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AIVC International Conference 2010

The 31st AIVC Conference
26-28 October 2010
Seoul, Korea

Host Organizations

Architectural Institute of Korea(AIK)

Korea Institute of Construction Technology(KICT)

IEA Energy Conservation in Buildings and Community Systems(ECBCS)

Air Infiltration and Ventilation Center(AIVC)

International Network for Information on Ventilation and Energy Performance(INIVE)

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01 Greetings

KICT, AIK & AIVC invite you to the AIVC 2010 Conference in Seoul.

Nowadays, Indoor air quality of buildings is getting worse and the term “sick building syndrome” even became a word on everybody’s lips. This problem has occurred in the process of pursuing air-tightness of building envelopes for energy conservation and the harmful substances emitted from poor building materials and products.

Indoor air quality affects not only the health and safe of occupants but also their working productivity and efficiency.

As you may already know, the most effective way of improving such indoor air quality is through ventilation system. We would like to come up with a way of developing ventilation system that is environmentally friendly, energy efficient and low cost.

We can assure you that AIVC conference will be a good opportunity to discuss and learn the low energy and sustainable ventilation technologies for Green buildings related to healthy indoor air quality.

Exchanging research information among nations can help bring realistic solution to or problems. So, we strongly encourage experts in these fields to attend the conference.

Kim, Hway-suh Ph.D

Vice President

Architectural Institute of Korea

Cho, Yong-Joo Ph.D

President

Korea Institute of Construction Technology

02 General Information

Title AIVC 2010 International Conference

Date October 26th (Tuesday) ~ October 28th (Thursday), 2010

Venue Renaissance Seoul Hotel, Seoul, Republic of Korea

Official Language English (No simultaneous Interpretation service)

Registration Desk

- Registration Desk will be available from 08:00 on October 26th (Tuesday) and it will be located in the 4th floor of Renaissance Seoul Hotel.

Host Organizations

- Korea Institute of Construction Technology (KICT)
- Architectural Institute of Korea (AIK)
- IEA Energy Conservation in Buildings and Community Systems (ECBCS)
- Air Infiltration and Ventilation Center (AIVC)
- International Network for Information on Ventilation and Energy Performance (INIVE)

Organizing Committee

- Jin Chul Park (Chung-Ang University, Korea)
- Yun Gyu Lee (KICT, Korea)
- Hway-Suh Kim (Dankook University, Korea)
- Geun Young Yun (Kyung Hee University, Korea)
- Peter Wouters (BBRI, Belgium)
- Takao Sawachi (BRI, Japan)
- Max Sherman (LBNL, USA)
- Hyun Jae Jang (Hongik University, Korea)
- Jae-Weon Jeong (Sejong University, Korea)
- Sumin Kim (Soongsil University, Korea)
- Myoung Souk Yeo (Seoul National University, Korea)
- Hyuen Joon Moon (Dankook University, Korea)
- Yinping Zhang (Tsinghua Univ. China)

Secretaries

- Jin Chul Park (Chung-Ang University, Korea)
- Yun Gyu Lee (KICT, Korea)

03 Program

October 26

Registration (4F, Hotel Renaissance Seoul)

Time	
8:00	
9:00	Welcome speech (UNIVERSAL)
	Keynote speech 1 (UNIVERSAL)
10:00	Break
	Session 1A & 1B (TOPAZ, UNIVERSAL)
11:00	
12:00	Lunch (DIAMOND)
13:00	
	Keynote speech 2 (UNIVERSAL)
14:00	Break
	Session 2A & 2B (TOPAZ, UNIVERSAL)
15:00	
	Break & Poster presentation (PRE FUNCTION AREA)
16:00	
	Session 3A & 3B (TOPAZ, UNIVERSAL)
17:00	
18:00	Welcome party (DIAMOND)
19:00	
20:00	

October 27

Registration (4F, Hotel Renaissance Seoul)

Time		
8:00		
9:00	Keynote speech 3 (TOPAZ)	
	Break	
10:00	Session 4A & 4B (TOPAZ, SAPPHIRE+RUBY)	Workshop (LILY)
	Break	
11:00	Session 5A & 5B (TOPAZ, SAPPHIRE+RUBY)	
12:00	Lunch (UNIVERSAL)	
13:00		
	Session 6A & 6B (TOPAZ, SAPPHIRE+RUBY)	
14:00		
15:00	Break & Poster presentation (PRE FUNCTION AREA)	
16:00		
	Session 7A & 7B (TOPAZ, SAPPHIRE+ RUBY)	
17:00		
18:00	Banquet (DIAMOND)	
19:00		
20:00		

