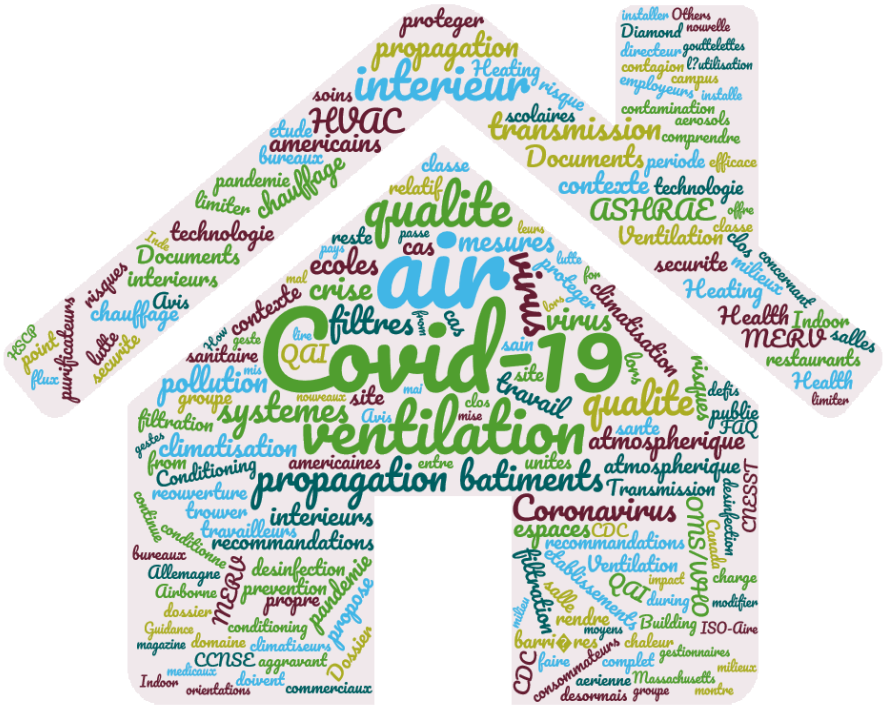

Bulletin de veille AéroCovid
N°108 - 29/01/2025

Objectif : *Air intérieur, ventilation, climatisation et propagation du Covid-19*

La validation des informations fournies (exactitude, fiabilité, pertinence par rapport aux principes de prévention, etc.) est du ressort des auteurs des articles signalés dans la veille. Les informations ne sont pas le reflet de la position de l'INRS. Les éléments issus de cette veille sont founis sans garantie d'exhaustivité.

Les liens mentionnés dans le bulletin donnent accès aux documents sous réserve d'un abonnement à la ressource.

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Dewi, W. C., Raharjo, M.

Analysis of airborne germ concentrations and Covid 19 transmission at Port Health Office of Semarang.

9th International Conference on Energy, Environment, Epidemiology and Information System (ICENIS 2024). Semarang, Indonesia, October 29-30, 2024

Covid 19 as a new emerging disease has spread all over the world. Covid 19 case also occurred at Port Health Office of Semarang, where the number of Covid 19 cases was 71 of 126 employees (56% percentage) and the airborne germ rate in preliminary study exceeded the standard set by American Conference of Governmental Industrial Hygienist (ACGIH) which was 500 CFU/m3. The purpose of analyzing the number of airborne germs with the incidence of Covid 19 cases at KKP Semarang. This study is an observational study by measuring the physical quality of the air in the research location and taking air samples to calculate the number of germs in the air in the room. The results of this study that the number of airborne germs is influenced by factors such as temperature, humidity, and lighting. The use of ventilation systems (using air conditioning or fans) will also affect the development of microorganisms in the room. Efforts have been made to control the development of airborne germs in the room, including the placement of a humidifier, maintenance of air conditioners/fans, and the obligation to use PPE (masks) in the room to minimize the transmission of Covid 19 during activities.

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Shin, H. W., Park, H. W., Park, J. H., Kang, D. H.

