ASHRAE Region XIII
APCBE-2023 KUALA LUMPUR

17TH ASIA PACIFIC CONFERENCE ON BUILT ENVIRONMENT (APCBE)

ASHRAE REGION XIII

Connexion Conference & Event Centre (CCEC)
Kuala Lumpur, Malaysia
www.ashrae.org.my/apcbe

17th ASIA PACIFIC CONFERENCE ON THE BUILT ENVIRONMENT (APCBE), MALAYSIA 2023

Unique Challenges & Solutions for Climate Change in HVAC&R Industry

3rd & 4th November 2023, Connexion Conference & Event Centre – (CCEC), Kuala Lumpur, Malaysia

Asia Pacific Conference on the Built Environment (APCBE) is a biennial event of ASHRAE Region XIII and was first launched in 1991. In response to the growing technology, the Conference scope has been expanded from HVAC&R to cover various aspects related to the built environment. This international conference provides an excellent platform for researchers and practitioners to share ideas, best practices, new technologies and future prospects.

This is a 1½ -days conference with participants from academics, architects, building owners, consultants, contractors, facilities managers, government, industries, suppliers, and other parties who have an interest in the design, installation, testing, commissioning, operation and maintenance of the built environment.

CONFERENCE CONTACT INFORMATION
Website: https://www.ashrae.org.my/apcbe-2023/
Email: apcbemalaysia2023@gmail.com

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Message from Director & Regional Chair, ASHRAE Region XIII

The Asia Pacific Conference on Built Environment (APCBE) is unique to our ASHRAE Region XIII since it was first organized in 1991 in Singapore.

It is a platform for our ASHRAE members to share, learn and exchange intellectual knowledge, experiences, views, and opinions.

It is also where ASHRAE Region XIII members meet after our CRC to foster stronger rapport and friendship.

I like to make a special mention of appreciation to thank Dr. Ng Wen Bin, the Chair for this 17th APCBE. He meticulously put everything in place and set a high standard in organizing this event. It is indeed a mountainous and unenviable task which he carried out voluntarily and efficiently despite his busy daily work schedule. Thank you, Wen Bin!

The next APCBE will be held in Singapore in 2025, so look out for further updates.

I hope all of you, the participants, will find this conference fruitful and enriching. I also hope that this conference will stir our minds onto deeper understanding and insights to help build a more sustainable carbon free world.

Thank you!

Leong Cheng Wee
Director & Regional Chair (2022-2025)
ASHRAE Region XIII

Message from Conference Chair

On behalf of the APCBE Malaysia 2023 Committees, I am deeply honoured to extend my warmest welcome to all of you who have joined us for the 17th Asia Pacific Conference on Built Environment, focusing on "Unique Challenges & Solutions for Climate Change in the HVAC&R Industry." I would also like to express my gratitude to ASHRAE Malaysia Chapter for providing me with the opportunity to share my thoughts in this Souvenir Programme.

Our chosen theme, "Unique Challenges & Solutions for Climate Change in HVAC&R Industry," closely aligns with ASHRAE's broader theme for 2023–2024, "Challenge Accepted: Tackling Climate Change." This overarching theme underscores ASHRAE's commitment to educating, training, and mobilizing its members to become leading authorities in the design, operation, and construction of buildings that effectively address the challenges posed by climate change within the built environment.

This conference serves as a valuable platform for engaging in meaningful discussions and exchanging innovative ideas within this vital realm of research. I am confident that our gathering will be of great benefit to professionals from diverse sectors, including engineers, building operators, and researchers, all of whom play crucial roles in shaping the future of the built environment.

To all our esteemed delegates and speakers, I extend our heartfelt welcome and look forward to the fruitful exchanges and sharing of new knowledge and insights that will undoubtedly emerge during this conference.

Ts. NG Wen-Bin
Organizing Chair, APCBE Malaysia 2023

ASHRAE Region XIII - APCBE Steering Committee (2023-2024)

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Program Schedule

Day 1: Friday, 3rd November 2023

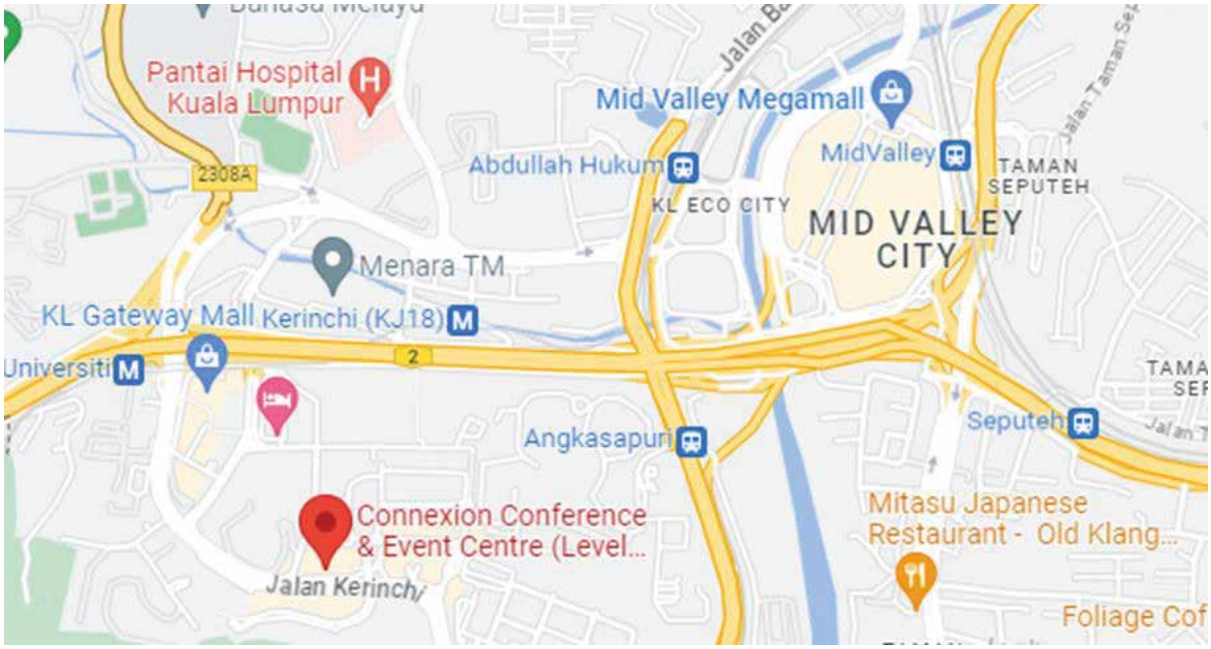
Time	Activities	Presenters
8:00 AM	Registration	
9:00 AM	Opening of Plenary Session (Strictly Formal Attire: Coat & Tie)	
9:10 AM	Title 1: THE OVERVIEW OF MONTREAL PROTOCOL IMPLEMENTATION IN MALAYSIA	**Keynote Speaker 1:** **Mr. Ryan Ooi Chean Weai** *Ketua Penolong Pengarah Kanan, Department of Environment, Malaysia*
10:00 AM	Q&A	
10:15 AM	Tea Break	
10:30 AM	Title 2: THE NEW CARBON STANDARDS: NET ZERO OPERATIONAL, EMBODIED, WHOLE LIFE AND UPFRONT ENERGY (CARBON)	**Keynote Speaker 2:** **Mr. Luke Leung** *P.Eng., Fellow ASHRAE, LEED® Fellow, BEMP, Distinguished Lecturer*
11:30 AM	Title 3: ASHRAE 241P - PATHOGEN MITIGATION STANDARD IMPACTS TO FUTURE OFFICE AND RESIDENTIAL DESIGN	**Keynote Speaker 2:** **Luke Leung** *P.Eng., Fellow ASHRAE, LEED® Fellow, BEMP, Distinguished Lecturer*
12:30 PM	Lunch	
2:00 PM	3 Parallel Sessions	Various authors
5:30 PM	End of Day 1 Session	
6:30 PM	Banquet Dinner	

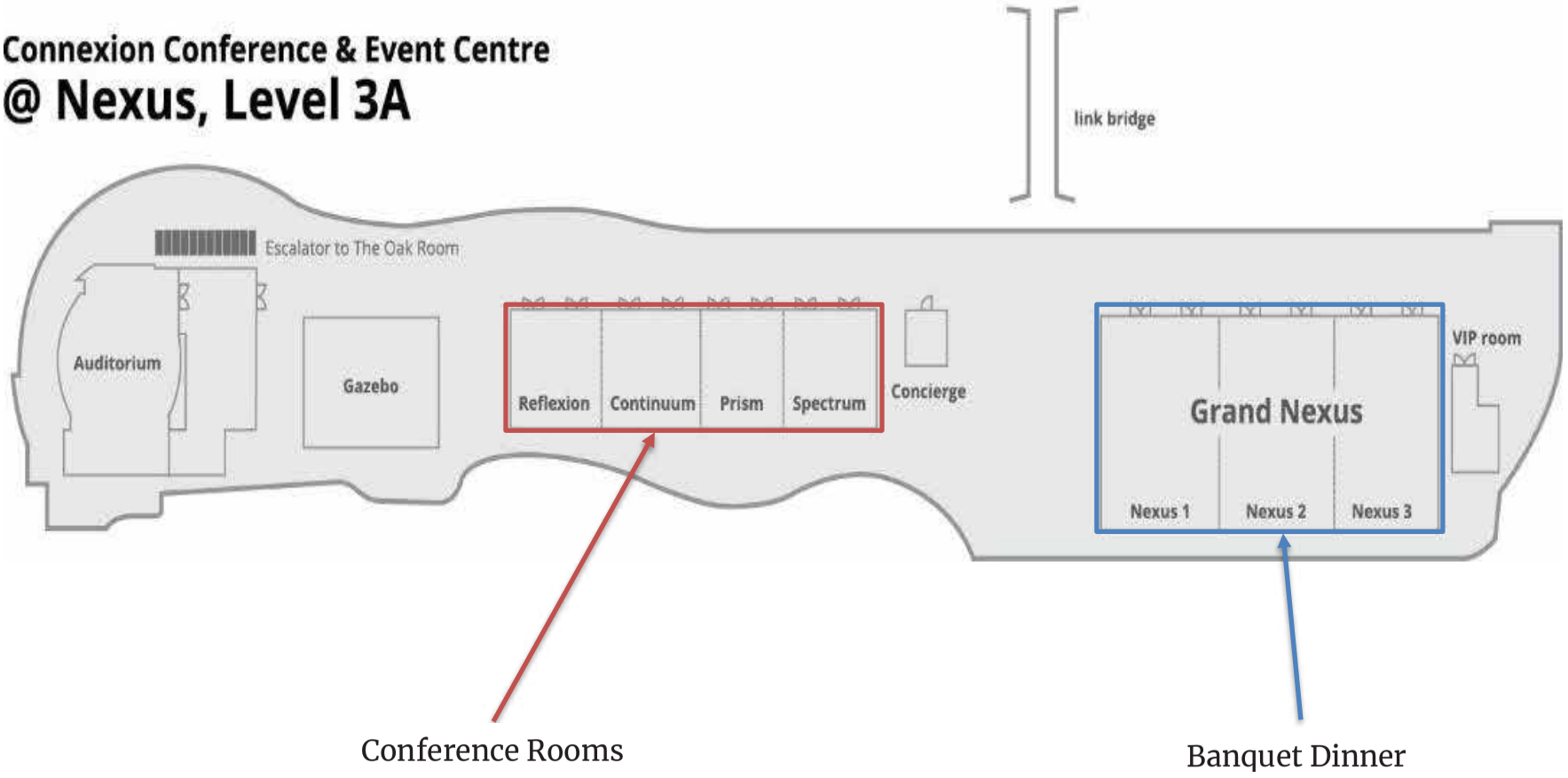
Day 2: Saturday, 4th November 2023

Time	Activities	Remarks
9:00 AM	3 Parallel Sessions	Various authors
10:20 AM	Tea Break	
10:40 AM	3 Parallel Sessions	Various authors
1:00 PM	End of Day 2 Session	

Venue Layout

Connexion Conference & Event Centre (CCEC), Bangsar South, Kuala Lumpur, Malaysia




Connexion Conference & Event Centre
@ Nexus, Level 3A
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Escalator to The Oak Room
Auditorium
Gazebo
Reflexion
Continuum
Prism
Spectrum
Concierge
Grand Nexus
Nexus 1
Nexus 2
Nexus 3
VIP room
Conference Rooms
Banquet Dinner

Keynote Speaker – Mr. Ryan Ooi Chean Weai

Presentation Title:
THE OVERVIEW OF MONTREAL PROTOCOL IMPLEMENTATION IN MALAYSIA

Mr. Ryan Ooi Chean Weai currently holds the position of Senior Principal Assistant Director and leads the Ozone Protection Section in the Air Division, Department of Environment Headquarters in Putrajaya.

Before in his current position, he served as an Environmental Officer in the Sarawak State's DOE enforcement team for about 7 years and as a Senior Environmental Officer in Sabah State's DOE enforcement team for 3 years. He has more than 19 years of experience in knowledge of the Environmental Quality Act 1974, Rules, and Regulations under the Act. He attended a few international meetings of parties on the Montreal Protocol and participated in negotiations. He also joined the World Bank team in the preparation of the Kigali Implementation Plan.

Keynote Speaker – Mr. Luke Leung

Presentation Title:
THE NEW CARBON STANDARDS: NET ZERO OPERATIONAL, EMBODIED, WHOLE LIFE AND UPFRONT ENERGY (CARBON)

and

ASHRAE 241P – PATHOGEN MITIGATION STANDARD IMPACTS TO FUTURE OFFICE AND RESIDENTIAL DESIGN

Luke Leung (P.Eng., Fellow ASHRAE, LEED® Fellow, BEMP, Distinguished Lecturer) is a LEED (Leadership in Energy and Environmental Design) Fellow; He is also a Centennial Fellow from The Pennsylvania State University Architectural Engineering Department; Board of Directors for USGBC (United State Green Building Council), Illinois; Chairman of the ASHRAE (American

Society of Heating, Refrigeration and Air Conditioning) Committee on "Tall Buildings"; Chairman of the Building Pressure Committee, Chicago Committee on High Rise Buildings; Sustainable Committee with Council on Tall Buildings and Urban Habitat; Part Time Professor at IIT; Member of the Chicago Sister Cities Program with China; MBA from University of Chicago, MS and BAE from Architectural Engineering at Penn State University.