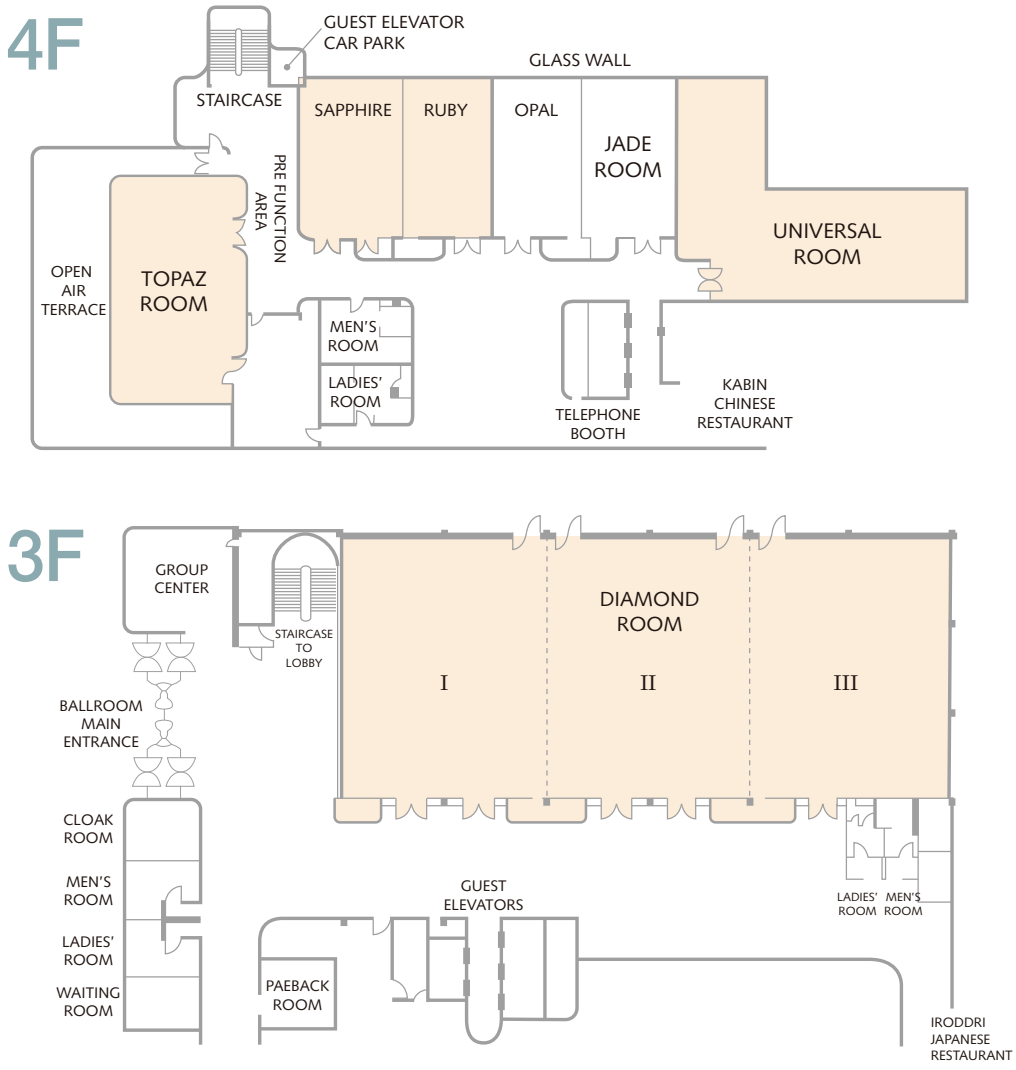
October 28

Registration (4F, Hotel Renaissance Seoul)

Time	
8:00	
9:00	Keynote speech 4 (TOPAZ)
	Break
10:00	Session 8A & 8B (TOPAZ, SAPPHIRE+RUBY)
11:00	Closing session (TOPAZ)
12:00	