Assessment of Airborne Cross-infection Risk Across Various Body Orientations in Indoor Airflow Environments.

44th AIVC - 12th TightVent - 10th venticool Conference – Dublin, Ireland - 9-10 October 2024

This study aims to evaluate airborne cross-infection risk under different discharge angle (-20°, 0°, and +20°) and supply temperatures (18, 25, and 30 °C) of an air-conditioner, with various body orientations (face-to-face, side-by-side, and back-to-back). Field experiments on particle dispersion were conducted within a full-scale test chamber using a manikin-shaped particle generator and detector with simulated particles (NaCl). Initial trends in particle transmission varied with body orientations. Meanwhile, the cross-infection risk was lower at -20° and higher at +20° under a supply temperature of 25°C for all body orientations. However, discharge angles associated with lower or higher cross-infection risk varied with changes in supply temperatures. The findings indicated that body orientation is a crucial factor influencing cross-infection risk, and careful adjustment of discharge angles and supply temperatures is essential to prevent airborne cross-infection in such airflow environments.

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Santarpia, J. L., Lau, J., Shom, D., Ratnesar-Shumate, S. A., Carnes, E. C., Santarpia, G. W.*, et al.*

Association between in situ ventilation and human-generated aerosol exposure in meatpacking plants during the COVID-19 pandemic.

PLoS One, Vol. **19** n°(12), (2024)

During the COVID-19 pandemic, meatpacking workers were disproportionately affected by disease. Large outbreaks at meatpacking facilities resulted in loss of life and threatened the well-being of workers across the globe. Much work was done throughout the pandemic to understand and prevent these outbreaks. This

study combined ventilation system evaluation and measurement of human-generated respiratory aerosol to investigate and identify areas of highest risk for disease transmission. These findings confirm that improved ventilation reduces exposure to human-generated aerosols in meatpacking facilities, including those that may contain infectious agents, such as SARS-CoV-2. This study suggests areas of greatest risk are likely areas where workers break from work, such as cafeterias and locker rooms, where ventilation is poorer, use of face masks is reduced, and people congregate. Furthermore, these findings also suggest that ventilation of production areas of the plant, which have been designed for food safety, is sufficient to reduce exposures and likely contributes to reduced transmission in those spaces. Based on these findings, two controls should be prioritized to minimize the likelihood of exposure to potentially infectious aerosols: (1) improving mechanical ventilation and/or adding mitigation strategies such as media filters, germicidal ultraviolet, and other air cleaning technology and (2) applying administrative practices that minimize large congregations of people in poorly ventilated spaces. Importantly, this work demonstrates a method for in situ measurements of human-generated particles that can be used more broadly to understand exposure and risk in various occupied spaces.

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Xia, Y., Ma, H., Malikov, K., Straus, S. E., Fahim, C., Moloney, G.*, et al.*

Connectivity between long-term care homes and subsequent SARS-CoV-2 outbreaks.

medRxiv, (2025)

Objectives To describe the relationship between individual workers employed at more than one LTCH (inter-LTCH connectivity) across long-term care homes (LTCH) and SARS-CoV-2 outbreaks.

Design A retrospective cohort study using long-term care home surveillance and mobile geolocation data.

Setting Using data observed between February 26th, 2020, and August 31st, 2020, from Ontario, the province where close to one-third of the Canada’s SARS-CoV-2 cases among long-term care homes residents were reported.

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Martel, M., Taylor, M., Kirychuk, S., Choi, K., Guo, H., Zhang, L.

Electrostatic Particle Ionization for Reduction in Livestock and Potash Dust.