Luke Leung is the Director of the Sustainability Engineering Studio for Skidmore, Owings and Merrill LLP. He is the incoming Chair of ASHRAE Environmental Health Committee; Team leader for ASHRAE Epidemic Task Force, Commercial Buildings; Group Leader for LCA and Embodied Carbon, ASHRAE Decarbonization Task Force; National Renewable Energy Laboratory IN2 Incubator Industry Advisor; BOMA Toronto, Health Committee Co-Chair. His work includes Burj Khalifa, the world's current tallest man-made structure; Multiple times "Excellence in Engineering" award from the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE); Selected projects also include Pertamina Tower (Net Zero Supertall), General Motors Global Headquarters, XiongAn Net Zero Development, Beijing Finance Street, Embassy of Ottawa in Canada, Embassy in Beijing, Lakeside – 55 million sqft low energy development, a LEED Platinum building with the first large scale horizontal wind turbine in the city of Chicago; etc., and has served as a member of the editorial team for the CTBUH guide Natural Ventilation in High-Rise Office Buildings, ASHRAE "Design Guide for Tall, Supertall, Megatall Building Systems", among other publications.

Schedule of the Parallel Sessions

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4:00 PM	4:20 PM	Paper 21		Paper 17
4:20 PM	4:40 PM	Paper 24		Paper 28
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5:20 PM	5:30 PM	Tea Break & Visit Exhibition Booth		

		Room 1 (Reflexion)	Room 2 (Prism)	Room 3 (Continuum)
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10:20 AM	10:40 AM	Tea Break		
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19	A Comparative Analysis of ERV And Streamer Duct Chamber	Yau, Yat Huang*; Wong, Chun Mun; Chin, Wai Meng; Ong, Hwai Chyuan
20	Low Delta-T Syndrome in District Cooling System – The Malaysian Experience	A Rahim, Arul Hisham Bin*
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Abstracts

Paper ID: 3

Mathematical Model Analysis of a Vacuum Pump-Heat Pump Integration Water Distillation System

Win-Jet Luo, Alfi Syahri Ramadhan and Jun-Jie Cao

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Abstract. This study developed a water distillation system integrating a vacuum pump and a heat pump and analysed the performance of the distillation system under different heating temperatures and saltwater concentrations with analytical simulations and experiments. The vacuum pump is used to reduce the saturation pressure and temperature inside the boiler, and the heat pump is used to supply hot water to heat the wastewater inside the boiler. The generating steam from the boiler can be condensed into distilled water by an evaporator of the heat pump. With the developed water distillation system, the specific moisture evaporation rate (SMER) can be attained 1.2 kg/kWh under the heating temperature of 55°C.

Keywords: Vacuum Pump, Heat Pump, Water distillation, Evaporation rate, Mathematical
model

Paper ID: 7

Improving the Age-of-Air Distribution and Air-Change Effectiveness in Detention Cells: A CFD Analysis of Supply Air Configurations in a City Jail in Rizal, Philippines

J N Omlang* and J D Lopena

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*E-mail: jnomlang@gmail.com

Abstract. Overcrowded detention cells are often poorly ventilated, leading to health risks for detainees due to a buildup of airborne contaminants. To improve the living conditions of inmates, there is an increasing demand for better ventilation systems in detention facilities, particularly in areas where overcrowding is a recurring issue. This study was conducted in a city jail in Rizal, Philippines to evaluate the impact of different supply air configurations on the age-of-air (AoA) distribution and air-change effectiveness (ACE) in detention cells. Four configurations were analyzed using Computational Fluid Dynamics (CFD) simulations utilizing k-ε turbulence model with scalable wall functions. The first configuration has three-line ducting with four supply air grilles on each duct, the second has three-line ducting with ten grilles per duct, the third has two-line ducting with four grilles per duct, and the fourth has two-line ducting with ten grilles per duct. Results were analyzed based on airflow velocity, AoA distribution, and ACE. The study found that three-line ducting provides comfortable wind conditions for all levels of bunk beds, and there was no significant change in average air velocity between the four and ten grilles per duct setup. However, the latter resulted in a decrease in average AoA, thereby increasing ACE. The fourth configuration exhibits better ACE across all cells when compared to the first, but it cannot provide comfortable wind conditions on the first level of bunk beds. The second configuration showed the most promising results in terms of air flow inside the cells, average AoA, and ACE.

Keywords: Computational fluid dynamics, Age-of-air distribution, Air-change effectiveness, Ventilation system.

Paper ID: 8

The Experimental Study of Employing Additive Manufacturing (AM) for Injection Molding Inserts

Diana Rose T. Rivera[1]*, Leif Oliver B. Coronado[2], Julius Colega[3]

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[2]Mechanical Engineering Department, National University, Sampaloc 1008, Manila, Philippines
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Abstract. Injection molding is a process of melting the polymer at a high temperature and injecting it to the molder under high pressure. This has been widely used due to the growing demand in the polymer-based components and is well suitable for mass production. Plastic injection (PI) molds are manufactured using tool steels as it can withstand the high temperature requirement during molding. In the industry where there is a demand for a few products or short runs of parts to be utilized by the customer in need, prototype plastic injection molds can also be used. However, the molding casing prototype takes weeks and thousands of dollars are needed for its development and manufacturing. Additive manufacturing (AM), also called rapid prototyping or 3D printing, is a process of additively producing three dimensional parts through a layered process. Due to the limitations of the production of injection molding parts, additive manufacturing (AM) is now used to develop prototype Plastic Injection (PI) mold inserts. This reduces the customers waiting time as well as the overall cost of producing the functional parts for quoting prospective clients. In this study, the 3D printed mold cavity for Plastic Injection (PI) Molding for high precision injection mold machine (Roboshot s2000 i 15B) is assessed to determine the potential of replacing Plastic Injection (PI) mold with a 3D printed mold cavity. In addition, parameters such as compression pressure, hold time, and cooling were also considered. The first natural frequency observed is at 1257.1 Hertz while at the sixth order, the natural frequency increases to 2525.3 Hertz. The pattern also shows bending and translation for the first six order of mode shapes. The maximum amplitude observed is 1798.3 mm, seen on the first order of the natural frequency. It was also revealed that after 30 shots, under 0.4 MPa, 289 ºC @v1; 238 ºC @v2, the flow line, sink mars, and slight jetting of the 3D printed injection molding were observed.

Keywords: Additive manufacturing, injection molding, 3D print.

Paper ID: 9

Preventing Airborne Transmission of the Coronavirus in a University Office Space with an Effective Ventilation Strategy

Jaclyn Yen-Tching Lo, Victor Nee-Shin Bong*, Basil T. Wong

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Abstract. The emergence of Covid-19, caused by the novel SARS-CoV-2 virus, in late 2019 resulted in a worldwide health threat and left a staggering economic impact on many countries. Evidence suggests that the main transmission mode is via the distribution of airborne virus-laden particles through air movement. Hence, strict intervention measures from social distancing to border lockdowns and closure of commercial and work premises were implemented in many countries in the early stage of the pandemic. The high infection risk related to airborne transmission modes shifted the emphasis to ventilation control which is essential to maintain acceptable air quality in the indoor environment. Guidelines from authorities such as the World Health Organization (WHO) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) also outlined the importance of adequate ventilation in indoor settings especially during times of the pandemic. Findings from previous works suggested that ventilation strategies including inlet/exhaust locations and airflow patterns will affect the spread pattern of the virus and hence the infection risk. Therefore, this study investigates the influence of ventilation strategies in an air-conditioned office in the university to mitigate the transmission of Covid-19 by taking into consideration the effect of the placement of outlet vents on the airflow patterns. A commercial Computational Fluid Dynamics (CFD) software, ANSYS Fluent, is used in this study to assess the particle trajectory for different outlet locations. The ventilation layout plan coupled with natural ventilation, achieved with an open window, shows the best particle removal performance. In addition, the airflow path between the infected source and the outlet is also an important factor that affects the transmission risk.

Keywords: Ventilation strategy, COVID-19, airborne transmission, airflow simulation, indoor air quality.

Paper ID: 10

Reducing Airborne Transmission Risk in Indoor Eateries in Kuching, Sarawak with a Natural Ventilation Strategy

Pei Yun Lai, Victor Nee-Shin Bong*, Basil T. Wong

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Abstract. The COVID-19 pandemic, caused by the SARS-Cov-2 virus has severely impacted people's lives worldwide. The adoption of COVID-19 preventive measures such as social distancing, voluntary use of face masks, and hand hygiene has shown that Malaysians have adapted to the new norms brought upon by the pandemic. It has been widely known that the main transmission mechanism of this coronavirus is through airborne pathways, while indoor premises have often been earmarked as places with higher infection risks. The airborne transmission of the virus in indoor eateries, in particular, has been widely studied since the start of the pandemic. Airborne particles are known to be capable of remaining in the air for hours if the space is not well-ventilated. The purpose of this study is to investigate the effectiveness of natural ventilation systems, mechanical ventilation systems, and mixed-mode ventilation systems in minimizing the transmission risk of airborne diseases in an enclosed indoor eatery. A Computational Fluid Dynamics (CFD) simulation on four different scenarios is conducted using ANSYS Fluent. An intermediate shop lot unit with no windows has been assumed for this study. Natural ventilation is introduced by opening the doors. The boundary conditions and design parameters used in the simulation are in accordance with the ASHRAE Standards and the relevant local codes. Overall, it can be observed that the natural ventilation system brought about significant improvement to the ventilation efficacy of the premise of interest.

Keywords: Ventilation strategy, COVID-19, airborne transmission, airflow simulation, indoor air quality.

Paper ID: 11

Reducing Energy Consumption and Improving Indoor Air Quality by Using Low Energy Nanofibrous Air Filter in a Commercial Building

Eddie Fung[1], Taylor CF Chow[2]

[1]Nanofil Filtration Technology Limited, CEO - inventor of patented nanofibrous air filter and the manufacturing method.
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Abstract. Decarbonisation is the one of the important roadmap for most of the countries. Hong Kong Special administrative region (HKSAR) set a net zero plan by 2050. Reducing energy usage play an important role for this plan as 90% of electricity used in Hong Kong for Building and 60% of Hong Kong's carbon emission. Improving building efficiency in a building not only can reduce the carbon emission but it can also reduce the energy cost in the building. For this win-win solution, using Low Energy Nanofibrous Air Filter in the building can also reduce the electricity consumption from the fan and improve the indoor air quality in the building. To achieve a high filtration efficiency and at the same time a low pressure drop, a review on quality factors of air filters made of different kinds of filter media and in different structure has been conducted. Various case studies on use of nanofibrous filter on primary air unit, air handling units and fan coil units have been conducted and it has been revealed that composite nanofibrous filter media outperforms others, such as traditional micro-glass fiber and synthetic fibre, in terms of lower pressure drop at the same filtration efficiency.

Keywords: Indoor Air Quality, Nanofibrous filter media, Energy Saving, Decarbonization

Paper ID: 13

Assessment of New Refrigerant Blends as Environmentally Friendly Alternatives to R410a in Residential Split Air Conditioners

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Abstract. The Kigali Amendment is an international agreement that aims to address the environmental impact of high-GWP (Global Warming Potential) refrigerants and curb their contribution to climate change. High-GWP refrigerants are potent greenhouse gases that have a strong ability to trap heat in the Earth`s atmosphere, leading to an enhanced greenhouse effect and contributing to global warming. By controlling the use of these potent greenhouse gases and encouraging the adoption of more environmentally friendly alternatives, the amendment plays a crucial role in advancing sustainable practices in the refrigeration and air conditioning industries. Therefore, the replacement refrigerants being considered in this study must have lower GWP values compared to R410A, aligning with the Kigali Amendment`s objectives. This study focuses on finding potential refrigerants to replace R410A in air-cooled split air conditioners while meeting Kigali Amendment's GWP requirements. By combining environmental indexes and thermodynamic properties, the study can systematically evaluate and compare different refrigerant blends to identify those that are environmentally friendly, energy-efficient, and meet the GWP requirements of the Kigali Amendment. The evaluation identifies promising R410A replacements, including R446A for high-temperature applications and R32 for air conditioning at higher temperatures. R447B, R452B, and R454B show improved system performance and efficiency due to the smallest temperature glide during phase change. R454B has the highest Coefficient of Performance (COP) and volumetric refrigeration capacity, indicating better energy efficiency and reduced environmental impact. These findings provide valuable insights for selecting suitable refrigerant alternatives, addressing environmental challenges and adhering to Kigali Amendment regulations. This study advances environmentally friendly refrigeration solutions and supports sustainable practices in the air conditioning sector.

Keywords: R410A, low GWP Refrigerant, Air Conditioner, GWP.

Paper ID: 14

Experimental Investigation of a Cascade Heat Pump System Based on Low-Cycle Compressor Speed Variation for Indoor Air and Water Heating Performance

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Abstract. Recently, a cascade heat pump system was studied to be applied residential buildings for energy saving when supplying domestic hot water in cold regions in winter. The purpose of this study is to find the system operating conditions capable of supplying indoor air heating and domestic hot water, simultaneously. The system is consisted of two single-heat pump cycles connected through an intermediate heat exchanger. An additional heat exchanger is installed on the low-cycle heat pump for indoor heating. The refrigerants used in each heat pump system were R410A for low-cycle heat pump and R134a for high-cycle heat pump. The geothermal system was used as the low-cycle heat source. A geothermal simulator was used to simulate 10°C water obtained through the geothermal pipe in winter. The cascade heat pump system was installed in the basement of an experimental building and the experiment was conducted in the form of a field test. Since the indoor temperature in the basement was 15°C, the inlet temperature of the indoor unit was maintained as 15°C. The hot water temperature was maintained as 40°C by installing a water tank. In the experiment, the minimum and maximum compressor speed of the low-cycle compressor was 90 Hz to 160 Hz, and the compressor speed was adjusted by 10 Hz. The air volume on the indoor unit side was supplied at 600 CMH. The target indoor air heating load was 4.14 kW, and the domestic hot water load was 12.10 kW. At this time, the target was 40°C for air heating and 60°C for domestic hot water. As a result, when the low-cycle compressor speed was 160 Hz, the heat supply for indoor air heating reached 4.25 kW and the domestic hot water supply achieved 12.54 kW. The total energy consumption was 5.41 kW. The system COP was 3.10, which was derived the result of 4.8% improvement compared to the reference case where the low-cycle for indoor heating and high-cycle for water heating were separately operated under the same conditions.

Keywords: Experimental investigation, Cascade heat pump, Building thermal load, Parametric study, Operation condition

Paper ID: 15

Energy-Efficient Retrofitting of a Data Center in the University

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Abstract. Data centers have been widely deployed all over the world to meet demands for IT services, cloud computing, and IoT applications. Small data centers with insufficient cooling require much power to keep IT equipment running reliably. As a result, retrofitting has become an efficient method to increase energy efficiency and save operating costs. This study examines the impact of retrofitting on energy efficiency in a data center at a University in Taiwan. The data center under consideration underwent a comprehensive retrofitting process. Adding two more cooling systems increases the data center's cooling capacity, resulting in more efficient cooling and improved temperature control and eliminating an ineffective cooling system that helps to achieve an energy-efficient and cost-effective data center. A SCADA system was set up throughout the retrofitting procedure, which allowed a real-time study of energy consumption to identify and address any inefficiencies. Data were collected before and after retrofitting, including power usage effectiveness (PUE), energy consumption, and temperature measurements. The cooling efficiency could be improved effectively through retrofitting. The PUE of the data center before/after retrofitting was 2.17 and 1.51, respectively. The results showed a significant improvement in energy efficiency, with a PUE reduction of 0.66, which also reveals that energy efficiency, has been improved by 30.4%. The retrofitting project results in significant cost savings and environmental benefits.