04 Venue Layout

Venue Renaissance Seoul Hotel



Date/Time	Program	VENUE
Oct 26(Tue)	Opening ceremony	UNIVERSAL
	Conference	TOPAZ, UNIVERSAL
	Lunch & Dinner	DIAMOND (3F)
Oct 27(Wed)	Conference	TOPAZ, SAPPHIRE+RUBY
	Lunch	UNIVERSAL
	Dinner	DIAMOND (3F)
Oct 28(Thu)	Conference	TOPAZ, SAPPHIRE+RUBY
All Day	Poster Display	PRE FUNCTION AREA

05 Program in Detail

October 26(Tue) 2010

Time	Program		Location	
08:00~18:00	Registration		4F, Hotel Renaissance Seoul	
09:30~09:40	Welcome Speech *(Hway-Suh Kim, Korea)*		4F, UNIVERSAL	
09:40~10:20	Keynote Speech Ⅰ *(Hal Lavin, USA)*			
10:20~10:30	Break		PRE FUNCTION AREA	
	Session 1A Air Distribution Venue Topaz (Renaissance Seoul Hotel 4F) Chairs Yoshino Hiroshi, Geun Young Yun	Session 1B Chemical pollutants & Particles Venue Universal (Renaissance Seoul Hotel 4F) Chairs Carrie Francois Remi, Jaedong Chang		
10:30~10:55	1A-1 Year-round Energy Saving Potential for a Stratum Ventilated Subtropical Office *Zhang Lin (City University of Hong Kong)*	1B-1 Health Hazards in Indoor Air *Max H. SHERMAN (LBNL)*	4F, TOPAZ	4F, UNIVERSAL
10:55~11:20	1A-2 Numerical Prediction of Airflow and Temperature Distribution in Large-Scale Agricultural PVC Greenhouse *Keita Hattori (Kyushu University)*	1B-2 Experimental method for determining removal efficiency of house dust by mechanical ventilation *Kurihara Genta (Tohoku University)*		
11:20~11:45	1A-3 Exposure Risk Assessment by Coupled Analysis of CFD and SIR model in Enclosed Space *Takayuki Fukuoka (Kyushu University)*	1B-3 Distribution of CO in 30 Homes with Unvented Gas Fireplaces *Paul W. FRANCISCO (University of Illinois)*		
11:45~12:10		1B-4 Numerical prediction of particle transport passed through ventilator by CFD with Lagrangian method *Nguyen Lu Phuong (Kyushu University)*		
12:10~13:30	Lunch		3F, DIAMOND	
13:30~14:10	Keynote speech Ⅱ (Masanori Shukuya, Japan)		4F, UNIVERSAL	
14:10~14:20	Break			
	Session 2A Health Indoor Air Quality and Productivity 1 Venue Topaz (Renaissance Seoul Hotel 4F) Chairs Wouter Borsboom, Sumin Kim	Session 2B HVAC System 1 Venue Universal (Renaissance Seoul Hotel 4F) Chairs Pierre Deroubaix, Youngshik Kim		
14:20~14:45	2A-1 A Study on Indoor Environments Made by Thin Line Type Ventilators in Apartment Houses *Keun-Je CHO (Hongik Graduate School)*	2B-1 Rotary heat exchanger model for control and energy calculations *Bjørn R. SØRENSEN (Narvik University College)*	4F, TOPAZ	4F, UNIVERSAL
14:45~15:10	2A-2 A study on eco friendly furniture for mitigation of the indoor air pollution *Hyunsun AN (KICT)*			
15:10~16:10	Coffee break and Poster presentation		PRE FUNCTION AREA	
	Session 3A Health Indoor Air Quality and Productivity 2 Venue TOPAZ (Renaissance Seoul Hotel 4F) Chairs Ohba Masaaki, Janghoo Seo	Session 3B HVAC System 2 Venue Universal (Renaissance Seoul Hotel 4F) Chairs Li Angui, Jinwoo Moon		
16:10~16:35	3A-1 A Study on the field survey of the IAQ in the childcare center *Jung Ha PARK (Chung Ang University)*	3B-1 Measured Duct Leakage and Resulting Envelope Pressure Differences *Paul W. FRANCISCO (University of Illinois)*	4F, TOPAZ	4F, UNIVERSAL
16:35~17:00	3A-2 Case-Control study for the Association Between Indoor Environmental Factors and Children's Health Problems in Japan-Part1 a nationwide questionnaire study among 1664 primary school students *Ando Naoya (Tohoku University)*	3B-2 Calculation of Dehumidification Coeffecients for Numerical Simulation of Desiccant Wheel *Yoshihisa MOMOI (Osaka University)*		
17:00~17:25	3A-3 Case-Control study for the Association Between Indoor Environmental Factors and Children's Health Problems in Japan – Part 2 Results of Measurements during Rainy Season and Winter *Hamada Kensuke (Tohoku University)*	3B-3 Development of a heat pump system with the heat source network model using solar, ground and air heat source *Yujin NAM (The University of Tokyo)*		

