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Aéraulique et COVID-19

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Google Scholar, Lens et WoS

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Mckee, G., Scharpf, D., Loudin, L. C.
Calibrated Networkable UV-C Sensors for Real-time Dosage Characterization of UVGI Devices.
Conference on Light-Emitting Devices, Materials, and Applications XXVI at SPIE Photonics WEST OPTO Conference, SPIE OPTO, 2022, San Francisco, California, United States

Ultraviolet Germicidal Irradiation (UVGI) is a proven method of disinfection for both bacterial and viral pathogens. Since the acceleration of the COVID-19 pandemic caused by SARS-CoV-2, the industry has witnessed significant technological innovation and an influx of UV-C LEDs, devices, and disinfectant enclosures. To ensure germicidal efficacy, UV-C LEDs and associated devices need accurate characterization of their optical power and irradiance. When UV-C sources are installed in enclosures and rooms, additional challenges arise that need to be evaluated to ensure germicidal efficacy is maintained. These challenges include 1) under- and over-dosing due to non-uniformity of UV-C dosage, 2) poorly understood room/chamber dynamics and reflectance, 3) shadowing, and 4) sensor, material, and source degradation. Here, we introduce a new detector portfolio that is calibrated at critical UV-C wavelengths, such as 265 nm, and enables real time UV-C Irradiance measurements at near-field and far-field. Temporal monitoring of irradiance allows for real time dosage calculation. Seasoned optical components ensure accurate detector performance and enable source output degradation monitoring. An adaptable API, network capability, and a dashboard facilitate simultaneous monitoring of multiple detectors and easy integration with existing installation infrastructure. With a proprietary cosine diffuser, these detectors include an exceptional f(2) directional response making them ideal for deployment in rooms, enclosures, and HVAC systems.

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Durand-Moreau, Q.
COVID-19 et travailleurs essentiels hors secteur de la santé : le cas des travailleurs des abattoirs et des services funéraires.
Archives des Maladies Professionnelles et de l'Environnement, Vol. **83** n°(4), (2022), pp. 357-358

La pandémie de COVID-19 a été l'occasion de mettre en lumière les travailleurs essentiels, définis comme étant indispensables pour préserver la vie, la santé et le fonctionnement de base de la société. Des travaux ont été initiés pour étudier les répercussions de la COVID-19 chez les professionnels de la santé. Il semble qu'à ce jour il y ait moins d'études qui se soient penchées sur les autres populations de travailleurs essentiels. Nous aborderons le cas des professionnels de l'abattage et des services funéraires. Début mai 2020, un quart de la totalité des cas de COVID-19 de l'Alberta étaient rattachés à trois abattoirs et près de 1000 rattachés à l'abattoir de High River. Nous avons réalisé une revue rapide de la littérature afin de comprendre les facteurs de risque propres aux abattoirs. Nous avons identifié une variété de facteurs de risque expliquant à la fois une meilleure stabilité du SARS-CoV-2 (surfaces métalliques, humidité, température…) et une contamination facilitée entre travailleurs (organisation des chaînes de production, espaces réduits dans les vestiaires, ventilation inadéquate…). Des facteurs sociaux ont également joué un rôle majeur dans la genèse de ces clusters : mauvaise maîtrise de la langue avec un accès complexe aux informations officielles, relayées de manière déformée par les chefs de production, faible niveau de protection sociale et encouragements à rester travailler malgré les symptômes… La surmortalité liée à la COVID-19 a généré un surcroît de travail pour les professionnels du secteur funéraire. Les restrictions en place ont modifié la manière d'envisager les sépultures (restrictions de la taille des groupes, funérailles par webcam…). Nous avons initié une enquête à l'échelle fédérale canadienne avec 58 professionnels du secteur funéraire afin d'évaluer leurs niveaux d'anxiété, de

dépression et de stress au travail entre mai et juillet 2020. Aucun travailleur n'a déclaré avoir eu la COVID-19. Nous n'avons pas mis en évidence de lien entre les niveaux d'anxiété et de dépression et la province d'origine, classées en fonction de la sévérité de l'épidémie. Nous avons identifié des éléments sans lien avec la COVID-19 comme une différence homme-femme significative sur le niveau d'anxiété, l'accès à des responsabilités managériales ou le surinvestissement au travail. Il est important de s'intéresser aux travailleurs essentiels hors secteur de soin. Les clusters de COVID-19 dans les abattoirs à l'échelle mondiale sont toujours relativement fréquents. Ils illustrent l'intrication entre santé au travail et santé publique. En revanche, la pandémie à COVID-19 ne doit pas faire perdre de vue les autres problématiques professionnelles qui persistent.

