Conference Agenda

15th ROOMVENT Conference

Session

SV: Special ventilation issues (hybrid, evaporation, hoods)

Session Chair: **Zoltan Magyar**

Presentations

Study on natural ventilation drive force by void

Arisa Okuda[1], Takashi Kurabuchi[1], Kunio Mizutani[2], Kuoichiro Saito[3], Shigekazu Yagi[3], Yoju Homma[1], Minori Shibata[1]
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With regard to the improvement of thermal and air environments in buildings, using natural ventilation under moderate climatic conditions are effective for energy saving and improvement of workplace productivity, and there are many buildings that incorporate ventilation voids to improve natural ventilation performance. PASSIVETOWN first block is one of these buildings, with ventilation void located in the center of the building. This building has two significant features; one is a space connected to the void on the first floor called Path, and the other is a guide vane attached to the rooftop, next to the opening of the void. However, there was possibility of Path reducing ventilation by letting wind flow into the void, and effectiveness of guide vane in improving ventilation performance were not known.

Therefore, we confirmed the effectiveness of these two features by wind tunnel experiment using housing complex model, which is the scale model of PASSIVETOWN first block. We also experimented with a cuboid version of the model to reproduce general rectangular buildings, by removing the Path, staircase and terrace parts along with guide vane attached to the roof. The wind direction considered in the experiment is same as the prevailing wind of day and nighttime in the area. We then conducted experiments with screen as the device, which have been proved by previous studies to improve ventilation performance.

Next, in CFD, we analyzed a cuboid model that reproduced the experimental cuboid model. The turbulent model is the Realizable k-ε, and the wind reproduces the approach flow measured by the wind tunnel experiment. Comparing wind tunnel experiment results and CFD results, the values were generally consistent, so we move on to device effectiveness verification based on CFD analysis results.

In this research, the performance comparison of four types of device shapes, including screen, are performed. Guide vane and venturi are designed to accelerate wind near void openings for a condensed flow effect. As a result, the following findings were obtained in this study. With the housing complex model, the Path is hindrance to the improvement of ventilation performance, and guide vanes are not effective. With the cuboid model, the two devices, venturi and guide vane, cannot be expected to condense effect. It is most effective to use screen as the device to improve ventilation.

Study on the effect of packaged air conditioner on the capture efficiency of hood exhaust in commercial kitchen

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From the perspectives of comfort and reduced energy use, the capture efficiency of hood exhaust is a crucial index to determine the required ventilation air flow rate for a commercial kitchen. It is required to collect and organize the capture efficiency of hood exhaust data under various disturbance conditions of various cooking equipment.

In this study, the capture efficiency of hood exhaust data was collected for the low range when the airflow from a packaged air conditioner was assumed. And a proposal for improving the capture efficiency of hood exhaust was proposed and studied.

Package air conditioners were installed on the front and side of the hood, and the capture efficiency of hood exhaust was measured in each case. Data on the capture efficiency of hood exhaust was collected by changing the installation distance and blowing angle of the packaged air conditioner.

As a result, it was found that the installation distance and blowing angle of the packaged air conditioner are factors that greatly affect the capture efficiency of hood exhaust. When the packaged air conditioner was installed in front of the hood, the capture efficiency of hood exhaust tends to decrease as the installation distance increased and the blowing angle increased. Similarly, when the packaged air conditioner was installed on the side of the hood, the capture efficiency of hood exhaust tends to decrease as the installation distance increased and the blowing angle increased.

In each case where packaged air conditioners were installed on the front and side of the hood, we examined the capture efficiency of hood exhaust improvement solution and found an effective method for improving the capture efficiency of hood exhaust. When a packaged air conditioner was installed in front of the hood, the capture efficiency of hood exhaust was improved by installing a baffle wall at the outlet of the packaged air conditioner. Also, when a packaged air conditioner was installed on the side of the hood, the capture efficiency of hood exhaust was improved by installing a hanging wall on the hood.

Therefore, this study clarified the factors affecting the capture efficiency of hood exhaust when a packaged air conditioner was installed. And this study proposed an effective improvement solution for the capture efficiency of hood exhaust.

The impact of controlled natural ventilation in residential buildings

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Current trend in building construction pushes towards high insulated and airtight buildings which, if not supported by a sufficient and effective ventilation, lead to a poor indoor air quality and increase the overheating risk. On the other hand, the outdoor pollutants dominate the burden of disease attributed to indoor exposures and the impact of health-based ventilation energy on the overall energy demand of the building increases. Although natural ventilation, combined with other passive strategies, has the potential to avoid the use of active cooling in most residential buildings, drawbacks due to less control and no air filtration possibility prevent its application in new buildings design. Controlled natural ventilation allows to overcome some of

these drawbacks by fully exploiting the potential of ventilation through the activation and control of all the windows within an apartment in a synergic way.

The paper investigates the potential of controlled natural ventilation in a multifamily house under northern Italian climate. A multizone reference apartment model has been simulated under a range of natural ventilation strategies (single-sided, cross and stack ventilation) through a coupled thermal and airflow model able to predict natural airflows within the apartment.

The impact of controlled natural ventilation will be evaluated in terms of reduction of cooling loads due ventilative cooling and more relaxed comfort ranges, reduction of ventilation loads for health-based ventilatio, and on capital costs of ventilation due to the whole or partially replacement of cooling and ventilation system as well as on operation and maintenance costs.

