Rapport de veille n° 10-2024

Qualité de l’air intérieur

15/10/2024

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WoS, Google Scholar et Lens

Kottapalli, K., Zaatari, M., Jackson, M., Molyneux, S. a. M.
Aerosol Tracer Testing Comes of Age in ASHRAE Standard 241.
ASHRAE Journal, Vol. **66** n°(9), (2024)

In recent years, building owners and operators have faced the ongoing challenge of finding ways to reduce disease transmission while saving energy. ASHRAE Standard 241-2023, Control of Infectious Aerosols, introduces a groundbreaking test method for assessing the equivalent clean airflow rate (ECAi) for infection risk control, providing a comprehensive solution to this challenge. This test method considers all physical removal mechanisms, including ventilation, filtration and deposition, and accounts for air distribution within the breathing zone. This column shares results from 395 tests conducted in schools and offices across 21 cities in five countries and three continents, covering various climate zones. By comparing actual in-space airflow to CDC guidelines1 and ASHRAE targets, we show that the Standard 241-2023 Appendix C test not only demonstrates compliance with these guidelines, but also helps save energy in offices while improving indoor air quality (IAQ) to reduce infection risks.

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Tejani, A.
AI-Driven Predictive Maintenance in HVAC Systems: Strategies for Improving Efficiency and Reducing System Downtime.
ESP International Journal of Advancements in Science & Technology (ESP-IJAST) Volume, Vol. **2**, (2024), 6-19 p.

The current research seeks to analyze the use of artificial intelligence-based predictive maintenance techniques in HVAC systems, with particular emphasis on reducing equipment downtime. Work done in this paper shows that conventional maintenance techniques, such as reactive and preventive maintenance, contribute to rising operational costs and unanticipated system breakdowns. Predictive maintenance, on the other hand, is an AI and machine learning-based solution that helps identify failure points in advance and provides the best time for maintenance and upkeep of the systems for uninterrupted runtime by the system. This study also presents the current developments in AI technologies, such as data analytics models, sensors, and real-time monitoring, that aid in the identification of early signs of anomalies and prediction. The performance of the proposed approach is explained with the help of case studies and empirical facts that show that AI-driven predictive maintenance has positive effects on energy consumption, cost, and reliability of the systems. The results prove that the role of AI is significant for the development of the HVAC industry and the improvement of its effective and innovative maintenance.

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Jeong, C., Heo, S., Woo, T., Kim, S., Yoo, C.
AI-driven ventilation control policy proximal optimization coupled with dynamic-informed real-time model calibration for healthy and sustainable indoor PM2.5 management.
Energy and Buildings, Vol. **323**, (2024)

Indoor air quality (IAQ) is an important factor for determining quality of life and urban sustainability. In underground subway stations, improving IAQ through ventilation systems remains challenging due to the complexity and nonstationary nature of IAQ resulting from diverse influential factors such as subway schedules, passenger volume, and outdoor air quality (OAQ). Therefore, this study aimed to develop a novel artificial intelligence (AI)-driven ventilation system for healthy and sustainable IAQ management in subway stations. First, an IAQ mechanistic model coupled with genetic algorithm (GA)-driven rolling-horizon calibration was developed from the collected IAQ big dataset, and global sensitivity analysis was then employed to identify the dominant variables in IAQ dynamics. Subsequently, proximal policy optimization (PPO), one of the reinforcement learning (RL) algorithms, was employed to control the ventilation system in both the lobby and platform areas of a subway station. The results demonstrated that the IAQ mechanistic model can capture IAQ dynamics with acceptable modeling performance, achieving around 19 % of mean absolute percentage error (MAPE). Furthermore, the PPO-driven ventilation control system can reduce energy consumption by around 22 % while maintaining IAQ at an acceptable level.

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Estella, L.
Air filtration and sterilization.
ResearchGate, (2024)

The rapid advancement of healthcare facilities demands a focus on clean, sustainable, and safe environments for both patients and staff. The Leadership in Energy and Environmental Design (LEED) v4.1 provides a comprehensive framework for building performance, particularly in healthcare facilities where air quality is critical. This article explores advanced air filtration and sterilization techniques tailored to meet the stringent air quality requirements in LEED v4.1 healthcare environments. It provides a detailed analysis of different air filtration systems, sterilization techniques, and how they contribute to healthier environments. Furthermore, the article highlights the integration of these systems with LEED certification goals such as energy efficiency, sustainability, and overall environmental impact.

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Asim, M. M., Amjad, M. M., Sarfaraz, A., Ali, Z.
Analysis and Monitoring of Air Quality through Discrete Time Markov Chai.
Preprints, (2024)

The term Air Quality (AQ) pertains to the standard of air, which has a direct impact on the health and well-being of individuals. It is crucial to maintain high Air Quality (AQ), for better health and productivity. Though most of people spend more time indoors nowadays, it is not to be overlooked that the pollutant concentration in indoor air is directly linked to the outdoor air quality. Due to the changes in occupancy patterns, outdated maintenance of ventilation systems, and structural flaws in buildings, the indoor air is significantly polluted; pollutants emitted outdoors enter indoor air through open windows, ventilation systems and infiltration. In this paper, we have proposed a new technique, DTMCPM (discrete-time Markov chain (DTMC) model for the analysis and forecasting of AQ, using the power method). Specialized sensors and equipment to measure different pollutants, such as particulate matter, ozone, nitrogen dioxide, sulfur dioxide, benzene and toluene, are used to collect data by the Institute of Pakistan Air Quality Monitor in various cities; the data is converted to US EPA standard for all pollutant species. This data is used to calculate the transition matrix, steady-state values and mean return rate for the analysis of IAQ. The calculated and actual return rates have been compared and the proposed model is found to have a low average prediction error of 2.356%.

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Cheng, H., Engineers, T., Wendler, P.
Are we prioritizing the right thing? Cutting carbon emissions in California's large office buildings before installing a heat pump.
UC Berkeley: Center for the Built Environment, (2024)

We studied a combination of heating system measures in two large commercial office buildings in San Francisco (110,000 and 120,000 ft 2 respectively) within a project funded by the California Energy Commission’s Public Interest Efficiency Research program. We retrofitted the existing heating plants and updated the HVAC controls to ASHRAE Guideline 36-2021 as closely as possible while retaining the existing controller hardware. These measures decreased annual natural gas consumption by about 70 percent while also reducing HVAC electricity consumption. The results reinforce previous work showing significant natural gas reductions in 3 other buildings that underwent full controls retrofits (including controller hardware), and large savings from another 3 buildings that underwent partial controls upgrades. We show that on today’s electricity grid, which is quite dirty during the winter and early morning hours when most heating occurs, the carbon emissions reduction from these measures exceeds the reduction from fully electrifying the existing heating system’s load with today’s air-to-water heat pumps. More importantly, these solutions are mutually beneficial. Acknowledging that we also need to electrify HVAC loads to meet our climate goals, replacing controls first will reduce the size, weight, first cost, and ongoing operating cost of the subsequent heat pump installation requiredto fully electrify, and will make it more feasible to do so. This paper highlights an overlooked opportunity for enormous decarbonization in the existing commercial building stock using a solution that is available, cost effective, and scalable. We should prioritize these measures first,and then electrify, rather than focusing solely on electrification.

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Decardi-Nelson, B., You, F.
Artificial intelligence can regulate light and climate systems to reduce energy use in plant factories and support sustainable food production.
Nature Food, Vol. **5** n°(10), (2024), 869-881 p.

Plant factories with artificial lighting (PFALs) can boost food production per unit area but require resources such as carbon dioxide and energy to maintain optimal plant growth conditions. Here we use computational modelling and artificial intelligence (AI) to examine plant–environment interactions across ten diverse global locations with distinct climates. AI reduces energy use by optimizing lighting and climate regulation systems, with energy use in PFALs ranging from 6.42 kWh kg−1 in cooler climates to 7.26 kWh kg−1 in warmer climates, compared to 9.5–10.5 kWh kg−1 in PFALs using existing, non-AI-based technology. Outdoor temperatures between 0 °C and 25 °C favour ventilation-related energy use reduction, with outdoor humidity showing no clear pattern or effect on energy use. Ventilation-related energy savings negatively impact other resource utilization such as carbon dioxide use. AI can substantially enhance energy savings in PFALs and support sustainable food production.

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Abdul Ghani, A. A., Awang, N., Abu Bakar, N. F., Aman, M., Abdullah, R., Abdul Rahman, S. A.*, et al.*
Assessment of Indoor Air Chemical Pollutants at Faculty of Health Sciences Administrative Offices Universiti Kebangsaan Malaysia, Kuala Lumpur Campus.
Oriental Journal of Chemistry, Vol. **40** n°(4), (2024)

The 2010 guidelines for indoor air quality (ICOP IAQ 2010) provide a framework for evaluating and sustaining healthy indoor environments in enclosed spaces, promoting a safer and more comfortable atmosphere for occupants. Chemical pollutants in indoor air measured in this study are particulate matter (PM10), carbon monoxide (CO), carbon dioxide (CO2), total volatile organic compounds (TVOC), formaldehyde (CH2O) and ozone (O3). A total of six sampling locations were selected, namely P1 (ReaCH), P2 (CORE), P3 (H-Care), P4 (iCaRehab & CODTIS), P5 (PD) and P6 (PTD). The results of the study found that all chemical parameters measured were found to comply with the limits allowed by ICOP IAQ 2010 except for ozone (O3) readings. The average range of carbon monoxide (CO) readings was recorded to be (0.0+0.0 ppm - 0.6+0.01 ppm) and still below the ICOP IAQ 2010 limit (10 ppm). CO2 readings ranged between (582+104 ppm - 847+67 ppm) with all readings at sampling locations complying with ICOP IAQ 2010 limits (1000 ppm). The average value for PM10 readings ranges between (0.01+0.01 ppm - 0.03+0.01 ppm) and all readings are below the ICOP IAQ 2010 limit (0.15 ppm). TVOC readings range between (0.0 + 0.0 ppm - 1.8 + 0.01 ppm) and all readings are below the ICOP IAQ 2010 limit (3 ppm). The average value for formaldehyde concentration between the reading range (0.00 + 0.00 ppm – 0.96 + 0.01 ppm) and it complies with the ICOP IAQ 2010 limit (0.10 ppm). The average O3 concentration exceeds the ICOP IAQ 2010 standard (i.e., 0.05 ppm) in the range of 0.00 + 0.00 – 0.06 + 0.01 ppm. Overall, the indoor air quality in all UKM Faculty of Health Sciences administrative offices is in good condition. However, monitoring indoor air quality periodically needs to be done to ensure that the occupants are always healthy and in a comfortable condition as well as being able to increase work productivity.

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Prameela, R., Bhukya, R.
Assessment of seasonal variations in dry eye syndrome prevalence among office workers.
Asian Journal of Medical Sciences, Vol. **15** n°(9), (2024), 100-105 p.

Background: Dry eye syndrome (DES) is prevalent among office workers and influenced by various environmental and individual factors. This study assesses the prevalence, seasonal variations, symptom severity, and environmental influences on DES among office workers.
Aims and Objectives: The study aimed to assess the prevalence of DES among office workers in Warangal, Telangana, India, and to evaluate the impact of seasonal variations, symptom severity, and environmental factors on DES.
Materials and Methods: A cross-sectional study was conducted with 100 office workers aged 25–55 years old. Data were collected through questionnaires on DES symptoms, environmental conditions, and demographics. The prevalence of DES was calculated, and seasonal variations were analyzed. Symptom severity was recorded on a scale from 1 to 10. Environmental factors such as humidity, air-conditioning use, screen time, and indoor air quality were examined for their correlation with DES prevalence.

Results: The overall prevalence of DES was 45%, with females showing a higher prevalence (50%) compared to males (37.5%). Seasonal variations showed the highest DES prevalence in winter (40%) and the lowest in summer (16%). Symptom severity scores were highest in winter (6.5 overall) and lowest in summer (3.8 overall). Low humidity in winter was associated with a 55% prevalence of DES, especially among females (65%). High air-conditioning use in summer correlated with a lower DES prevalence (12.5%). Increased screen time (>6 h/day) resulted in a 60% prevalence of DES, with seasonal peaks in winter (65%). Poor indoor air quality was reported by 70% of participants and linked to a 50% prevalence of DES.
Conclusion: The study highlights significant gender differences, seasonal variations, and environmental factors impacting DES prevalence and severity among office workers. Interventions focusing on improving workplace conditions, managing screen time, and enhancing indoor air quality may mitigate DES symptoms.