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Boatman, M. N.
Detecting SARS-CoV-2 From Dorm HVAC System Using PCR.
Honors Thesis, East Carolina University 2022

As universities became more acclimated to the hardships of COVID-19, East Carolina University began to search for other preventative detection methods as the campus reopened for students. We implemented air sampling of the HVAC systems in campus dorms to determine if SARS-CoV-2 could be detected. We present findings here from the fall 2021 semester. Two large dormitories were tested during the four-month sampling period. Each dorm contained one button air sampler that measured over a 24-hour period before collection. In one of the experimental dorms, the AerosolSense sampler was deployed for 5 weeks before being transferred to the isolation dorm suite, containing students with confirmed COVID-19. The known COVID positive dorm was sampled using four different methods: Button Sampler, Filter Cassette, BioSampler, and AerosolSense sampler, with sampling times ranging from 30 minutes to 24-hours. We developed protocols for stabilizing and extracting the RNA and performed qRT-PCR analysis to detect the presence of the SARS-CoV-2 virus. In the two large experimental dorms, we detected 12 positives, 10 using Button Samplers out of 58 samples and 2 using the AerosolSense Sampler out of 10 samples. In the COVID isolation dorm, we detected 22 positive samples out of 137 samples. Of the 22 samples, 11 were retrieved from Button Samplers out of 74 samples, 4 from Filter Cassettes out of 25 samples, 6 from the BioSampler out of 25 samples, and 1 from the AerosolSense Sampler out of 11 samples. Out of 203 samples collected over the semester, 34 (16.7%) were positive for SARS-CoV-2 by qRT-PCR testing, however there were no confirmed COVID cases on many of those days so we would expect no detection. We have demonstrated that it is possible to detect the SARS-CoV-2 virus using air samplers in HVAC systems of shared living spaces, such as dormitories. However, we do not know the lower limit of detection. Further work will be needed to determine how virus detection in the air relates to disease transmission.

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Zhang, Y.
Evaluation and Suggestions of commercial spaces for Covid-19 prevention in Edinburgh, UK.
2022 International Conference on Civil Engineering, Architecture and Transportation (CEAT 2022)

The global outbreak of COVID-19 poses a severe threat to various frontiers of life, which has attracted the wide attention of the government and the people to the epidemic disease. Various industries, therefore, have formulated epidemic prevention measures. The city's public spaces are the main areas of close contact with people, which is the difficulty and critical point of epidemic prevention, especially in ancient cities with dense buildings. This article takes the city of Edinburgh in the UK as an example to explore the current situation and spatial problems of public space in residential areas along the street in the post-epidemic era by questionnaire survey. Meanwhile, this study also discusses and proposes measures to optimize the spatial contradictions of commercial spaces on the ground floor affected by the epidemic. Results show that commercial spaces on the ground floor are urban spaces with a highly dense crowd, high-risk disease diffusion, and relatively inferior control capability during the epidemic. Many ancient buildings in Edinburgh that have been preserved for

hundreds of years also have some drawbacks such as narrow interior space and poor ventilation conditions, exacerbating the spread of the epidemic. By contrast, green space is more conducive to epidemic prevention and control. Combined with the advantages of green space, it is suggested to introduce green plants and improve ventilation of commercial spaces to reduce the spread of the epidemic, such as green plants separating spaces and ventilation filtering air.

