

CONTENTS

Host Chapter, Officers, and Conferences and Expositions Committee	xiii
State of the Society Address, Darryl K. Boyce, 2019–2020 ASHRAE President	xiv
Inaugural Address, Charles E. Gullledge III, 2020–2021	xvi
Technical Program	xx

EXTENDED ABSTRACTS

VC-20-A001	Occupant-Dependent Residential End Use Load Profiles for Demand Response Under High Renewable Energy Scenarios Niraj Kunwar, Student Member ASHRAE; Soham Vanage, Student Member ASHRAE; Emily Peruski; Debrudra Mitra, Student Member ASHRAE; Kristen Cetin, PhD, PE, Member ASHRAE.....	3
VC-20-A002	Superheated Condensation of Refrigerant Mixtures R448A and R452A Tabeel A. Jacob, Student Member ASHRAE; Brian M. Fronk, PhD, PE, Associate Member ASHRAE.....	6
VC-20-A003	Validated TRNSYS Model for a Building in Marrakech, Morocco Fatima Zahra Benaddi, Student Member ASHRAE; Paulo Cesar Tabares- Velasco, PhD, Associate Member ASHRAE; Lahcen Boukhattem, PhD; Brahim Benhamou, PhD.....	10
VC-20-A004	Seasonality and Trends in Indoor Air Quality Based on Continuous Monitoring Samy Clinchard, Salvatore della Vecchia, Rick Aller, Ulla Haverinen-Shaughnessy	13
VC-20-A005	A Novel Ventilation Approach of a Large Vertical Space for Achieving Fire Safety and Energy Efficiency Haohan Sha, Student Member ASHRAE; Dahai Qi, PhD, Member ASHRAE	17
VC-20-A006	An Update on the Evaluation of Air Mixer Performance Hyunjin Park, Student Member ASHRAE; Christian Bach, PhD, Associate Member ASHRAE; Omer San, PhD	20
VC-20-A007	Analysis of a Fuel Cell Hot Water Heater for Combined Heat and Power Rhushikesh Ghotkar, Student Member ASHRAE; Ryan J. Milcarek, PhD, Member ASHRAE	23

CONFERENCE PAPERS

VC-20-C001	Challenges to Statewide Net-Zero Energy Buildings: The Oregon Experience Mark Heizer, PE, Member ASHRAE; Blake Shelide, PE, Member ASHRAE.....	29
VC-20-C002	Embodied Energy and Carbon Emissions of DOE Prototype Buildings from a Life Cycle Perspective Jay H. Arehart, Student Member ASHRAE; Wil V. Srubar III, PhD; Francesco Pomponi, PhD; Bernardino D'Amico, PhD	38
VC-20-C003	Clearing the Path to ZNE with Energy Codes John Arent, PE, Member ASHRAE; Rahul Athalye, Associate Member ASHRAE; Silas Taylor	47
VC-20-C004	Scheduling of Hybrid Heating and Cooling System Based on Energy Resources for Mixed-Used Multistory Building Kuljeet Singh, PhD; Caroline-Hachem-Vermette, PhD.....	55
VC-20-C005	Identifying Thermal Characteristics using Smart Thermostats for Data-Driven Residential Vulnerability Assessment to Extreme Temperatures Krissy Govertsen, Student Member ASHRAE; Michael Kane, PhD, Member ASHRAE	63