Keywords: Data center, Retrofitting, CFD simulation, Power Usage Effectiveness (PUE), energy efficiency,

Paper ID: 16

A Simplified Model for Estimating the Dehumidification Performance of a Low-Flow Liquid Desiccant System

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Abstract. Because most of the energy is used to cool and heat the solution for dehumidification and regeneration in a liquid desiccant system, the low-flow liquid desiccant system has been proposed to reduce the solution cooling and heating energy. However, the numerical analysis of the system is complicated because of the comprehensive consideration such as the suspension time of solution droplets, heat and mass transfer between the air and solution. Therefore, the simplified model of a low-flow liquid desiccant system is needed to analyze the system performance. The main objective of this study is to suggest the simplified dehumidification performance estimation model for a low-flow liquid desiccant system based on the solution atomization with tiny droplets. To establish the empirical model, experimental data were obtained by the pilot apparatus under various operating conditions. The solution temperature, solution mass flow rate and air mass flow rate were also considered as the design variables to significant effect on dehumidification performance. Using statistically analyzing dehumidification performance data generated by the experiment, the effects of design variables and their combinations on the liquid desiccant dehumidification was estimated by the 2k factorial experimental design method. The simplified linear regression model that returns the humidity ratio difference was derived as a function of the designed major variables that have significant impacts on the dehumidification performance of the low-flow liquid desiccant system. The experimental data and predicted data by the derived model were compared, and the results showed an error of less than 10%. The simplified humidity ratio difference estimation model can be used to design the optimization operating conditions of a low-flow liquid desiccant system.

Keywords: Liquid desiccant system, Low-flow rate, Humidity ratio difference, Correlation models, ANOVA analysis

Paper ID: 17

Energy Saving Potential of Vacuum-Based Membrane Dehumidifier with Indirect Evaporative Cooler for Classrooms

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Abstract. The purpose of this study is to propose a decoupled air-conditioning system using vacuum-based membrane dehumidifier for a classroom in hot and humid climates. The proposed system consists of an indirect evaporative cooler, a vacuum-based membrane dehumidifier, and an air handling unit. The indirect evaporative cooler pre-cools the outdoor air, and the pre-cooled outdoor air is mixed with recirculating air to reduce energy consumption. The mixed air is completely dehumidified by the vacuum-based membrane dehumidifier. After dehumidification, the air handling unit adjusts the air temperature to the target supply air temperature. In a conventional air handling unit, the air is overcooled by a cooling coil for condensation dehumidification and reheated by a heating coil to reach the target supply air temperature. On the other hand, in the proposed system, the vacuum-based membrane dehumidifier handles most of latent heat load of the inlet air without temperature change, through the isothermal dehumidification process. To investigate the energy-saving potential of the vacuum-based membrane dehumidifier, an energy consumption simulation was conducted between the proposed decoupled system and a reference system in the classroom during the cooling season. The reference system consists of an indirect evaporative cooler and an air handling unit. The indoor thermal loads of the classroom were calculated using TRNSYS 18, and the energy consumption simulations were performed using the Engineering Equation Solver (EES). The simulation results revealed that the proposed decoupled system can reduce energy consumption compared to the reference system in the classroom. The total energy consumption was reduced 15.3 % compared to the reference system due to the absence of the overcooling and reheating energy consumption.

Keywords: Vacuum-based membrane dehumidifier, Indirect evaporative cooler, Isothermal dehumidification, Energy saving, decoupled system

Paper ID: 19

A Comparative Analysis of ERV and Streamer Duct Chamber

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Abstract. The study evaluates the effectiveness of Energy Recovery Ventilation (ERV) and Streamer Duct Chamber (SDC) in improving indoor air quality by reducing CO2 levels and removing particulate matter (PM2.5 and PM10). The energy consumption of different ventilation systems is also assessed. ERV ventilation significantly reduces CO2 concentration, achieving a remarkable reduction compared to no ventilation. On average, ERV ventilation reduces peak CO2 levels by approximately 50%, improving indoor air quality. Ventilation systems with SDC effectively mitigate PM2.5 and PM10 pollution compared to ventilation without air filtration, making them optimal for maintaining healthy indoor air quality. The study also highlights the energy efficiency of ERV ventilation, showcasing significant energy savings compared to non-ERV ventilation. These findings emphasize the potential of ERV systems in enhancing energy efficiency and indoor air quality. The research underscores the importance of well-designed ventilation systems for creating post-COVID-19 indoor environments that are healthy and energy-efficient, providing valuable insights for policymakers and facility managers.

Keywords: Indoor air quality, Energy Recovery Ventilation (ERV), Streamer Duct Chamber (SDC), CO2 reduction, Particulate matter removal, Energy efficiency

Paper ID: 20

Low Delta-T Syndrome in District Cooling System – The Malaysian Experience

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Abstract. District cooling system (DC) has been installed in Malaysia since the mid-1990s in many government and commercial developments. Low delta-T syndrome is a common issue plaguing the DC chilled water systems that can lead to reduced cooling capacity and low energy efficiency. Low delta-T in a chilled water system refers to the condition where the temperature difference between the supply and return water is lower than the design value. Initially, the effects of low delta-T are not well understood by DC operators. Coupled with a relatively cheap energy and utilities costs, DC operators did not pay much attention to it. As the system ages, the effects of low delta-T have become more pronounced. With the ever-increasing utilities costs, now DC operators are imposing new requirement on customers to return the chilled water at the prescribed temperature or higher; failing which a penalty would be imposed on the customer. Low delta-T can lead to increased energy consumption and decreased system performance, as more chiller plant equipment has to be run to achieve the desired cooling effect. The impacts of low delta-T are discussed and various factors that cause this syndrome are presented and elaborated. Examples of the causes of low delta-T found in Malaysian's scene are presented. In order to address this issue, it is important to identify the underlying causes and implement appropriate solutions. The effectiveness of the solutions is also evaluated. Addressing low delta-T requires a systematic approach that includes identifying the root cause, conducting performance testing, and implementing corrective actions. Properly addressing low delta-T can help optimize system's performance, reduce energy costs, and improve overall building comfort. Improved chiller plant efficiency and system's performance reduces the carbon footprint in line with Malaysia's decarbonization policy by year 2050.

Keywords: Low delta-T, district cooling, energy efficiency, carbon footprint, decarbonization.

Paper ID: 21

Studying the Distribution of Droplets, while Speaking in a Ventilated/Closed Room

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Abstract: The wave of COVID-19 virus in 2020, has put up a lot of importance on measures like social distancing, masking, room ventilation, placement of HVAC equipment etc. If a standard meeting room size is considered, wherein about 6 people can sit, the spread of droplets that originate due to speaking/sneezing becomes a critical thing to evaluate. Improper ventilation, inadequate distancing can spread the airborne virus within no time. Qualitatively, one can put up a protocol of distancing, ventilation/ air conditioning, circulating fresh air within the room etc., but still a real understanding of the "Spreading" mechanism is far from being understood. A systematic and scientific study of the spread of virus or droplets can make us understand the aftereffects in a quantitative manner. Computational Fluid Dynamics (CFD) is one such means to simulate, study, and quantify the distribution of species like virus, air droplets in a specific operating environment. For studying the way in which the virus/droplets will be distributed once emitted from the source (mouth), a CFD model of the room, with objects like table, chairs and the human beings sitting inside it, can be modelled. Virus can be considered as a massless particle (species) and droplets can be considered as particles with non-zero mass. Once these particles are injected in the air stream (air is a real fluid), depending on the natural or forced air flow, the forces acting on the particles are evaluated. The resultant force will then track and calculate the time-based position of the particle and species. Performance parameters like concentration index at any point/region in the room can be defined and the efficacy of different ventilation options can then be compared. In this paper, we'll be giving a detailed estimate of how CFD modelling can help us track the virus/air borne particles in the room, for different ventilation options.

Keywords: Droplets, HVAC, COVID-19, CFD

Paper ID: 23

ACMV System Design for Performance and Resilience for a Super-Low Energy Building in Tropical Climatic Conditions

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Abstract. A Super low energy building in Singapore is defined as the best-in-class energy performing Green Mark building that can achieve 60% energy savings with reference to 2005 building codes. To achieve such steep energy savings will require all the building systems to be designed to perform optimally with the least energy consumption as possible and the energy production through renewables to be maximized both spatially and in terms of system performance. In the tropical climate condition, ACMV systems which consume 40% of the overall building energy then becomes the most critical building system for the 60% energy savings target to be achieved. This paper investigates the design philosophy and critical performance criteria to be met by the ACMV systems to achieve the super – low energy status for a tall building in Singapore. Strategies and technologies to achieve the required savings are investigated through an energy model simulation study using IES VE. With climate change in consideration the paper also investigates the margins to be maintained while designing the ACMV systems so that the performance is not compromised over time due to higher loads and operational temperatures resulting from global warming.

Keywords: Super-low energy building, ACMV design, Design for performance, Design for Climate Resilience

Paper ID: 24

The Effectiveness of Daikin Streamer in Air-Conditioners and Air Cleaners to Improve the Indoor Air Quality (IAQ) of Residential or Office Room.

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Abstract. Awareness of Indoor Air Quality (IAQ) has recently been supercharged through the rise of the Covid-19 pandemic. Volatile organic compounds (VOCs), carbon dioxides, particulate matter (PM2.5), and bio-aerosols that carry airborne pathogens that serve as primary transmissions of diseases and sickness in the air are major components being considered when evaluating indoor air quality. In this experimental study, effort was given to investigate the effectiveness of Daikin Streamer in its associated equipment to improve the IAQ of a residential or office room by reducing the risk posed by pathogens and bio-aerosols. The wall-mounted air-conditioner (SMARTO), ceiling-cassette air-conditioner (NCCK), and Streamer Duct Chamber (SDC) were investigated for their bactericidal performance effect against E-Coli based on JEM 1467 Appendix F evaluation standard, whereby after 4 hours of exposure, results were 99.7%, 99.9%, and 99.99% reduction respectively in a room volume of 31.2m3. Additionally, the SDC and air purifier (MC55XVMM) models were investigated on its effectiveness in removal of airborne pathogens based on JEM 1467 Appendix D evaluation standard, whereby the SDC removed 99.9% of airborne Staphylococcus Aureus in 30 minutes in a room volume of 24.03m^3, and the air purifier removed 99.98% airborne SARS-CoV 2 virus in 2.5 minutes in a chamber volume of 1.06m^3. Hence, the application of such equipment in homes and offices will help to mitigate the risk of infections by bacteria and viruses.

Keywords: Indoor Air Quality, Daikin Streamer, Air-conditioner, Air Cleaner, Bacteria, Virus.

Paper ID: 27

The Influence of Green Roof Pot Openings on the Heat Flow Field in the Growth Medium by CFD Simulation

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Abstract. Pot-type green roofs often face concerns regarding high root temperatures. Openings can be made in the pot wall to mitigate root temperature effectively. However, understanding the complex mechanisms affecting the pot's root temperature is crucial. Therefore, this article investigates the convective benefits by utilizing computational fluid dynamics (CFD) to simulate the impact of different opening modes in the green roof pot on the heat flow field within the growth medium. Firstly, measured data establishes and verifies a thermal flow field model of the pot medium. Secondly, the CFD analysis explores the opening ratio of the pot and the green roof pot in a controlled workshop setting. The results demonstrate that as the opening ratio increases, the air velocity within the medium and the cooling effect also increase. However, the rate of improvement gradually diminishes when the opening ratio reaches 40% to 100%. The airflow rate is higher in the perforated pot compared to the non-perforated one. Based on the findings, it is recommended to incorporate proper openings in the green roof pots. This practice can enhance the aeration of the growth medium, reduce root temperature, and optimize the overall growth environment for plants.

Keywords: perforate ratio, root zone temperature, porous, thermal convection, ventilation

Paper ID:28

Comparison of Contaminant Concentration and Energy Consumption According to Condition of Negative Pressure Isolation Ward Air Conditioning and Suggestion of Energy Saving Method

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Abstract. The buildings accounts for one-third of the world's energy consumption, and the HVAC system accounts for about 10-20 % of the energy consumption of advanced countries. Hospitals have the second highest energy usage among all buildings in Korea, so it is essential to save hospital energy. In particular, negative pressure isolation ward (NPIW) has higher air change rate than general inpatient ward, is operated 24 hours, and NPIW's air is conditioned by 100 % outdoor air system, so energy consumption of NPIW is huge. To solve this problem, efficient control technology of HVAC system is required to establish an energy-saving facility system. Accordingly, in this study, a representative model was selected by analyzing the types and HVAC system more than 20 wards among the government-designated NPIW facilities in Korea. And the energy consumption for the model with the air change rate and pressure difference suggested by the government-designated NPIW guidelines and ANSI/ASHRAE/ASHE Standard 170 was analyzed using Design Builder. In addition, the energy consumption of general ward and NPIW with a heat recovery system was compared. As a result of the analysis, the energy consumption of NPIW was higher than that of general ward, but the heat recovery system could reduce the energy consumption of NPIW. Depending on the analysis results, several plans were proposed to save energy while maintaining performance of NPIW such as pressure difference and air change rate in the NPIW.

Keywords: Heating, ventilation, and air conditioning (HVAC) system, Negative pressure isolation ward (NPIW), Energy consumption

Paper ID: 29

Performance Validation of a DIY Air Purifier in Compliance with ASHRAE Standard 170

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Abstract. Since July 2021, to handle the COVID-19 situation, the Government of Thailand has encouraged people to carry out home isolation (HI) because the hospitals were overloaded with COVID-19 patients. Many organizations helped create several prototypes of negative pressure rooms. According to the ASHRAE Standard 170, the air inside must be recirculated and treated with a minimum rate of 12 ACH and passed through a HEPA filter before being exhausted. Most prototypes were too big and too expensive especially when an air conditioner and an air purifier or other types of air treatment were included. Therefore, a question came up whether it was possible to build a do-it-yourself (DIY) air purifier from a portable air conditioner attached with additional filters so that clean air and comfortable condition were delivered at the same time. Even though many experts were against this idea due to a large pressure drop would be induced. An artificial room with a volume of 10.9 m^3 (1.9 m x 2.6 m x 2.2 m) was used in this study. A 12,000-Btu/h portable air conditioner was affixed with a MERV-8 pre-filter and a HEPA filter (99.97% efficiency) and turned out to be a DIY air purifier that could also provide thermal comfort. A large pressure drop occurred as expected. At 3 fan speeds, the air flow rate was dropped by 35 to 53%. However, by calculating the clean air delivery rate (CADR), also known as the effective cleaning rate (ECR), it was found that even at the lowest fan speed, a CADR of 273.8 m3/h was delivered. This was equivalent to 25.2 ACH which is more than twice of that required by the standard. This means that there is a potential that ordinary, non-technical people could easily build this kind of DIY air purifiers to take care of themselves during their hard time.