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Wu, J., Chen, J., Olfert, J. S., Zhong, L.
Filter evaluation and selection for heating, ventilation, and air conditioning systems during and beyond the COVID-19 pandemic.
Indoor Air, Vol. **32** n°(8), (2022)

Particle size removal efficiencies for 0.1–1.0 μm (PSE 0.1-1.0) and 0.3–1.0 μm (PSE0.3-1.0) diameter of Minimum Efficiency Reporting Value (MERV) filters, an electrostatic enhanced air filter (EEAF), and their two-stage filtration systems were evaluated. Considering the most penetrating particle size was 0.1–0.4 μm particulate matter (PM), the (PSE0.1-1.0) as an evaluation parameter deserves more attention during the COVID-19 pandemic, compared to the PSE0.3-1.0. The MERV 13 filters were recommended for a single-stage filtration system because of their superior quality factor (QF) compared to MERV 6, MERV 8, MERV 11 filters, and the EEAF. Combined MERV 8 + MERV 11 filters have the highest QF compared to MERV 6 + MERV 11 filters and EEAF + MERV 11 filters; regarding 50% of PSE0.1-1.0 as the filtration requirements of two-stage filtration systems, the MERV 8 + MERV 11 filtration system can achieve this value at 1.0 m/s air velocity, while PSE0.1-1.0 values were lower than 50% at 1.5 m/s and 2.0 m/s. EEAF obtained a better PSE0.3-1.0 in the full-recirculated test rig than in the single-pass mode owing to active ionization effects when EEAF was charged by alternating current.

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Launer, J.
How to avoid getting COVID-19: a guide for the perplexed.
Postgraduate Medical Journal, Vol. **98** n°(1163), (2022)

In some countries including the United Kingdom and United States, much of the population has effectively stopped taking any precautions against COVID-19. Collectively, people have decided to 'live with COVID-19' – as if this means making no attempts to mitigate it. Doctors appear to be no exception. I attended a medical conference in June where fewer than five per cent of the audience wore masks. Emergency doors were shut rather than kept open for ventilation. Because of this I only entered the auditorium for my own presentation, which was on a stage at a distance from the audience. I asked if the other presentations could be streamed so I could watch them on a screen in another room. I wore an N95 mask in the foyer and held an interactive workshop outdoors. Although I went to two dinners for the speakers, I asked to sit near an open door or window. Everyone was kind and obliging about my requests, but I was the only person among several hundred doctors to behave in this way. Many participants came away with COVID-19. I did not. Although luck probably played a part, I doubt if it was the only factor. Afterwards, I discovered that a conference organisation in California now requires indoor masking and provides catering outdoors, as well as doing case tracing. After an event in February when they followed these rules, they evidently had no cases of COVID-19.1 My experience led me to think there is a need for simple guidance to support anyone who is unhappy about 'living with COVID-19' and wants to avoid it if possible without becoming a hermit. Many people, even doctors, seem have become defeatist about COVID-19 and expect they will catch it anyway, or they are perplexed by contradictory information and advice. Public health …

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Aleksenko, B. A., Dobrotvorskiy, S., Basova, Y., Sokol, Y., Edl, M., Dobrovolska, L.

Innovative Technology to Combat Sars-Cov Using a Finely Dispersed Catching Medium and Microwave Energy.
International Conference on Reliable Systems Engineering (ICoRSE) - 2022

Due to the current acute problem of combating the SARS-CoV coronavirus, our team has proposed an innovative technology to combat the virus in closed or ventilated rooms. The developed design of ventilation equipment ensures the inactivation of coronavirus by thermal exposure of sufficient duration. The virus is destroyed outside the human body, so sterilization is preventive. Capturing the virus from the airflow and its retention with subsequent disinfection occurs using a finely dispersed catching medium, using the effect of coagulation of the medium vapors, its coalescence, and intense heating. The use of highly efficient heating technology using microwave energy allows sterilizing the virus with minimal energy consumption. Unlike virus disinfection technologies developed in the world using ultraviolet radiation, the technology we offer involves a long-term deactivating thermal effect on the virus, which ensures a high degree of disinfection.