VC-20-C006	Labeling Modes of Operation and Extracting Features for Fault Detection with Cloud-Based Thermostat Data Austin Rogers, PhD, Affiliate Member ASHRAE; Fangzhou Guo; Jonathan Martinez; Bryan Rasmussen, PhD, PE, Member ASHRAE	71
VC-20-C007	Data-Driven Energy Prediction in Residential Buildings using LSTM and 1-D CNN Yiyi Chu, Student Member ASHRAE; Debrudra Mitra, Student Member ASHRAE; Kristen Cetin, PhD, PE, Fellow Member ASHRAE	80
VC-20-C008	Typical Meteorological Year and Actual Weather Data in Data-Driven Machine Learning Models for Residential Building Energy Use Ehsan Kamel, PhD; Shaya Sheikh, PhD	88
VC-20-C009	Compliance with Florida’s New Residential Building Air Leakage Testing Requirements: A Field Study Jeffrey K. Sonne	96
VC-20-C010	Sensitivity of Building Energy Model Predictions to Spatial Variations in Climate under Different Levels of Urbanization Elham Jahani, Student Member ASHRAE; Soham Vanage, Student Member ASHRAE; Kristen Cetin, PhD, PE, Member ASHRAE; William Gallus, PhD; David Jahn, PhD	104
VC-20-C011	Energy Efficiency and the Swedish Catalog House Anthony Denzer, PhD, Affiliate Member ASHRAE	113
VC-20-C012	Data-Driven Modeling of Adaptive Occupant Thermostat Behavior Dynamics Michael Kane, PhD, Member ASHRAE; Kunind Sharma, Student Member ASHRAE.....	123
VC-20-C013	Exploring Electricity Peak Load Shifting of DC System with Solar PV and EV Battery Yihao Luo, MEng; Yi Zhang, PhD; Yi Zhang, PhD	131
VC-20-C014	Smart and Efficient Building Envelopes: Thermal Switches and Thermal Storage for Energy Savings and Load Flexibility Sven Mumme; Nelson James, PhD, Member ASHRAE; Mikael Salonvaara, Member ASHRAE; Som Shrestha, PhD, BEMP; Diana Hun, PhD	140
VC-20-C015	Mechanically Ventilated Double Skin Façade with Semi-Transparent Photovoltaics, Implementing Electrical Storage and Heat Pumps to Reduce Peak Demand Zisis Ioannidis, Student Member; Andreas K. Athienitis, PhD, PE, Fellow Member ASHRAE; Ted Stathopoulos, PhD, Member ASHRAE; Anamaria Buonomano, PhD.....	149
VC-20-C016	WITHDRAWN	
VC-20-C017	WITHDRAWN	
VC-20-C018	WITHDRAWN	
VC-20-C019	Improving the Interoperability of gbXML Data Model through Redefining Data Mapping Rules of HVAC Systems Ruiji Sun; Zhizhang Hu; Krishnan Gowri, Fellow Member ASHRAE; Weili Xu, PhD, Associate Member ASHRAE	157
VC-20-C020	Estimating Hourly Heating and Cooling Loads from Monthly Results Sébastien A. Brideau, PhD, ASHRAE Associate Member	166
VC-20-C021	Evaluation of a Modern Commercial HVAC Control System in the Context of Occupants’ Perceived Control Connor Brackley, Student Member ASHRAE; William O’Brien, PhD, PE, Associate Member ASHRAE; Chantal Trudel.....	174
VC-20-C022	Development of Typical Occupant Profiles in Academic Buildings in the United States Debrudra Mitra, Student Member; Yiyi Chu, Student Member ASHRAE; Kristen Cetin, PhD, PE, Member ASHRAE	183