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Agius, R. M.
A better approach to mitigate the risk of airborne infections in workplaces.
Occupational Medicine, (2024)

In 2010, this journal highlighted the potential challenge of a pandemic in the ensuing decade [1] and so it came to pass. During the peak of the pandemic, 'Occupational Medicine' played its part both in disseminating new knowledge and in expressing authoritative opinion. Looking to the future, many observers are awaiting cues from the outcomes of the coronavirus disease 2019 (COVID-19) Public Inquiry. The Module 1 report showed that the UK Government failed its citizens with its lack of preparation or a preventive strategy [2]. The report also emphasized the need to build resilience in government, associated institutions and their plans, but it has yet to address the resilience built into traditional occupational health control measures such as ventilation [3]. Module 3 [4] might address these measures but the limitations of the Inquiry could disappoint those concerned with workplace health, such as by addressing only health and social care workplaces (HSCW). Analyses of 'lessons learned' from COVID-19 [5–7] indicate various but sufficient reasons to eschew attitudes of 'living with the virus' or of reversion to 'business as usual' when facing common airborne infections at work such as coronaviruses, influenza and respiratory syncytial virus (RSV).

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Ghimire, U., Musa, T. H., Juan, Z.
A Bibliometric Analysis Of Sick Building Syndrome Research.
Journal of Epidemiology and Public Health, Vol. **2** n°(3), (2024), 1-10 p.

Introduction: Sick-building syndrome (SBS) is a common but neglectedhealth issue in the world. Thus the study was to assess and analyze theanuualscientific output of SBS and evaluate the pertinent publication from the past decades. Methods: A comprehensive list of citation classics in SBS was generated by searching the Scopus databases using keywords; Title (sick and building and syndrome) title (building and syndrome) during the period 1975 to march 2020. The main bibliometric indicators including, year of publications, country of origin, initiations, article type, productive journals, prolific authors, and funding sources.A statistical software package called R (Biblioshiny) and VOSviewer were used for data analysis and visualization. Results: A total of 587 documents were retrieved from Scopus , with an average of 18.63 citations per documents, an average of 2.3 authors per documents. The United States was a leading country with the highest research documents(114), followed by Sweden (62) and United Kingdom(50). Geographical distribution of publications showed Asiancountries such as Japan(34),China(28), Malaysia(17) are the most active one among others. Chiba and Uppsala University (n =15) were the most active institution. The top-cited documents focused on the impact of SBSoutcome and its related symptoms. Conclusions: The annual number of publications are slowly increasing fromthe past decades. There are not many Asian countries involved in SBS research, and very few numbers of paper are published in journal with good impact factor.Thus , this study highlights that a growing of documents in SBS research collaboration in this field needs to be strengthened to improve the global attention to SBS issue and others SBS factors need to be addressed.

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Alavi, H., Kookalani, S., Rahimian, F., Forcada, N.
BIM-Based DSS for Enhancing Occupants' Comfort.
In: Integrated Building Intelligence. Springer Nature Switzerland; 2024. 79-99 p.

In this chapter, we will explore the integration of BIM with a probabilistic model to assess various aspects of occupants' comfort within building environments. Specifically, we will focus on thermal comfort, acoustic comfort, indoor air quality, visual comfort, and space adequacy. The study employs a meticulously developed satisfaction survey alongside an occupants' comfort probabilistic model to systematically identify and evaluate the underlying causes of discomfort experienced by occupants. The integration process commences with the identification of essential data required by the probabilistic model, followed by synthesizing this data with feedback obtained from occupants through the satisfaction survey. BIM technology plays a key role in facilitating this synthesis by supporting the aggregation and analysis of data and enabling the visual representation of occupants' comfort levels across different spaces within a building. By utilizing a color scale for visualization, the model offers an intuitive understanding of comfort variations while highlighting areas that require attention. Moreover, this integrated approach provides substantial advantages for facility managers and property owners. It allows them to identify specific factors contributing to discomfort, empowering them to implement precise interventions to effectively address these issues. The result is a more favorable living and working environment that significantly enhances occupant satisfaction and well-being. The effectiveness and relevance of this model are further bolstered by a case study, which offers empirical evidence validating the model's capability to accurately assess and improve occupants' comfort. This case study not only confirms the model's validity but also demonstrates its practical implications in real-world settings, making it a valuable tool for enhancing the habitability and functionality of modern building environments.

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Lin, Y., Wang, J., Yang, W., Chan, M., Hu, X.
A case study of multi-objective design optimization of a healthy building in Shanghai, China.
Journal of Building Engineering, Vol. **96**, (2024)

Energy efficient healthy buildings design is important in achieving carbon neutrality and occupants' health, yet not sufficiently explored. This paper aims to optimize a healthy building in Shanghai, China, based on energy consumption, indoor air quality and visual comfort. A four-step optimization method was proposed. Firstly, Latin Hypercube-Soubert sampling method was used to generate 375 design samples and performance data through computer simulation and calculation. Secondly, five different machine learning approaches were applied for prediction model development. Thirdly, the best prediction models were coupled with eleven optimization algorithms to find Pareto solutions. Finally, optimization on different combinations of design parameters were conducted. It was found that the back propagation neural network and Pareto Envelope-based Selection Algorithm II were the best prediction models and optimization algorithm. The average reduction of building energy consumption, visual discomfort, and improper indoor air quality hours were found to be 25.73 %, 46.24 %, and 38.34 %, respectively. The recommended windows to wall ratios of the east, south, west and north walls, absorptance of solar radiation and filter types are in the range of 20%–35 %, 10%–45 %, 10%–30 %, 10%–40 %, 0.7–0.9, and S7-S9, respectively. This study contributes to enrich the case study of healthy buildings, provide a quick design optimization approach and analysis on the importance of each design parameter. Its originality lies in the optimization methodology, comparative analysis of prediction models, optimization algorithms, and combination effects of design parameters. The outcomes can guide the building designers in performing energy efficient design while maximizing indoor air quality and visual comfort.

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Farmer, D. K., Vance, M. E., Poppendieck, D., Abbatt, J., Alves, M. R., Dannemiller, K. C.*, et al.*
The chemical assessment of surfaces and air (CASA) study: using chemical and physical perturbations in a test house to investigate indoor processes.
Environmental Science: Processes & Impacts, (2024)

The Chemical Assessment of Surfaces and Air (CASA) study aimed to understand how chemicals transform in the indoor environment using perturbations (e.g., cooking, cleaning) or additions of indoor and outdoor pollutants in a well-controlled test house. Chemical additions ranged from individual compounds (e.g., gaseous ammonia or ozone) to more complex mixtures (e.g., a wildfire smoke proxy and a commercial pesticide). Physical perturbations included varying temperature, ventilation rates, and relative humidity. The objectives for CASA included understanding (i) how outdoor air pollution impacts indoor air chemistry, (ii) how wildfire smoke transports and transforms indoors, (iii) how gases and particles interact with building surfaces, and (iv) how indoor environmental conditions impact indoor chemistry. Further, the combined measurements under unperturbed and experimental conditions enable investigation of mitigation strategies following outdoor and indoor air pollution events. A comprehensive suite of instruments measured

different chemical components in the gas, particle, and surface phases throughout the study. We provide an overview of the test house, instrumentation, experimental design, and initial observations – including the role of humidity in controlling the air concentrations of many semi-volatile organic compounds, the potential for ozone to generate indoor nitrogen pentoxide (N_2O_5), the differences in microbial composition between the test house and other occupied buildings, and the complexity of deposited particles and gases on different indoor surfaces.

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Berardino–Luca, L., Hoffmann–Wili, W. C., Tronville–Paolo, P.
Choosing air filters for general ventilation by engineering calculations.
MERCOFRIO 2024 - 14º CONGRESSO INTERNACIONAL DE AR CONDICIONADO, REFRIGERAÇÃO, AQUECIMENTO E VENTILAÇÃO

The WHO global air quality guidelines published in 2021 and the recent COVID-19 pandemic have shown that air quality is a public health issue. Indoor Air Quality should be an imperative aspect in designing air conditioning systems for indoor environments where people spend most of their time. The greatest concern regarding harmful effects on human health is PM2.5. Considering the concentration of PM2.5 present in outdoor air in most urban centers it is obvious the need to clean outdoor air, which seldom meets the values prescribed by the WHO. Therefore, devices to purify the air of particulate matter are becoming increasingly important, and their selection is one of the critical aspects of indoor air conditioning system designs. Calculating the essential components to guarantee indoor air quality can be done by carrying out a mass balance of the contaminants of concern. This calculation becomes more complicated in the case of particles due to the size dependence of behaviors and properties. However, it is possible to calculate the PM2.5 concentration after fixing the particle size distribution and thus reducing its representation to a single number. ABNT NBR ISO 16890-1:2018 standard offers the designer the possibility of selecting filters and calculating airflow rates, sizing the ventilation system by choosing the battery of filters capable of meeting the project's objectives. The draft revision of ABNT NBR 16401-3 takes advantage of this important advance to calculate the internal concentration of particles, an essential parameter for guaranteeing a healthy indoor environment.

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Lavia, O.
Comparing LEED v4. 1 healthcare scores with other green building certifications.
ResearchGate, (2024)

As the demand for sustainable healthcare facilities grows, different green building certification systems have been developed to assess environmental performance. LEED v4.1 is one of the most widely adopted certifications globally, especially in healthcare, but it is not the only option available. This article compares LEED v4.1 healthcare scores with other prominent green building certifications such as BREEAM, WELL, and Green Globes. By analyzing the criteria and scoring methodologies, this paper explores the advantages and limitations of each system in addressing sustainability in healthcare facilities. The comparison highlights the strengths of each certification in promoting energy efficiency, indoor environmental quality, water conservation, and overall sustainability.

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Xu, Y., Han, X., Cao, X. E.
Comprehensive performance evaluation of HVAC systems integrated with direct air capture of CO2 in various climate zones.
Building and Environment, Vol. **266**, (2024)

Direct Air Capture (DAC) is a rapidly evolving technology that extracts CO2 directly from ambient air. This study presents a comprehensive performance evaluation of integrating DAC in HVAC systems, which can reduce indoor CO2 concentration and improve energy efficiency of HVAC systems. The DAC equipment is modeled in Modelica based on isotherm and thermodynamic equations, and pressure drop curves of the CO2 sorbent described in literature. The model is validated with data from the literature, and then integrated into a typical HVAC system available in Modelica Buildings library. The HVAC system is a Variable Air Volume (VAV) with reheater system for a one-floor office building with standard ASHRAE 2006 control sequences. Demand control ventilation strategies are designed to reduce the outdoor air flowrates when indoor CO2 concentrations are lower than the threshold, which is to maximize the benefits of integrating DAC. Four cases are proposed to assess the impacts of integrating DAC and DCV in HVAC systems in 8

different ASHRAE climate zones in the USA. The results show that by integrating DAC unit into the HVAC system, the average indoor CO2 concentration can be significantly reduced by over 45 % against the baseline without a DAC unit. By integrating DCV, 0.39–21.66 % of annual energy savings and 226–9539 kg carbon emissions reduction are observed across different climate zones. The highest energy savings are found to be achieved with cold climatic conditions while the lowest energy savings occur with favorable weather.

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Kanaan, M., Amine, S., Gazo-Hanna, E.
Computational Simulation and Analysis of Local Thermal Comfort and Indoor Air Quality in Space with Displacement Ventilation.
Engineering, Technology & Applied Science Research, Vol. **14** n°(5), (2024), 16383-16388 p.

Displacement ventilation has been known for its capacity to lower energy consumption and improve air quality, but it has major thermal comfort limitations. The aim of this paper is to optimize the DV supply conditions by using computational fluid dynamics modeling to achieve acceptable CO2 concentration in the breathing layer at minimum energy cost while preventing local discomfort due to draft and air temperature difference between ankles and head. The results revealed that up to 44% energy savings can be achieved if the selection of supply conditions is optimized. The model can be put into practice to give recommendations on displacement ventilation preliminary design.

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Guo, F., Ham, S. W., Kim, D., Moon, H. J.
Deep reinforcement learning control for co-optimizing energy consumption, thermal comfort, and indoor air quality in an office building.
Applied Energy, Vol. **377**, (2025)

With the recent demand for decarbonization and energy efficiency, advanced HVAC control using Deep Reinforcement Learning (DRL) becomes a promising solution. Due to its flexible structures, DRL has been successful in energy reduction for many HVAC systems. However, only a few researches applied DRL agents to manage the entire central HVAC system and control multiple components in both the water loop and the air loop, owing to its complex system structures. Moreover, those researches have not extended their applications by incorporating the indoor air quality, especially both CO2 and PM2.5concentrations, on top of energy saving and thermal comfort, as achieving those objectives simultaneously can cause multiple control conflicts. What's more, DRL agents are usually trained on the simulation environment before deployment, so another challenge is to develop an accurate but relatively simple simulator. Therefore, we propose a DRL algorithm for a central HVAC system to co-optimize energy consumption, thermal comfort, indoor CO2 level, and indoor PM2.5 level in an office building. To train the controller, we also developed a hybrid simulator that decoupled the complex system into multiple simulation models, which are calibrated separately using laboratory test data. The hybrid simulator combined the dynamics of the HVAC system, the building envelope, as well as moisture, CO2, and particulate matter transfer. Three control algorithms (rule-based, MPC, and DRL) are developed, and their performances are evaluated on the hybrid simulator environment with a realistic scenario (i.e., with stochastic noises). The test results showed that, the DRL controller can save 21.4 % of energy compared to a rule-based controller, and has improved thermal comfort, reduced indoor CO2 concentration. The MPC controller showed an 18.6 % energy saving compared to the DRL controller, mainly due to savings from comfort and indoor air quality boundary violations caused by unmeasured disturbances, and it also highlights computational challenges in real-time control due to non-linear optimization. Finally, we provide the practical considerations for designing and implementing the DRL and MPC controllers based on their respective pros and cons.

