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Aéraulique et COVID-19

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Google Scholar, Lens et WoS

Schulz, J., Lochte, V. N., Blessing, S., Stroh, A., Kriegseis, J., Kemper, N.*, et al.*
Air cleaner prototype: Reduction of airborne viruses and effects of UV-C irradiation on virus concentration and RNA copy numbers considering modeled residence times and doses.
Aerosol Science and Technology, (2024), 1-13 p.

A prototype of an air cleaner was investigated for its ability to inactivate airborne MS2 viruses via UV-C irradiation. AGI-30 impingers were used to measure virus concentrations and RNA copy numbers at the air cleaner?s inlet and outlet, which was integrated into a testing system. UV-C doses were estimated by modeling the viruses? dwell times in the device and measuring the UV-C radiance level. The appliance reduced infectious viruses by 99% to 92% in airflows ranging from 113 to 153?m?/h, with the reduction rate decreasing as airflow increased. Estimated UV-C doses ranged between 2.11 and 2.95 mWs/cm2. There was a significant correlation between the virus reduction and corresponding doses (Spearman ??=?0.77, p?=?0.0092; Kendall?s τ?=?0.60, p?=?0.0157). Modeling showed that assuming laminar flows or air exchange rates would overestimate the viral particles? residence time in the device. Measurements indicated that viral particles remained partly trapped in the device, and RNA copy numbers did not correlate with the number of infectious viruses. RNA copy number concentrations were up to 3.7 log units above plaque-forming units (PFU) levels (for non-irradiated samples) and reduced only by 19% following UV-C exposure. This discrepancy could be attributed to the RT-PCR used, which also detects RNA fragments from incomplete or noninfectious virus particles. The mismatch between RNA copy detection and the number of infectious viruses raises questions about the appropriateness of using nucleic acid copy numbers for risk assessments or modeling.

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Hamid, Z., Meyrick, B. K., Macleod, J., Heath, E. A., Blaxland, J.
The application ozone within the food industry, mode of action, current and future applications, and regulatory compliance.
Lett Appl Microbiol, (2024)

The food industry faces numerous challenges today, with the prevention and reduction of microbial contamination being a critical focus. While traditional chemical-based methods are effective and widely used, rising energy costs, the development of microbial tolerances, and growing awareness of the ecological impact of chemical biocides have renewed interest in novel biocides. Ozone, in both its gaseous and aqueous forms, is recognized as a potent disinfectant against bacteria, viruses, and fungi due to its high oxidation potential. Our review highlights several studies on the applications of ozone within the food industry, including its use for surface and aerosol disinfection and its capacity to reduce viable Listeria monocytogenes, a pertinent foodborne pathogen harbouring environmental and biocide stress tolerances and biofilm former. We also explore the use of ozone in food treatment and preservation, specifically on blueberries, apples, carrots, cabbage and cherry tomatoes.While ozone is an effective disinfectant, it is important to consider material incompatibility, and the risks associated with prolonged human exposure to high concentrations. Nevertheless, for certain applications, ozone proves to be an efficacious and valuable alternative or complementary method for microbial control. Compliance with the Biocide Products Regulation (BPR) will require ozone device manufacturers to produce proven efficacy and safety data in line with British standards based on European standards (BS EN), and researchers to propose adaptations to account for ozone's unique properties.

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Isman, N. I. I., Jalaludin, J., Suhaimi, N. F., Hashim, F., Tualeka, A. R.