VC-20-C023	Comparative Study on the Impact of Building Type and Location on the System Efficiency and Energy-Saving Potential of a Ground Source Heat Pump System Rui Miao, Student Member ASHRAE; Yao Yu, PhD, Associate Member ASHRAE; Xiaou Hu, Student Member ASHRAE	192
VC-20-C024	Field Tests of Large Diameter Shallow Bore Helical Ground Heat Exchanger with Simulated Heating Loads Antash Najib, MEng, Student Member ASHRAE; Curtis Harrington, PE, Member ASHRAE; David Springer, Member ASHRAE; Michael Slater, PE; Angelo Zarrella, PhD, Member ASHRAE; Vinod Narayanan, PhD, Member ASHRAE	206
VC-20-C025	A Simulation-Based Investigation on the Performance of a Hybrid Ground Source Heat Pump System Integrated with Thermal Energy Storage Defeng Qian, Student Member ASHRAE; Xiaobing Liu, PhD, Member ASHRAE; Zheng O'Neill, PhD, PE, Member ASHRAE	214
VC-20-C026	Nationwide Energy Saving Analysis for Office Buildings with Occupant Centric Building Controls Zhihong Pang, Student Member ASHRAE; Yan Chen, Member ASHRAE; Zheng O'Neill, Member ASHRAE; Jian Zhang, Member ASHRAE; Hwakong Cheng, Member ASHRAE; Bing Dong, Member ASHRAE	224
VC-20-C027	Experimental Validation of Cooling Coil Control Valve Performance with Cascade Control Rodney Hurt, Student Member ASHRAE; Gang Wang, PhD, PE, Member ASHRAE; Li Song, PhD, PE, Member ASHRAE.....	233
VC-20-C028	Modelling of a CO ₂ Refrigerant Booster System for Waste Heat Recovery Applications in Retail for Space Heating Provision Emilio J. Sarabia, PhD; Salvador Acha, PhD, Member ASHRAE; Niccolo Le Brun, PhD; Victor Soto, PhD; Jose M. Pinazo, PhD; Nilay Shah, PhD	242
VC-20-C029	The Design Sequence for a Continuous, In-Situ HVAC Gaseous Air Purification System Stephanie Shaw, PEng, Student Member ASHRAE; David Wood; Bill Van Heyst, PhD, PEng	250
VC-20-C030	Three Tier Tunnel Ventilation System Om Hari Pande, Rajesh Kr. Jain, Member ASHRAE	259
VC-20-C031	Intelligent Energy Efficiency Measures for Underground Metro Stations Om Hari Pande; Rajesh Kr. Jain, Member ASHRAE; Mayank Prakash Chauhan	267
VC-20-C032	Preliminary Energy Performance Study of an Integrated Heating, Cooling, and Hot Water System with Latent Heat Thermal Energy Storage in Different U.S. Climate Zones Emmanuel Hakizimana; Hamidreza Shabgard, PhD, Member ASHRAE; Li Song, PhD, PE, Member ASHRAE.....	275
VC-20-C033	Cost Effectiveness Analysis for an Air-Conditioning System with Water Spray Cooling K. Han, PhD, PE, Member ASHRAE.....	284
VC-20-C034	Energy and Latent Performance Impacts from Four Different Common Ducted Dehumidifier Configurations Charles R. Withers, Jr.	292
VC-20-C035	Pre-Feasibility Modelling and Market Potential Analysis of a Cloud-Based CHP Optimiser Matthew Hart; Andreas V. Olympios; Niccolò Le Brun, PhD; Nilay Shah, PhD, CEng; Christos N. Markides, PhD; Salvador Acha, PhD, CEng.....	300
VC-20-C036	Exploring Water-Energy Nexus at the Building Level Amirreza Heidari; Dolaana Khovalyg, PhD, Associate Member ASHRAE	308
VC-20-C037	Parametric Analysis of Different Binary Mixtures in Solution Heat Exchanger of Absorption Refrigeration System Sambhaji T. Kadam, PhD; Ibrahim Hassan, PhD; Aziz Rahman, PhD; Athanasios I. Papadopoulos, PhD; Panos Seferlis, PhD	315