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Meena, J. S., Sharma, G., Bansal, H., Yadav, R., Sharma, L. K.
Design and development of an air purifier and humidifier using water as a filter.
PRATIBODH, (NCFTME), (2024)

Air pollution is a major issue, especially in India's towns and cities. In 2019, 21 of the 30 most polluted cities worldwide were in India. According to 2016 data, at least 140 million Indians breathe air that exceeds WHO's safe limit by 10 timesor more, leading to 2 million premature deaths each year. Pollution sources include industry (51%), vehicles (27%), crop burning (17%), and Diwali fireworks (5%). The Air (Prevention and Control of Pollution) Act of 1981 was intended to

regulate air pollution, but enforcement has been weak. To address pollution, an air filter made of reusable plastic with low-cost filter media ionic filters, foam filters, and activated carbon is proposed. This filter can monitor real-time air quality through gas and dust sensors. Additionally, a water-based air purifier has been developed to avoid expensive filters. It uses high-power, low-noise fans to draw air through a water tank, which traps dust, fungi, and bacteria. The humidified air can be mixed with essential oils for added benefits like relaxation and antimicrobial properties. This multi-function device can serve as an air purifier, humidifier, and oil diffuser, providing a cost-effective solution to combat air pollution.

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Syed Azahar, S. N., Sopian, N. A., Abdull, N., Mat Hussin, N. H.
Determination of Mold Invasion and Occupants' Respiratory Health in University Laboratories.
Aerosol and Air Quality Research, Vol. **24**, (2024)

The presence of mold can have detrimental effects on both the integrity of buildings and occupants' health. This cross-sectional study aimed to explore the extent of mold invasion on the respiratory health of occupants at the university laboratories through the integration of quantitative bioaerosol sampling and semi-quantitative strategies. The latter approach involved the application of the NIOSH Dampness and Mold Assessment Tool (DMAT) to assess the damage, presence of mold and dampness in the laboratories. Instruments such as biostage impactors and air velocity meters were used to collect samples and data on the biological and physical parameters of indoor air quality (IAQ). Furthermore, a validated questionnaire was also used to gather information on respiratory symptoms among occupants. The findings of DMAT showed that "visible mold" and "wet/damp" were the most significant factors based on the lab classification. Meanwhile the variables "damage/stain" and "room" were the most significant variables when comparing numbers of doors ($p < 0.05$). When assessing the physical and biological parameters in the laboratories, it was disclosed that temperature and total bacterial count were the most significant factors among all ($p < 0.001$). Interestingly, relative humidity significantly correlated well with both total fungal count ($r2 = 0.362$) and total bacteria count ($r2 = 0.202$). The completed questionnaire indicated that 18.57% of the occupants were technical staff while the remaining 81.43% were students. It portrayed that cough ($p = 0.002$) was the most significant respiratory symptom with the highest prevalence of 74.3% among occupants. In addition, the logistic regression model disclosed that all IAQ parameters significantly influenced cough symptoms, except temperature ($r2 = 0.641$, $p < 0.05$). In conclusion, this study adds to our understanding of the complex link between indoor mold exposure, IAQ parameters, and respiratory health in laboratory occupants. The high prevalence of cough symptoms and their association with IAQ indicators emphasized the importance of focused intervention strategies to enhance indoor environmental quality.

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Jalgaonkar, K., Jagajanantha, P., Mahawar, M. K., Dhakane-Lad, J., Patil, S., Raja, A. S. M.*, et al.*
Development of air purifying curtain using activated charcoal embedded multilayer fabric for effective indoor air filtration.
The Journal of The Textile Institute, (2024), 1-10 p.

Air pollution poses a significant threat to global health, necessitating effective solutions to mitigate its impact. In this study, we propose an innovative approach to combat indoor air pollution through the development of a multilayer fabric-based air purifying curtain. The curtain comprises inner and outer layers of cotton fabric sandwiched around a middle layer of activated charcoal-treated polyester and cotton blend (PC blend) fabric. Fabrication involved a pad-dry-cure process with activated charcoal particles applied to the fabric surface. To test the efficacy of the developed fabric in filtering hazardous substances such as particulate matter 2.5 (PM2.5), particulate matter 10 (PM10), and total volatile organic compounds (TVOCs), filter quality testing equipment is being designed and fabricated. Comparative analysis with a market-available air purifying curtain (MAPC) revealed comparable air permeability and filtration efficiency for PM2.5, PM10, and TVOCs. Notably, the developed air purifying curtain exhibited a lower contact angle (86°) than MAPC (117°), indicating a hydrophilic nature contributing to enhanced filtration. Our findings suggest that the proposed curtain offers a sustainable and effective solution for indoor air quality improvement.

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Bachelier, F., Mascles, M., Mcgillen, M. R., Amiet, J.-P., Grosselin, B., Bazin, D.*, et al.*
Development, optimization and validation of automated volatile organic compound data analysis using an on-line thermal desorption gas chromatograph with dual detection and application to measurements in ambient air.

Journal of Chromatography A, Vol. **1735**, (2024)

Because of their major role in indoor and outdoor air pollution, even at trace levels, VOCs are of great interest, and their monitoring requires sensitive analytical instruments. Several techniques are commonly used, such as portable sensors, Proton Transfer Reaction Mass Spectrometry (PTR-MS) and Thermal Desorption Gas Chromatography (TD-GC). The latter is widely used off- and on-line with Flame Ionization Detectors (FID) or Mass Spectrometers (MS). Given the large number of molecules detected per chromatogram, the data generated by these monitoring techniques are usually checked and reprocessed manually. This process is extremely time consuming and could result in human error. The challenge is to provide reliable results as quickly as possible. In this study, the performances of an on-line TD-GC system with dual detection FID and MS were tested. The Method Detection Limits (MDL), linearities and accuracies of 60 VOCs (alkanes, aromatics, oxygenated and halogenated) were calculated both for FID and MS detectors. The MDLs and accuracies ranged from 0.006 to 0.618 ppbv and from 77 % to 100 % for FID, and from 0.018 to 0.760 ppbv and from 80 % to 100 % for MS. Both detectors showed good complementarity and allowed the development of two programs to facilitate data analysis. These algorithms were designed to autonomously select optimal results between FID and MS detectors, and were evaluated for outdoor and indoor measurement conditions. Measuring VOCs in field campaigns is challenging, and it is anticipated that these programs could be extended to other types of dual-detector systems or for the comparison of data from different calibrated instruments.

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Itani, M. Y., Chehade, H., Akhdar, A.
Displacement Ventilation for an Auditorium in a Hot Climate.
ASHRAE Journal, Vol. **66** n°(9), (2024)

While various traditional and novel ventilation strategies exist, displacement ventilation has become more widespread in nonindustrial spaces, especially those with high ceilings where the natural rising motion of thermal plumes is promoted and where contaminant levels are low and system energy efficiency is a priority. This article presents a case study on the implementation of the displacement ventilation system in the Riad Salameh Auditorium, which was built in 2017 and that is part of the Middle East Airlines Training and Conference Center in Beirut, Lebanon.

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Omar, M. H., Kamal, M. M., Abotaleb, H. A.
The effectiveness of impulsive jet fans ventilation on CO concentration in closed car park.
Engineering Applications of Computational Fluid Mechanics, Vol. **18** n°(1), (2024)

As there is a risk of CO contamination by vehicles running inside the car park. This research was initiated with the objective of assessing jet fans' impulsive ventilation ?IV? performance and studying its effect on CO contamination in such garages, where a 1350 m2 UG (2.65 m high) was considered as a case study. 39 scenarios were proposed; visualized in a matrix, and simulated by a Computational Fluid Dynamics ?CFD? model (ANSYS FLUENT 2019 R3), natural ventilation, and impulsive ventilation were studied. The proposed scenarios considered the jet fans ?JFs? arrangement, in terms of number and interspacing and location within the garage, flow of JFs, and load capacity, in terms of the number of cars in operation. A code notation was made to describe each case's properties. The results highlighted valuable insights into the optimal arrangement of jet fans in UG. It flagged the importance of adjusting the number of fans, spacing, and location to attain reasonable ventilation performance. The research suggested implementing an inverter variable speed drive in the ventilation system to provide 6 or 10 ACH and adjusting them based on UG occupancy whether at normal load or peak load, Additionally, the On-Off system allows for the utilization of different arrangements according to the load requirements. A collective correlation was attempted to identify the values of CO in PPM according to load percentage and ACH.

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Narayanan, V. V., Hashemi, A., Elsharkawy, H., Newport, D.
Effects of Occupant Behaviour and Air Filtration on Indoor Air Quality in Social Housing.
International Sustainable Ecological Engineering Design for Society (SEEDS) 2024 27 - 29 Aug 2024. Leeds Beckett University, Leeds, UK and online

Indoor air pollution poses a significant threat to human health, making it crucial to identify sources, assess levels, and develop strategies to enhance indoor air quality. The main objective of this paper is to assess Indoor Air Quality (IAQ) and the effectiveness of air purifiers and tailored behavioural interventions in improving IAQ in social housing properties in London. The methodology involved monitoring key pollutants, including Carbon Monoxide (CO), Particulate Matter (PM10 and PM2.5), Total Volatile Organic Compounds (TVOCs), and humidity levels using data loggers during three distinct phases: a) pre-intervention, b) with air purifiers, and c) after the behavioural intervention. The installation of air purifiers significantly reduced CO and PM10 levels, consistently maintaining them near or below recommended guidelines across all CSBs; however, the impact on TVOC levels was less pronounced, with levels often remaining above the recommended guideline. Subsequent behavioural interventions aimed at educating occupants on best practices for reducing pollutant generation yielded variable results across CSBs and pollutants. The study demonstrated the potential benefits of combining air purifier installation with tailored behavioural interventions, effectively reducing CO, PM10, and PM2.5 levels. However, the persistent issue of elevated TVOC levels across all case study buildings underscores the need for further research and more comprehensive strategies, including source control measures.

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Li, Y., Wang, Z., Zhao, T., Li, H., Jiang, J., Ye, J.
Electronic nose for the detection and discrimination of volatile organic compounds: Application, challenges, and perspectives.
TrAC Trends in Analytical Chemistry, Vol. **180**, (2024), 117958 p.

The electronic nose, commonly referred to as e-nose, has become an essential tool for the detection of volatile organic compounds (VOCs) which play critical roles in air quality, climate change, and human health. Inspired from the human olfactory system, e-noses offer key advantages in portability and cost-effectiveness, making them indispensable for identifying a series of VOCs. This review explores advancements in e-nose technology for VOC detection, detailing the operational principles of various sensors, and assessing their strengths and weaknesses. It also examines the conventional and novel algorithms for VOC pattern recognition, highlighting their role in enhancing detection accuracy and application robustness. Moreover, the review discusses the diverse applications of e-noses, ranging from environmental monitoring to critical sectors such as food processing and medical diagnostics. Finally, the review addresses current challenges in e-nose applications, such as selectivity and sensitivity, and offers insights into emerging trends and future perspectives in e-nose development.

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Annadurai, G., Mathews, A. J., Krishnan, E. N., Gollamudi, S., Simonson, C. J.
Energy recovery ventilators to combat indoor airborne disease transmission: A sustainable approach.
Science and Technology for the Built Environment, Vol., 1-12 p.

Ventilation plays a crucial role in preventing indoor airborne disease transmission. Nevertheless, ventilation increases the energy consumption of HVAC systems. Therefore, energy efficiency measures or alternative methods must be adopted to reduce the energy demand of HVAC systems, which is necessary to achieve sustainability in the building sector. This study proposes a method of utilizing an energy recovery ventilator (ERV) to provide supplementary ventilation to reduce airborne disease transmission. The proposed method is tested for an office building with one source room (with an infected occupant) and two connected rooms (no infection source). The contributions of the present study are (i) the development and verification of a new supplement ventilation method using an ERV to reduce the probability of infection from airborne pathogens and (ii) providing the economic and environmental benefits of the proposed method to promote its adaption by the building managers/HVAC engineers. The results of the present study show that the proposed method can reduce the probability of infection by 10 to 40% and demonstrate that utilizing an ERV is a sustainable and economical method to improve ventilation to reduce indoor airborne disease transmission.

