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Editorial

Special Issue on the Advances on Indoor Air Quality Systems for Healthy and Sustainable Buildings

Healthy building is an emerging concept that is being slowly realized by the advancing sensor technologies and the rapid expansion use and integration of the internet of things. This concept prioritizes the health and well-being of occupants who spend a significant amount of time in indoor environments such as homes, workplaces, schools, and malls. Global awareness and interest in understanding the extent of the relationship between indoor air dynamics and indoor environment contamination has been rising sharply in recent years and led to a dramatic increase in indoor air quality research interest. It is well known that indoor environment contaminations and viruses like COVID-19 are commonly spread by recirculating air in an indoor environment where heating, ventilation, and air conditioning (HVAC) systems recirculate 60–100% of indoor air depending on the type of air conditioning and building usage. This air recirculation impacts the occupants' thermal comfort, productivity, and well-being. In 2021, the World Health Organization (WHO) released updated air quality recommendations, cutting the PM2.5 guideline in half and lowering the recommended NO_2 exposure from 40 $\mu g/m^3$ to 10 $\mu g/m^3$. Furthermore, on May 12, 2023, the United States Centers for Disease Control and Prevention (CDC) updated its ventilation in buildings guidelines and recommended five or more air changes per hour (ACH) of clean air to help prevent airborne disease transmission [1]. On May 15, 2023, the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) released a draft of a standard for maintaining healthy indoor air quality (IAQ).

The progressive advances in collecting and use of big data from indoor environments have enabled automation technologies in homes and buildings toward the smart home concepts. In addition, the advancements in sensor technology, artificial intelligence, and data analytics are collectively revolutionizing our capacity to monitor indoor/outdoor environments in real-time and open exciting new possibilities for managing and enhancing indoor air quality (Fig. 1).

The current literature and published work are still lacking on multiple fronts despite a large amount of published literature on indoor air quality. This special issue addresses relevant research gaps and explores engineering innovations that are reshaping the way we perceive and manage indoor air quality. The contributions presented in this issue promise to accelerate progress in the field, ultimately leading to healthier and more comfortable indoor environments for all. This special issue is an outcome of a Workshop "Impact of Sustainable Buildings in Arid Environment on the Indoor and Outdoor Air Quality," held in Doha, Qatar, on May 17–19, 2022 with the participation of more than 50 experts in the field.[1] We reported the highlights of the workshop in the February 2023 issue of this journal [2].

There was a great response to the call for papers and eight manuscripts were accepted and selected for this special issue. These articles are authored by an outstanding roster of experts in their respective fields and tackle various research gaps that impact the quality of our indoor environments. The topics of this special issue spanned a large area that included the use of microchannels as a viable building insulation technique [3], enhancing the energy storage capabilities for solar-powered air conditioning systems [4], the impact of outdoor environment on the indoor air quality of commercial buildings using natural ventilation [5], utilizing machine learning for optimum manufacturing processes scheduling [6], utilizing a decision support tool for HVAC filters selection [7], decarbonization through electrification [8], improving demand-response flexibilities in pharmaceutical buildings using optimization software, [9] and methodology for predicting the energy consumption of buildings using deep neural networks [10].

Migliori and Najafi in their contribution "Energy Forecasting in Buildings Using Deep Neural Networks" proposed neural network methodologies to predict future energy consumption in buildings [10]. Gupta and Suhag in their article "Utilization of Distinct HVAC Operation Modes to Improve Demand Response Flexibility in the Pharmaceutical Industry and Economic Analysis for Optimization by HOMER Software" highlighted ways to minimize HVAC power consumption in the pharmaceutical industry [9]. Gamarro and Gonzalez-Cruz evaluated the environmental and energy infrastructure impacts of the electrification process of the building heating season from natural gas of the city of New York in their contribution "On the Electrification of Winter Season in Cold Climate Megacities—The Case of New York City" [8]. Al-Azba et al. in their work "Solar Air-conditioning Case Studies for Qatar Climate Conditions" explored ways to reduce dependency on energy storage for solar-powered air conditioning systems in harsh environments [7]. Houchati et al. described machine learning methods that can be used to optimize the utilization of available solar energy for scheduling manufacturing processes in their

[1]Impact of Sustainable Buildings in Arid Environment on the Indoor and Outdoor Air Quality Workshop, May 17–19, 2022, Doha, Qatar. Co-sponsored by Qatar National Research Fund (QNRF). Award No. CWSP18-W-0203-20038.