VC-20-C038	WITHDRAWN	
VC-20-C039	Thermodynamic Performance Analysis of a Novel Vortex Tube Integrated Vapour Compression Cycles Akhilesh Arora, PhD	323
VC-20-C040	Measurement of Adiabatic Single and Two-Phase Pressure Drop Behavior of R134a in Microchannel Tube Arindom Joardar, PhD, Associate Member ASHRAE; Thomas Visalli; Tobias H. Sienel, Member ASHRAE	332
VC-20-C041	High Efficiency Microchannel Polymer Heat Exchangers for Heating and Cooling Applications Erfan Rasouli, PhD; Adam Strong; Vinod Narayanan, PhD, Member ASHRAE	341
VC-20-C042	Development of a Novel Energy Recovery Heat Exchanger Coupled with Phase Change Materials for Building Temperature Control Sidney Hartz; Dacen Kinser; Marybeth Fuhlman; Parker Walvoord; Matthew Rushing; Sergio Turrubiarres; Carlos Zapata; Weihuan Zhao, PhD, Member ASHRAE	349
VC-20-C043	Using Bio PCM as Sensible Heat Storage in a Hot Arid Climate: A Case Study Neda Askari Tari, Maryam Nozaripour, Kristen Parrish, PhD.....	357
VC-20-C044	Temperature Measurement Correction for the Determination of the Effectiveness of Fixed-Bed Regenerators (FBRs) for HVAC Applications Hadi Ramin, Student Member ASHRAE; Easwaran N. Krishnan; Wahab Alabi, PhD, Student Member ASHRAE; Carey J. Simonson, PhD, PEng, Fellow Member ASHRAE	366
VC-20-C045	Transport and Containment of Infectious Disease Expelled by Coughing in an Aircraft Cabin Seif Mahmoud, Student Member ASHRAE; M.H. Hosni, PhD, Fellow Member ASHRAE; William G. Lindsley, PhD, Dylan Neu; Kenneth R. Mead, PhD, PE; James Bennett, PhD, Member ASHRAE; Jill M. Shugart; Tia McClelland	375
VC-20-C046	Co-Working Space Ventilation Code Study Yijun Yang, PhD, PE, Associate Member ASHRAE; Daniel Hallett, CPEng	384
VC-20-C047	Ventilation and Hazard Considerations of Lithium-Ion Battery Processes: Current Status and Future Needs Sean C. O'Hern, PhD, PE, Member ASHRAE; Michael Barry, PhD, PE, Member ASHRAE; Joel Sipe, PhD, PE	392
VC-20-C048	CFD Analysis of Air Change Rate (ACR) and Space Volume on Contaminant Dilution Kishor Khankari, PhD, Fellow Member ASHRAE	401
VC-20-C049	The Effects of Leakage Location on Building Air Change Rate in a Pressurized Building Justin Berquist, PEng, Associate Member ASHRAE; Adam Wills, PhD; Iain MacDonald, PhD, Member ASHRAE; Carsen Banister, PhD, Associate Member ASHRAE; Michal Bartko, PhD, Associate Member; Mark Vuotari	409
VC-20-C050	WITHDRAWN	
VC-20-C051	Improvement in the Operative Temperature Measurement of Radiant Cooling Panels Ardeshir Moftakhari, ASHRAE Member; Atila Novoselac, PhD, ASHRAE Member.....	419
VC-20-C052	Online Optimization of Cooling Water System in a District Cooling Plant by Using Digital Twin Kenichi Matsuoka; David Hill	427
VC-20-C053	Net CO ₂ Reduction, from Source Energy, from Active HVAC Indoor CO ₂ Scrubbing and Reduced Ventilation Rates, Compared to CO ₂ Mitigation Directly from Outdoor Air James Leidel, Member ASHRAE	435