Keywords: Air purifier, DIY, Portable air conditioner, clean air delivery rate (CADR), Effective cleaning rate (ECR)

Paper ID: 30

Analysis of Particle Concentration in Air Infection Isolation Room by Differential Pressure based on Experiments

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Abstract. Recently, the pandemic caused by COVID-19 has occurred for a long time. Accordingly, research on Air Infection Isolation (AII) rooms that can isolate infectious disease patients is being actively conducted. The purpose of this study is to observe the diffusion and removal effect of particles depending on the differential pressure between the AII room and anteroom when a patient lying in the AII room breathes. In a chamber built according to Korea's standard AII chamber, we experimented to check the concentration change by generating particles. The ventilation system was operated under three other differential pressures, and measurements were taken at three other points in the room. As a result, it was confirmed that as the differential pressure increased, the ventilation rate increased, and eventually, the concentration of particles in the AII room decreased. The higher the differential pressure, the higher the ventilation air flow rate, resulting in a significant change in airflow. Due to the air entering through the bottom of the door, the concentration of particles measured in front of the door differed from the center of the AII room, at the bottom of the exhaust diffuser. In this study, we assumed that there were no particles in the air entering through the leakage area but that the trend of particle concentration would be different if particles did enter.

Keywords: Air Infection Isolation room, Differential pressure, Leakage area, Particle concentration

Paper ID: 31

Daylight Control Positions for Lighting Energy Saving from Daylighting through Skylights for a Warehouse

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Abstract. This study provides the results of a simulation-based analysis from EnergyPlus to estimate the potential of electrical energy savings in lighting system which use skylights with daylighting controls for an open-space warehouse located in Thailand. The locations of wall mounted-daylight control sensors were investigated in order to meet the requirement of floor level illuminance. In this study, 4 daylight-control strategies including 2-stepped and 3-stepped controls, continuous control, and continuous/off control. The results of the continuous/off control method show the highest energy savings. From the one-way analysis of variance (ANOVA), the results conclude that there are significant differences between the daylight-control methods.

Keywords: Daylighting, Daylighting control, Skylight, Warehouse

Paper ID:32

Study on the Influence of Window-to-Wall Ratio on the Overall Envelope Thermal Performance in Tibet

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Abstract. Window openings in the envelope structure introduce outdoor solar radiation into the interior and at the same time disrupt the continuity and integrity of the external wall insulation, and the solar heat gain through the windows causes wall temperature changes on the internal surfaces of each wall, which in turn affects the heat transfer process within the wall. The effect of window placement on the overall thermal process of a building is therefore complex. Existing studies are unable to accurately describe the effect of window size, i.e. window-to-wall area ratio, on the overall thermal performance of the envelope and further research is necessary. This paper first analyses the actual building thermal environment under different envelope configurations based on field research and testing of Tibetan dwellings, using comprehensive thermal performance indicators of the envelope structure. Then, based on the results of the research and tests, the simulation of EnergyPlus software was used to compare the indoor air temperature of the building under different window-to-wall ratio settings for different room orientations. The results show that: window settings on external walls have a significant impact on the overall thermal performance of the envelope under actual conditions, and no distinction should be made between considering transparent and non-transparent parts for the thermal performance of the envelope; for Tibetan regions, a reasonable window-to-wall ratio setting for different wall constructions can increase the average indoor air temperature by 2-8°C.

Keywords: Envelope, Window-to-wall ratio, Lhasa, Thermal performance

Paper ID: 33

The Optimization Conditions for Silpakorn University, Archives, Thailand

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Abstract. This research is to study and improve the inside conditions of the Silpakorn University Archives, Sanam Chandra Palace Campus Nakhon Pathom Province, Thailand. This study generates 3D model from Ansys Fluent to examine the distribution of temperature and air velocity. Some areas in the room are found to have inconsistent temperatures and do not meet the requirement of ASHRAE Handbook 2019 recommendations. This study divides the Archive into 9 area with 18 points to validate the simulation. The model is used to solve the problem by adjusting the angle of the air conditioner to find the best position that makes the temperature comply with the ASHRAE Handbook 2019. The results show that most appropriate case is to adjust the direction of the 3rd air conditioner at 45° and the 4th air conditioner at 30° lower the horizontal level, causing the inside conditions to be in the range 16-23 °C and the relative humidity is in the range of 30-50%, which consistent to the suggested temperature and relative humidity range in the ASHRAE Handbook 2019.

Keywords: Archives, Simulation, ASHRAE, Ansys Fluent

Paper ID: 34

Investigation on Occupants' Metabolic Rate, TSV, and PMV in an Office Building. Study Case: Tokyo, Japan

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Abstract. This study investigated the relationship between metabolic rate, Thermal Sensation Vote (TSV), and Predicted Mean Vote (PMV) of occupants in an office building. The method of this study is collecting Indoor Environment Quality (IEQ), physiological data, and subjective responses of building occupants. IEQ data were collected by installing indoor sensors to record indoor air temperature, relative humidity, light, and air velocity. The Silmee W 22 wearable devices collected the physiological data of building occupants, such as energy expenditure, skin temperature, and heart rate. The subjects of this study were office workers in an office building in Tokyo, Japan. The investigation was conducted in the winter season (February 28th – March 30th, 2023). This study used questionnaires to collect subjective responses of building occupants on IEQ. The study compared the actual Thermal Sensation Vote (TSV) and PMV based on occupants' actual-metabolic rate and ASHRAE-55 standard. The result shows that the PMV calculation based on the ASHRAE-55 standard is more accurate to TSV compared to the PMV calculation based on the actual metabolic rate.

Keywords: Metabolic Rate, Thermal Sensation Vote, Predicted Mean Vote, Office building

Paper ID:36

Investigation of Thermal Comfort and Indoor Air Quality for a Library Building

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Abstract. Libraries are continuing to change from warehouses of information to a place where adults and children can spend hours studying and relaxing. However, modest study has been done on thermal comfort and indoor air quality in libraries. In addition to having an adverse effect on the occupants' mood and reading efficiency, poor thermal comfort and indoor air quality will also have a negative influence on the occupants' health. Therefore, this study investigates thermal comfort and indoor air quality for self-study reading room and children's learning center in a library building through a questionnaire survey and field measurement. CFD simulation is also conducted to validate the result. The results suggest that people prefer lower temperatures. According to the questionnaire survey, the thermal sensation is strongly related to thermal comfort and indoor air quality after improving fresh air intake. Furthermore, a room set temperature of 24°C with an air flow velocity of 0.2 m/s was determined after considering thermal comfort. It may provide useful information for designing better thermal comfort and indoor air quality in library buildings.

Keywords: Thermal Comfort, Indoor Air Quality, Field Measurement, Questionnaire Survey, Numerical Simulation.

Paper ID: 37

Potential Solar, Wind and Battery Storage Deployment to Decarbonize Emissions in ASEAN

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Abstract. Contributing to the carbon neutrality pathways will require multiple approaches to decarbonise the emissions in all sectors. Thus, this study will investigate the maximum contribution of solar and wind deployment together with energy storage potentials to change the solar and wind deployment from intermittent energy into the more stable load by combining energy storage system. The study uses the data producing from the exercise of linear programming model to minimize the total cost of the energy system when various constraints such as CO2 emissions and power supply-demand balance are given, in order to check the maximum contribution of solar, wind and the energy storage in the decarbonisation scenario of ASEAN. The findings provide policymakers a second opinion on how to scale up solar and wind in a large scale with battery storage in the contribution to deep decarbonisation in the future ASEAN.

Keywords: Solar PV, Battery Storage, System Integration, and Decarbonisation.

Paper ID: 38

Continuous Optimization of Parallel Chillers using Modified Barnacles Mating Optimizer Considering the Variation of Cooling Loads

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Abstract. Chiller plants are one of the most power-hungry systems in a building. In recent times, an increasing number of modern buildings have had multiple chillers operating in parallel to fulfill higher cooling loads. The optimal chiller loading (OCL) field is important in optimizing multi-chiller operations to result in the lowest total energy consumption. This study aims to improve the optimization approach of an existing OCL algorithm, the barnacles mating optimizer (BMO). The modified continuous BMO (CBMO) algorithm allows an optimization procedure to be conducted in multiple cycles, greatly reducing the result variations between each procedure. Using MATLAB R2023a, the algorithm's performance was compared to original BMO with past simulated case studies from two semiconductor factories and one hotel building. Results showed 61% to 100% standard deviation reductions by CBMO, highlighting its increased result consistency. Furthermore, the algorithm allows optimizations to be carried out across a series of cooling loads retrieved directly from an external data file, as opposed to the manual single-load input approach of conventional OCL studies. This modification was tested on a series of cooling loads collected from a local office building in the form of an Excel file, which could be directly read and optimized by the algorithm. Although CBMO requires more processing time in each procedure compared to its native algorithm, the optimization requires only 9 seconds to process, as opposed to the chiller plant data logging interval of 15 minutes, which is sufficient for the optimized load distributions to be implemented. As a result, periodic optimizations can be performed in line with cooling load variations, to determine the most efficient load distributions in a multi-chiller system. These modifications improve the reliability and feasibility of the OCL algorithm in practical applications, where cooling loads in a building can fluctuate drastically with time and season.

Keywords: Chiller switching, Stochastic algorithm, Metaheuristic, Part load ratio, Daily optimization, Chiller sequencing

Paper ID: 39

Investigation of Standing Wave Thermoacoustic Refrigeration System's Performance under Atmospheric Condition

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Abstract. Thermoacoustic refrigeration system operates by converting the sound energy to cooling power. This technology has the potential on providing cooling capacity without using substances such as the refrigerants used in vapour compression cycle that may contribute to ozone depletion and global warming issues. The medium used in the systems is either air, inert gas, or a mixture of gases. The fundamental construction of the thermoacoustic refrigeration system is relatively simple compared to the vapour compression refrigeration system. There is no moving part in the system. However, the main disadvantage of the thermoacoustic refrigeration system is its low coefficient of performance (COP) compared to other conventional refrigeration systems. A standing wave thermoacoustic refrigeration system with quarter wavelength was constructed. This system was operated using atmospheric air with room temperature and pressure. The thermoacoustic tube length, dimension, and sound frequency of a quarter wavelength were verified by using Kundt Tube experiment. The optimum stack centre position, x_s was determined to be 37mm ($\lambda/60.8648$) measured from the pressure antinode which allowed the system to produce the highest temperature difference between hot and cool sides. Besides that, the relation between the end correction factor, drive ratio, and ΔT were also investigated and discussed. The spiral and parallel stacks were compared based on the thermal contact area between stack plates and working gas, the temperature difference relative to stack length, and stack plate spacing. Based on the experimental result, the maximum temperature difference between the hot and cold end, ΔT was 24°C at 146Hz. The temperature difference between the cool side and room temperature, ΔT_c was 10.5°C, where T_{room} was 25°C and T_{low} was 14.5°C.

Keywords: Thermoacoustic, Refrigeration, Coefficient of Performance, Stack, Acoustics

Paper ID: 40

High Efficiency Axial Fan System for AHU & Ventilation Delivers the Lowest Carbon Footprint

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Abstract. From an overall building services perspective, ventilation system is amongst the top 5 end use energy consumer. Therefore, in order to lower the carbon footprints of the buildings, improving the efficiency of the ventilation systems becomes critical. Today, technologies are available that have the potential to reduce the energy consumption of ventilation systems by up to 60% and can deliver specific fan power of as low as 0.25 Watts/CMH, thus aiding the buildings to secure the Super Low Energy Building certification. This technical article gives an overview of the traditional ventilation solutions and their efficiencies followed by insights into the modern high efficiency axial fan ventilation solution that are especially designed for AHUs and ventilation applications. System effect is another important variable that has significant impact on the ventilation systems' efficiency in real life situations as it is dependent on the geometry of the installation apart from the fans aerodynamic performance. The article also provides an overview of the influence of the system effect on the ventilation system's efficiency. A case story on Keppel Bay Tower gives insights into the energy savings delivered upon retrofitting the AHUs with high efficiency axial fan ventilation solution thus aiding the building to secure the country's first Green Mark Platinum (Zero Energy) certification from the Building and Construction Authority of Singapore.

Keywords: axial fan, AHU, lowest carbon footprint, high efficiency

Paper ID: 41

Heat Recovery Efficiency of Ventilation Systems in Cold Climate

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Abstract. As the building energy use is becoming ever more topical subject, addressing building energy consumption through examining and optimization of heat recovery solutions is gaining more attention. Along with the increased share of ventilation heating needs in well-insulated and airtight buildings, heat recovery systems in mechanical ventilation systems are increasingly common. Ventilation heat recovery is one of the most efficient and viable means to reduce ventilation heat losses and save energy. An examination of a ventilation unit was carried out utilizing an actual installation within an apartment located in Riga, Latvia. The objective of this study was to examine the heat recovery efficiency of the ventilation system in the Latvian climate with changing outdoor and exhaust air parameters, given that the dry heat recovery efficiency is different from the actual heat recovery efficiency. The ventilation unit was equipped with a plate heat exchanger boasting an airflow rate of 105 m^3/h. Comprehensive measurements of air temperature and relative humidity were carried out to evaluate the heat recovery efficiency. To validate the reliability of the measurements and evaluate the correlations, the collected measurements were analysed through statistical regression. By revealing the complex correlations of heat content, moisture, and sensible air parameters, this research contributes essential insights for optimizing heat recovery systems and advancing energy-efficient ventilation practices, particularly in cold climate conditions.

Keywords: Heat recovery, Ventilation, Mechanical ventilation, Energy efficiency

Paper ID: 43

Chiller System Efficiency Improvement in China

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Abstract. There are many chiller plant systems in the air conditioning market but not so many are operating in high performance. NM5 receives many requests to improve the chiller system performance by applying optimizing control system. Upon making operation analysis and we found some points of improvements in the design of chiller plant systems. We have categorized these design gaps which consultants / design institutes made and propose counter measures to improve the operation through control system. We have found chiller system efficiency improved from a yearly system COP of 2.6. In this paper, we would like to explain our past chiller system operation analysis and identified problems. We also suggests some form of improvements. We propose all variable systems by using VSD (Variable Speed Drive) in all equipment including chillers, pumps and cooling towers. All these equipment together with their variable speed drives are connected in fast communication system to replace the traditional Programmable Logic Controller (PLC) which are usually expensive. By applying communication based chiller control system, efficient chiller plant operation can be realized.

Keywords: Chiller System performance improve.