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Molino, D., Ferraro, G., Lettieri, S., Zaccagnini, P., Etzi, M., Astorino, C., *et al.*
Enhanced CO_2 Detection Using Potentiometric Sensors Based on PIM-1/DBU Imidazolate Membranes.
Advanced Sustainable Systems, Vol. **n/a** n°(n/a), (2024)

A novel potentiometric sensor for carbon dioxide (CO2) detection utilizing a composite membrane of Polymer of Intrinsic Microporosity (PIM-1) and 18-diazabicyclo[5.4.0]undec-7-ene imidazolate (DBU-imidazolate) is presented. The

high surface area and gas permeability of PIM-1, combined with the chemical affinity and ion-exchange properties of DBU-imidazolate, contribute to enhanced CO2 sensitivity and selectivity. The research objectives included the synthesis of PIM-1 and DBU-imidazolate, the preparation of composite membranes, and the evaluation of their performance as CO2 sensors. Solvent casting and impregnation methods are employed to prepare the membranes, which are characterized using Thermal Gravimetric Analysis (TGA), and Field Emission Scanning Electron Microscopy (FESEM). CO? absorption tests and Electrochemical Impedance Spectroscopy (EIS) are conducted to assess the sensors' performance. The PIM-1/DBU-imidazolate membrane exhibited high efficiency in CO? capture and release. Open circuit voltage (OCV) measurements are performed under varying concentrations of CO2 exposure and cycles of adsorption/desorption. Results show that the membrane achieves steady state faster at higher CO2 concentrations, with a logarithmic relationship between CO2 concentration and voltage variation, indicating potential for CO2 detection in human environments. These results confirm the sensor's ability to detect varying CO2 concentrations, highlighting its potential for reliable and efficient CO2 monitoring in environmental and industrial applications.

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Touqan, B., Ameer, A. A.
Enhancing HVAC multivariable system performance through hybrid modeling and direct Nyquist Array control.
Building Services Engineering Research and Technology, (2024)

This study explores a closed-loop multivariable control system for HVAC systems. A hybrid distributed parameter-lumped model was developed using MATLAB?s System Identification Application, resulting in a transfer function matrix. The Direct Nyquist Array (DNA) control strategy was applied, dividing the HVAC system into two SISO loops, each equipped with PID controllers. Stability analysis confirmed system stability according to the Nyquist criterion. Simulation of the system under DNA control showed improved performance over the open-loop setup, with faster response times of nearly 1 s and overshoots between 7% and 15%, maintaining thermal comfort and occupant satisfaction. The system effectively managed ambient heat transfer variations, maintaining desired airflow rate and air temperature. The closed-loop setup exhibited robustness against disturbances, quickly returning to steady-state values. Settling times ranged from 1 to 2 s with minimal impact on HVAC performance. Overall, the closed-loop multivariable DNA control with SISO PID controllers proved reliable for enhancing energy efficiency and thermal comfort in HVAC systems.Practical applicationThis study provides a comprehensive framework for multivariable control in HVAC systems, significantly benefiting built environment professionals by enhancing energy efficiency and occupant comfort. By applying advanced control strategies, the research offers practical solutions for optimizing HVAC performance, reducing operational costs, and ensuring sustainability in building management. The detailed analysis and methodologies presented can be directly implemented to improve system reliability and responsiveness, thereby supporting professionals in creating smarter, more resilient, and environmentally friendly built environments.

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Dicu, T., Botoş, M., Cucoş, A., Grecu, Ş., Florică, Ş., Tunyagi, A.
Evaluating radon concentration and temporal correction factors in residential and workplace buildings: A comparison of passive and active methods.
Heliyon, Vol. **10** n°(17), (2024)

Effective mitigation of the health impacts of radon exposure begins with accurate measurement of this environmental contaminant. Typically, radon surveys require measurements over a period of several months. This process involves the application of temporal correction factors (TCF). Disparities in indoor radon concentration (IRC) are evident across building types. While the integrated technique has traditionally been considered the most reliable for measuring IRC, the active method is becoming more prevalent due to the availability of commercial radon measurement instruments. The aim of this study is to compare IRC using passive (CR-39) and active (ICA device) methods across 69 indoor spaces, including 35 workplaces and 34 residential buildings. The investigation was conducted over a span of one year and included 966 CR-39 detectors that were replaced every 3 and 6 months, respectively, to assess seasonal fluctuations and facilitate the computation of TCF. Statistically significant differences in IRC were observed between residential and workplace buildings ($p < 0.001$). Among workplaces, educational and research institutions showed the highest average IRC (166 Bq/m3), while hospitals exhibited the lowest (25 Bq/m3). Significant differences in TCF were found between the two measurement methods ($p < 0.05$), making TCF specific to the passive method inapplicable to active method. Moreover, distinctions between workplace and residential buildings, including the presence of air conditioning units and differing occupancy patterns, lead to substantial differences in both IRC ($p < 0.001$) and TCF. The assessment of radon

exposure based on room occupancy duration revealed substantial variations: workplaces showed lower actual exposure (62 Bq/m3 vs. 75 Bq/m3, $p < 0.001$), while residential settings, particularly at night, displayed higher exposure (278 Bq/m3 vs. 245 Bq/m3, $p = 0.02$) than integrated measurements suggest. Continuous monitoring systems offer critical insights into true radon exposure levels.

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Xu, R., Wu, F., Shen, L., Fan, Z., Yu, J., Huang, Z.
Experimental study on bioaerosols behavior and purification measures in a subway compartment.
Scientific Reports, Vol. **14** n°(1), (2024)

Bioaerosols in public transportation systems raise critical environmental concerns, seriously threatening passenger health and safety. In this study, we investigate the spread characteristics of bioaerosols in a standard type-B subway compartment using both air sampling and sediment sampling methods. Additionally, without compromising indoor passenger comfort, two self-designed air purification devices, based on intense field dielectric (IFD) and dielectric barrier discharge (DBD) technologies, respectively, are successfully applied for the improvement of the subway air quality. The results show that bioaerosols can propagate rapidly throughout the entire compartment in 5 min via airborne transmission. Under the effect of the symmetric air ducts and compartment structure, the difference in bioaerosol concentration in the air is less than 10% between both ends of the compartment. Concurrent substantial bioaerosol deposition on the ground, seats, and windows underscores the risk of contact transmission. Furthermore, the real-time purification rates of the two devices integrated into the air conditioning system reach 59.40% and 44.98%, respectively. With their demonstrated high efficiency in purifying bioaerosols and modular design featuring low energy consumption, easy cleaning, and reusability, these devices stand out as viable long-term solutions for large traffic vehicles. These research findings provide practical equipment recommendations and installation strategies for optimizing indoor air quality in subways and are applicable to other similar transportation systems.

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Baharin, K. W., Aminuddin Rosli, N. H., Norizan, M. N., Mohd Rosli, M. A., Ahmad Shah, N. A., Taufik, S.*, et al.*
Exploring Novel Approaches: Surface Functionalization of Metal Organic Semiconductor as Sensing Material for Volatile Organic Compounds Detection.
Journal of Advanced Research in Micro and Nano Engineering, Vol. **22** n°(1), (2024), 26-42 p.

Detecting volatile organic compounds (VOCs) is imperative in healthcare, industrial safety, and environmental monitoring due to their potential harm to human health and the environment. Addressing the challenges in VOC detection, research has focused on creating sensors with rapid response and high selectivity, notably through surface functionalization of metal organic semiconductors. Metal organic semiconductors offer advantages over standard metal oxide semiconductors (MOS), demonstrating superior sensitivity and selectivity even at low temperatures and concentrations. Notably, conductive particle-polymer hybrids and conjugated polymers as metal organic semiconductors show promise for VOCs detection. This review comprehensively explores surface functionalization in metal organic semiconductors, covering principles, mechanisms governing gas sensing behavior and the pivotal role of surface functionalization in enhancing selectivity and performance. Additionally, various surface functionalization options, such as nanoparticles, nanostructures, and organic ligands, are discussed.

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Agustinur, S. C., Ramadani, R.
Formaldehyde Measurements: A Bibliometric Analysis and Systematic Literature Review.
Jurnal Pendidikan, Sains, Geologi, dan Geofisika (GeoScienceEd Journal), Vol. **5** n°(4), (2024), 674-683 p.

It can cause respiratory issues such as coughing, shortness of breath, and chest pain. In extreme cases, it can even lead to fluid buildup in the lungs, a condition that can be life-threatening. Formaldehyde can be measured using various chemical analysis methods, ranging from classical methods to modern instrument-based techniques, such as specific chemical reagents that react with formaldehyde, spectroscopy, chromatography, and electronic-based sensor techniques. This research aims to provide a comprehensive overview of the evolution of research related to formaldehyde measurements, especially relative humidity. This type of research is a systematic literature review (SLR) using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method. The database used was Scopus, covering the years 2014 to 2023, and obtained 3,489 documents. The literature review results show a

significant influence between relative humidity (RH) and formaldehyde emissions from various building materials, such as paint, wood panels, and furniture materials. The consistency of these findings suggests that relative humidity influences the amount of formaldehyde released into indoor air.

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Lavia, O.
The future of LEED v4. 1 in us hospital construction and renovation.
ResearchGate,(2024)

The Leadership in Energy and Environmental Design (LEED) v4.1 certification has significantly impacted hospital construction and renovation practices in the United States. As healthcare facilities face increasing pressures to reduce environmental impacts while maintaining high operational standards, LEED v4.1 offers a comprehensive framework for sustainable development. This article explores the future of LEED v4.1 in U.S. hospital construction and renovation, examining the evolving trends, innovations, and challenges. With a focus on sustainability, energy efficiency, and patient well-being, LEED v4.1 will likely become an essential tool for modern healthcare infrastructure, driving long-term environmental benefits and operational excellence.

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Ait Benhamou, A., Boussetta, A., Salim, M. H., Mennani, M., Kasbaji, M., Kassab, Z.*, et al.*
How can cellulosic fibers enhance adhesion in engineered wood?
Materials Science and Engineering: R: Reports, Vol. **161**, (2024), 100852 p.

Cellulosic fibers have garnered significant attention in both academic research and industry due to their appealing physicochemical properties, distinctive structural qualities, and wide-ranging applications. In the realm of wood adhesives, the utilization of cellulose has witnessed a substantial surge in the last decade. Cellulose is employed either as reinforcement in the manufacturing of various wood adhesives or as a binder for wood bonding, offering a sustainable and eco-friendly alternative to traditional adhesives. This surge in the utilization of cellulose-based wood adhesives has led to remarkable improvements in both mechanical and physical properties, contributing to enhanced wood composite materials. This review aims to provide insight into recent developments in the rapidly expanding field of cellulose-based wood adhesives, encompassing fundamental research to practical applications. The initial section offers an updated depiction of cellulose, encompassing its chemical structure, characteristics, classification, and chemical modifications, highlighting its versatility and suitability in adhesion science. The paper culminates with a comprehensive overview of its benchmarking, addressing economic and environmental aspects, and outlining prospects and future directions for sustainable wood adhesive technology. In summary, cellulose derivatives have become pivotal in enhancing wood adhesive properties while aligning with sustainability goals, making this review a valuable resource to navigate the evolving landscape of cellulose-based wood adhesives.

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Al-Rikabi, I. J., Alsaad, H., Carrigan, S., Voelker, C.
Human exposure to respiratory aerosols: Impact of ventilation rates, mixing ventilation configuration, and breathing patterns.
Journal of Building Engineering, Vol. **97**, (2024)

This study investigates airborne transmission dynamics between occupants in office rooms equipped with mixing ventilation (MV). The primary aim was to assess how different ventilation configurations, air change rates (ACH), breathing patterns, and supply air temperatures influence cross-exposure and infection risks. The experimental setup involved two thermal manikins simulating an infected and an exposed occupant within a climate chamber. The investigated parameters included four ACH levels (1.2, 2, 4 and 6.6 $h^{-}1$, representing four EN 16798–1 ventilation categories), two MV configurations (near-ceiling and near-floor inlets), two breathing patterns (nose and mouth breathing), and two supply air temperatures (19 °C and 21 °C). Carbon dioxide (CO_2) was used as a tracer gas to simulate exhaled aerosols, enabling precise measurements of effectiveness (εv), intake fraction (IF), and infection probability (P). The findings indicate that higher ACH do not uniformly improve εv but are linked to reduced cross-exposure risk. The near-floor inlet MV configuration significantly outperformed the near-ceiling configuration in reducing IF and P by 15–41 % under most investigated scenarios. Additionally, mouth breathing increased IF and P compared to nose breathing, especially at higher ACH (2, 4, and 6.6 $h^{-}1$). The results also showed that lower supply temperatures do not always

correlate with higher IF and P, as MV configuration and breathing patterns significantly influence outcomes. This research provides insights into optimizing ventilation strategies for safer indoor environments, emphasizing the importance of airflow dynamics, breathing patterns, and supply temperature in ventilation design.