Association between indoor air quality and sick building syndrome among workers in food outlets in Selangor, Malaysia.
J Environ Health, Vol. **16** n°(4), (2024)

Introduction: Indoor air pollution, causing health issues like Sick Building Syndrome (SBS), is the third largest global contributor to disability-adjusted life years, emphasizing the urgent need for improved indoor air quality. This study aimed to determine the association between Indoor Air Quality (IAQ) and SBS among workers at food outlets in Selangor, Malaysia. Methods: A cross-sectional study was carried out among 107 workers in mall, new and old food outlet. A set of standardized and validated version questionnaires of the Industry Code of Practice on Indoor Air Quality (ICOP IAQ) 2010 was distributed to obtain respondents' sociodemographic information, symptoms present at the workplace, and psychosocial information. Results and Discussion: The study found significant differences in temperature (p = 0.004), air velocity (p = 0.037), ultrafine particles (p = 0.005), and carbon dioxide (CO2) concentrations (p = 0.006) in malls, new and old food outlets. Workers in old food outlets had the highest prevalence of SBS (66.7%), compared to those in new outlets (60.5%) and mall outlets (64.7%). Environmental characteristics, such as increased dust and particulate matter during renovation (OR = 6.17, 95% CI = 1.34-28.34), repair (OR = 2.43, 95% CI = 1.03-5.76), along with temperature variations (OR = 7.21, 95% CI = 2.52-20.66) significantly influencing SBS. Conclusion: SBS prevalence in food outlets is not significantly linked to IAQ parameters, but exposure to UFP and PM2.5 may contribute to its development. However, it is significantly associated with workplace renovations and repairs for interior design, as well as varying temperatures.

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Kumar, A.
Building resilience to airborne pathogens.
In: Clean Energy: Technology, Advances, and Applications. CRC Press; 2024. 318 p.

The ongoing coronavirus disease (COVID-19) pandemic continues to escalate, profoundly altering the lives of billions of people worldwide. Meteorological parameters have been identified as inevitable factors contributing to the exponential spread of SARS-CoV-2. Poor air quality, exacerbated by modern lifestyle choices, has influenced the potential for airborne spread of the virus in indoor environments, underscoring an urgent need to improve the Air Quality Index (AQI). While lockdowns imposed due to COVID-19 temporarily improved the AQI, this alone is insufficient to fully address the problem. Although effective drugs and vaccines are available, they are not sufficient for safeguarding public health. It is important to limit or slow the spread of the coronavirus. Ventilation and air cleaning can be one important element in reducing the risk of airborne transmission indoors. This chapter reviews the AQI, explores the relationship between air quality and coronavirus transmission, assesses the impact of lockdowns on air quality, and discusses various air purifying filters that can reduce the transmission risk and improve indoor air quality. Based on these studies, a smart room management model is proposed to enhance indoor air quality.
https://www.routledge.com/Clean-Energy-Technology-Advances-and-Applications/Verma-Singh-Rajak-Nashine-Dwivedi-Kumar/p/book/9781032861043?srsltid=AfmBOorXCr53Ma3CMezYlsB7_uSxmDKm5h-72kjkSPHrEKjakSM0BYT2

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Lia, X., Zhua, L., Zhangc, N., Liud, J., Huae, W., Douf, W.*, et al.*
Can the infection risk in elevators be negligible? A comparative study of airborne.
Energy and Buildings, Vol.**324**, (2024)

People in crowded and poorly ventilated elevators are at risk of respiratory infection. However, due to the short duration of the elevator ride, the transmission of respiratory diseases in elevators does not get enough attention. To evaluate the infection risk, this study investigated the airborne transmission of respiratory

diseases in the hospital elevator by comparison to the conference room. A validated computational fluid dynamics (CFD) model was adopted to simulate airflow, temperature and tracer gas dispersion in the elevator and conference room. We used Wells-Riley model to evaluate the infection probability of the susceptible persons. In addition, the influences of source patient posture and ventilation strategy on the transmission of tracer gas were analyzed. The results showed that the infection probability in the elevator with 5 minutes (average 2.70%) was higher than that in the conference room with 50 minutes (average 1.77%). The effects of source patient posture and ventilation strategy on the infection probability in the elevator were more significant than those in the conference room. Local air circulation could gather the tracer gas inside a confined space in the elevator and led to a high infection probability. The infection risk of respiratory diseases in the elevator was non-negligible.