Optimal Control of Earth-to-Air Heat Exchanger System by Reinforcement Learning

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In this paper, our main purpose is to explore the applicability of an optimal control for an earth-to-air heat exchanger by reinforcement learning controls. Firstly, we describe a high-speed analysis method for earth-to-air heat exchangers based on CFD analysis that we previously developed. Moreover, we report the results of reinforcement learning control for earth-to-air heat exchangers using that acceleration method as an environmental simulator. Following results are obtained; 1) the total reward increase with each episode and it take about 200 episodes to get a stable total reward. 2) it is confirmed that the accumulated obtained heat quantity gradually increased as an episode progressed on reinforcement learning control. Similarly, the condensation frequency tended to decrease. 3) in June and July, the monthly accumulated heat quantity on reinforcement learning control is increased as compared with that through the scheduled control.

HEALTH BENEFITS OF THE USE OF PORTABLE AIR PURIFIERS THAT REDUCE EXPOSURE TO PM2.5 IN RESIDENCES: THE CASE OF CHILDHOOD ASTHMA IN LONDON

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Home air purifiers (HAPs), utilizing HEPA filtration as the primary mechanism of air cleaning aim to reduce particulate matter (PM) concentrations that are known to be harmful to health. In the work described here, $PM_{2.5}$ concentrations were continuously monitored for 6 months inside and at the ground floor exterior of 18 flats in London. Median bedroom $PM_{2.5}$ concentration of all flats was measured at 14 µg m^{-3} in the bedroom at the start of HAP operation. In the bedrooms where the HAP was in use, a clear decay curve was seen resulting in a 45% reduction of $PM_{2.5}$ over 90 minutes of run time. Based upon these findings, and the published positive association between $PM_{2.5}$ and asthma (OR = 1.28 per 3.2µg/m^3), an estimated 1,361 additional QALYs per 10,000 children were achieved using HAPs in health impact models.

Impact of Natural Night Ventilation in Energy Performance of Office Buildings with Windows Filled with Phase Change Materials (PCMs) in a Semiarid Climate

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Phase Change Materials (PCMs) are materials with high latent heat that solidifying at a certain temperature. When PCMs are incorporated into the glazing façade of buildings are able to reduce cooling loads, control daylight transmission and overheating. Currently, office buildings have a fully-glazed façade without opaque elements, so they have a lack of thermal inertia. PCM glazing arises as a solution to improve the thermal performance of the façade. To guarantee the maximum potential of PCM glazing, the phase change must occur during whole work hours. Semiarid climates (Bsk according to Köppen Geiger climate classification) are characterized by high temperature and solar radiation during more than half of months of the year, and high fluctuation temperature between day and night. This type of climate has the potential to use night ventilation to ensure the phase change from liquid to solid of PCMs in office buildings. Then, the aim of this paper is to analyze the impact of different night ventilation ratios in the energy performance of an office building with PCM glazing located in Santiago of Chile by means of an energy simulation tool. A Prototype Building Model of a medium-sized office building for Albuquerque of 4980 m2 and a window-to-wall ratio of 0.3 is considered as a case study. To proof the potential of night ventilation, three values of infiltration rate are evaluated, 1 ACH, 3 ACH and 5 ACH; and two different paraffin of Rubitherm® company RT25HC and RT28HC filled the window. Energy simulations are carried out using EnergyPlus and a heat transfer model of PCM glazing previously developed and integrated to EnergyPlus. The results show the benefit of natural night ventilation during the summer season to ensure the complete phase change and decrease the cooling loads for window filled with both PCMs considered.

Propagation modeling of airborne nanoparticles evaluating the inhalation exposure under different ventilation systems

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The inhalation of nanoparticles generated in a working process is approximated by combining a CFD method with material release data. The working process takes place in a repair shop by processing materials on a work bench. Different options of ventilation systems are analyzed concerning the resulting exposure of the working person. It is found that buoyancy forces should always be taken into account, otherwise the expose might be considerably underestimated.

The thermal behavior of the model room envelope and the flow field within the room are modeled based on a coupled system of a transient CFD-code (ParallelNS) and a building and system simulation program (TRNSYS-TUD). The modelling of the airborne particles is carried out based on a passive scalar equation (neglecting of particle loss by deposition, concentration decrease by agglomeration, size dependent segregation by inertia or gravitational settling) and the particle supply is modelled adiabatic and interference free without directional momentum. Various exposure scenarios

derived from five different release scenarios (based on the release processes wiping, sanding, spraying) and three different ventilation scenarios (natural ventilation by door slit infiltration, natural ventilation by pivot-hung window, technical ventilation system) are analyzed for both near-field and far-field exposure. Two sensors are positioned in a height of 1.6 m within the model room as the basis for the exposure studies, one for near field considerations in front of the person and one for the far field behind the person in the corner of the room.

During the simulation of the different exposure scenarios, the exposure concentration over time is calculated based on the sensor data. If a gender- and activity-averaged breathing rate of 386 cm^3/s is assumed and if a modified ICRP 66 model (Human Respiratory Tract Model for Radiological Protection. ICRP Publication 66) is applied, quantitative data for inhaled particles and for fractions of deposited particles in certain regions of the human reparatory tract could be determined and related to the release quantities.

For the examined scenarios, the ratios between the inhaled particles and the release quantities varied between 0.07 - 2400 ppm for the nearfield, and between 0.02 - 230 ppm for the far field.

To evaluate the influence of the human thermal plume, the investigations were additionally carried out based on a thermal inactive (adiabatic) person. It turned out that the negligence of the human thermal plum leads for the examined exposure scenarios to an exposure underestimation in the nearfield of up to 5 times and to an overestimation of up to 1.8 times for the far field. Accordingly, for a correct prediction of the exposure, it is essential to consider thermal buoyancy caused by the humans. Since it is not possible to consider all relevant influences within the presented simulation method, it represents a very good starting point for more detailed propagation modeling.