Paper ID: 45

Void Fraction and Flow Patter of Dimethyl Ether in a Horizontal Condenser: Effect of Condensing Temperature

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Abstract. Flow quality, void fraction, and flow pattern are important parameters in two-phase flow that are often found in evaporator and condenser of an air conditioner. A study on these parameters of DME refrigerant in a horizontal condenser under different condensing temperature has been carried out on an air conditioner with a nominal cooling capacity of 2.64 kW. Based on simulation using Refprop, it is obvious that condensation occurs first at the lower condensing temperature. From the condenser inlet to 90% of condenser length, the higher rate of change of void fraction is found for the higher condensing temperature. At the axial position near the condenser outlet, however, the higher rate of change of void fraction is found for the lower condensing temperature. Three main flow patterns are identified in the condenser: annular, intermittent, and stratified-wavy. Annular flow occurs at flow quality higher than 0.33, while the stratified-wavy flow is found at a range of flow quality 0 to 0.15. Intermittent flow is found at the transition between the annular and stratified-wavy flow.

Keywords: Dimethyl ether, Refrigerant, Air conditioner, Void fraction, Flow pattern

Paper ID: 46

Effect of Evaporating and Condensing Temperature on the Performance of DME and R134a

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Abstract. Dimethyl ether (DME) is an environmentally friendly refrigerant that has the potential to replace R134a due to the similar working pressure and temperature. Performance comparison studies between DME and R134a have been carried out through simulations to determine the performance of each refrigerant. The simulation was carried out at an evaporation temperature range of -15 to +5°C and a condensation temperature of 35 to 55°C. The test results show that in terms of cooling capacity DME has advantages at low temperatures and high condensation temperatures. In terms of power consumption, DME is better in all test ranges with maximum savings reaching 9.8%. Meanwhile, in terms of overall performance, systems with DME have a higher COP. The maximum improvement in COP with DME reached 12.8% at an evaporation temperature of -15°C and a condensation temperature of 55°C.

Keywords: Dimethyl ether, Refrigerant, COP, Cooling capacity, Power consumption

Papaer ID: 47

A Study of Radiative Cooling with Thermoelectric for Power Generation in the Tropics

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Abstract. Radiative cooling (RC) is an intriguing cooling technology that operates without external energy sources. It works by emitting thermal radiation into outer space, utilizing a long-wave infrared window with a wavelength range of 8 µm to 13 µm. This passive cooling system cools the surrounding area by allowing thermal radiation to escape from the Earth's surface. A thermoelectric generator (TEG) converts thermal energy into electrical energy using the Seebeck effect. By applying a constant heat flux and temperature difference, TEG can continuously generate power for up to 24 hours. Combining a radiative cooling material with a TEG creates the necessary temperature gradient and continuous heat flux for electricity generation. In this work, a TEG system with various radiative cooling coatings was developed and evaluated. The coatings studied included barium sulfate ($BaSO_4$) and silicon dioxide (SiO_2). The TEG system with different coating layers demonstrated varying radiative cooling effects. With a double-layer coating, the system was able to generate a daytime voltage of at least 128 mV and a continuous nighttime voltage of 27 mV. The theoretical calculations indicated that the system has the highest power generation of 22.54 mW and 352.30 mW/m^2. These findings underscore the potential of the TEG system with a double-layer radiative cooling coating. It enhances cooling and enables nighttime passive power generation.

Keywords: Radiative cooling, Thermoelectric generator, Power generation

Paper ID: 50

An Operability Study of Green Building Design for New Construction

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Abstract. Green building design is one of the solutions to mitigate global warming. Nowadays many different green building rating systems (GBRSs) are adopted to design and certify green buildings for sustainability, especially the new construction. Unfortunately, many of these "certified" buildings are not sustainable because either the actual operation departs from the original design or the building developer cares about the certificate to sell property more than preserving the nature resource. With only limited research investigating the effectiveness of operation management (OM) aspects in GBRSs, this paper aims at reviewing the OM related criteria for new construction among three GBRSs being adopted in Hong Kong; and the research is based on the quantitative and qualitative criteria of GBRSs. The operability study identified that the China Assessment Standard for Green Building (GB/T 50378) pays more attention to operability while the Building Environmental Assessment Method (BEAM Plus) is less focus on the OM assessment items. Possible problems such as inadequate assessment time node are identified among the three GBRSs. A proposed framework is therefore suggested for improving operability, which may include different assessment timeline, some new categories, and re-assessment process for integration into the existing GBRSs. The proposed parameters are carefully examined so as to sustain the green building features. Limitations and implications for future research work will also be discussed.

Keywords: Green building design and rating systems, operability, assessment framework, GBL, BEAM Plus, LEED

Paper ID: 51

Adopting Thermal Radiation System in Tropical Climate

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Abstract. Thermal radiation system is commonly adopted in European countries for energy saving and thermal comfort reasons. However, it is challenging for use in tropical climate due to high humidity. This paper discusses the challenges of adopting an advanced thermal radiation system in a typical office tower in Hong Kong and the mitigating measures to deal with some common problems. Building information modelling (BIM) and computational fluid dynamics (CFD) were applied to critically assess the thermal performance, the energy performance, and compare with that of the traditional variable-air-volume (VAV) system. ASHRAE predicted mean vote (PMV) analysis for temperature distribution in occupied zone and psychrometric analysis for dedicated outdoor air system (DOAS) were carried. Various control strategies were studied. The findings suggested that the application of the thermal radiation system in open office area may save more energy and increase thermal comfort compared to the system. The use of DOAS supplying 100% fresh air to the occupied zone may promote indoor air quality (IAQ) and with underfloor air distribution design it can help mitigate the risk of communicable situation like CoV-19. Some common problems such as condensation can be minimized or eliminated through proper design of control strategies and careful selection of equipment/sensors.

Keywords: Thermal radiation systems, Chilled beam, Chilled ceiling, Variable-Air-Volume, energy saving, thermal comfort

Paper ID: 52

Sustainability Development at Air Filtration Industry

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Abstract. Technology is growing rapidly to cope with the market needs. Particle filtration target is running into a nano size particle size capture needs in filtration system at different industries such as microelectronic and pharmaceutical. On top of that, to have highest efficiency of productivity in office or manufacturing environment, the molecular filtration becomes a focus in the filtration system requirement where new molecular filter classification ISO 10121-3 was just launched recently. All these help towards providing clean air and at the same time there is expand the needs of sustainability development that is not jeopardize the future generation environment. Focus on the goals of UN does help the world to move toward sustainability direction while setting the vision in specific industry line. In term of clean air solution, energy saving, CO2 emission reduction and production footprint are very important aspect to be focused as the first step to help on sustainability development.

Keywords: Sustainability, Energy saving, CO2 emission, footprint

Paper ID: 54

Investigation of Indoor Environment in Low-Rise Urban Condominiums in Bangkok

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Abstract. Indoor Environmental Quality (IEQ) plays a crucial role in maintaining comfortable and healthy environments, especially within residential spaces. Cities such as Bangkok pose distinct challenges in relation to IEQ, especially when it comes to low-rise condominiums, which typically consist of 1 to 8 floors. These condominiums often encounter design constraints for ventilation and are situated in closer proximity to sources of pollution. As a result, they may experience more intricate IEQ dynamics, which can have a detrimental impact on the well-being of their occupants. Currently the number of this type of buildings in Bangkok increasing significantly. However, studies focusing on this type of building remain scarce. This research aims to investigate on this issue through the method involving a survey amongst residents of five condominiums in Bangkok and IEQ measurements in two selected residential units. The measurement results show that certain IEQ parameters meet the established standards, but others, including noise, lighting, and CO2 levels, do not. The occupants' satisfaction survey also highlights compliance with IEQ standards, except for lighting and CO2 concentration, were people still express satisfaction. This reveals disparities between residents' preferences and these established standards. Regarding behaviour effect from IEQ, residents tended to depend on artificial sources as air conditioning and lighting. Additionally, 70% of respondents often kept windows closed even when not using air conditioning, contributing to elevated CO2 levels within the building. In terms of IEQ impacts, while IEQ may not directly affect residents' health, it does have significant effects on their comfort, sleep quality, and work productivity at home. In summary, the challenges posed by the external environment and the behaviours of residents can lead to a decline in IEQ quality, thereby impacting the overall quality of life for inhabitants of low-rise condominiums.

Keywords: Indoor Environmental Quality (IEQ), Urban area, low-rise Condominium, Occupant Satisfaction, Well-being building

Paper ID: 55

The optimum performance evaluation in the chilled water wall in hot and humid area

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Abstract. A chilled water wall (CWW) integrated with heat pump in an opened water fall film for ambient temperature cooling, dehumidifying, and air cleaning has been developed. found that the optimum water flow rate is from 300 l/hour to 500 l/hour during the running of the water wall, due to the water film is not formed at lower flow rate and water bounced off the water film at higher flow rate. This study tries to test the different flow rates in 300 l/hour, 500 l/hour, and 700 l/hour to evaluate the optimum performance of indoor hygrothermal environment and indoor air quality in hot and humid environment. The results present that CWW integrates heat pump in 300l/hour is the optimum condition for air cooling, dehumidifying, air cleaning, and energy saving in hot and humid environment.

Keywords: Chilled water wall, Cooling, Dehumidifying, Air cleaning, Energy saving

Paper ID: 57

Investigations on Surface Disinfection Efficacy of Far-UVC 222 nm Germicidal Irradiance (UVGI) Device at Controlled Environment

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Abstract. The Coronavirus disease 2019 (COVID-19) pandemic which lasted for about three years has significantly affect the health, economy, and social impact on humanity. The continuous mutations of the virus variants have accelerated the demand of scientific research on disinfection techniques for a safer indoor environment. Ultraviolet germicidal irradiance (UVGI) has been proven for its air and surface disinfection efficacy; however, its usage is limited to unoccupied condition. This study investigated the efficacy of far-UVC-222 nm UVGI experimentally to bridge the research gap. Staphylococcus epidermidis and Mycobacterium smegmatis were employed for surface disinfection at laboratory. Total plate count was used to determine the disinfection efficacy after far-UVC intervention. Under the laboratory setting, 4-log10 reduction were achieved in 3.5 mins and 12 mins for Staphylococcus epidermidis and Mycobacterium smegmatis respectively. This study carefully examined how far-UVC irradiation performs effectively for surface disinfection in a controlled testing environment. The result offers useful reference for subsequent field tests to verify the performance of far-UVC in real applications setting.

Keywords: UVGI, Surface disinfection, 222 nm, Laboratory

Paper ID: 58

Conceptual Design: an Energy Efficient Approach to Design Centralized Air-Conditioning VRV System for Commercial Buildings

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Abstract. To align with SDG 7 Affordable and Clean Energy, and SDG 13 Climate Action, optimizing energy utilization in a commercial building is important, especially when the air-conditioning system consumes more than 50% of total building electrical load. Often times, designers use equipment's rated power consumption or coefficient of performance (COP) to design for an energy efficient building, but overlooked on some factors that could affect the equipment efficiency. In this paper, all these factors will be discussed, together with the suitability of centralized air-conditioning, i.e., VRV system, for commercial buildings; and a proposal for building structural change is given which potentially improves the air-conditioning system efficiency.

Keywords: Sustainable Development Goals (SDG), energy efficiency, VRV system efficiency, commercial buildings.

Paper ID: 60

Indoor Air Quality in Healthcare Industry

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Abstract. This comprehensive presentation discusses the pivotal theme of Indoor Air Quality (IAQ) within the healthcare sector, encompassing various dimensions critical to understanding and improving IAQ for the well-being of patients, healthcare staff, and visitors. The exploration commences with an introductory overview, offering insights into IAQ's historical evolution, global context, prevalent air pollutants, and the importance of maintaining high-quality indoor air. It emphasizes the growing concerns associated with Sick Building Syndrome (SBS), a phenomenon characterized by occupant health discomfort in indoor environments. The presentation then transitions to the legal landscape concerning IAQ, delving into litigation, regulations, and in healthcare settings, the inherent responsibilities of healthcare institutions in preserving occupant health. Furthermore, the study navigates through the vital parameters that constitute the framework for assessing IAQ and Indoor Environmental Quality (IEQ). It explains the key metrics and factors employed to evaluate the quality of indoor air, clarifying their significance. Subsequently, the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) framework emerge as a central theme, applying its systematic approach to recognize potential hazards, evaluate associated risks, and implement control measures for the enhancement of IAQ. This segment expounds on the sequential phases within HIRARC, underscoring its role in protecting the well-being of occupants in healthcare environments. To provide a tangible perspective, the presentation incorporates insightful case studies, offering practical examples of IAQ and IEQ concerns within healthcare settings. These cases exemplify real-world challenges and strategies employed to address IAQ issues in hospital buildings and specific healthcare units. In conclusion, this presentation serves as a valuable resource, equipping healthcare professionals, administrators, and policymakers with a profound understanding of the complexities and solutions related to maintaining high-quality indoor air in the healthcare sector, ultimately contributing to safer and healthier indoor environments within healthcare facilities.

Keywords: Indoor Air Quality, Healthcare, Air Pollutants, Indoor Environmental Quality

DAIKIN

VRV IV

HEAT RECOVERY HOT WATER SYSTEM

VRV IV HEAT RECOVERY HOT WATER SYSTEM

VRV IV HRHW not only provides cooling, it is also available to provide hot water without incurring extra energy.

7 AFFORDABLE AND CLEAN ENERGY

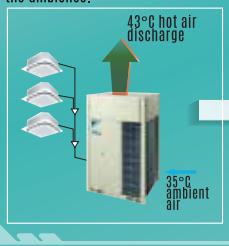
12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

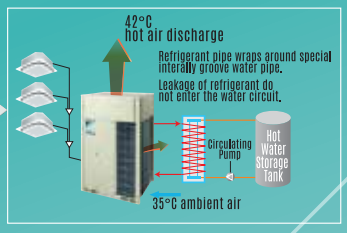
THE ENERGY-EFFICIENT SYSTEM

The energy-efficient system recovers waste heat as energy to heat hot water.

In a conventional system, waste heat from air conditioning is released into the ambience.

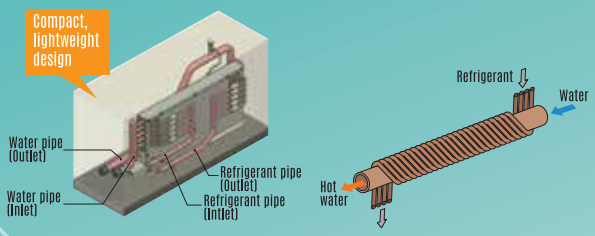


The VRV IV HRHW system recovers waste heat from air conditioning to heat water.



DAIKIN SERPENTINE HEAT EXCHANGER

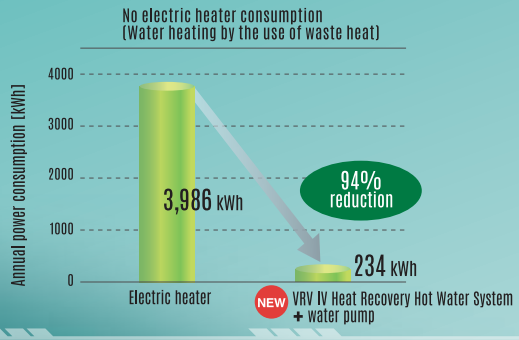
The proprietary Serpentine Heat Exchanger achieves excellent heat exchange efficiency.