05 Program in Detail

Time	Program		Location	
17:25~17:50	3A-4 A Study on Incomplete Ventilation in High-Rise Residential Building *Jungmin Seo (Sungkyunkwan University)*	3B-4 Energy Saving Potentials of Dedicated Outdoor Air System in High-rise Apartment Buildings *Kim Min-Hwi (Sejong University)*	4F, TOPAZ	4F, UNIVERSAL
18:00~20:00	Welcome Party		3F, DIAMOND	

October 27(Wed) 2010

Time	Program			Location		
08:00~18:00	Registration			4F, Hotel Renaissance Seoul		
09:00~09:40	Keynote speech Ⅲ *(Yingxin Zhu, China)*			4F, TOPAZ		
09:40~09:50	Break					
	Session 4A Natural Ventilation 1 Venue TOPAZ (Renaissance Seoul Hotel 4F) Chairs Sherman Max, Jaehun Jo	Session 4B Computer Simulation 1 Venue Universal (Renaissance Seoul Hotel 4F) Chairs Op t Veld Peter, Jin chul Park	Workshop Workshop on Airtightness Measurement Techniques Venue Lily(Renaissance Seoul Hoteal 23F)			
09:50~10:15	4A-1 Prediction of Heat Emission Effect at Small Single-sided Openings in Apartment Houses *Keigo Nomura (The Univ. of Tokyo)*	4B-1 STUDY ON THE VENTILATION EFFICIENCY IN URBAN STREET CANYONS USING CFD ANALYSIS Influence of the Configuration of Consecutive Street Canyons and Atmospheric Stability *Byoungchull OH(The Univ. of Tokyo)*	6C-1 Recent developments with the revision of ISO 9972 *Hirsohi Yoshino (JAPAN)*	4F, TOPAZ	4F, SAPPHIRE + RUBY	23F, Lily
10:15~10:40	4A-2 Design Method of Vertical Ventilation with Wind Chimney on Roof Driven by Wind and Buoyancy *Toshio Yamanaka (Osaka University)*	4B-2 Energy Demand Prediction Method in the Operating Stage of the Office Building Using Real-Time Data *Young-Hoon Kwak (University of Seoul)*	6C-2 Estimating the uncertainty of an airtightness measurement *Max Sherman (USA)*			
10:40~10:50	Break			PRE FUNCTION AREA		
	Session 5A Natural Ventilation 2 Venue TOPAZ (Renaissance Seoul Hotel 4F) Chairs Charvat Pavel, Han Hwataik	Session 5B Computer Simulation 2 Venue SAPPHIRE+RUBY (Renaissance Seoul Hotel 4F) Chairs Willem de Gids, Gyeong Seok Choi				
10:50~11:15	5A-1 Effect of Intermittent Operation of Ventilation System on Indoor Air Quality in Apartments *Cheol-woong Shin (Hanyang University)*		6C-3 Common problems with building preparation *Stefanie Rolfsmeier (DENMARK)*	4F, TOPAZ	4F, SAPPHIRE + RUBY	23F, Lily
11:15~11:40	5A-2 Development of Zonal Model for Predicting Temperature Distribution inside an Office Room with Hybrid Air-conditioning System *Eunsu LIM (Osaka University)*	5B-2 Modularizing and Validating CFD Parts of Four-way Cassette Type Outlets *Hidekazu Tanaka (University of Tokyo)*	6C-4 Recent experience with tests on large buildings *Colin Genge (CANADA)*			
11:40~12:05	5A-3 Modelling wind driven airflow rate with CFD and verification of approximation formulas based on wind pressure coefficients *S. Leenknegt (K.U.Leuven)*	5B-3 Fungal Growth Prediction on Building Materials by Reaction-Diffusion Model Coupled with Heat and Moisture transfer *Kazuhide Ito (Kyushu University)*	Discussion			
12:05~13:30	Lunch			4F UNIVERSAL		

