE; Michael B. Pate, Life Member ASHRAE	577

SOCIETY BUSINESS

2018–2019 ASHRAE Officers, Directors, Staff, and Council and Committee Members	593
2018–2019 ASHRAE Chapter Officers	599
2018–2019 ASHRAE Technical Committees, Task Groups, Technical Resource Groups, and Multidisciplinary Task Groups	603
2018–2019 ASHRAE Standard and Guideline Project Committees	653
Past ASHRAE Conferences	669
Society Presidents	672
ASHRAE Honors and Awards	674
2018–2019 ASHRAE Intersociety Representatives	713
ASHRAE Associate Societies	714
In Memoriam, July 2018 to June 2019	718
Index of Extended Abstracts, Conference Papers, and Technical Papers, Volume 125, Part 2	721