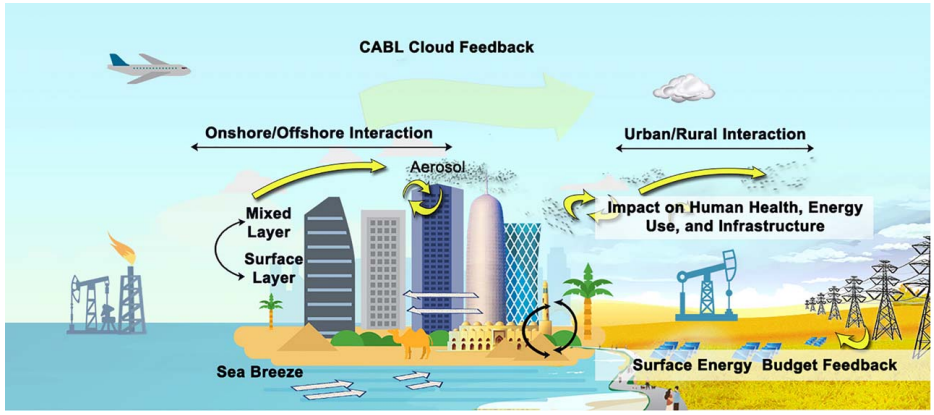

Fig. 1 A schematic diagram illustrating the building system and the dynamic interactions between the outdoor and indoor environments [2]

paper "Toward Sustainable Manufacturing Facilities: Utilization of Solar Energy for Efficient Scheduling of Manufacturing Processes" [6]. Zhai et al. investigated the impact of the building exterior design on the indoor environment and the ventilation rates in their work "Applying Natural Ventilation for Commercial Buildings With Atrium: Indoor Environment Prediction and Outdoor Pollutant Impact" [5]. Al-Azba and Mahgoub in their paper "Parametric Analysis and Multi-Objective Optimization for Energy-Efficient and High-Performance HVAC Air Filter Design and Selection" highlighted the impact of HVAC filters on the overall system performance and proposed optimization techniques for filter selection and concluded that the filter performance should be included as a factor for HVAC selection [4]. In closing, Shafiee and Dicko in their paper "A Dynamic Insulation Technique for Building Envelop by Using Microchannels" numerically highlighted the benefits that can be achieved when using microchannels for building insulation [3].

These eight contributing articles contained in this issue offer invaluable insights and guidance for a diverse array of stakeholders including homeowners seeking to enhance indoor air quality within their residences to organizations strive to promoting healthier work environments. We hope that the issue facilitates collaboration and knowledge sharing, aiming to equip a larger audience with the information and tools to prioritize indoor air quality and bring about healthier indoor environments.

In conclusion, this special issue underscores the growing importance of this field and the collective effort to create healthier, more sustainable indoor spaces. We invite readers to explore the diverse perspectives and innovative solutions presented in this special issue and embrace the challenges and opportunities embedded in indoor air quality research. We are deeply grateful for the support of our expert reviewers who ensured the high quality of this special issue. Our hope is that this collection of articles can help to highlight the challenges and opportunities for improved management of indoor environments and inspire further discussion, research, and applications on this key subject.

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References

[1] The US Centers for Disease Control and Prevention, 2023, "CDC Sets First Target for Indoor Ventilation," https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html
[2] Beitelmal, A. H., Gonzalez-Cruz, J. E., and Fountoukis, C., 2023, "Impact of Sustainable Buildings in Arid Environment on the Indoor and Outdoor Air Quality: Workshop Report," ASME J. Eng. Sustain. Build. Cities, **4**(1), p. 011101.
[3] Shafiee, S., and Dicko, H., 2023, "A Dynamic Insulation Technique for Building Envelop by Using Microchannels," ASME J. Eng. Sustain. Build. Cities, **4**(3).
[4] Al-Azba, M., and Mahgoub, M., 2023, "Parametric Analysis and Multi-Objective Optimization for Energy-Efficient and High-Performance HVAC Air Filter Design and Selection," ASME J. Eng. Sustain. Build. Cities, **4**(3), p. 031003.
[5] Zhai, Z., Baum, J., and Griego, D., 2023, "Applying Natural Ventilation for Commercial Buildings With Atrium: Indoor Environment Prediction and Outdoor Pollutant Impact," ASME J. Eng. Sustain. Build. Cities, **4**(3), p. 031005.
[6] Houchati, M., Alabtah, F. G., Beitelmal, A. H., and Khraisheh, M., 2023, "Toward Sustainable Manufacturing Facilities: Utilization of Solar Energy for Efficient Scheduling of Manufacturing Processes," ASME J. Eng. Sustain. Build. Cities, **4**(3), p. 031002.
[7] Al-Azba, M., Cen, Z., and Abotaleb, A., 2023, "Solar Air Conditioning Case Studies for Qatar Climate Conditions," ASME J. Eng. Sustain. Build. Cities, **4**(3), p. 031001.
[8] Gamarro, H., and Gonzalez-Cruz, J., 2023, "On the Electrification of Winter Season in Cold Climate Megacities—The Case of New York City," ASME J. Eng. Sustain. Build. Cities, **4**(3).
[9] Gupta, A., and Suhag, S., 2023, "Utilization of Distinct HVAC Operation Modes to Improve Demand Response Flexibility in the Pharmaceutical Industry and Economic Analysis for Optimization by HOMER Software," ASME J. Eng. Sustain. Build. Cities, **4**(3), p. 030801.
[10] Migliori, M., and Najafi, H., 2023, "Energy Forecasting in Buildings Using Deep Neural Networks," ASME J. Eng. Sustain. Build. Cities, **4**(3), p. 031004.