Time	Program		Location	
	Session 6A Natural Ventilation 3 Venue TOPAZ (Renaissance Seoul Hotel 4F) Chairs Ito Kazuhide, Jae-Weon Jeong	Session 6B-1 Envelope Air Tightness Case Study Building Venue SAPPHIRE+RUBY (Renaissance Seoul Hotel 4F) Chairs Yun Gyu Lee, Hyuenjoon Moon		
13:30~13:55	6A-1 The influence of stochastic modeling of window actions on simulated summer comfort in office buildings *Wout PARYS (K.U.Leuven)*	6B-1 Ventilation and RH control in museum showcases *Marco PERINO (Politecnico di Torino)*	4F, TOPAZ	4F, SAPPHIRE + RUBY
13:55~14:20	6A-2 Influence of natural ventilation usage on cooling energy consumption and cooling capacity of an air conditioner *Hiromi HABARA(Hiroshima Institute of Technology)*	6B-2 Effective flow area estimation method using a gas *Koji Fujita(Kobe University)*		
14:20~14:45	6A-3 Implementation of measurement and quality frameworks in the french regulation for achieving airtight envelopes *F.R. Carrié (CETE de Lyon)*	6B-3 Development of Infiltration Modeling Parameters for a SIPs Building *Francisco Paul (University of Illinois)*		
14:45~15:10		6B-4 Analysis on CO2 Emissions Reduction Effect of Zero Energy Multi-famiy Housing to cope with UNFCCC *Yoon Yong Sang (KICT)*		
15:10~15:50	Coffee break and Poster display		PRE FUNCTION AREA	
	Session 7A Natural Ventilation 4 Venue TOPAZ (Renaissance Seoul Hotel 4F) Chairs Shen Henggen, Myungsouk Yeo	Session 7B Others Venue SAPPHIRE+RUBY (Renaissance Seoul Hotel 4F) Chairs Sun Sook Kim, Jaedong Chang		
15:50~16:15		7B-1 Robustness and True Performance of Demand Controlled Ventilation in Educational Buildings – Review and Needs for Future Development *Mads Mysen (SINTEF)*	4F, TOPAZ	4F, SAPPHIRE + RUBY
16:15~16:40	7A-2 Velocity Measurement Inside and Outside a Cross-Ventilated Building by Means of PIV *Hisashi KOTANI (Osaka University)*	7B-2 Energy Requirements of a Multi-Sensor Based Demand Control Ventilation System In Residential Buildings *Nam Chul Seong (Kyoungwon University)*		
16:40~17:05	7A-3 Building simulation on utilization of roof window in detached house by using cross-ventilation *Ohba Masaaki (Tokyo Polytechnic University)*	7B-3 Experimental Evaluation of the Moisture Buffering Effect of Hygrothermal Material *Suzuki Hiroaki (Tohoku University)*		
17:05~17:30	7A-4 The climatic potential for a double skin facade integrated with cross ventilation *Won-Jun Choi (University of Seoul)*			
18:00~20:00	Banquet (optional)		3F, DIAMOND	