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Conet, A., Bogaert, P.
Modélisation du CO2 en tant qu'indicateur de l'efficacité de la ventilation dans les écoles.
Faculté des bioingénieurs, Université catholique de Louvain Thèse 2022

Dans nos sociétés modernes, la population passe en moyenne entre 80% et 90% de son temps dans des espaces clos (habitats, locaux de travail, moyens de transport, …). Ces espaces se sont avérés contenir une multitude de contaminants préjudiciables pour la santé à court terme (SBS, performances scolaires, inconfort) et à long terme (exacerbation des symptômes de l'asthme, développement de maladies cardiaques et pulmonaires, voire cancers). Pour améliorer la qualité de l'air intérieur (QAI) dans les bâtiments, la ventilation est une approche particulièrement intéressante dans la mesure où permet de diluer et d'évacuer les contaminants intérieurs, d'impacter positivement les performances scolaires et de diminuer le niveau d'inconfort lié aux odeurs corporelles. Plusieurs études ont cependant montré que, dans la plupart des établissements scolaires, la ventilation ne permet malheureusement pas d'atteindre les exigences de ventilation et peut donc être qualifiée d'insuffisante. En Belgique, ce constat a notamment été fait par la Cellule Régionale d'Intervention en Pollution Intérieure (CRIPI) de Bruxelles Environnement pour les écoles de la Région de Bruxelles-Capitale. Dans ce contexte, le but principal de ce travail est d'émettre des recommandations en termes de gestion de la ventilation (position des ouvrants, durée et fréquence d'ouverture) permettant de maintenir les concentrations en CO2 sous le seuil défini par les autorités, à savoir 1000 ppm. Pour cela, nous avons tout d'abord trouvé un modèle permettant de simuler l'évolution temporelle du CO2 dans les classes en fonction du nombre d'occupants, de la fréquence et de l'efficacité de la ventilation (ici, taux de renouvellement de l'air). Dans un second temps, les taux de renouvellement de l'air (N) pour différentes positions d'ouvrants ont été estimés sur base des concentrations en CO2 mesurées dans des écoles du projet ExpAIR-écoles. Ensuite, nous avons construit 16 stratégies de ventilation sur base d'une revue de la littérature. Finalement, nous avons simulé l'effet de ces 16 stratégies sur l'évolution temporelle de la concentration en CO2 dans une classe type. A travers cette étude, nous avons observé que les concentrations en CO2 simulées pour une stratégie de ventilation donnée peuvent fortement différer en fonction des valeurs de N utilisées pour la simulation. Sur les 16 stratégies, seule l'ouverture complète des portes et des fenêtres durant toute la journée permet de maintenir les concentrations en CO2 dans les classes en-dessous de 1000 ppm, et cela quelles que soient les valeurs de N utilisées (pour les simulations). Nous avons cependant souligné qu'une telle stratégie génère au minimum 1.5 fois plus de pertes énergétiques que la plupart des autres stratégies. Une alternative intéressante serait de limiter les périodes de ventilation aux récréations et à la pause de midi. Appliquer cette alternative permettrait de diviser (au minimum) les pertes énergétiques par 4. Les étudiants seraient par ailleurs exposés à des niveaux acceptables en CO2 pendant au moins 21.2% de leur temps en classe. Au vu de la variabilité observée au sein des distributions de N et des limites de ce travail, d'autres études devront être menées à posteriori pour affiner les résultats, améliorer la

qualité des simulations et proposer des stratégies plus réalistes. Ce travail ne constitue donc pas une fin en soi mais une base pour de futures études.

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Mallineni, S. K.
Modern Modifed Aerosol Box: An Isolation for oral health care professions during Oral and Dental Procedures during and Post Pandemic: Modern Modifed Aerosol Box.
Journal of Population Therapeutics and Clinical Pharmacology, Vol. **29** n°(03), (2022)

COVID-19 affected healthcare professionals globally and especially dentists. This vulnerable disease transmits through contact and is airborne. Most of the dental procedures are aerosol generated and these aerosols in dental practice tend to transmit acute respiratory infections like COVID-19. Recently there are a few authors who recommended the use of the aerosol box to reduce the aerosol count in the dental setting. However, the purpose of the manuscript was to describe and recommend a reformed aerosol box design with a stand to practice safe dentistry.