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Happaerts, M., Geenen, C., Michiels, J., Gorissen, S., Swinnen, J., Beuselinck, K.*, et al.*
Centralised Air Sampling From a Ventilation System for the Surveillance of Respiratory Pathogens.
Indoor Air, Vol. **2024** n°(1), (2024)

Background: The COVID-19 pandemic has triggered a renewed interest in indoor air sampling for infectious disease surveillance. However, scalability is currently limited, as samples are usually collected in a single indoor space. An alternative is to place the device within a heating, ventilation, and air conditioning system (HVAC), but this approach has not been tested against room air sampling. Methods: In this observational study, we sampled the air in an indoor fitness centre for 2 or 6?h, simultaneously in three locations of the main exercise hall and in the return plenum of the HVAC system. Samples were collected twice weekly for 11 weeks. All samples were tested for 29 respiratory pathogens using PCR. We compared the ventilation system and exercise hall air with regard to the presence and quantity of pathogens. Findings: Samples collected in two locations in the exercise hall had a similar overall sensitivity to the HVAC sampler for detecting pathogens, while a third sampling location was associated with significantly lower sensitivity. Overall, the pathogen concentration was similar in the ventilation system and the exercise hall air (ratio: 1.0; 95% CI: 0.8?1.3). Interpretation: Our results show that air sampling within a ventilation system can have equal sensitivity for detecting respiratory pathogens, compared to room-based sampling. Thus, placing samplers within central ventilation systems could increase the scalability of air sampling for infectious disease surveillance.

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Ozelame, K., Daiana.
Commissioning-based analysis of heating, ventilation, and air conditioning systems in biopharmaceutical cleanrooms: enhancing energy efficiency and reducing cost.
Revista Brasileira de Ciências Ambientais, Vol. **59**, (2024)

Cost reduction through improvement in energy efficiency is a determining factor for the optimization of operational processes and the economic sustainability of organizations. One opportunity for achieving significant levels is by designing energy-efficient heating, ventilation, and air conditioning systems for new industrial facilities. Cleanrooms, used in biopharmaceutical companies, require high air change rates to maintain cleanliness, which are particularly energy intensive. This paper analyzed data collected from third-party sources, demonstrating a method used in a biopharmaceutical facility in Ireland. The study's objective was to compute the parameters related to energy efficiency before and after fresh air volume control implementation, aiming to ascertain the effectiveness of this approach in optimizing energy consumption and ventilation performance. This case study analyzed 185 cleanrooms of different sizes and classifications; it was observed that all rooms exceeded the recommended air change per hour. The data indicated that rooms with higher volumes had greater energy waste, underscoring the importance of optimizing airflow management in large cleanroom environments. The implementation of fresh air volume control showed a reduction of 8.87% in fan energy consumption, equivalent to a decrease of 46,666 units of air change per hour annually. This

decrease in units was accompanied by a substantial reduction in fan waste, amounting to 203,399.1 kWh, and saving more than €49,055.8 per year using pressure gradient control strategies in the ventilation system. Overall, the present work provides insights into improving energy efficiency in the biopharmaceutical industry and highlights the economic and energy-saving benefits associated with implementing the proposed method. Furthermore, it offers a practical solution to reduce operational costs and environmental impact while maintaining stringent cleanliness standards, essential for cleanroom operations.

https://www.rbciamb.com.br/Publicacoes_RBCIAMB/article/view/2036
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Yao, G., Liu, Z., Shi, J., Liu, H., Ding, M., He, J.
Comprehensive evaluations of the bioaerosol filtration performance of high- and medium-efficiency filters under different influencing factors.
Building Simulation, (2024)