VRV IV HRHW VS ELECTRIC HEATER

Comparison between VRV IV HRHW System and electric heater.

Recovering waste heat for water heating, VRV IV HRHW reduced annual electricity consumption by 3,752kwh/year, equivalent to reduction of 2,064kg CO_2e/year.

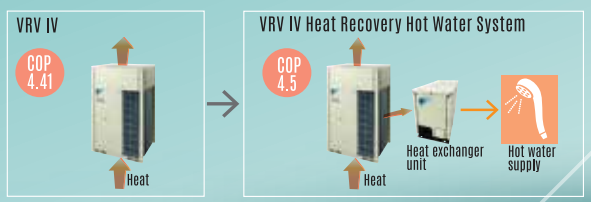


86 TREES SAVED

OUTDOOR UNITS ENERGY EFFICIENCY

Increased energy efficiency of the outdoor unit.

The waste heat from air conditioning is transferred to heat water. This mechanism reduces the amount of heat processed by the outdoor unit, resulting in better operation efficiency.



* Comparison of air conditioning using a 6 HP outdoor unit

SUITABLE FOR DIFFERENT COMMON APPLICATIONS

- House
- Apartment
- Clubhouse
- Hotel and Resort
- Health and Wellness Club
- Restaurant

DAIKIN MALAYSIA SALES & SERVICE SDN. BHD. 198301014326 (109719-M)

Call Centre: 1300-88-DAIKIN (324546) daikinmalaysia

DAIKIN

Every Professional Choice

HFO-1233zd (E)
Magnetic Bearing

Magnetic Bearing
Turbocor Compressor

Two Stage
Centrifugal

Magnetic Bearing
Daikin Compressor

HFO-1234ze
Magnetic Bearing

Water Cooled
Single Screw

Single Stage
Centrifugal

Air Cooled
Inverter Screw

Fan Wall

DAIKIN APPLIED (MALAYSIA) SDN.BHD.
199501041033 (370237-T) | email : dapmsal@daikin.com.my

DAIKIN

RA SERIES

R32 Inverter

Wall Mounted (Flagship)

FTKM Series
1.0 - 3.0hp

Wall Mounted (Premium)


FTKH-B Series
1.0 - 2.0hp

Wall Mounted (Deluxe)

FTKU-B Series
1.0 - 3.0hp

Wall Mounted (Prime)

FTKP-A Series
1.0 - 2.5hp

Wall Mounted (Standard)

FTKF-C Series
1.0 - 2.5hp

Multi-Split S

MKC Series

Multi-Split

MKM Series

R32 Non Inverter

Wall Mounted (Premium)

FTV-A Series
1.0 - 2.5hp

Wall Mounted (Standard)

FTV-P Series
1.0 - 3.0hp

SkyAir SERIES

R32 Inverter

Ceiling Cassette (Premium)

FCFG-A Series
2.0 - 6.0hp

Ceiling Cassette (Standard)

FCFC-A Series
2.0 - 6.0hp

Ceiling Exposed (Standard)

FHFC-A Series
2.0 - 6.0hp

Ceiling Concealed (Standard)

FDMFC-A Series
2.0 - 6.0hp

R32 Non Inverter

Ceiling Cassette (Premium)

FCFV-A Series
2.0 - 4.5hp

Ceiling Cassette (Standard)

1)FFC-A Series (1.0 - 1.5hp)
2)FCC-A Series (2.0 - 5.0hp)

Ceiling Exposed (Standard)

FHC-A Series
2.0 - 6.0hp

Ceiling Concealed (Standard)

1)FDBC-A Series (1.0 - 1.5hp)
2)FDMC-A Series (2.0 - 6.0hp)

AIR COOLED PACKAGED

R32 Non-Inverter | R410A Non-Inverter

Floor Standing

FVC-A Series
3.0 - 5.0hp

Floor Standing

FVGR-P Series
8.0 - 15.0hp

AIR COOLED PACKAGED

R410A Non-Inverter

Double Skin Ducted

FBHN/ FBVN Series
8.0 – 75.0hp

Double Skin Ducted

FBDHN Series
8.0 - 50.0hp

Rooftop

UATN-C Series
6.0 - 30.0hp

CONTROL SYSTEM

Control System

Intelligent Touch Manager System

DCM601B51
* 3rd party equipment management possible via WAGO I/O

Reiri- Smart Control Solution


Reiri for Office/ Home Hotel Seires

IAQ SOLUTION

Fresh Air

Outdoor Air Processing Unit (OAPU)

FXMQ-BF Series
Airflow Rate 406 - 1,271 CFM

Heat Reclaim Ventilator with DX-Coil (VKM)

VKM-GC Series
Airflow Rate 500 - 950m³/h

Heat Reclaim Ventilator (VAM)

VAM-H Series
Airflow Rate 150 - 2,000m³/h

Air Handling Unit (AHU)

Standard Series: 6.0 - 120.0hp
Outdoor Air Series: 8.0 - 60.0hp

AIR PURIFIER

Fresh Air

Humidifying Air Purifier

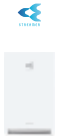
MCK55UVMM

Air Purifier

MC55XVMM

Air Purifier

MC40XVMM

Air Purifier

MC30YVMM

Air Purifier

MCQ30ZVMM-H

IAQ SOLUTION

Pure Air

Streamer Duct Chamber (SDC)

BDEZ-AVM Series
Airflow Rate 80 - 5,100m³/h

High Performance Prefilter (MERV8)

BAF552A160

VRV SERIES

Indoor Units R410A Inverter

Round Flow Cassette with Streamer and Sensing Type

FXFTQ-AVM Series
1.0 - 6.0hp

Round Flow Cassette with Sensing Type

FXFSQ-AVM Series
1.0 - 6.0hp

VRV SERIES

Indoor Units R410A Inverter

Ceiling Concealed Type

FXMQ-PAVE Series
1.0 - 6.0hp

Ceiling Suspended Type

FXHQ-MAVE Series
1.25, 2.5 & 4.0hp
FXHQ-BVM Series
5.0 & 6.0hp

Outdoor Units R410A Inverter

VRV X (High Efficiency)

RXUQ-AYM Series
6.0 - 60.0hp

VRV X Max (Heavy Anti-Corrosion High Efficiency)

RXUQ-AYMW Series
6.0 - 60.0hp

VRV A (Space Saving)

RXQ-AYM Series
6.0 - 60.0hp

VRV A Max (Heavy Anti-Corrosion Space Saving)

RXQ-AYMW Series
6.0 - 60.0hp

VRV IV Heat Recovery Hot Water (HRHW)

RWHQ-T Series
6.0 - 60.0hp

VRV WS / VRV IV W (Water Cooled System)

1)RWXQ-A Series (4.0- 6.0hp)
2)RWEYQ-T Series (6.0 - 36.0hp)

VRV IV S / VRV S High Seasonal Efficiency

1)RXMQ-A/B Series (4.0 - 6.0hp)
2)RSUQ-A Series (4.0 - 9.0hp)

VRV IV Q (Replacement Use)

RQQ-T(E) Series
6.0 - 48.0hp

HCAC

Home Central Air Conditioning

Ceiling Mounted Cassette (Ventilating Moisture Control Bathroom)
BATHROOM

FPEBQ-AV1 Series
0.8hp

Ceiling Mounted Cassette (High Durability Moisture Control Kitchen)
KITCHEN

FPEKQ-AVM Series
0.8 - 1.25hp

Ceiling Mounted Cassette (Moisture Control Closet)
CLOSET

FPECQ-AVM Series
0.8hp

Ceiling Mounted Duct Intelligent 3D Air flow (Moiture Control)
3Di+

FPRSQ-APVM Series
0.8 - 2.5hp

Ceiling Mounted Duct Compact (Mositure Control)
COMPACT+

FPRQ-APVM Series
0.8 - 2.5hp (Compact+)

VRV Home Series

RPZQ Series
4.0 - 12.0hp

Note : For VRV IV S Series, MYHJAU mark only applicable to RXMQ4AVE.

Perfecting the Air

WATER COOLED CHILLER

Two Stage Centrifugal

500 - 3,000 RT

Single Stage Centrifugal

300 – 1500 RT

Magnetic Bearing Daikin

400 - 1,500 RT

Magnetic Bearing Turbocor

100 - 1,200 RT

VFD Screw

115 - 550 RT

Fixed Speed Screw

100 - 520 RT

HFO-1233zd (E) Magnetic Bearing
NEW!

300 - 900 RT

HFO-1234ze Magnetic Bearing
NEW!

100 - 550 RT

AIR COOLED CHILLER

Magnetic Bearing

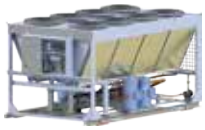
90 - 440 RT

VFD Screw SV3

105 – 465 RT

Fixed Speed Screw

100 - 456 RT

Scroll Chiller

40 - 100 RT

Modular Chiller

19 - 80RT

Mini Chiller

2.5 - 12.5RT

Heat Pump

100 - 450 RT

High Efficiency VFD Screw
NEW!

48 - 200 RT

AIR SIDE

Air Handling Units

60mm with TB1 Casting
700 - 53,000 cfm

Air Handling Units

700 - 53,000 cfm

Fan Coil Units

200 - 4,500 cfm

DIRECT EXPANSION (DX)

Water Cooled Package Unit

5 - 78 RT

DX AHU + Outdoor Unit

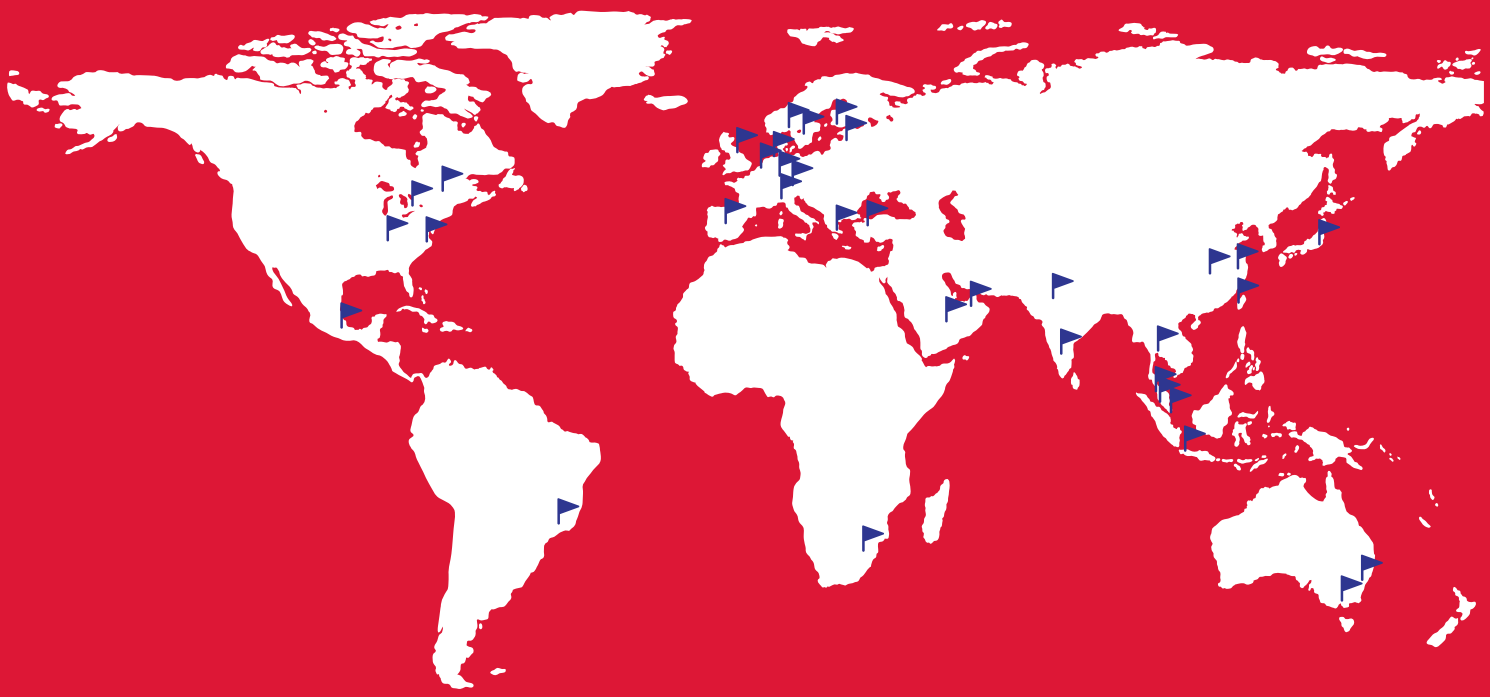

Refrigerant Condensing Units

Low Temp (1.75 - 8.25HP)
Med Temp (4 - 16 HP)

AAF®
INTERNATIONAL

GLOBAL CLEAN AIR SOLUTION PROVIDER FOR OVER 100 YEARS

MORE THAN 50 YEARS IN ASIA & OCEANIA



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AAF Australia Pty Ltd
(Head Office, NSW & QLD Sales Office)
Unit 2/1 Dupas Street,
Smithfield NSW 2164,P.O. Box 2108,
Smithfield NSW 2164

Business Sector

At AAF, providing total clean air solution is of utmost importance to ensure everyone enjoys clean fresh air. Thus, our service is available to all industries such as, and not limited to :-

- Microelectronics
- Healthcare
- General Building
- Power & Industrial
- Data Centers
- Pharmaceuticals
- Pulp & Paper
- Food & Beverages
- Agriculture & Livestock
- Refineries
- Nuclear
- Waste water treatment

Bringing clean air to life.®
www.aafasia.com

AAF® INTERNATIONAL

TOTAL CLEAN AIR SOLUTION

AIR PURIFICATION SYSTEMS

AAF fresh air and purification systemoffers a plug-and-play solution to improve indoor air quality in applications such as healthcare facilities, school classrooms, and commercial real estate.

CONTAINMENT SYSTEMS

AAF offers multiple containment systems which are meticulously designed to minimize exposure risks, improved accessibility, and optimized quality and performance.

AHU FILTERS SOLUTIONS

AAF is able to provide filters of various grades and specifications to be installed in your AHU, ranging from primary filters to HEPA filters, as well as chemical filters.

CLEANROOM MODULES

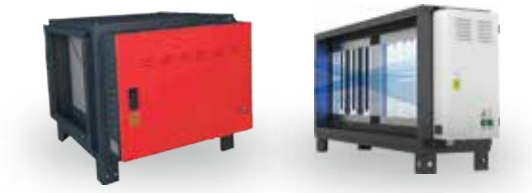
AAF offers a broad range of matching cleanroom modules and components installed with HEPA/ULPA filters that accommodates your indoor air quality needs.