Atmosphere, Vol. **16** n°(1), (2025)

Airborne dust is an important contaminant affecting the health and the environment, and a crucial concern in many workplaces such as animal facilities and potash mines. One of the techniques used for dust control is electrostatic particle ionization (EPI). This technology has been proven effective in reducing airborne dust; however, it has downsides, such as the generation of ozone and corrosion of electrodes. Thus, this study tested a corrosion-resistant carbon-fiber discharge electrode and compared it with electrodes commonly used in EPI systems, that is, stainless-steel and tungsten electrodes, in terms of collection efficiency for potash dust and wheat flour (representative of livestock dust), ozone production, and power consumption. The carbon-fiber electrode performed comparably to stainless-steel electrodes, particularly for potash dust, and performed better than the tungsten electrode in terms of dust collection efficiency. Moreover, it had the lowest energy consumption and generated the least amount of ozone. However, because of the limitations of this study (e.g., fewer samples, low air velocity, controlled conditions, and the use of wheat flour instead of livestock dust), tests under real barn or mining conditions are necessary to confirm the results.

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Lee, S., Kim, H., Roh, J., Yeo, M.-S.

Estimation of Airborne Particle Removal Efficiency in Personal Isolation Room based on Full-scale Experiment.

44th AIVC - 12th TightVent - 10th venticool Conference – Dublin, Ireland - 9-10 October 2024

This study investigates the performance of Temporary Isolation Rooms (TIRs) in controlling airborne transmission of aerosols. The study utilized a full-scale experimental chamber with various airflow rates of Fan Filter Units (FFUs) and Air Changes per Hour (ACH). Aerosol removal efficiency and penetration coefficients were evaluated using Di-Ethyl-Hexyl-Sebacate (DEHS) particles and optical particle counters. Results showed that TIR performance varies significantly with aerosol diameters and FFU airflow rates. Larger aerosol diameters and higher airflow rates improved removal efficiency, crucial for controlling smaller aerosols relevant to airborne transmission. However, aerosols with diameters from 0.3 µm to 0.46 µm consistently penetrated the TIR from the room, regardless of airflow rate. This study underscores the importance of optimizing airflow dynamics and understanding aerosol behavior for effective infection control in healthcare settings.

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Mcgill, G., King, M.-F., Mcgrath, J., Booker, D.

Filling the Indoor Air Quality Data Gap: Research Challenges and Opportunities.

44th AIVC - 12th TightVent - 10th venticool Conference – Dublin, Ireland - 9-10 October 2024

This paper presents a review of existing monitoring standards/guidance and available datasets to propose a roadmap to standardise the collection, storage and analysis of IAQ data for the purpose of evidencing the impact on health. This information will provide a useful resource for researchers and practitioners interested in measuring building performance and IAQ. Future research directions and opportunities are also discussed, with strategies presented on how to fill the IAQ data gap.

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Yang, X., Chen, Z., Deng, F., Wang, R.

Heat-pump-coupled sorbent system toward efficient atmospheric water production and indoor air conditioning.

Cell Reports Physical Science, Vol. **6** n°(1), (2025)

Water scarcity and the need for sustainable indoor air conditioning are driving research toward innovative solutions. This perspective addresses the integration of a heat pump with an atmospheric water sorption system, presenting a promising approach to simultaneously harvesting water from the air and regulating indoor environments. The system leverages the moisture capture capability of advanced hygroscopic materials with the high-energy efficiency of heat pumps. Here, we detail the working principle, highlight key components, and analyze current research developments regarding this hybrid system. Furthermore, we discuss future research directions to further improve system efficiency and explore potential applications for broadening its practical use. With potential to efficiently alleviate water scarcity and advance indoor climate solutions, a heat-pump-coupled sorbent system represents an essential step toward addressing global environmental challenges.

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Miguel, Y., Akihiro, K., Hisashi, H.

Implementation of Real-Time Simulation of Infection Risk Using CO2 Sensors and Local Positioning Systems.