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Adelodun, A. A., Rezaei, M., Ardkapan, S., Jakobsen, N. N., Johnson, M.
Impact of Sensor Placement on Indoor Air Quality Monitoring: A Comparative Analysis.
ChemRxiv Home, (2024)

This study investigates the impact of sensor placement on the accuracy and responsiveness of indoor air quality (IAQ) monitoring focusing on particulate matter concentrations. Measurements were conducted in a controlled environment using three intercalibrated sensors positioned at different locations: a wall-mounted sensor installed at 1.2 meters above the ground, a sensor placed at the inlet of an air purifier, and a sensor located at breathing height in the center of the room. A particle source was introduced at four different points within the room to simulate varying pollution scenarios. The results revealed that the wall-mounted sensor exhibited delays of up to 200 seconds in detecting peak pollutant concentrations compared to the sensor near the air purifier. Additionally, the wall-mounted sensor consistently recorded lower pollutant levels compared to the other two sensors. The findings underscore the critical importance of strategic sensor placement for accurate and real-time IAQ monitoring. Placing sensors closer to breathing zones and pollution sources provides data that more accurately reflects human exposure risks. The study concludes that wall-mounted sensors may not provide real-time air quality data in dynamic indoor environments. Further research, including computational fluid dynamics (CFD) simulations, is recommended to optimize sensor placement strategies.

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Dalay, L., Aytaç, G.
Improvement of Indoor Air Quality through CO2 Capturing Algae-Integrated Architecture.
14th International Conference on Environmental Pollution and Remediation (ICEPR 2024). 25 - 27 August, 2024 | Barcelona, Spain

A large proportion of daily activities in urban civilization are performed in enclosed spaces, which can be recognized by complex and quantitatively ranged air quality. As cities continue to grow, indoor air pollution levels increase as a consequence, causing both economic damage and major health problems. In the field of urban health, the negative effects of exposure to indoor air pollution on individual and public health are of particular concern. The negative impact of indoor air pollution and high carbon dioxide levels on public health has been linked to a higher incidence of respiratory diseases and other linked health problems occurring at the workplace, in households, in the school environment, and in vehicles. Under this scenario, healthcare costs are likely to rise while society's well-being and productivity decline [1]. Therefore, research on the effects of indoor air purifier use on human health has shown that there are advantages, particularly with regard to respiratory health [2]. This indicates that interior air quality may be improved and that air filtration systems, such as those that use algae, could actually improve human health [3]. It is emphasised in the existing literature that a multi-dimensional set of interventions is necessary to improve indoor air quality. Those methods include both preventive measures, physicalchemical technologies, and biotechnologies [4]. The study's main emphasis, biotechnological advances serves as helpful instruments in this field. In nature-based treatment systems are capable of successfully eliminating hydrophobic indoor contaminants while simultaneously controlling the relative humidity of the purified air. Thus the scope of this study focuses on the architectural integration of photobioreactor systems in which algae are grown and their potential is analysed. By lowering carbon dioxide levels and raising oxygen contents, these systems not only increase thermal control but also minimize ecological footprints, enhance aesthetic appeal, and enhance thermal regulation. Beyond air cleaning, though, the algal biomass produced in this manner has other benefits, such as extraction of valuable chemicals and production of biofuels. It is obvious that further investigation will be required to investigate the particular air purification capabilities of indoor algal systems and to optimize the design and functionality of these systems. By integrating the use of photobioreactors, this research will demonstrate and explore the potential uses and studies regarding employing algae to improve indoor air quality.

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Heimar Andersen, K., Johra, H., Rohde, L., Marszal-Pomianowska, A., Kvols Heiselberg, P., O'brien, W.
Increased Understanding of Building Operational Performance Through Occupant-Centric Key Performance Indicators.

Energy and Buildings, Vol. **323**, (2024)

This article introduces a novel framework for Occupant-Centric Key Performance Indicators (OC KPIs) which aims to increase the understanding of building performance by aligning with occupant presence during the operational phase. Unlike traditional Key Performance Indicators (KPIs), OC KPIs can better emphasize the usefulness of energy use in the building to provide services and indoor comfort to occupants when they are actually present. Within this framework, the study explores 52 traditional KPIs and OC KPIs focusing on heating use, electricity use, domestic hot and cold water use, thermal comfort, and air quality. The study case is a multi-story residential low-energy building located in Denmark (five apartments, 16 rooms). The findings suggest that incorporating occupancy data in the OC KPI calculations enables a deeper understanding of energy-related occupant behavior and Indoor Environmental Quality (IEQ). These include 1) the potential for installing a more advanced heating control algorithm by analyzing occupancy over time in relation to heating use, and 2) the identification of significant appliance-related behavior in correspondence with load matching, which can be used for predictive maintenance or personalized energy use feedback. Furthermore, OC KPIs show the potential to help detect insufficient IEQ, energy use inefficiencies due to system anomalies/faults and/or occupant behavior, and guide towards savings opportunities. Finally, this article discusses the practical implementation of OC KPIs, and compares the latter with traditional KPIs, thus supporting a paradigm shift towards a more occupant-centric assessment of building performance.

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Aldakheel, J., Mankibi, M. E., Bahrar, M.
Indoor Air Conditions Multicriteria Optimization: Finely Instrumented and in-Situ Experimental Based Investigations of Mechanical Ventilation Systems Potential.
2024 ASHRAE Annual Conference - Indianapolis

Heating, ventilation, and air conditioning (HVAC) systems emerge as the main contributor of energy demand in buildings. Reducing their energy consumption while maintaining acceptable indoor air quality and thermal comfort holds the promise of substantial environmental and financial benefits. This paper explores optimal mechanical ventilation strategies for an office space environment within the experimental setting of "HYBCELL," an advanced laboratory facility at ENTPE, France. “HYBCELL” characterizes building level environmental conditions, encompassing thermal comfort, air quality, and heating and ventilation management strategies. The study rigorously examines various levels of control strategies—manual control and simple control based on PID control, to assess their effectiveness in simultaneously enhancing occupant comfort and reducing electrical energy consumption. Emphasizing the pivotal role of thermal comfort and indoor air quality in HVAC design, double-flow ventilation is used as an energy-efficient method to improve air quality and thermal comfort. Several control scenarios are implemented to assess proper ventilation rates. These include the Demand-based Ventilation Control strategy, which adjusts ventilation rates based on occupancy levels and pollutant concentrations, and the Dynamic Setpoint Control Strategy, which adjusts the temperature and humidity setpoints of HVAC systems based on external conditions, occupancy, and IAQ measurements. The testing involved three different scenarios including observing humidity and CO2 levels without mechanical ventilation, while the second scenario employed PID control to activate mechanical ventilation, maintaining temperature and specific CO2 levels for optimal comfort. The last scenario involved manual control for ventilation to regulate temperature and fan speeds for effective humidity and ventilation rate management. The experimental setup in "HYBCELL" meticulously monitors critical indoor parameters, exploring diverse scenarios to evaluate the impact of ventilation strategies on occupant well-being and energy consumption in real-world building conditions. The scenarios also encompass testing environmental parameters at different heights within the room. Data acquisition is conducted using LABVIEW environment through collecting real-time data from sensors. In conclusion, the paper provided valuable insights into the selection and application of ventilation control strategies, which can improve ventilation conditions, guiding the design and operation of energy-efficient, comfortable indoor environments.

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Dam-Krogh, E. P., Clausen, G., Toftum, J.
Indoor environment and user perceptions in offices in Greenland compared to Denmark.
Journal of Building Engineering, Vol. **97**, (2024), 110875 p.

Most of the Greenlandic building stock comprises residential houses and apartments. Consequently, the indoor environment in Greenlandic office buildings has not been subject to wide-ranging investigations. The purpose of this

study was to investigate the indoor environment in office buildings in Greenland and to characterise the buildings, their indoor environment, and occupant well-being, health and self-assessed performance. This was done through a post occupancy evaluation (POE), where 22 office buildings, including 70 offices in Nuuk and Sisimiut, were evaluated based on indoor environment measurements and questionnaires of occupants' perceived indoor environment. This was compared with data and results from a related study in office buildings in Denmark (26 office buildings, including 83 offices) collected in the same period. The Danish office buildings performed slightly better than the Greenlandic office buildings regarding the perceived indoor environment. The measured indoor environment differed in performance between the countries when benchmarking towards the requirements and guidelines of the Danish Working Environment Authority (DWEA). It was concluded that the office buildings in Greenland did not differ much from the office buildings in Denmark regarding the measured and perceived indoor environment.

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Keller, M., Campagnolo, D., Borghi, F., Carminati, A., Fanti, G., Rovelli, S.*, et al.*
Influence of Time-Activity Patterns on Indoor Air Quality in Italian Restaurant Kitchens.
ATMOSPHERE, Vol. **15** n°(8), (2024)

This study aims to delve deeper into the relationship between the professional activities carried out in restaurant kitchens and some key air pollutants. The ultrafine particles (UFPs), nitrogen dioxide (NO2), ozone (O3), Total Volatile Organic Compounds (TVOCs) and formaldehyde (HCHO) indoor air concentrations were determined using real-time monitors. Simultaneously, the kitchen environment was characterized using video recordings with the aim to retrieve information pertaining to cooking, cookware washing and surface cleaning activities. Statistical analysis was carried out separately for the winter and summer campaigns. The obtained results confirmed that the professional activities carried out in restaurant kitchens had a significant impact on the concentrations of all the selected pollutants. Specifically, this study revealed the following key results: (i) indoor UFPs and NO2 concentrations were significantly higher during cooking than during washing activities (e.g., about +60% frying vs. handwashing and dishwasher running), mainly in the winter; (ii) washing activity had a statistically significant impact on the TVOC (+39% on average) and HCHO (+67% on average) concentrations compared to other activities; (iii) some specific sources of short-term pollutant emissions have been identified, such as the different types of cooking and opening the dishwasher; and (iv) in some restaurants, a clear time-dependent relationship between O3 and UFP, TVOC and HCHO has been observed, underlining the occurrence of ozonolysis reactions.

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Tejani, A.
Integrating Energy-Efficient HVAC Systems into Historical Buildings: Challenges and Solutions for Balancing Preservation and Modernization.
ESP Journal of Engineering & Technology Advancements (ESP-JETA), Vol. **1** n°(1), (2021), 83-97 p.

The case of retrofitting energy-efficient HVAC in historical buildings is rather specific in terms of challenges as well as potential benefits. This paper seeks to uncover the fine line between the preservation of the structural and aesthetic nature of heritage structures and the necessary introduction of contemporary HVAC technologies that work in harmony with the promotion of sustainability and energy efficiency. It is not enough to retain the looks and cultural message of historical constructions; circulation and utilisability of the constructions in today’s world should also be maintained. Since environmental issues are becoming ignorable, energy-efficient systems are crucial to mitigate costs and impacts. However, the retrofitting process is never easy owing to historical preservation codes, restrictions created by the existing building structure, and the threat that the latter poses to historical integrity. This paper also describes several concerns and issues to which solutions and strategies have been given to overcome these challenges, such as minimum invasion during installation, selecting a proper HVAC system, and incorporating advanced materials and technologies. Furthermore, this paper looks at the different cases where integration was possible and shows the advantages and possible disadvantages of the strategy. It also addresses the legal requirements on such intercessions of the general guidelines of the multifaceted interventions that require interdisciplinary cooperation to yield the best positive results. Lastly, this research confirms that the integration of historic structures into contemporary design solutions should consider the value of the former but not ignore the opportunities of the latter.

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Badmus, E.

The integration of smart technologies in LEED v4. 1 healthcare buildings.
ResearchGate, (2024)

The integration of smart technologies in healthcare facilities is becoming a critical component for achieving LEED v4.1 certification, with a focus on enhancing sustainability, improving patient care, and optimizing operational efficiency. This article explores the role of smart technologies in various LEED v4.1 categories, such as energy management, water efficiency, indoor environmental quality, and innovation. It examines how healthcare buildings can leverage smart systems to meet sustainability goals, improve resource management, and create healthier environments for patients and staff. The integration of smart building systems helps bridge the gap between sustainability and healthcare performance, ensuring that these complex facilities operate efficiently while maintaining high standards of care.

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Clements-Croome, D.
Intelligent Buildings and Infrastructure with Sustainable and Social Values
Emerald Publishing, 2024, 384 p.

Intelligent Buildings and Infrastructure with Sustainable and Social Values, Third edition is a comprehensive guide and an international reference source to the latest knowledge on the design, management, operation and technology of intelligent buildings and cities for sustainable developments that meet the needs of users now and in the future. A transdisciplinary approach underpins the beliefs expressed in the book. Written by authors from industry and academia, the book considers cultural changes affecting the way people live and work, the importance of an integrated approach to design and management, and the benefits technological developments can bring in developing sustainable buildings that meet users' needs and those to mitigate climate change.