HEALTHCARE SOLUTIONS

AAF provides multiple solutions to reduce the risk of airborne transmissions and to ensure the safety of all medical staff and patients.

KITCHEN ECOLOGY SOLUTIONS

AAF Kitchen Ecology Solution offers 3-in-1 solution such as smoke, grease, and odour removal technology to filter contaminants before exhausting to the environment.

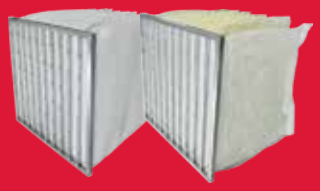


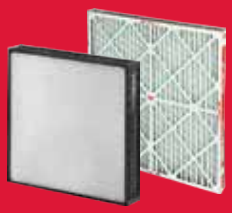
GAS-PHASE FILTRATIONS

AAF has a wide range of gas-phase filtration solutions and products that are most suited for efficient removal of almost all types of harmful environmental contaminants.

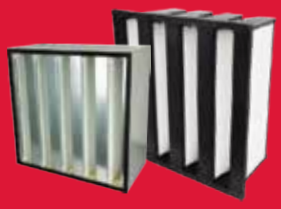
AAF FILTER RANGE

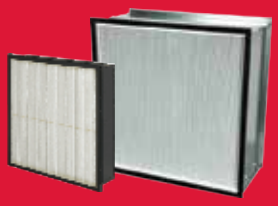
Coarse	Medium	Fine
G1 G2 G3 G4	M5 M6	F7 F8 F9





EPA	HEPA	ULPA
E10 E11 E12	H13 H14	U15 U16 U17





AAF CONNECT

- Visualize your air quality
- Scheduling at your ease
- Control & automate your devices
- Monitor you air quality changes

DOWNLOAD AAF CONNECT

Available on the Google Play

Download on the App Store

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(Penang - Malaysia) Tel : +60 4638 4100

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(VIC Sales Office) Tel : +61 3 9701 5251

AAF International (Thailand) Co., Ltd. Tel : +66 2348 3870

AAF Singapore Pte. Ltd. Tel : +65 6897 0383

PT. AAF International Indonesia Tel : +62 813 2051 8183

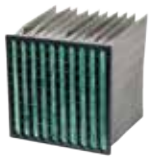
FOLLOW US

ISO 10121-3

FIRST CLASSIFICATION SYSTEM FOR MOLECULAR FILTERS USED IN GENERAL VENTILATION

The ISO 10121 series of standards provides test methods to define the filtration efficiency of molecular air filter and filter media against various gases. ISO 10121-3, published in October 2022, is the first classification system for molecular air filter for general ventilation. It contains comprehensive filter classes for the most common air pollutants in outdoor air. This greatly facilitates the selection of the molecular filter, depending on the local outdoor air quality.

ISO 10121-3 CLASSES FOR SELECTED "CITY" FAMILY PRODUCTS

Product Depth	**City-Flo XL** 520 mm	**CityPleat 200** 44 mm	**City-Flo** 534 mm	**CityCarb I** 292 mm
Reference gas				
Ozone	vLD 20	LD 55	HD 85	HD 80
SO_2	vLD 10	vLD 30	MD 55	MD 50
NO_2	vLD 20	vLD 50	LD 85	LD 70
Toluene	vLD 30	LD 75	MD 80	MD 80

Doses LD, MD, HD predict the lifetime of the filter
(vLD (very Light Duty) are filters that do not qualify as LD)
- LD (Light Duty) = relatively short lifetime / low capacity
- MD (Medium Duty) = **4 times higher lifetime*** / capacity
- HD (Heavy Duty) = **16 times higher lifetime*** / capacity

*compared to LD

%- value indicates the average efficiency
- LD 60 = 60% average efficiency over short lifetime
- MD 60 = 60% average efficiency over medium lifetime
- HD 60 = 60% average efficiency over very long lifetime

DESIGNED TO DELIVER THE **BEST-IN-CLASS PERFORMANCE**

The new CamCarb XG with improved design and performance is equipped with a proprietary conical shape. The lightweight, intuitive design offers high media utilization and a long lifetime against corrosive, odorous and irritant gaseous contaminants.

CamCarb XG is a versatile, ergonomic, cost-effective and corrosion-resistant filter suitable for supply, recirculation and exhaust air systems in commercial, industrial and process applications

INNOVATIVE CONICAL SHAPE CYLINDER

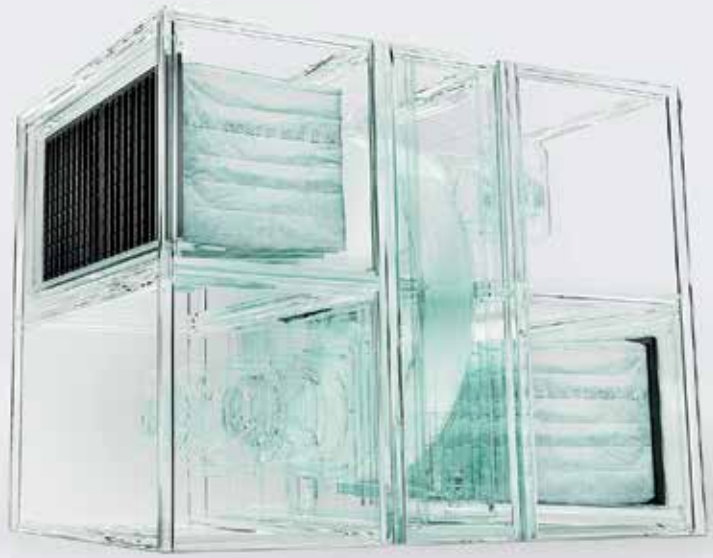
- Higher media utilization, lighter weight and improved filter performance.
- Robust construction, corrosion resistant and incinerable.
- No adhesive used in construction, no degradation of media and negligible outgassing.
- Fillable with a wide range of molecular filtration medias for various applications.

CamCarb XG

www.camfil.com

Hi-Flo

NEXT GENERATION BAG FILTERS



THE BEST BECOMES BETTER

At Camfil we are proud of our generations of innovation. The Hi-Flo bag filters were launched in 1969 as a direct response to the need for high quality filters to the European market. The Hi-Flo bag filters have been developed with performance and sustainability in mind. Performance means long service life, low energy consumption and stable filtration efficiency throughout its lifetime.

With the Hi-Flo Next Generation we continue our promise to innovate both for coming Camfil product generations but also to protect future generations with healthy indoor air and at the same time spare our planet's scarce resources.

With the Hi-Flo Next Generation we deliver even better performance on our key variants ePM1 60% and ePM10 60% up to A+ equals up to 12% energy reduction. A further enhancement means that now the Hi-Flo bag filters sustainability performance has also been measured, with an Environmental Product Declaration (EPD) available for this upgrade.

www.camfil.com

Upgrading to Hi-Flo will help to continue to protect your people, processes and the environment

The example calculation below shows the impressive savings potential, both in monetary terms and to the environment.

Price of electricity:

0,25 €/kWh

Number of filters

10

Old filter

*Market average performance 640**

New filter

Camfil Hi-Flo 640-10

= **€1.115** *yearly saving*

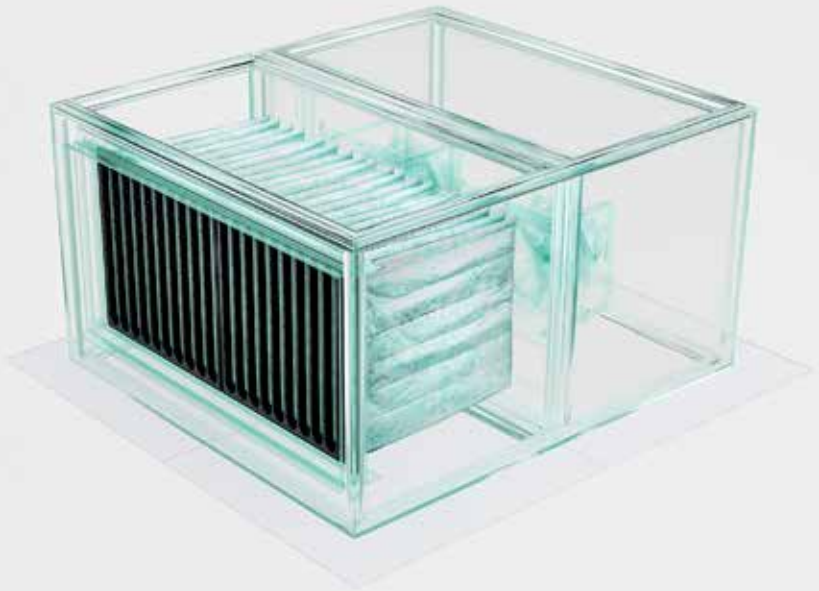
= **1,1 tonnes** *yearly saving*

= *a CO_2 saving equivalent to* **2.580 kms** *driven in a petrol powered car*

**based on Eurovent 4/21 published energy ratings*

Upgrade to Hi-Flo Next Generation and start saving

The Hi-Flo family delivers certified performance based on extensive testing and certification. We guarantee that the Energy Label on the outside of the box matches the performance of the filter inside the box. We call that promise "What's on the Box is in the Box".



HI-FLO NEXT GENERATION BENEFITS

ENERGY EFFICIENT

105+ million annual kWh energy reduction the Hi-Flo upgrade will bring to existing users.

EMISSION REDUCING

25.620+ tonnes of CO2 emissions reduced from the carbon handprint of this generation of Hi-Flo filters.

COST EFFICENT

31+ million euros saved in energy costs by our customers through the latest Hi-Flo generation.

UPDATED ENERGY PERFORMANCE

HI-FLO NEXT GENERATION – ePM1 60%

Filter	Energy consumption [kWh/a]	Eurovent energy class	Energy savings Δ
640-12	803	A+	-4%
370-12	1275	C	-11%
640-10	811	A+	-12%
520-10	943	A	-9%
370-10	1389	C	-15%
520-6	1528	D	-22%

HI-FLO NEXT GENERATION – ePM10 60%

Filter	Energy consumption [kWh/a]	Eurovent energy class	Energy savings Δ
640-10	474	A+	-13%
520-10	568	A	-7%
600-8	522	A	-4%
640-6	631	B	-18%
600-6	645	B	-14%
520-6	836	C	-24%

Tested according to ISO 16890 standard

MayAir®

ABOUT MAYAIR

MayAir, a global leading manufacturer, developer and service provider of air purification equipment and clean air solutions was established since 2001. The company centers around the air filtration research and development, design and build, production, distribution, installation and service maintenance of clean air solutions for the industrial, commercial and residential sectors.

The group's core business historically has been in providing HVAC filters as well as fan filter units (FFU) and air filtering equipment for use in industrial cleanrooms, an area in which it has established itself as one of the leading providers worldwide. Powered by 900 world class engineers, MayAir has established as one of the pioneers of air filtration product manufacturers with multiple manufacturing plants across asia. With the strong footprint and successful achievements made, the company is expanding swiftly to United States, Europe, Middle East and the rest of the world.

With more than 20 years of experience and breakthroughs, MayAir stands proven as a highly-dependable air filtration company and developer of effective air filtration equipment and clean air solutions with the capabilities in providing full spectrum of clean air solutions to various business segments, especially cleanrooms in semiconductor, pharmaceutical, data center, power plant, electrical and electronic, biomedical industries and etc.

FOR MORE INFORMATION
PLEASE SCAN THIS
QR CODE

MayAir Sales Office and Manufacturing

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MayAir Technology (China) Co., Ltd — Tel : +86 25 5212 4676
MayAir Singapore Pte. Ltd. — Tel : +65 8350 1959
MayAir Thailand Co., Ltd — Tel : +66 9096 56162

MayAir®

KEU

COMMERCIAL KITCHEN EXHAUST UNIT

PRODUCT FEATURE

1. PWM bipolar steady-state power module control with ionization section voltage of 12000V and dust collection section voltage of 6000V for higher efficiency and better stability.
2. The ionizer is made of durable stainless steel plate, while the dust collecting module is made of aviation aluminium alloy plates, which are corrossion resistant.
3. Equipped with running, cleaning alarm and fault alarm signal indicators, together with signal transmission and connection with the building management system.
4. High waterproof performance without the need of canopy for outdoor installation.
5. Double protection interlocking system.

PRODUCT CERTIFCATIONS

- UL 867: Electrostatic Air Cleaners
- CE for Low Voltage Directive 2014/35/EU, EN 60335-1, EN 62233
- EN 1822: PAO Tested
- NIOSH 5026 : >95% single-pass efciency
- ASHRAE 52.2 : Up to MERV 15 single-pass efciency

FOR MORE INFORMATION
PLEASE SCAN THIS
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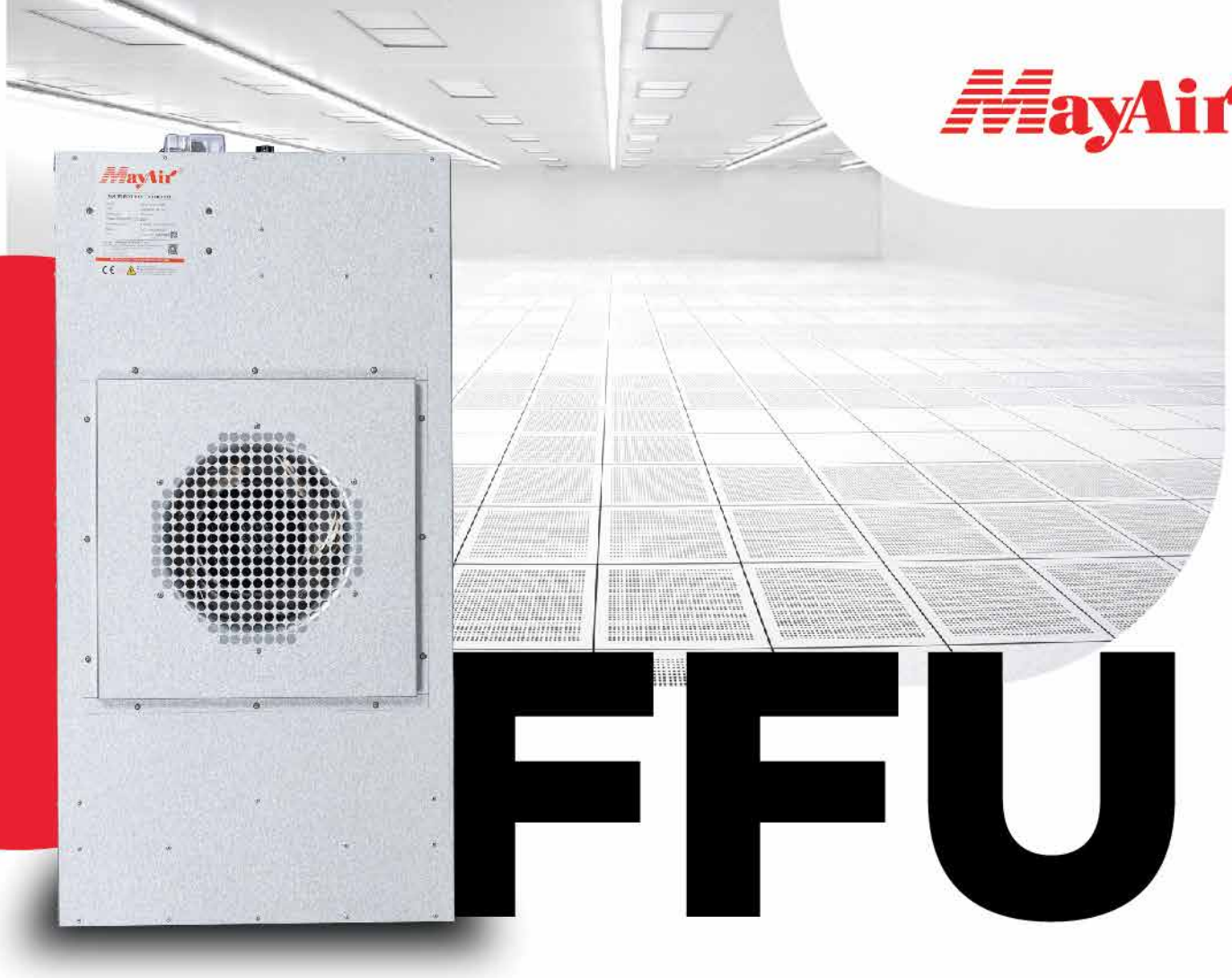
MayAir Thailand Co., Ltd — Tel : +66 9096 56162

MayAir®



FFU

FAN FILTER UNIT

FFU stands for "Fan Filter Unit". It is a modular end-stage air supply device with a built-in fan and efficient air filtration capabilities. The fan draws in air from the top of the FFU, which then passes through a HEPA high-efficiency filter. The filtered clean air is uniformly delivered at a speed of 0.45 m/s ±20% across the entire outlet surface. FFUs are suitable for environments requiring higher levels of cleanliness. They provide high-quality clean air for cleanrooms and micro environments of different sizes and cleanliness levels.