Bioaerosol filtration is crucial for improving indoor air quality and reducing cross-infection risk. It is necessary to conduct a comprehensive study on the bioaerosol filtration performance of air filters under different influencing factors. Firstly, this study proposed a standardized test scheme for the comprehensive evaluation of bioaerosol filtration performance. Additionally, the high-efficiency particulate air (H13) and medium-efficiency particulate air (F8) filters were evaluated in depth using Serratia marcescens bioaerosol, considering the face velocity, relative humidity (RH), and operating time. This study also investigated the impact of removing static electricity on the bioaerosol filtration efficiency (BFE) of F-filter materials. The pressure drop (ΔP) value of H13-filter and the BFE of F8-filter were significantly affected by face velocity and RH. When the face velocity increased from 5 to 20 cm/s, the H13-filter maintained a BFE above 99%, while ΔP increased by 303 Pa. During a 90 min test, the maximum change in the BFE of the H13-filter was 0.80% and ΔP increased by 26 Pa. Conversely, the BFE of the F8-filter decreased by up to 12.21%, while ΔP increased by only 3 Pa. Higher RH resulted in more pronounced changes in BFE. After removing the static electricity from the F8-filter material, the BFE decreased significantly, with a maximum reduction of 25%. The results may provide valuable insights into the application of conventional filters in bioaerosol filtration and serve as a guide for the enhancement and optimization of filter design.

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Dehne, T., Volkmann, A., Schmeling, D.
Experimental Study of Aerosol Dispersion in a Single-Aisle Aircraft with Cabin Displacement Ventilation.
Deutsche Gesellschaft für Luft- und Raumfahrt. Congrès 2024

Novel ventilation systems for aircraft cabins have attracted the attention of scientists and aircraft manufacturers over the last years due to their potential in terms of energy saving and generating a higher level of thermal comfort. Since the coronavirus pandemic the spread of aerosol particles in cabins has become another important criterion. Recent studies based on computational fluid dynamics simulations highlight the advantages of cabin displacement ventilation (CDV): reduced spreading of aerosol particles in the cabin and faster as well as enhanced particle removal. The aim of the present study is to experimentally determine the aerosol dispersion of state-of-the-art mixing ventilation (MV) -- currently installed in almost all commercial aircraft - and of CDV in the Do 728 test facility of the German Aerospace Center in Göttingen. Both concepts were analyzed in terms of various airflow rates. Further, the location of the index passenger was varied in spanwise and longitudinal direction to allow for a detailed analysis and to improve the fundamental knowledge on the parameters determining the aerosol dispersion. Overall, the results of the present study expand the knowledge regarding the influence of passenger cabin ventilation on the spread of aerosol particles. The main result is a wider distribution under mixed ventilation conditions as well as higher concentrations due to forced convection, while cabin displacement ventilation shows a much better removal of the aerosol particles. Further, the mean and maximum aerosol concentrations are lower for CDV compared

to MV conditions. In case of MV, the spread of particle is strongly influenced by the source position, both longitudinally and in the cross-section direction.

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Wu, Y., Zhou, W., Liang, X., Su, X., Xu, K., Xia, Y., *et al.*
Influence of trains meeting on the ventilation performance of equipment compartment with independent air duct in high-speed train: numerical and experimental study.
Railway Engineering Science, (2024)

During the train meeting events, train equipment compartments are exposed to the worst pressure changes, potentially affecting the ventilation performance of equipment, particularly for electrical facilities equipped with independent air ducts. In this paper, a two-step method is used for numerical computation: (1) obtaining the temporal and spatial transient node data of the flow field sections during the train-passing simulation and (2) using the data as the input data for the equipment compartment simulation. In addition, this paper also compares the difference in equipment ventilation between the single-train and train-passing scenarios in real vehicle tests. The results indicate that the primary factors influencing ventilation effectiveness are the aerodynamic compression and deceleration of airflow induced by the other train's nose, as well as the instability of the external flow field in the wake of the other train. During train crossing, the air is forced into the air duct, with a maximum ratio of the airflow in-duct to the airflow out-duct reaching 3.2. The average mass flow falls below the rated mass flow for the converter. Compared to the rated air volume of converter, the maximum suppression rates obtained from testing and simulation are – 24.5% and – 16.8%, respectively. Compared to the single-train operation, the maximum suppression rates obtained from testing and simulation are – 15% and – 18%, respectively. These findings provide valuable insights into the design and operation of high-speed trains.