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Mafop, N. N., Abidin, A. Z., Mohamad, H.
IoT-Based Monitoring System for Indoor Air Quality using Thingsboard.
In: 2024 IEEE International Conference on Applied Electronics and Engineering (ICAEE). 27-27 July 2024. 2024. pp. 1-6.

Indoor air pollution is a big problem because most people spend more time indoors than outdoors. Breathing in indoor pollutants for a long time can make people sick. Things like temperature, humidity and air ventilation affect people’s comfortability and health while indoors space. Indoor Environmental Quality (IEQ) is how clean the air is inside a building. It’s important for homes and workplaces to have good IEQ. During the COVID-19 pandemic, people must stay at home more which can make indoor air quality worse. Bad air in indoor space can make people sick. This project’s main goal is to make a cheap system using the Internet of Things (IoT) to monitor indoor air quality. The system monitors parameters like air temperature, humidity, Carbon Dioxide (CO 2) levels, Total Volatile Organic Compounds (TVOC) and dust density in real-time. The ESP32 microcontroller reads the sensor data and sends it to a server called Thingsboard. The server processes the data and displays it on dashboard in Thingsboard. Users can check the indoor air quality anytime and anywhere. If the sensor readings go above a threshold, an alarm is sent to users through Telegram. The system is tested in two places to make sure it works well and the results are explained.

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Vanbaelinghem, L. B. N.
Life cycle assessment of alternative heating, ventilation and air-conditioning systems for application in poultry houses.
University of British Columbia. Thèse 2024

The world population is growing rapidly, creating increasing demand for food production and security. In parallel, this also challenges our ability to sustainably meet this rising food demand. Industrial egg production is one of the fastest growing livestock sub-sectors. Hence, achieving sustainability improvements is critical for the future of the egg industry. Alternative heating, ventilation, and air-conditioning (HVAC) systems, such as geothermal systems, offer opportunities to potentially reduce the environmental footprint of conventional HVAC systems in poultry houses, which are responsible for substantial use of direct non-renewable energy use and emissions in on-farm operations. To date, the suitability of alternative HVACs in poultry houses as possible environmental impact mitigation solutions is largely unknown, as most of the literature focuses on alternative HVACs for residential and other commercial purposes. The

research objectives were first to identify a subset of alternative HVAC systems that could potentially be suitable for poultry housing by considering the thermal requirements of poultry houses, the environmental impact mitigation potentials of current systems, and their technological maturity and feasibility. The results showed that ground-source heat pumps (GSHP) and earth-air heat exchangers (EAHE) were promising systems compared to air-source heat pumps (ASHP), water-source heat pumps (WSHP) and ground-source air heat pumps (GSAHP). Thereafter, a life cycle assessment of conventional HVACs and this subset of most promising alternative HVACs for application in poultry houses was performed. This was done to compare their potential resource use, direct energy use, and environmental impacts across poultry houses in different provinces of Canada, specifically Quebec, British Columbia, Ontario, Alberta, and Nova Scotia. The comparative life cycle assessment results demonstrate that GSHP and EAHE could possibly reduce life cycle emissions and environmental impacts per tonne of eggs produced compared to the conventional HVAC systems currently used in free-run poultry houses. These alternative HVACs' environmental impact reduction potential was found to depend strongly on the local electricity grid mix and climatic region. These research insights provide a starting point to support selecting more environmentally benign HVAC systems for Canadian egg farms.

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Dingil, B.
Life cycle assessment of furniture products: A case study of a chair.
Middle East Technical University (Turkey). Thèse 2024

Furniture products have long been integral to human daily life, serving not only functional needs but also enhancing comfort and aesthetic appeal in various living spaces. However, due to the harmful effects of furniture production, the industry is under immense pressure, highlighting the critical need for sustainable practices to mitigate potential damage to the environment and human health. Life Cycle Assessment (LCA) serves as a crucial method for evaluating the environmental hotspots of processes by examining the entire life cycle of products. This study encompasses the cradle-to-grave LCA of a dining chair, based on actual and country-specific production data from Türkiye. The assessment was conducted using SimaPro 9.2.0.2 software with the Ecoinvent 3.7.1 and the U.S. Life Cycle Inventory (USLCI) databases, interpreting results across midpoint and endpoint impact categories using the ReCiPe 2016 Hierarchist method. The endpoint single score results indicated that the manufacturing stage has the highest environmental impact throughout the chair's life cycle, followed by packaging. Within the manufacturing phase, the veneer joining and upholstering stages were identified as the main contributors due to the use of urea-formaldehyde (UF) resin and woven cotton, respectively. Furthermore, scenario analysis demonstrated that recycling packaging material and the final product notably reduces environmental impacts compared to incineration. Additionally, substituting non-woven fabrics for woven textiles emerges as a promising alternative in upholstered furniture. It is concluded that the proposed alternatives, when combined, can reduce the environmental impacts of a chair product by up to 48%, highlighting significant improvement opportunities in the industry.

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Mulyawati, S. D.
Literature Review : Faktor Determinan Sick Building Syndrome pada Pekerja.
Creation: Jurnal Pengabdian Masyarakat, Vol. **1** n°(2), (2024), 20-26 p.

Sick Building Syndrome (SBS) is a health issue that affects individuals who spend a significant portion of their time in indoor environments. The symptoms of SBS include eye, nose, and throat irritation, headaches, fatigue, and difficulty breathing. This literature review examines the causes of SBS among workers, with a particular focus on recent research from the past five years. The review employed a methodology based on a review of the literature, and selected articles from Science Direct and PubMed were identified using specific keywords. The articles were required to have been published between 2020 and 2024, to be available in full text, and to be open access. Additionally, they had to focus on risk factors for SBS among the working population. The findings indicate that SBS is influenced by a number of factors, including indoor air quality, the work environment, individual sensitivity, and building characteristics. To effectively prevent SBS, strategies must be comprehensive, addressing issues such as improving air quality, optimizing the work environment, considering individual sensitivities, and maintaining building standards.

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Nazaroff, W. W., Weschler, C. J.
Methanol and ethanol in indoor environments.

Indoor Environments, Vol. **1** n°(4), (2024), 100049 p.

Although rarely the subject of focused research, methanol (CH3OH) and ethanol (C2H5OH) are among the most abundant organic compounds in indoor air. We review the state of knowledge about these alcohols as constituents of indoor air, first summarizing their physical, chemical, biological, and toxicological characteristics. Central tendencies of concentrations measured in ordinary indoor environments are 35 ppb for methanol (median; mean = 34 ppb) and 44 ppb for ethanol (median; mean = 163 ppb), much higher than in outdoor air. Concentration variability can be large both among indoor environments and over time within a given environment. Indoor ethanol concentrations above 1 ppm have been reported. Emissions from occupants contribute substantially to indoor concentrations. Other important indoor sources of methanol include wooden building materials and furnishings. Methanol emissions indoors exhibit substantial increases with increasing temperature. Indoor ethanol concentrations are strongly influenced by episodic emission events, including cooking, cleaning activities, and alcoholic beverage consumption. Homogeneous oxidation pathways appear slow as a removal mechanism relative to ventilation. Evidence regarding the importance of sorption to indoor surfaces is not fully resolved, with known sorptive reservoirs indicating little importance of this process, but a variable-ventilation experiment suggesting substantial reversible sorption for ethanol. Photocatalytic oxidation devices, intended to control indoor levels of volatile organic compounds, have a demonstrated tendency to convert ethanol to acetaldehyde, a more toxic indoor air contaminant. Ethanol transported outdoors from indoor sources may contribute to urban and regional photochemical smog.

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Gibeaux, S., Lecompte, T.

Mini revue de littérature sur les performances thermiques des isolants biosourcés et leur impact sur la qualité de l'air intérieur.

Academic Journal of Civil Engineering, Vol. **42** n°(1), (2024), 700-715 p.

Cette revue de la littérature examine les études récentes concernant les performances thermiques des matériaux biosourcés pouvant être utilisés pour l'isolation des bâtiments et leurs impacts sur la qualité de l'air intérieur (QAI). Il met notamment en évidence les risques pour la santé liés aux émissions de composés organiques volatils (COV) en intérieur. Les données soulignent l'importance de l'isolation des bâtiments pour garantir un environnement intérieur sain et économe en énergie, notamment en période de chaleur dans le contexte de changement climatique. Les matériaux biosourcés apparaissent comme une alternative prometteuse aux matériaux conventionnels, offrant des performances thermiques satisfaisantes et des émissions de COV réduites. Cependant, cette revue met également en les lacunes dans les connaissances concernant les performances thermiques et les impacts de ces matériaux sur la QAI, et la nécessité de mener des études à long terme dans des applications de construction réelles. Enfin, des suggestions sont formulées pour le développement d'un système innovant qui permettrait d'obtenir des données adaptées à chaque situation.

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Gajaba, P., Dissanayake, P.

Misconceptions in heating, ventilation and air conditioning-airside strategy implementation of commercial buildings in Sri Lanka.

12th World Construction Symposium 2024. 9-10 August 2024. Colombo, India

To lower energy consumption and emission patterns in the building sector, discussions about climate change, the depletion of fossil fuels, and energy conservation are emphasised to create a more sustainable built environment. Thus, this paper examines common misconceptions regarding the implementation of HVAC airside strategies in commercial buildings, with a primary focus on Sri Lankan commercial buildings, where Heating, Ventilation and Air Conditioning (HVAC) systems account for a significant portion of electricity consumption. For this purpose, a comprehensive literature synthesis was conducted, a qualitative research approach was used to pursue the research aim, and an interview survey using semi-structured interviews was conducted targeting 17 experts. The collected data was then analysed using content analysis using the NVivo software. The findings of the research were discussed under three topics i.e., (i) adaptation of HVAC airside strategies to a tropical country, (ii) adaptation of HVAC airside strategies to coastal and highly humid areas, and (iii) sufficiency of prioritising waterside efficiency to gain overall HVAC system efficiency. In conclusion, it was derived that a balanced approach between airside and waterside HVAC systems should be maintained for optimal energy efficiency and the HVAC system can be tailored to diverse environmental conditions

buildings are situated in. The knowledge gathered through this study can be used by industry professionals to enhance HVAC energy performance, while aiding academia in researching this sub-branch of HVAC systems in the Sri Lankan context.

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Zheng, J., Zhou, X., Wang, B., Dai, F., Liu, J.
Modified PVDF/PMMA/SiO2 composite nanofibrous membrane in airborne filtration: Transparency, mechanical properties and filtration performance.
Journal of Environmental Chemical Engineering, Vol. **12** n°(6), (2024)

A comprehensive study on four modified Polyvinylidene Fluoride (PVDF) nanofibrous membrane was conducted to fabricate transparent air filters for the first time when adding Polymethyl methacrylate (PMMA) and SiO2. The modified PVDF nanofibrous membrane properties were extensively characterized using scanning electron microscopy, infrared analysis, crystallinity, and investigated the optical transparency, mechanical properties, and filtration performance. The enhancement of PMMA is greater than the weaken of SiO2 with the PVDF/PMMA/SiO2 membrane average transparency of 70.48 %. The PVDF membrane mechanical strength enhanced by SiO2 and weakened by PMMA is visualized by a Weibull two-parameter distribution model. The PVDF/PMMA/SiO2 membrane filtration efficiency is 94.12–96.39 %, and the impressive quality factor (Qf) of 0.074 Pa^{-1} is superior to other three modified membranes in filtration performance while maintaining the sufficient ultimate tensile strength (UTS) of 20.41±0.28 MPa.

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Fadillah, I., Chan Shiau, W.
Obstacle and work-related factors that affect employee wellbeing at worplaces.
International Journal of Accounting, Finance and Business, Vol. **9** n°(55), (2024)

Nowadays, employees' wellbeing is becoming a popular topic in the world. The employer takes the wellbeing of their workers as a significant topic as a wellbeing worker can increase their productivity and improve the organization's performance. However maintaining wellbeing are also challenging because there are many obstacle that preventing wellbeing at work place. Therefore, this paper is designed to explore about what is wellbeing and why should organizations care about wellbeing. The types at workplaces, what is the major obstacle and factors that affect employee wellbeing in the workplace are also being discussed in this article. There are six types of wellbeing that an employee should granted, which included the physical wellbeing, social wellbeing, mental health wellbeing, life satisfaction wellbeing, emotional wellbeing, and psychological wellbeing. Major obstacle preventing wellbeing in the workplace such as Cost Barrier, awareness, time management, practice management, discrimination and Organizational Policies/Practices. It has been identified that there are six domain factors that affect employee wellbeing at workplaces. Besides, there are some advantages brought by wellbeing to the organization, which increasing employee resilience, employee engagement, reducing absenteeism due to illness, and hence increasing the performance and productivity of employee. Employee is an asset to the company. To ensure the success of the company or businesses, wellbeing at the workplace is an important element to achieve it. Organization need to pay more attention and take as much action as possible so that wellbeing can be maintain and improved. In a nutshell, an organization should care about the employees' wellbeing at the workplace to ensure that their workers are free of stress and able to improve productivity.