FFUs are ideal for both the construction of new cleanrooms and the renovation of existing cleanrooms and manufacturing facilities. They can enhance cleanliness levels, reduce noise and vibration, lower operational costs and offer easy installation and maintenance. FFUs are the preferred air purification units for clean environments.

FFU fan filter units can be modularly connected and are widely used in cleanrooms ranging from Class 10 to Class 100,000, clean workbenches, clean production lines, modular cleanrooms, and localized environments with specific cleanliness requirements. Typical FFU sizes are 2x4 feet (575x1175mm) or 4x4 feet (1175x1175mm).

FOR MORE INFORMATION
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MayAir Singapore Pte. Ltd. — Tel : +65 8350 1959
MayAir Thailand Co., Ltd — Tel : +66 9096 56162

B A G - I N - B A G - O U T

A Multi-Stage High Efficiency Filtration System

BIBO (BAG-IN-BAG-OUT Filter Housing) is a filtering device that allows for the safe replacement of filters using airtight bags. The key feature is that both installation and replacement of filters are performed under the protection of a high molecular weight polyester film replacement bag. The filtration unit remains completely isolated from direct contact with people and the external environment, ensuring the safety of personnel and the environment.

BIBO originated in the nuclear industry, where its initial design purpose was to filter, capture, or isolate hazardous pollutants within a sealed enclosure. Once the system is operational, all potential hazardous pollutants are either trapped by highly efficient physical filter media or adsorbed by high-performance chemical molecular media. They are all contained within the sealed chamber until they can be safely disposed of.

PRODUCT FEATURES

1. Professional CFD simulation laboratory;
2. According to BIBO diversified structural airflow simulation analysis;
3. Distribution analysis of pressure points;
4. Velocity distribution analysis and uniformity analysis;
5. Airflow direction and streamline analysis;
6. Prediction and simulation of resistance, efficiency, and dust holding under the particle filtration model;
7. Simulation of adsorption efficiency, flow field and lifetime prediction under the gaseous pollutant model;
8. Provide the optimal structure to meet the optimal results;
9. Reasonable selection of flange size and length.

FOR MORE INFORMATION
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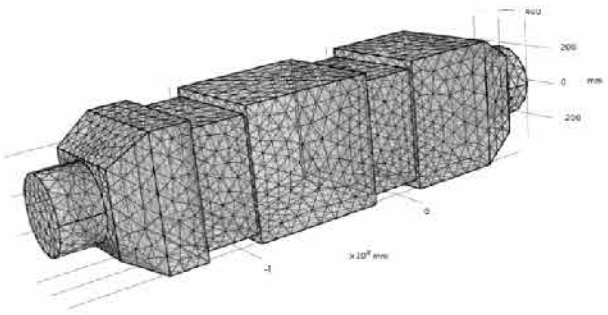

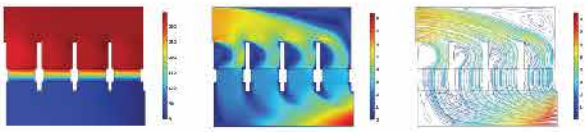

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* Testing organisation: Texcell (France)
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Report No. : 1140-01 A1

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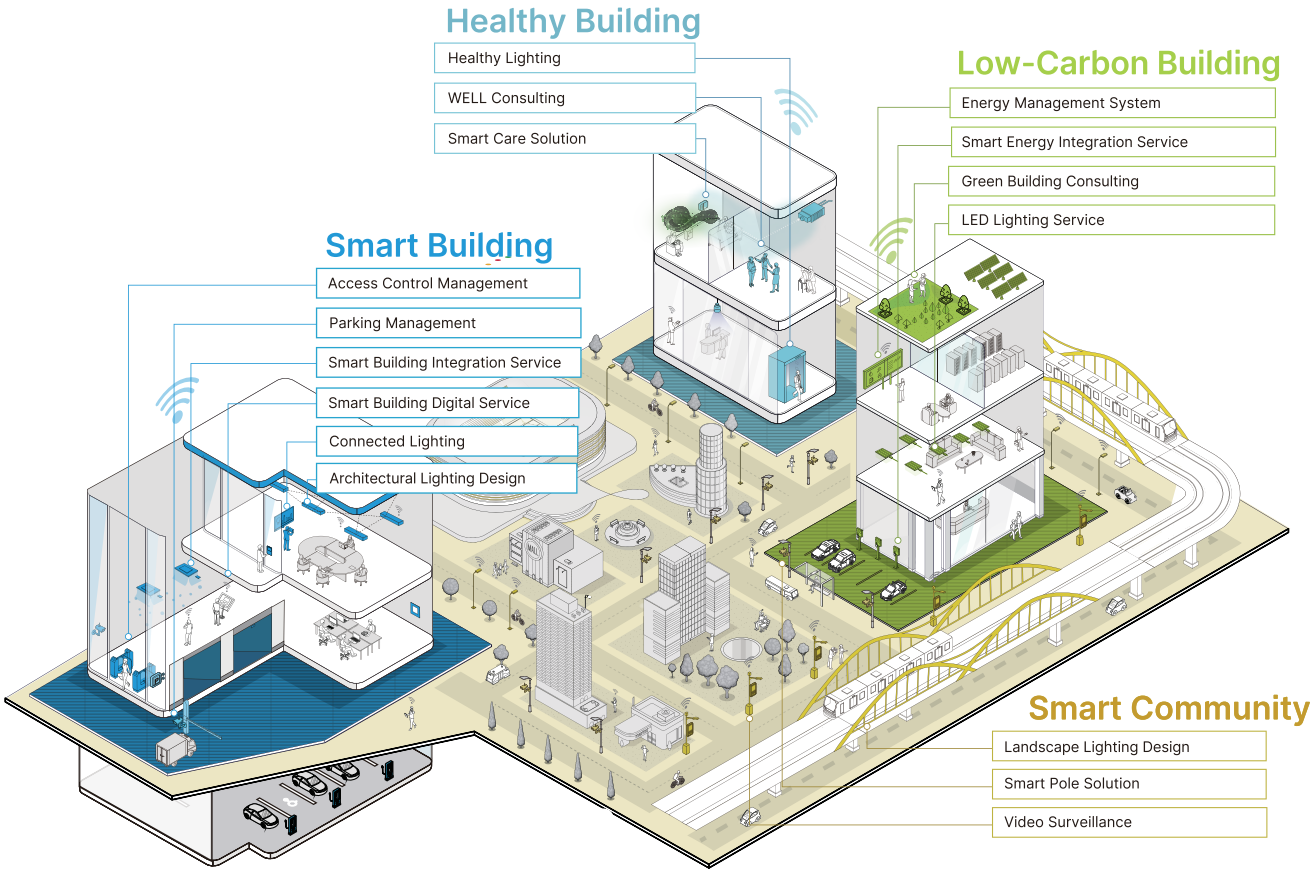

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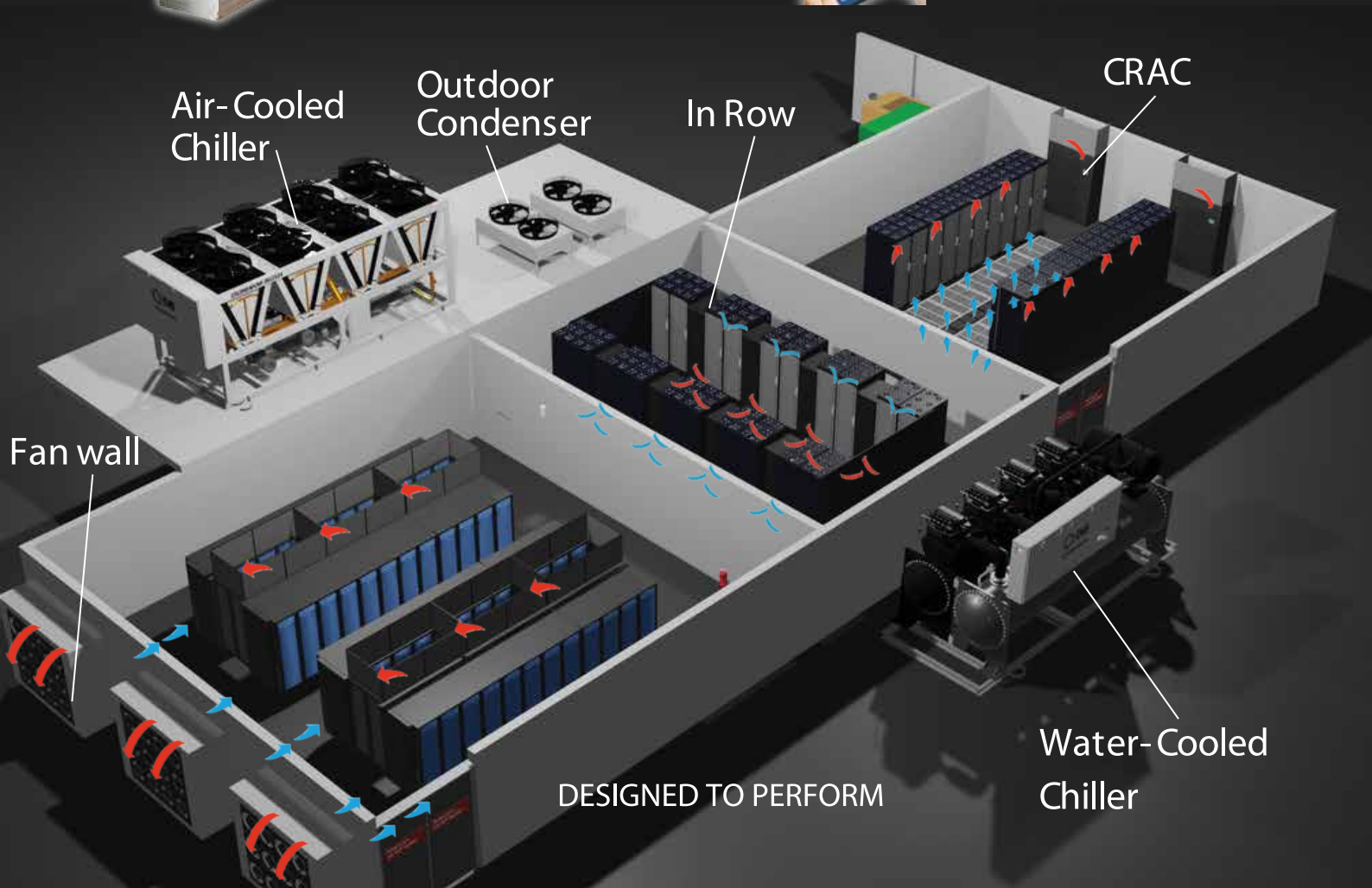

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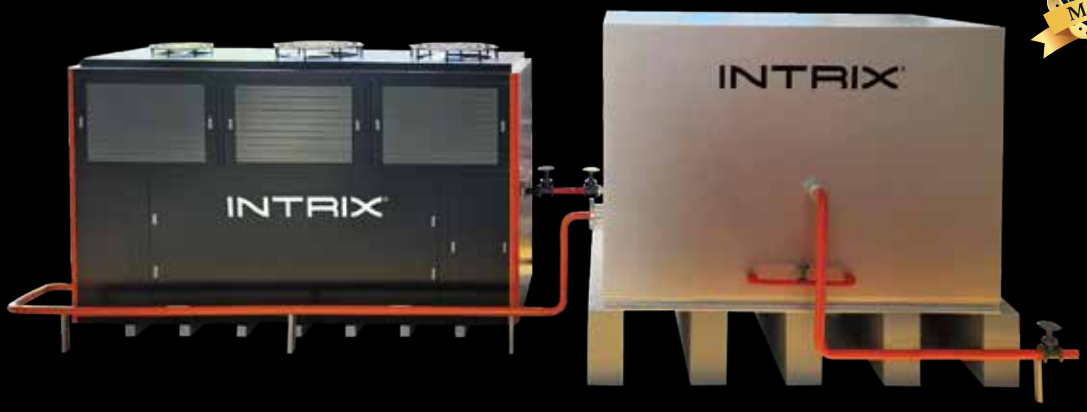

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Certifications & Awards

PSA 2021 Gold Award
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4th	MALAYSIA	03-06 NOV	1997
5th	TAIWAN	29 NOV -02 DEC	1999
6th	SINGAPORE	14-17 NOV	2001
7th	HONG KONG	18-19 NOV	2003
8th	PHILIPPINES	25-26 NOV	2005
9th	THAILAND	22-23 NOV	2007
10th	TAIWAN	05-06 NOV	2009
11th	INDONESIA	20-21 OCT	2011
12th	PHILIPPINES	05-06 NOV	2013
13th	HONG KONG	19-20 NOV	2015
14th	INDONESIA	18-19 NOV	2017
15th	TAIWAN	18-19 OCT	2019
16th	MACAU	07-08 OCT	2022
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