ASim Conference 2024: 5th Asia Conference of IBPSA. December 8th – 10th, 2024, Osaka, Japan

In the aftermath of the COVID-19 pandemic, there has been an increased focus on countermeasures against emerging infectious diseases. In view of this development, this study aimed to implement a system to simulate infection risks due to through the air transmission in real time. A method based on the Wells-Riley model was employed to predict the infection risk distribution due to airborne transmission/inhalation

from CO2 concentrations, and due to direct deposition from occupant locations. A web application was developed to predict infection risk on the cloud, utilizing application programming interfaces (APIs) to interface with CO2 sensors and local positioning systems (LPS) via a building operating system (BOS). For verification, the system was employed in an office building to confirm the predicted infection risk. In terms of airborne transmission/inhalation, the model predicted a higher infection risk in areas with higher CO2 concentrations, which could be attributed to poorly ventilated spaces and periods. In terms of direct deposition, the model predicted a higher infection risk with no or insufficient social distancing among people, and a lower infection risk when social distancing was sufficient. The integrated infection risk distribution was similar to the combination of the infection risk distribution due to airborne transmission/inhalation and that due to direct deposition. Therefore, the proposed system was confirmed to reasonably predict the infection risk distribution. The system enables early detection of seats and areas with a high infection probability. This implies that the building manager can utilize the system as a reference for ventilation decisions, whereas in a hot desking office, occupants can utilize the system as a reference for selecting seats, thereby enabling infection control measures in accordance with the actual situation.

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Manikandan, P., Swedheetha, C., Mohan, R. L. R., Kumar, S. L., Reddy, P. D., Sai, P. a. S.

Intelligent Monitoring System for Automatic Air Conditioning System.

2024 International Conference on IoT Based Control Networks and Intelligent Systems (ICICNIS). 17-18 Dec. 2024. Bengaluru, India

In order to improve indoor air quality, optimize energy consumption and avoid the accidents due to gas leakage, this paper proposes an intelligent air conditioning system that integrates several sensors such as DHT11, PIR sensors, MG6 Gas sensor and PMS7003 sensor and control mechanisms. An Arduino Mega, the system's central component, synchronizes data from several sensors to efficiently control the air conditioner and other linked equipment. This system keeps track of how many people enter and leave the space, enabling the air conditioning system to modify its settings in real time according to occupancy. When the room is empty, this feature saves energy. If gas leakage is present, system notifies users through a buzzer and turn off the AC. Many users often forget to clean their AC filters regularly, which can lead to reduced efficiency, higher energy consumption, and poorer air quality. Our innovative AC system addresses this common issue. Once the dust level crosses a predefined threshold, the system triggers a clean filter alert, reminding to act before it affects performance. Also, the air conditioner kicks on to cool the room if the outside temperature is high and the inside temperature is higher than an acceptable level. In contrast, the air conditioner is shut off to avoid needless cooling if the inside temperature is low. A display unit shows temperature, humidity, occupancy, gas levels, and dust concentration. This integrated technique automatically modifies the system's operation based on conditions, ensuring not only a more hygienic and comfortable environment but also improved energy efficiency.

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Mydeen, V. J. P., Vijayaram, E. N.

Introduction to Ultraviolet Light: Principles, Advantages, Limitations, and Applications.

In: Nonthermal Light-Based Technologies in Food Processing. Apple Academic Press; 2025. 21-35 p.

The deployment of Ultraviolet (UV) light in processing sectors has been a potential source of microbial inactivation in recent years that works on improving the safety of foods with minimal influences on characteristic features of the food product. UV-light irradiation has a favorable public perception as a physical preservation technology and has a higher prominence in the processing area as an alternative to thermal inactivation of microbes. This chapter focuses on basics of Ultraviolet light, principle of microbial inactivation, advantages.

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Posani, M., Voney, V., Odaglia, P., Du, Y., Komkova, A., Brumaud, C.*, et al.*

Low-carbon indoor humidity regulation via 3D-printed superhygroscopic building components.

Nature Communications, Vol. **16** n°(1), (2025), 425 p.