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Ahmed, S., Gobato, R., Sengupta, S., Chaudhuri, T. R., Zaman, S., Mitra, A.
Optimizing indoor air quality in hospitals with special reference to carbon dioxide.
Science and Education, Vol. **10** n°(5), (2024), 11-18 p.

Maintaining optimal CO2 levels in patient wards is crucial for ensuring the health and safety of patients and healthcare staffs. This paper explores the various factors that influence CO2 levels in critical patient wards such as ICUs, burn wards, and operating theatres of Behala Balananda Brahmachari Hospital and Research Centre in Kolkata (India). Factors such as ventilation, patient density, the presence of indoor plants, room occupancy, and design are discussed. Additionally, permissible CO2 levels are examined based on guidelines from the World Health Organization (WHO), Occupational Safety and Health Administration (OSHA), and the American Society of Heating, Refrigerating, and Air-

Conditioning Engineers (ASHRAE). Effective strategies for monitoring and managing CO2 levels are also outlined. The present paper has great significance as CO2 level within the healthcare units impacts the health and wellbeing of the patients.

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Sharma, A., Sharma, A.
Optimizing ventilation system retrofitting: balancing time, cost, and indoor air quality with NSGA-III.
Asian Journal of Civil Engineering, (2024)

Improving ventilation systems is essential for better indoor air quality, energy efficiency, and overall building performance. This study introduces a new optimization model to tackle the trade-offs between time, cost, and indoor air quality (IAQ) in ventilation system retrofitting projects. Using the Non-dominated Sorting Genetic Algorithm III (NSGA-III), the model evaluates various retrofitting options, including upgrades for ventilation capacity, energy efficiency, air quality, noise reduction, and aesthetic improvements. Each option is assessed for its impact on project duration, cost, and indoor air quality. The goal is to find the best combinations of these options that minimize both project time and cost while improving indoor air quality and meeting resource constraints. The NSGA-III algorithm generates a set of optimal solutions, providing a range of choices for balancing these factors. A comparison with existing methods shows that this new approach offers better solutions for managing these trade-offs. By selecting the most effective solution from these options using a weighted sum method, the study demonstrates NSGA-III's power in handling complex optimization problems. This model supports better decision-making in retrofitting projects, advancing both sustainability and indoor environment quality.

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Estella, L.
Post-certification performance tracking for leed v4. 1 certified hospitals.
ResearchGate, (2024)

Post-certification performance tracking is a critical aspect of ensuring the long-term success of LEED v4.1-certified hospitals. While the certification process focuses on design and construction, ongoing monitoring is essential to verify that these facilities maintain their sustainability goals in real-world operations. This article delves into the strategies and tools for tracking the post-certification performance of hospitals certified under LEED v4.1, focusing on energy consumption, indoor air quality, water use, and waste management. It explores challenges and best practices in aligning operational outcomes with the sustainability metrics initially set during certification. Furthermore, it highlights how data analytics, real-time monitoring, and predictive maintenance can support performance optimization in LEED-certified healthcare environments.

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Fatehi Karjou, P., Khodadad Saryazdi, S., Stoffel, P., Müller, D.
Practical design and implementation of IoT-based occupancy monitoring systems for office buildings: A case study.
Energy and Buildings, Vol. **323**, (2024)

This study introduces a scalable, cloud-based approach to occupancy monitoring designed to optimize HVAC operations in office buildings. It addresses the challenges of developing and implementing a multi-parameter IoT-based occupancy monitoring system by integrating various off-the-shelf sensors—CO2, infrared (IR), motion (PIR), and door status detection—into a cohesive system. Leveraging wireless LoRaWAN and novel cloud technologies, the system ensures easy installation, efficient maintenance, and robust data management. CO2-based occupancy detection models were trained using data from a reference office and validated in another office environment. Among the various models evaluated, the four best-performing ones—Decision Trees, Random Forest, LightGBM, and K-Nearest Neighbors—were selected for integration into a multi-parameter detection system. To further enhance system performance and identify optimal sensor combinations and configurations for cost-effective and accurate occupancy detection, a data fusion methodology was employed. This methodology, validated with ground-truth data from a test bed, tested the monitoring system in different office settings, ranging from single to quadruple-occupant rooms. Integration of additional parameters into the developed data fusion approach significantly improved system performance, achieving a True Positive Rate (TPR) of 95% compared to 81% with a simple baseline data fusion method. This approach also reduced

false detections during unoccupied periods, as tested in multiple rooms within the studied building, thereby enhancing the system's reliability for integration into occupancy-aware HVAC control strategies.

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Zhai, D., Bahadure, S., Ong, B., Soh, Y. C.
Predicting Carbon Dioxide Levels for Built Environment of Flexible and Hot-Desking Offices in Different Scenarios. In:
2024 IEEE 19th Conference on Industrial Electronics and Applications (ICIEA). 5-8 Aug. 2024. 2024. pp. 1-6.

This paper proposes a novel featured neural network of predicting carbon dioxide levels for built environment of flexible offices in Singapore via data-driven approach. In this work, different versions, scenarios and training algorithms are evaluated. Key findings are as follows: (1) Both version 1.1 and 1.2 are able to perform well on predicting CO 2 levels at accuracies of 90%+ and 74%+, respectively. (2) Predictive results are not significantly impacted with consolidated remarks between scenarios. (3) Experimental results show that the neural networks with batch gradient descent (BGD) outperforms stochastic gradient descent (SGD) in all versions and scenarios. The advantage differences between BGD and SGD are about 3% for version 1.1, and 13% for version 1.2.

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Atamaleki, A., Asadi, Z. S., Moradinia, M.
Quantification and probabilistic health risk assessment of benzene series compounds emitted from cooking process in restaurant kitchens.
Building and Environment, Vol. **266**, (2024)

The formation of volatile organic compounds (VOCs) during cooking processes is a significant contributor to indoor pollution. Benzene, toluene, ethylbenzene, and xylene isomers (BTEX) are aromatic hydrocarbons emitted during various cooking styles, posing potential carcinogenic (CR) and non-carcinogenic health risks (n-CR). This study measured BTEX compound concentrations emitted from three common cooking methods (barbecuing, frying, and boiling) in eight restaurant kitchens located in Birjand city, South Khorasan province, Iran. Sampling was conducted near the inhalation zone for each cooking style. The associated risk from the measured concentrations was assessed probabilistically. The study results demonstrated that frying emitted the highest levels of B, X, and E, followed by barbecuing and then boiling. For T, barbecuing showed the highest emissions, followed by frying and boiling. Overall, barbecuing generated the most pollutants, followed by frying and boiling, respectively. This pattern was also reflected in the carcinogenic (CR) and non-carcinogenic (n-CR) risks associated with each cooking method. Among the kitchens examined, all showed significant n-CR, with only one kitchen indicating a possible risk level for CR. Sensitivity analysis highlighted that chemical concentrations were the primary factor influencing exposure in most kitchens, although staff behavior was also significant in other kitchens. The findings underscore the health risks posed to kitchen staff by cooking emissions. Government policies, interventions, and legislation aimed at restaurant owners, focusing on education and environmental health, are crucial steps to mitigate this problem. Staff awareness of inhalation risks associated with emissions and strategies to reduce exposure—including proper ventilation, modifying cooking styles, and using respiratory protective equipment—can significantly mitigate health risks.

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Aljashaami, B. A., Ali, B. M., Salih, S. A., Alwan, N. T., Majeed, M. H., Ali, O. M., *et al.*
Recent improvements to heating, ventilation, and cooling technologies for buildings based on renewable energy to achieve zero-energy buildings: A systematic review.
Results in Engineering, Vol. **23**, (2024)

Due to global climate change and energy market turmoil, the world is seriously pushing to switch to renewable and diversifying energy sources. The building sector consumes an amount of energy, accounting for approximately 40 % of global energy. Therefore, the concept of zero-energy buildings has become more realistic than before. This study reveals the latest developments in zero-energy buildings through a comprehensive literature review of the past ten years. Emphasis has been placed on buildings' heating, ventilation, and cooling systems, as they constitute the most important part of the energy demand. Also, the role of negative energy resulting from an improved building envelope through the design of a building compatible with the surrounding environment, thermal insulation materials, phase change materials, vegetation cover, etc. A review was also made of the most significant renewable energy technologies, which include solar energy installations, wind turbines, and geothermal heat exchangers. The study showed that three main

axes must be achieved to reach an energy-free building: Reducing energy waste through the energy-conserving building envelope and improving HVAC systems. Raising the efficiency of the performance of renewable energy facilities by using hybrid systems with the ability and flexibility to respond to changing energy demand. These three axes are an integrated approach to achieving ZEBs; none can be neglected. This study provides important references for researchers, institutions, and decision-makers to unify efforts to achieve ZEBs. It also aims to attract attention and focus research by raising questions and identifying gaps that future research efforts can address.

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Allen, J. G.
Recommitting to Ventilation Standards for Healthy Indoor Air Quality.
American Journal of Public Health, Vol. **114** n°(10), (2024), 991-993 p.

The history of ventilation is fraught, indeed. We are in the sick building era, ushered in by a historic mistake in the 1970s with the promulgation of a standard that lowered ventilation rates in nearly every building we spend our time, and which represented a gross departure from earlier health-focused higher ventilation targets.

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Feng, Z., Ge, M., Meng, Q., Chen, Y.
Research on Old Building Renovation Strategies by using Green Building Technologies.
Preprints, (2024)

In light of the accelerated pace of economic growth and urbanisation, the transformation of green buildings has emerged as a prominent area of re-search. A considerable number of existing buildings have been constructed and are still in use. However, the energy consumption and environmental impact throughout the entire life cycle of these buildings are not adequately considered in the renovation design. This results in high energy consumption and poor indoor comfort. In this work, we include improving the thermal insulation of buildings, such as thickening the insulation of external walls and replacing energy-efficient windows to reduce energy losses caused by temperature differences between in-door and outdoor buildings; Adopt energy-efficient HVAC systems to reduce en-ergy consumption and improve indoor air quality by upgrading equipment effi-ciency, optimizing duct design, and intelligent control systems; At the same time, we will introduce renewable energy sources such as solar energy, and we will not only install solar photovoltaic panels to generate electricity, but also use solar thermal collector systems to provide hot water and heating, so as to achieve di-versified and sustainable use of energy. Combined, these measures can effec-tively reduce the overall energy consumption of the building, reduce carbon emissions, and improve the comfort and health of the indoor environment. During the experimental analysis, the energy consumption and indoor comfort before and after the renovation were evaluated, and the results showed that the energy consumption was significantly reduced and living comfort was improved.

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Kumar, S. H., Kanish, T. C.
A review on indoor air quality monitoring system: a mechatronics approach.
Aerobiologia, Vol. **40** n°(3), (2024), 373-390 p.

Indoor air pollution directly affects mortality and also morbidity; it is also a vital issue of concern for the majority of nations that are in their developing phase. Coal and biomass (crop waste, wood, dung, and charcoal) are the main household energy sources for approximately around three billion people worldwide. Additionally, as most persons spend nearly 80–90% of their time in an indoor environment regularly, indoor air quality has a vital and direct effect on both general health and productivity of them. Although outdated, air pollution monitoring is nevertheless a very important idea in daily life. The monitoring of air quality has been done using both conventional methods and the most advanced computing techniques. However, as everyone needs access to clean air, many advanced wireless technologies have been used and some of them are quite helpful in giving information related to real-time data on air quality. The main purpose of this study is to describe some advanced techniques and devices used to monitor indoor air pollution and some of the significant advancements which have been done in this research field.

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Llabrés Morey, M. A., Río Merino, M. D., Hormigos Jiménez, S.