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William, M. A., Jose Suarez-Lopez, M., Soutullo, S., Fouad, M. M., Hanafy, A. A., El-Maghlany, W. M.
Multi-objective integrated BES-CFD co-simulation approach towards pandemic proof buildings.
Energy Reports, Vol. **8**, (2022), pp. 137-152

COVID-19 has posed an extraordinary burden to those professionals responsible for properly operating and safely maintaining facilities throughout this disaster. Considering this global pandemic, the common spaces in buildings must be reconsidered to accommodate a future in-presence existence. Governments address human health and safety as the most vital considerations worldwide; thus, Heating, Ventilation, and Air Conditioning (HVAC) designs, airflow patterns, and temperature distribution must all be reconsidered to achieve such healthy circumstances. Based on this, a Building Energy Simulation-Computational Fluid Dynamics (BES-CFD) validated model has been analysed in terms of various HVAC designs. The simulations assessed the proposed solutions in terms of energy-saving, operational CO2 emissions, thermal comfort enhancement, and infection control. The results were closely examined and showed that the Underfloor Air Distribution (UFAD) system generates approximately laminar vertical airflow, reducing the likelihood of indoor infections and viral transmission. Supply air is delivered to the inhabitants' zone without sacrificing mixing efficiency, ensuring long-term indoor environmental quality. Moreover, the UFAD model proved to be more cost-efficient compared to the Conventional Overhead Distribution (COHD) and has a lower carbon footprint and energy consumption. In terms of thermal comfort, the dynamic simulations showed a noticeable enhancement in PMV. Additionally, the UFAD provides a vertical temperature gradient profile that is sufficiently uniform. Moreover, the integrated DOAS-UFAD systems' effectiveness was proved through a techno-economic analysis with a Return on Investment of 8.25% and a Payback period of 7.3 years.

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Park, S., Mistrick, R., Rim, D.
Performance of upper-room ultraviolet germicidal irradiation (UVGI) system in learning environments: Effects of ventilation rate, UV fluence rate, and UV radiating volume.
Sustainable Cities and Society, Vol. **85**, (2022)

Previous studies show that upper-room ultraviolet germicidal irradiation (UVGI) systems can help contain infectious airborne viruses indoors. However, there has been a lack of research on the performance of an upperroom UVGI system in learning environments such as a school classroom. Since classrooms are more vulnerable to airborne transmission of diseases due to high occupancy for long hours, airborne infection characteristics are different from other occupied indoor environments (e.g., offices and residences). The

objective of this study is to investigate UVGI system performance in a classroom considering detailed effects of ventilation rate, UV fluence rate, and UV radiating volume. Two analytical models, a one-zone and a two-zone material balance model, along with computational fluid dynamics (CFD) simulations, were employed to analyze viral aerosol concentrations under a representative range of classroom operating conditions. The CFD results show that increasing ventilation rate from 1.1 h-1 to 5 h-1 yields about 85% of airborne disinfection while doubling UV radiating volume results in a 60% disinfection. However, increasing UV fluence rate from 25 mu W center dot cm-2 to 50 mu W center dot cm-2 yields a moderate additional disinfection of 18%. Overall, the study results reveal that operating a UVGI system in an occupied classroom can markedly disinfect airborne viruses up to 96%, which is as effective as increasing ventilation rate more than five times. Furthermore, the results suggest that the one-zone and two-zone analytical models used in several previous studies could result in notably meaningful errors in analyzing viral aerosol concentrations, especially in occupied rooms with a highly non-uniform airflow distribution.

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Guyot, G., Sayah, S., Guernouti, S., Mélois, A.
Role of ventilation on the transmission of viruses in buildings, from a single zone to a multizone approach.
Indoor Air, Vol. **32** n°(8), (2022)