05 Program in Detail

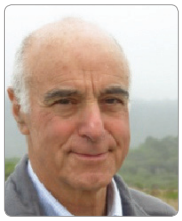
October 28(Thu) 2010

Time	Program		Location	
08:00~18:00	Registration		4F, Hotel Renaissance Seoul	
09:00~09:40	Keynote speech Ⅳ *(Peter Wouter, Belgium)*		4F, TOPAZ	
09:40~09:50	Break			
	Session 8A Post Occupancy Evaluation and Surveys in Building Ventilation Venue TOPAZ (Renaissance Seoul Hotel 4F) Chairs Wouter Peter, SeungMin Lee	Session 8B Sustainable Technologies for Building Ventilation Venue SAPPHIRE+RUBY (Renaissance Seoul Hotel 4F) Chairs Schild Peter, Lee Keon Ho		
09:50~10:15	8A-1 Potential of the Solar Thermal Desiccant Cooling in Asia-Pacific Region *N. ENTERIA (SERIS, National University of Singapore)*	8B-1 Natural Ventilation in Thai Hospitals: A Field Study *Vorapat INKAROJRIT (Chulalongkorn University)*	4F, TOPAZ	4F, SAPPHIRE + RUBY
10:15~10:40	8A-2 Dynamic Insulation System applied to Window Frames (Part 1) Evaluation of the thermal insulation efficiency of the proposed window frames *Sihwan Lee (University of Tokyo)*	8B-2 Study on Optimum Air-Conditioning Control System for Energy Conservation Field Assessment of the Thermal Comfort of Occupants in Office *Utsumi Yasuo (Sendai Naitonal College of Technology)*		
10:40~11:05	8A-3 Dynamic Insulation System applied to Window Frames (Part 2) Energy saving effects of the proposed system in residential buildings *Miho Tanaka(The University of Tokyo)*	8B-3 Measurement of temperature distribution and CO2 concentration in a space-heated classroom *Shuzhao Liu (Tohoku University)*		
11:05~11:45	Closing session		4F, TOPAZ	