Revisión de estudios sobre materiales que mejoren la calidad del aire interior en edificios.
Actas de congresos, 2024

The objectives of sustainability in recent decades have focused on reducing the impact that humans generate on the environment with our lifestyle. More recently, a new sustainable approach has emerged, which measures our impact on nature while placing peoples health and well-being at the center of benefits. One of these approaches is the WELL certification that represents a transformative approach in the architectural and building management sectors, focusing on enhancing indoor environmental quality, particularly in the domains of indoor air quality (IAQ) and thermal comfort. This certification underscores the intricate relationship between building environments and occupant health, well-being, and productivity. From a technical perspective, IAQ is a critical component of WELL certification, necessitating a comprehensive analysis of air composition within buildings. This encompasses the evaluation of factors such as ventilation efficacy, emission levels from building materials, and the prevalence of dust and mold. Scientific evidence links poor IAQ to a range of health issues, including respiratory ailments, cardiovascular diseases, and lung cancer. Furthermore, IAQ is directly correlated with cognitive function and productivity. Empirical studies have demonstrated that exposure to indoor air pollutants, notably PM2.5 and VOCs, can significantly impair cognitive performance, thereby affecting productivity and error rates in occupational and educational environments. Thermal comfort is another essential criterion of WELL certification that demands a more holistic approach to achieve an indoor environment with optimal temperature conditions. This approach involves a meticulous balance of variables including humidity, air movement, and personal clothing preferences, which have been identified as factors that could precipitate health complications such as heat stress or hypothermia and can adversely affect mental concentration and work efficiency when are inadequate. This study refers to the findings in indoor air quality and thermal comfort that the Performance Testing Agents from ACSOS have been identified through Performance Verifications in more than thirty buildings certified with the Well Seal in Spain, Italy, Norway, and Portugal. This information represents an office area of more than 200,000 square meters and allows us to take a glimpse of the office buildings conditions in Europe. The air quality and thermal comfort tests conducted follow a rigorous scientific basis with calibrated instruments and in collaboration with standardized laboratories from Spain.

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Feyzi, V., Alboghobeish, A., Esmaeili, S. V., Zendehdel, R., Dehghan, S. F.
A scoping review on advantages and drawbacks of nanotechnology in the field of occupational health.
Nanotechnology for Environmental Engineering, (2024)

Nanotechnology’s advancements have revolutionized industries, but concerns about its health risks for workers have intensified. Occupational health specialists play a vital role in assessing and mitigating these risks. While nanotechnology offers benefits in manufacturing, medicine, and materials science, addressing health effects and regulating nanomaterials are critical for workplace safety and efficiency. This study reviews the pros and cons of Nanotechnology in Occupational Health, examining 75 articles from reputable databases with a focus on originality and relevance. By analyzing publications up to 2024, the research team highlights key insights on the impact of Nanotechnology in promoting workplace safety and health. Initially, 198 articles were considered, leading to the selection of 73 articles that met the inclusion criteria after applying exclusion criteria. The chosen articles focused on practical and occupational aspects, including the use of nanomaterials in products such as textiles, personal protective equipment (PPE), air purification, and sensors, in alignment with the study’s objectives. The integration of nanotechnology in occupational health has led to transformative advancements in workplace monitoring, protection, and worker well-being. Nanosensors improve air quality monitoring, while smart textiles enable real-time vital sign tracking and toxic substance detection for worker safety. Despite these benefits, challenges like nanoparticles’ reactivity and health concerns require risk assessment, collaborative efforts, and regulatory frameworks to ensure safe nanomaterial use and protect worker health and the environment.

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Chukwudi Obi, I.
Sick Building Syndrome Overview- UK'S Indoor Sick Building Syndrome Formation Analysis.
International Journal of Innovative Science and Research Technology (IJISRT), (2024), 2021-2028 p.

Building-related illnesses pose a critical risk to public health and have consistently been a source of concern. The illnesses are collectively referred to as Sick Building Syndrome (SBS) and are used to elaborate on a situation in which

the occupants of a house experience headaches discomfort-related effects or symptoms of air borne diseases that seems to be connected to the time spent in houses. Symptoms are many, but in general, occupants may experience throat, eye, and nose discomfort, as well as fatigue and, on occasion, dizziness. The increased prevalence of this syndrome has prompted substantial research. Although there is no known specific cause of SBS, some experts have concluded that indoor pollutants have a significant role in exacerbating the illness. The sources of indoor pollutants include biological contaminants, chemical contaminants, and particulate matter. These contaminants include bacteria, volatile organic compounds (VOCs), and dust, respectively. This study will examine the role of indoor pollutants in Sick Building Syndrome symptoms, investigate the causes and effects, and recent progress in understanding and controlling SBS caused by these contaminants.And also outlines an overview of the UK's SBS issues.

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Yang, M., Ye, J., Yu, T., Song, Y., Qian, H., Liu, T.*, et al.*
Smartphone-based colorimetric detection of formaldehyde in the air.
Building Simulation, (2024)

Adverse impacts of exposure to formaldehyde on human health significantly increases attention in monitoring formaldehyde concentrations in the air. Conventional formaldehyde detection methods typically rely on large and costly instruments and requires high skills of expertise, preventing it from being widely accessible to civilians. This study introduced a novel approach utilizing smartphone-based colorimetric analysis. Changes of green channel signals of digital images by a smartphone successfully capture variation of purple color of 4-amino-3-hydrazino-5-mercapto-1,2,4-triazol solution, which is proportional to formaldehyde concentrations. It is because that green and purple are complimentary color pairs. A calibration curve was established between green channel signals and formaldehyde concentrations, with a correlation coefficient of 0.98. Detection limit of the smartphone-based method is 0.008 mg/m3. Measurement errors decrease as formaldehyde concentrations increase, with median relative errors of 34%, 17%, and 6% for concentration ranges of 0–0.06 mg/m3, 0.06–0.12 mg/m3, and 0.12–0.35 mg/m3, respectively. This method replaced scientific instrumentation with ordinary items, greatly reducing cost and operation bars. It would provide an opportunity to realize onsite measurements for formaldehyde by occupants themselves and increase awareness of air quality for better health protection.

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Khalil, R., El-Kordy, A., Sobh, H.
A socio-CFD approach to reduce the possibility of airborne bio-contaminant disease infection in indoor spaces.
Arab Academy for Science, Technology and Maritime Transport (AASTMT), 2024, Vol. **10** n°(2), (2024), 36 p.

This paper introduces a novel socio-CFD method called Epidemic Hybrid Retrofitting (EHR) for enhancing natural ventilation in indoor public spaces to reduce the spread of airborne bio-contaminant diseases, such as COVID-19. The method aims to reduce the infection rate of diseases by improving Indoor Air Quality (IAQ) as a quantitative objective and maximizing user satisfaction as a qualitative objective. The EHR method consists of three phases, with another method called Computational Fluid Dynamics Parametric Optimization (CFDPO) to accelerate the CFD simulation process. The proposed methods were tested in a shared office in Cairo, Egypt, using a combination of observation, investigation, questionnaires, CFD analysis, linear regression analysis, mathematical calculations, and hybrid evaluation. The study observed a recurrence of COVID-19 infections in the case study office, which was attributed to insufficient natural ventilation and occupants' lack of adherence to WHO precautionary measures. Four retrofitting scenarios were suggested based on the application of the CFDPO method. An occupant survey and CFD analysis were conducted to evaluate retrofitting scenarios, and then the Cost Reduction factor (CRf) was introduced and considered. Considering quantitative and qualitative objectives has identified the optimal scenario as Single-centered Openable Windows (SOW) by increasing the window-to-wall ratio (WWR) on the outdoor (north-facing) façade to 14.96% while maintaining a balanced indoor opening design. The optimum solution effectively achieved the desired air change rates and occupant satisfaction. The results demonstrated the applicability of the EHR and CFDPO methods to attain the objectives. The proposed methods can be further adjusted to address additional objectives in future practices. Received: 21 May 2024 Accepted: 04 August 2024 Published: 10 September 2024

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James, A., Badmus, E.
Sustainable healthcare facility operations and leed v4. 1 maintenance practices.

Researchgate, (2024)

Sustainability is a critical focus in healthcare facility operations due to their high energy consumption, waste generation, and the need for strict control over air and water quality. Leadership in Energy and Environmental Design (LEED) v4.1 provides a comprehensive framework for improving sustainability in both the construction and ongoing operations of healthcare facilities. This article explores the connection between sustainable healthcare operations and the best practices for maintaining LEED v4.1 certification. It examines strategies for reducing environmental impact while ensuring healthcare standards are upheld, focusing on energy management, water conservation, waste reduction, and indoor environmental quality.

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Dharmasena, P., Nassif, N.
Testing, Validation, and Simulation of a Novel Economizer Damper Control Strategy to Enhance HVAC System Efficiency.
Buildings, Vol. **14** n°(9), (2024)

Buildings account for over 40% of global carbon dioxide (CO2) emissions, with supply and return fans in air handling units consuming a significant portion of energy. To address this, researchers have explored innovative economizer damper control methods and identified the “split-signal” strategy, which optimizes supply airflow using a single damper as a promising approach. In this study, split-signal was further refined for practical application and energy simulation, aiming to demonstrate its effectiveness and encourage adoption in real-world building mechanical systems. Laboratory testing on chilled water variable air volume (VAV) system showed fan energy savings of 0.2–5% compared to traditional “three-coupled” control, depending on ventilation air proportions, and prevented reverse airflow. A statistical regression model, based on experimental data, was developed to predict energy savings and streamline comparisons. Energy simulations were conducted across various U.S. climate zones and revealed potential savings of 15–20% in energy use, operational costs, and CO2 emissions. With minimal financial investment, split-signal control offers a cost-effective solution to improve energy efficiency and reduce environmental impact, promoting its adoption in real-world building applications.

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Chen, S., Li, Z.
Understanding the fate of disinfection by-products in swimming pools: current empirical and mechanistic modeling insights.
Journal of Environmental Science and Health, Part C, 1-36 p.

Disinfecting swimming pool water plays a crucial role in preventing the spread of harmful bacteria. However, the interaction between disinfectants and precursors can lead to the formation of potentially disinfection by-products (DBPs). Prolonged exposure to these DBPs may pose health risks. This review study investigates recent research advancements concerning the formation, exposure, and regulation of DBPs within swimming pools. It also provides an overview of existing models that predict DBPs generation in pools, highlighting their limitations. The review explores the mechanisms behind DBPs formation under different disinfectant and precursor conditions. It specifically discusses two types of models that simulate the production of these by-products. Compared to drinking water, swimming pool water presents unique challenges for model development due to its complex mix of external substances, human activities, and environmental factors. Existing models can be categorized as empirical or mechanistic. Empirical models focus on water quality parameters and operational practices, while mechanistic models delve deeper into the kinetics of DBPs generation and the dynamic nature of these compounds. By employing these models, it becomes possible to minimize DBPs production, optimize equipment design, enhance operational efficiency, and manage mechanical ventilation systems effectively.

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Shi, H., Yang, X., Liu, Y., Huang, X., Du, X., Li, S.*, et al.*
UV-activated high-performance formaldehyde gas sensor based on P25/ZnO microspheres.
Journal of Materials Research, (2024)

Implementing sensitive and fast formaldehyde (HCHO) sensing at room temperature is still in extreme demand for practical indoor air quality monitoring. Herein, we synthesized P25/ZnO sensing materials for detecting low-concentration HCHO at room temperature. The sensing mechanism based on the P25/ZnO heterojunction was analyzed by the surface photovoltage (SPV), transient photovoltage (TPV), and X-ray photoelectron spectroscopy (XPS) results. Based on the P25/ZnO heterojunction, the obtained 1% P25/ZnO has the highest response among the synthesized sensing materials. The response of 1% P25/ZnO sensor materials to 0.9ppm and 19.1ppm HCHO reaches 44.85% and 255.42%, respectively, which is 21 and 20 times that of ZnO sensor materials (0.9ppm ~ 2.16%, 19.1ppm ~ 12.64%). Furthermore, the detection limit can be as low as 82 ppb under 360 nm light at room temperature. The selectivity, long-term stability, and repeatability of the obtained sensors at room temperature were also revealed.

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Gonçalves, S., Curling, S. F., Ormondroyd, G., Paiva, N. T., Martins, J., Magalhães, F. D.*, et al.*
Volatile organic compound (VOC) emissions from no-added-formaldehyde lignosulphonate/pMDI particleboards and their effect on indoor air quality.
Wood Material Science & Engineering, (2024), 1-9 p.

Wood-based panels, for example particleboards, are responsible for releasing formaldehyde and volatile organic compounds (VOCs), consequently polluting indoor air. Thus, the demand for eco-friendly wood adhesives, such as lignosulphonates (LS), has increased in detriment of the traditionally used urea-formaldehyde resins. However, combination with polymeric 4,4?-diphenylmethane diisocyanate (pMDI) is commonly proposed to minimize pressing times. In this study, particleboards were manufactured using a low lab-scale press factor of 7.5?s/mm. The adhesive contents were: 1.3% pMDI with 2.2% propylene carbonate (PC) solvent in the core layer and 15% LS in the surface layers. The VOC emissions of these boards were evaluated against those of commercial urea-formaldehyde boards. Headspace gas chromatography-mass spectrometry analysis indicated that the total VOC emissions were 66% higher for the LS/pMDI boards, comprising mainly of PC and furfural. After 14-days in a 25?L chamber, VOC emissions were examined according to ISO 16000-9:2006. LS/pMDI particleboards emitted four times more VOCs than standard boards, with 80% corresponding to PC and furfural, a suspected carcinogen. Consequently, the need for VOC quantification, even for bio-based boards is highlighted. An extension of EN 16516:2017?+?A1:2020 to furniture products is also advised.

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