In a virus pandemic context, buildings ventilation has been recognized as a solution for preventing transmission of the virus in aerosolized form. The impact of the widespread recommendation of window opening and sealing door on ventilation circuits needs to be considered with a multizone approach. We modeled the airflow distribution in a building where people are isolating in a pandemic context, including one infected person. We analyzed the impact of opening the window and sealing the door in the quarantine room on exposures and probability of infection for occupants of the flat and of adjacent flats. In order to study the sensitivity of the results, we tested three ventilation systems: balanced, exhaust-only, and humidity-based demand-controlled, and several window- and door-opening strategies. When the door of the quarantine room is sealed, we observe that opening the window in the quarantine room always results in increased exposure and probability of infection for at least one other occupant, including in neighbors' apartments. When all internal doors are opened, we observe moderate impacts, with rather an increase of exposure of the occupants of the same apartments and of their probability of infection, and a decrease for the occupants located in other apartments. Based on the analysis on the airflows distribution in this case study, we conclude that sealing the internal door has more influence than opening the window of the quarantine room, whatever the ventilation system. We observe that this widespread recommendation to open the window of a quarantine room and to seal the door is based on the consideration of a single zone model. We illustrate the importance of moving from such a single zone approach to a multizone approach for quantifying ventilation and airing impacts in multizone buildings as residences in order to prevent epidemics of viruses such as SARS-CoV-2. It highlights the need of air leakage databases.

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Silva, P. G., Branco, P. T. B. S., Soares, R. R. G., Mesquita, J. R., Sousa, S. I. V.
SARS-CoV-2 air sampling: A systematic review on the methodologies for detection and infectivity.
Indoor Air, Vol. **32** n°(8), (2022)

Abstract This systematic review aims to present an overview of the current aerosol sampling methods (and equipment) being used to investigate the presence of SARS-CoV-2 in the air, along with the main parameters reported in the studies that are essential to analyze the advantages and disadvantages of each method and perspectives for future research regarding this mode of transmission. A systematic literature review was performed on PubMed/MEDLINE, Web of Science, and Scopus to assess the current air sampling methodologies being applied to SARS-CoV-2. Most of the studies took place in indoor environments and healthcare settings and included air and environmental sampling. The collection mechanisms used were

impinger, cyclone, impactor, filters, water-based condensation, and passive sampling. Most of the reviewed studies used RT-PCR to test the presence of SARS-CoV-2 RNA in the collected samples. SARS-CoV-2 RNA was detected with all collection mechanisms. From the studies detecting the presence of SARS-CoV-2 RNA, fourteen assessed infectivity. Five studies detected viable viruses using impactor, water-based condensation, and cyclone collection mechanisms. There is a need for a standardized protocol for sampling SARS-CoV-2 in air, which should also account for other influencing parameters, including air exchange ratio in the room sampled, relative humidity, temperature, and lighting conditions.

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Parhizkar, H., Rockcastle, S., Fretz, M., Van Den Wymelenberg, K. G.
A Simulation-Based Approach To Mitigate Disease Transmission Risk From Aerosol Particles In Buildings. In:
ANNSIM '22, July 18-20, 2022, San Diego, CA, USA. IEEE Computer Society

Understanding the role of architectural design in identifying the risk of disease transmission is essential for creating resilience in buildings. Here we used a Grasshopper simulation workflow to execute aerosol disease transmission risk estimation coupled with EnergyPlus simulation inputs to assess the impact of architectural factors on the risk of COVID-19 transmission. We simulated the risk for a simple geometry with different window configurations and geographic locations. We observed that increasing the fractional opening of a single window as well as cross ventilation design can increase the outdoor air exchange, which corresponds to substantially reduced risk of disease transmission. Furthermore, indoor relative humidity in cold climates can be significantly lower in winter due to the impacts of increased mechanical heating which translates to an increased risk of infection. We demonstrate that early architectural design decisions implicate the resultant risk of disease transmission indoors that should be prioritized in the future.

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Yan, B., Yang, W., He, F., Huang, K., Zeng, W., Zhang, W.*, et al.*
Strategical district cooling system operation in hub airport terminals, a research focusing on COVID-19 pandemic impact.
Energy, Vol. **255**, (2022)

Part load ratio is often observed in real operations of airport terminal cooling system. This phenomenon is more obvious during the COVID-19 pandemic, as sudden flight restrictions impacting cooling demand are widely adopted in hub airport terminals. This research aims to propose optimal strategies of multi chiller in airport terminals based on cooling load characteristics modeling, to tackle the aforementioned issues. Numerical experiments based on a real-world Chinese airport terminal are conducted to validate the proposed method. The results show that an average cooling load drop of 30% is observed from scenario of normal flight before COVID-19 to scenario of COVID-19 Period flight, and the average cooling load drop reaches to 44% from scenario of busy flight before COVID-19 to scenario of COVID-19 Period flight. The results also reflect that cooling load presents synchronous trend with passenger flow, but presents asynchronous trend with outdoor temperature. The influence of outdoor temperature on cooling demand delays due to building envelops. It indicates that simple superimposition according to passenger flow change for chiller operation number is reliable, efficient and effective, but is not suitable for outdoor temperature change. The findings are helpful to develop optimal strategies for further realtime control of multi-chiller.