Indoor humidity can significantly impact our comfort and well-being, often leading to the use of mechanical systems for its management. However, these systems can result in substantial carbon emissions and energy precarity. This study offers an alternative: using low-carbon materials that naturally buffer moisture to passively regulate the indoor humidity. A geopolymer composite incorporating industrial waste is implemented via binder jet 3D printing technology. The superhygroscopic nature of the material, combined with the optimal geometry of 3D-printed components, unlocks remarkable potential for passive humidity regulation, achieving a moisture buffering value over 14 $g \cdot m^{-2} \cdot \%RH^{-1}$. The use of 3D-printed, geopolymer tiles for surface finishing in a library hosting 15 people was shown to improve annual indoor hygrometric comfort by up to 85%, a performance inconceivable with conventional materials and techniques. Additionally, the environmental impact of these tiles is significantly lower than that of a conventional dehumidification system. This study paves the way for merging highly hygroscopic, low-carbon materials with advanced manufacturing techniques to regulate indoor humidity levels and reduce our dependency on mechanical systems.

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Saari, S., Tuhkuri Matvejeff, A., Heikkilä, P., Silvonen, V., Sanmark, E., Oksanen, L.*, et al.*

Measurement of human respiratory aerosol emissions.

European Aerosol Conference 2024 (EAC2024). 25 – 30.8.2024 Tampere, Finland

This paper introduces a novel portable measurement system for studying respiratory particle emissions. The system features an aerosol chamber with a volume of approximately 0.5 m^3. After passing clean compressed air through a HEPA filter, the background aerosol concentration is effectively reduced to zero.

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Mathur, G.

Modeling Virus Infection Risks in Automobile Cabin.

SAE Technical Paper 2025

In the post Covid era, risk of infection in conditioned space is getting attention and has generated a lot of interest for the design of the new systems and strategies for the management and operations of the existing HVAC systems. Risk management plays a key role where the amounts of outside air and recirculated airs can be used to mitigate the propagation of the virus within the conditioned space. In other words, ventilation plays a huge role within the conditioned space along with strategies based on UV irradiation, ionization and use of highly efficient filters. Different air purification systems have been created by the researchers based on the titanium oxide-based UV photocatalysis system, filters with MERV ratings higher than 13 (ASHRAE Standard 52.2) and HEPA filters. Recent ASHRAE standard 243 (2023) on infectious diseases recommends using high ventilation rates within the conditioned space to reduce virus concentration, and hence, to reduce the risk of infection. Determining risk of infection is difficult as we cannot conduct tests by exposing the passengers to different viruses in vehicle. Instead, empirical models have been developed to predict probability of risk of infection based on a number of variables. This risk of infection is then multiplied by the total population to determine the people infected within the cabin. In this investigation the author has determined the risk of infection by using Wells-Riley and Gammaitoni-Nucci correlations to determine risk of infection for occupants when an infector is present in the vehicle cabin.

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García, A. C., Rodríguez-Sánchez, M. C., De Mera, M. D. P. D., Yahyaoui, I., Sánchez, G. M.

New Building Management Systems for Smart Cities: A Brief Analysis of Their Potential.

In. IntechOpen; Urban Pollution - Environmental Challenges in Healthy Modern Cities 2025

This chapter explores how smart cities can enhance building management through technologies like the Internet of Things (IoT) and advanced predictive models, focusing on energy efficiency and air quality. The escalating reliance on technology as the primary solution to contemporary and future challenges has highlighted Internet of Things (IoT), digitalization, and machine learning, among others, as new methodologies for assessing management in smart cities. Moreover, in the realm of defining innovative building management systems, pressing issues such as climate change and pandemic episodes like COVID-19 underscore the need to prioritize energy efficiency and air quality. This imperative has led to the emergence of digital twins, a technology integrating 3D models with real-time data, enabling a comprehensive understanding of building dynamics. In addition, automated prediction models leveraging advanced statistical and machine learning techniques contribute significantly to enhancing climatization control, energy efficiency, and air quality management. These predictive models analyze historical data, enabling accurate forecasts to assess future behavior, which is crucial for effective maintenance planning. The application of linear and non-linear regression models, alongside techniques like Support Vector Machines and neural networks, further refines predictions. Additionally, real-time monitoring and decision algorithms optimize information transmission during incidents, ensuring a rapid response to environmental factors or anomalies, thereby mitigating risks and maximizing operational efficiency.