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Zimmerman, T., Sharma, N., Bulu, H., Burrowes, V., Beymer, D., Mukherjee, V.
Interactive Simulation of Nonpharmaceutical Interventions of Airborne Disease Transmission in Office Settings.
International Journal of Environmental Research and Public Health, Vol. **21** n°(11), (2024)

The COVID-19 pandemic has caused major disruptions to workplace safety and productivity. A browser-based interactive disease transmission simulation was developed to enable managers and individuals (agents) to optimize safe office work activities during pandemic conditions. The application provides a user interface to evaluate the impact of non-pharmaceutical interventions (NPIs) policies on airborne disease exposure based on agents' meeting patterns and room properties. Exposure is empirically calibrated using CO2 as a proxy for viral aerosol dispersion. For the building studied, the major findings are that the cubicles during low occupancy produce unexpectedly high exposure, upgrading meetings to larger rooms reduces total average exposure by 44%, and when all meetings are conducted in large rooms, a 79% exposure reduction is realized.

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Mohd Razi, R. A., Wan Mohd Azmi, W. F.
Pandemic-Related Safety and Health Challenges in the Construction Industry.
International Journal of Business and Technology Management; Vol 6 No S2 (2024): SPECIAL ISSUE: International Undergraduate Conference (IUCon) 2024 - 2nd Edition, (2024)

The COVID-19 epidemic has significantly impacted the construction sector, affecting safety regulations and practices globally. This research addresses the multidimensional challenges of pandemic safety and their implications for workers and project management. Key issues include worker management, crew rotation, and compliance with public health laws. Previously routine practices like shift work and crew rotation have

become complex as projects strive to maintain productivity while safeguarding worker health. This study aims to ensure a safe working environment during a pandemic, both on-site and in the office. The main objective of this paper is to identify pandemic-related safety and health challenges. The research employed a quantitative method, distributing questionnaires to Grade G7 contractor firms in Selangor. Findings revealed that most contractors strongly agree on the challenges related to pandemic safety and health, such as emergency response, social distancing, and regulatory compliance. Ultimately, this paper provides a roadmap for safeguarding workers and sustaining productivity in the construction industry amidst ongoing and future public health crises.

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Cheng, P., Jia, W., Liu, L., Yen, H.-L., Li, Y.
A power-law distribution of infectious quanta for the top 30% of SARS-CoV-2-infected individuals.
Building and Environment, (2024)

Minimising airborne infection with respiratory viruses, such as SARS-CoV-2, requires knowledge of the infectious quanta generation rate for determining the minimum dilution requirement. The two existing methods for estimating quanta generation rates are the viral load method and outbreak method. The former method is challenged by significant uncertainty in input data, including dose-response parameters and infectious viral loads. The latter method, based on the Wells–Riley equation, is challenged by significant individual heterogeneity in quanta generation rates and lack of outbreak data. In this study, the two methods are integrated for studying the quanta generation profile of all individuals infected with an ancestral SARS-CoV-2 strain, based on four reported outbreaks of infection. The airborne transmission droplet size ranges in the four outbreaks, which were determined in previous studies, are used to estimate the hourly volume of expired droplets for the viral load method. Various viral load datasets and conversion factors from RNA copies to infectious quanta are tested. Two criteria are used to identify the probable quanta generation profile, i.e. 70% of infected individuals do not infect others, and the estimated quanta generation rates estimated using the outbreak method should be within the top 80%–99% of infected individuals. The predicted quanta generation profile of all individuals infected with SARS-CoV-2 follows a log-normal distribution, whereas that of the top 30% of infected individuals approximately follows a power-law distribution. Practical significance: A major obstacle in defining dilution requirements for minimising airborne infection is the lack of infectious quanta generation rates for the general population. Our approach integrates two existing quanta estimation methods and paves the way to obtaining reliable quanta generation rate profiles at the population level.