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Zypman, T.
Ultraviolet Sanitization and Filtration Equipment (UV SAFE).
Princeton University Senior Theses 2022

The spread of airborne particulate pathogens, such as the SARS-Cov-2 virus, is extremely common in public transportation environments. Many passengers are essential workers who have high contact with the general public, and the social distancing recommended to minimize pathogenic intra-individual transmission may not be possible when there is high passenger density. The SARS-Cov-2 virus, which is transmitted primarily through airborne water droplets, can persist in the air for minutes to hours. To address this issue, most public transportation systems employ single-point HVAC (heating, ventilation, and air conditioning) systems. However, they create turbulent flow that mixes air around and ultimately does not filter air quickly or efficiently. In this thesis, to tackle this obstacle, we introduce and characterize an ultra-compact sanitization and filtration system composed of UVC (ultraviolet light between 270 and 280 nm) LEDs, special Lambertian-reflecting materials, and a high-volume fan. We present a preliminary design and potential model improvements based on computer simulation and experimental validation.

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Fischer, R. J., Port, J. R., Holbrook, M. G., Yinda, K. C., Creusen, M., Ter Stege, J.*, et al.*
UV-C Light Completely Blocks Aerosol Transmission of Highly Contagious SARS-CoV-2 Variants WA1 and Delta in Hamsters.
Environmental Science & Technology, (2022)

Behavioral and medical control measures have not been effective in containing the spread of SARS-CoV-2 in large part due to the unwillingness of populations to adhere to “best practices”. Ultraviolet light with wavelengths of between 200 and 280 nm (UV-C) and, in particular, germicidal ultraviolet light, which refers to wavelengths around 254 nm, have the potential to unobtrusively reduce the risk of SARS-CoV-2 transmission in enclosed spaces. We investigated the effectiveness of a strategy using UV-C light to prevent airborne transmission of the virus in a hamster model. Treatment of environmental air with 254 nm UV-C light prevented transmission of SARS-CoV-2 between individuals in a model using highly susceptible Syrian golden hamsters. The prevention of transmission of SARS-CoV-2 in a natural system by treating elements of the surrounding environment is one more weapon in the arsenal to combat COVID. The results presented indicate that coupling mitigation strategies utilizing UV-C light, along with current methods to reduce transmission risk, have the potential to allow a return to normal indoor activities.

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Wang, J.-X., Wu, Z., Wang, H., Zhong, M., Mao, Y., Li, Y.*, et al.*
Ventilation reconstruction in bathrooms for restraining hazardous plume: Mitigate COVID-19 and beyond.
Journal of Hazardous Materials, Vol. **439**, (2022)

Converging evidence reports that the probability of vertical transmission patterns via shared drainage systems, may be responsible for the huge contactless community outbreak in high-rise buildings. Publications indicate that a faulty bathroom exhaust fan system is ineffective in removing lifted hazardous virus-laden aerosols from the toilet bowl space. Common strategies (boosting ventilation capability and applying disinfection tablets) seem unsustainable and remain to date untested. Using combined simulation and experimental approaches, we compared three ventilation schemes in a family bathroom including the traditional ceiling fan, floor fan, and side-wall fan. We found that the traditional ceiling fan was barely functional whereby aerosol particles were not being adequately removed. Conversely, a side-wall fan could function efficiently and an enhanced ventilation capability can have increased performance whereby nearly 80.9% of the lifted aerosol particles were removed. There exists a common, and easily-overlooked mistake in the layout of the bathroom, exposing occupants to a contactless vertical pathogen aerosol transmission route. Corrections and dissemination are thus imperative for the reconstruction of these types of family bathrooms. Our findings provide evidence for the bathroom and smart ventilation system upgrade, promoting indoor public health and human hygiene.

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