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Elsayed, M., Lastovets, N., Silvonen, V., Luoto, A., Rönkkö, T., Sormunen, P.

Particle concentration and indoor air quality in naturally ventilated patient rooms-A field study in a hospital building in Bucharest, Romania.

44th AIVC Conference : Retrofitting the Building Stock: Challenges and Opportunities for Indoor Environmental Quality - Croke Park, Dublin, Iceland. 9 - 10 Oct 2024

In response to the COVID-19 pandemic, there has been a significant emphasis on improving indoor air quality (IAQ), particularly within hospital buildings. Despite developments in integrated central advanced mechanical ventilation and filtration technologies in new hospital buildings, challenges persist in installing them in existing and old hospital buildings relying on traditional natural ventilation. In this context, portable air purifiers have been developed and utilised in hospital facilities as a solution to reduce airborne particulate matter (PM) concentrations and the potential airborne infection risk. However, there have been a limited number of IAQ studies in hospital buildings due to the unique operational environments of hospitals and the associated risks for researchers while conducting in-situ research in hospital facilities, especially in naturally ventilated hospital buildings. This has resulted in a knowledge gap concerning the measured effectiveness of portable air purifiers in traditionally naturally ventilated hospital buildings. To address this gap, a one-week measurement campaign was conducted at a naturally ventilated hospital building in Bucharest, Romania. The campaign aimed to assess PM concentrations before and after utilizing portable air purifier units in two distinct patient rooms — an intensive care unit (ICU) and an isolation room. Additionally, the study involved measuring various aspects of indoor environmental quality (IEQ) parameters, including CO2 levels, temperature, and relative humidity. Values of measured parameters were used for infection risk calculation. The effectiveness of the air purifier units was determined by comparing indoor and outdoor (I/O) PM concentration ratios before and after using the air purifiers. PM measurement results indicated a significant reduction in PM2.5 I/O ratios of (78% - 93%) with air purifier use. The findings from the infection risk assessment highlight the potential benefits associated with the employment of portable air purifiers featuring high-efficiency particulate air (HEPA) filters in reducing PM concentration and increasing the total Air Changes per Hour (ACH) in naturally ventilated patient rooms.

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Bia, P., Losardo, M., Manna, A., Brusaferro, S., Privitera, G. P., Vincentelli, A. S.

Selected microwave irradiation effectively inactivates airborne avian influenza A(H5N1) virus.

Scientific Reports, Vol. **15** n°(1), (2025)

The highly pathogenic avian influenza A(H5N1) virus threatens animal and human health globally. Innovative strategies are crucial for mitigating risks associated with airborne transmission and preventing outbreaks. In this study, we sought to investigate the efficacy of microwave inactivation against aerosolized A(H5N1) virus by identifying the optimal frequency band for a 10-min exposure and evaluating the impact of varying exposure times on virus inactivation. A(H5N1) was aerosolized and exposed to various microwave frequencies ranging from 8 to 16 GHz for a duration of 10 min. Viral titers were quantified using TCID50, and inactivation was assessed by comparing irradiated samples to controls. The 11–13 GHz band yielded the highest inactivation, with an average 89% mean reduction in A(H5N1) titer, particularly within the 11–12 GHz range, which exhibited peak efficacy. Based on the overall results, the optimal frequency band (8–12 GHz) was further tested with exposure durations of 1, 3, and 5 min. Inactivation was time-dependent, with a 5-minute exposure resulting in a 94% mean reduction, compared to 58% and 48% for 3- and 1-minute exposures, respectively. We conclude that optimized microwave emitters in high-risk environments like poultry farms and veterinary clinics could offer a novel, non-chemical approach to mitigating avian influenza spread and outbreaks.

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