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Kiil, M., Mikola, A., Võsa, K.-V., Simson, R., Kurnitski, J.
Ventilation effectiveness and incomplete mixing in air distribution design for airborne transmission.
Building and Environment, Vol. **267**, (2025)

How ventilation should be arranged to be effective at reasonable air change rates is one key question as ventilation criteria and standard airborne disease transmission models are based on the well-mixed assumption, but air distribution patterns lead to non-uniform spatial concentrations. In this study a new method for ventilation effectiveness application in ventilation design for airborne transmission was developed and tested with tracer gas measurements in 22 rooms. Contrary to existing ventilation effectiveness values measured with distributed source, the developed method uses a couple of point source locations corresponding to an infector to quantify infection risk for each occupant. Novelty of the method is new ventilation effectiveness indicator that makes it possible to describe the effect of spatial variation of concentration and risk with single parameter. Quanta were used as input data to calculate the ventilation rate supplied by air distribution system corresponding to a specified risk level, but the differences between studied cases do not significantly depend on the quanta values. Application of the method to measured rooms showed that simple ventilation effectiveness calculation from average concentration at the breathing height,

not requiring quanta data, provided lower ventilation effectiveness and higher ventilation rate in all cases. In many cases the difference in required ventilation rates was only a few percent, but in some large spaces it exceeded 10% with maximum of 39% in large open plan office with high concentration differences. Measured ventilation effectiveness values ranging from 0.5 to 1.4 indicate a substantial improvement potential in many cases.

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Nored, A., Fu, X., Qi, R., Batbaatar, N., Jia, C.

Volatile Organic Compound (VOC) Contamination in Hotel Rooms: A Pilot Study to Understand Sources and Health Risks.

International Journal of Environmental Research and Public Health, Vol. **21** n°(11), (2024)

The COVID-19 pandemic drove the use of cleaning products, causing organic solvent contamination in hospitality environments. This pilot study investigated the presence and concentrations of volatile organic compounds (VOCs) in selected hotels in four different US cities with varying star ratings at the end of the pandemic period. Targeting 139 VOCs, 57 were detected across eight groups: alcohols, halocarbons, aromatics, alkanes, terpenes, carbonyls, ethers, and esters, in the indoor air. Alcohols were the most prevalent, especially in lower-rated hotels, suggesting higher use of cleaning supplies. Elevated levels of aromatics were detected in hotels rated under three stars, with a notable disparity compared to higher-rated hotels. Additionally, alkanes and terpenes such as n-tetradecane and d-limonene were consistently detected. Health risk assessment showed concentrations of all VOCs remained below their health criteria for customers. The cumulative cancer risk was 2.25 × 10−6 for hotel workers from chronic occupational exposure to eight carcinogenic VOCs, representing 1/3 of the lifetime risk from these chemicals in the ambient air. Cancer risks from individual VOCs ranged from 0.001 × 10−6 to 1.07 × 10−6, with chloroform accounting for nearly half of the cumulative risk. The findings underscore the need for careful selection and use of furnishings and cleaning supplies and for effective indoor air pollution control and management in hotel indoor environments.

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Patrick, D.

What Has the COVID-19 Pandemic Taught Us?

In: Effective Pandemic Response: Linking Evidence, Intervention, Politics, Organization, and Governance. WORLD SCIENTIFIC; 2024. 3-7 p.

The COVID-19 pandemic is described by many people as an unprecedented event. Since its emergence in late 2019, SARS CoV-2 has spread around the world, caused millions of global deaths, reduced life expectancy, and caused widespread economic disruption and social upheaval. While most people alive today have never experienced a pandemic on this scale, these occurrences have been regular, if not predictable, throughout human history. Many have caused far greater relative mortality than what we experienced with COVID-19, and have changed the course of societies and civilizations [1]. While SARS CoV-2 is a dangerous pathogen, it has produced nowhere near the case-fatality rates of historic pandemics, such as bubonic plague. Moreover, we currently enjoy the benefit of applying germ theory, public health measures, microbial genomics, and immunization ? the application of which has had huge potential to reduce spread and morbidity; however, factors beyond science have led to unequal benefits from these advances?

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