VC-20-C054	Occupant Orientation (O2) Framework Cristine Gibney, Student Member ASHRAE.....	444
VC-20-C055	Measuring PM _{2.5} Deposition Rates under Different Natural Ventilation Rates in Two Classrooms Cong Liu, PhD; Chun Chen, PhD, Associate Member ASHRAE	452
VC-20-C056	Development and Validation of a Simulation Testbed for the Intelligent Building Agents Laboratory (IBAL) using TRNSYS Ojas Pradhan, Student Member ASHRAE; Amanda Pertzborn, PhD, Member ASHRAE; Liang Zhang, PhD, Member ASHRAE; Jin Wen, PhD, Member ASHRAE.....	458
VC-20-C057	Ozone Removal Tests for Activated Carbon Filters Mengjia Tang, Student Member ASHRAE; Atila Novoselac, PhD, Member ASHRAE.....	467
VC-20-C058	Study of the Performance of Tankless Coil Heating Boilers Thomas A. Butcher, PhD, Fellow Member ASHRAE; Neehad T. Islam, Affiliate Member ASHRAE; John Levey Member ASHRAE	475
VC-20-C059	An Advanced Membrane-Based HMX Model and its Application in Utilizing Sensible and Latent Heat Removed in Space Cooling Zhiming Gao, Member ASHRAE; Navin Kumar, Member ASHRAE; Zhiyao Yang, Member ASHRAE; Kyle Gluesenkamp, Member ASHRAE; Ahmad Abuheiba, Member ASHRAE; Van D. Baxter, Fellow Member ASHRAE.....	484
VC-20-C060	The Use of CFD to Analyze and Predict the Pressure Drop Along Flat Oval Duct Fittings Erin Drake; Nicole Okamoto, PhD; Ernie Thurlow, PhD.....	493
VC-20-C061	Analysis of Statistical Data (2017–2018) on the Annual Energy Use Intensity by End-Use in Office Buildings Based on Sample Measurement Soo-Yeon Ha; Hye-Sun Jin; Soo-Jin Lee; You-Jeong Kim; In-Ae Suh; Sung-Im Kim; Seung-Yeong Song, PhD	501
VC-20-C062	Quantifying the Residential Demand Response Participation of Dynamic Building Envelopes Brenton Kreiger, Student Member ASHRAE; Kyri Baker, PhD; Wil V. Srubar, PhD	510

TECHNICAL PAPERS

VC-20-001	Application of VFDs to Multiple Pump Sizes in HVAC Systems Jiajun Liao, PhD, Member ASHRAE; David E. Claridge, PhD, PE, Fellow/Life Member ASHRAE; Yintao Wang	521
VC-20-002	A Review of Relevant Practices for the O&M of High-Performance Buildings Jaya Mukhopadhyay, PhD, Member ASHRAE; Gilbert Kalonde, PhD; Loras O'Toole, PE, Member ASHRAE	532
VC-20-003	A Review of Training Programs for the O&M of High-Performance Buildings Jaya Mukhopadhyay, PhD, Member ASHRAE; Gilbert Kalonde, PhD; Loras O'Toole, PE, Member ASHRAE	546
VC-20-004	Feasibility of Low-Cost CO ₂ Sensors for Demand-Controlled Ventilation— Laboratory Chamber Testing Justin Berquist, PEng, Associate Member ASHRAE; Carsen Banister, PhD, Associate Member ASHRAE	557
VC-20-005	Development of a New Accelerated Corrosion Test for All-Aluminum Microchannel and Tube and Fin Heat Exchangers—Part II: Chamber Study (RP-1645) S. Nasrazadani, PhD, Member ASHRAE; H. Vaughan, Student Member ASHRAE; D. Ellerbrock, PhD, Member ASHRAE; C. Martin-Clizzo, PhD, Member ASHRAE	572
VC-20-006	CFD Study of Hydraulic Shock in Two-Phase Anhydrous Ammonia (RP-1569) Chidambaram Narayanan, PhD; Siju Thomas, PhD; Djamel Lakehal, PhD.....	581
VC-20-007	Using Normalized Airflows and Powers to Model the Performance of Multispeed Fan-Coil Units with Permanent Split Capacitor Fan Motors (RP-1741) Dennis L. O'Neal, PhD, PE; Peng Yin, PhD	594

SOCIETY BUSINESS

2019–2020 ASHRAE Officers, Directors, Staff, and Council and Committee Members	609
2019–2020 ASHRAE Chapter Officers.....	615
2019–2020 ASHRAE Technical Committees, Task Groups, Technical Resource Groups, and Multidisciplinary Task Groups.....	619
2019–2020 ASHRAE Standard and Guideline Project Committees.....	671
Past ASHRAE Conferences	687
Society Presidents.....	690
ASHRAE Honors and Awards	692
2019–2020 ASHRAE Intersociety Representatives.....	733
ASHRAE Associate Societies.....	734
In Memoriam, July 2019 to June 2020.....	738
Erratum.....	740
Index of Extended Abstracts, Conference Papers, and Technical Papers, Volume 126, Part 2	741