Detail Program : Poster Sessions

Poster ID	Topic	Title	Location
A-1	Air Distribution	EXHAUST EFFECTIVENESS BASED ON RESIDUAL LIFETIME OF CONTAMINANT IN A VENTILATED SPACE *Jang Kyungjin, Samgong, Republic of Korea*	PRE FUNCTION AREA
A-2	Air Distribution	Improvement of Temperatures Stratification caused by Air-conditioner by means of Ceiling Fan in Classroom *Wakamatsu Natsuka, Osaka University, JAPAN*	
B-1	Health Indoor Air Quality and Productivity	Experimental Assessment of Humidity Controlling the Performances of Moisture Adsorbing/Desorbing Building Materials *Kim Hea-Jeong, Hanyang University, Republic of Korea*	
B-2	Health Indoor Air Quality and Productivity	Characteristics on indoor air pollutant emission from wood-based flooring by environmental-friendly natural adhesive using CNSL *Lee Jeong-Hun, Soongsil University, Republic of Korea*	
B-3	Health Indoor Air Quality and Productivity	Environment-friendly Hwangtoh composites using water soluble resin for interior materials *Jisoo Jeon, Sumin Kim, Soongsil University, Republic of Korea*	
B-4	Health Indoor Air Quality and Productivity	Adaptation process of human olfactory under continues exposure to odor of ethyl acetate based on subjective estimation of odor intensity *Nagatsugu Hitoshi, Osaka University, JAPAN*	
C-1	Natural Ventilation	Experimental Investigation and Accuracy Study of CFD Analysis for Airflow around Cross-Ventilated Building *Asai Kaori, University of Tokyo, JAPAN*	
C-2	Natural Ventilation	Thermal Environment Generated by Occupant's Opening Control of Window at Naturally Ventilated Building *Kami Kyoko, Osaka University, JAPAN*	
C-5	Natural Ventilation	Study of cross- ventilated indoor air flow characteristics by frequency analysis *Endo Tomoyuki, Kanto Gakuin University, JAPAN*	
C-6	Natural Ventilation	The effect of ventilation rates and window areas on building energy use *Yun Geun Young, Kyung Hee University, Republic of Korea*	
C-7	Natural Ventilation	Performances of new innovative domestic ventilation systems in combination with low temperature floor heating *Op t Veld Peter, Cauberg-Huygen RI bv, NETHERLANDS*	
D-1	Mechanical Ventilation	Prediction of Plume above Residential Cooking Range by means of CFD analysis *Tsumura Yuji, Osaka University, JAPAN*	
D-2	Mechanical Ventilation	Influence of Partition Curtain on Vertical Profile of Temperature and Contaminant Concentration in Sickroom with Displacement Ventilation *Inagaki tatsuya, Osaka University, JAPAN*	
D-3	Mechanical Ventilation	CFD Analysis on Capture Efficiency in Commercial Kitchen using Low Radiative Cooking Equipment with Concentrated Exhaust Chimney *Toyomura Koki, Osaka University, JAPAN*	
E-1	Hybrid Ventilation	A Proposal of Hybrid Ventilation System Using Stack Effect in High-rise Buildings *Yoon Sung Min, Sungkyunkwan Univ., Republic of Korea*	
F-1	HVAC System	Simple error reduction in tracer-gas field-measurements of air handling units *Schild Peter, SINTEF, NORWAY*	
F-2	HVAC System	Investigation of the Usage of Ground Source Heat Pump System on Wall Heating *Yoru Yilmaz, YTU, TURKEY*	
F-3	HVAC System	Thermostat/Hygrometer vs ANN-Based Predictive/Adaptive Environmental Control Strategies *Chang Jae, University of Kansas, UNITED STATES*	
F-4	HVAC System	A Study on the Hybrid Air-conditioning system Coupled with Radiant Floor Cooling and Ventilation System *Park Jae-Hyung, BTU, Republic of Korea*	
F-5	HVAC System	Energy-saving Effect of Thermal Energy Storage Using Introduced Outdoor Air *Asano Yuka, Osaka University, JAPAN*	
F-6	HVAC System	Field Survey on Indoor Thermal Environment in Small to Medium Sized Building with Packaged Air Conditioners *Nakasone Haruka, Osaka University, JAPAN*	
F-7	HVAC System	Evaluation on the Availability of Treated Sewage Water as an Unused Energy Source in a Super High-rise Complex Building *Jae-Han Lim, Ewha Womans University, Republic of Korea*	
G-1	Case Study Building	School Eco-Renovation Method for Improvement of Thermal Environment in Large Workshop of High School without Air-Conditioning System *Yamada Junya, Osaka University, JAPAN*	
G-2	Case Study Building	Indoor Thermal Environment and Vertical Temperature Gradient in Large Workshop of School without air-conditioning *Yasui Saori, Osaka University, JAPAN*	
G-3	Case Study Building	A Study of Design principle and Technology performance applied in Passive House - Focused on cases of the apartment type of Passive Houses in European - *Shin sung-eun, KICT, Republic of Korea*	
H-1	Chemical pollutants & Particles	Prediction of mass transfer rate on the surface of tested building material using CFD analysis *Seo Janghoo, Chosun Univ., Republic of Korea*	
H-2	Chemical pollutants & Particles	Sensitivity Analysis of Parameters affecting Indoor Air Quality related to HCHO and TVOC Reduction *Kim Mi Yeon, Chung Ang University, Republic of Korea*	
I-1	Computer Simulation	Analytical estimation of optimal minimum airflow for air circulation *Park Jin-Hyeon, Yeungnam UNIV., Republic of Korea*	
I-2	Computer Simulation	Evaluation on the Daylighting performance of 'generative facade components' In the digital simulation *Yi Hwang, SAMOO corp., Republic of Korea*	
J-2	Envelope Air Tightness	Effective flow area estimation test using CO2 *Iwamoto Ken, Kobe University, JAPAN*	
J-3	Integration Performance of Building Envelope and Services	PCM cold storage under various ventilation conditions *Charvat Pavel, Brno University of Technology, CZECH REPUBLIC*	
J-4	Sustainable Technologies for Building Ventilation	Study on the Feasibility of Heat Pump Desiccant System Combined with Cogeneration System in Heating and Humidification Mode *Park Beungyong, University of Tokyo, JAPAN*	
J-5	Envleope Air Tightness	Air Leakage Tests for the requirements of the LEED in two high-rise residential buildings *Hyun Kook Shin, Chungbuk National University, Dept. of Architectural Engineering, Cheongju, Korea*	

06 Keynote Speakers Information



Hal Levin

- Research Architect with Building Ecology Research Group, Santa Cruz, California, USA
- President of the Indoor Air Institute and the Executive Director of the International Society of Indoor Air Quality and Climate
- Theme: Ventilation and Sustainability: Exploring the Connections

Masanori Shukuya

- Professor at the Faculty of Environmental and Information Studies, Tokyo City University, Japan
- Professor at the Graduate School for Environmental and Information Studies (He was the chairman for six years from September 2004 to August 2010)
- Theme: An Exergetic View on Sustainable Cooling and Ventilation

Yingxin Zhu

- Professor of Dept. of Building Science, School of Architecture, Tsinghua University, Beijing, China
- Vice-dean of School of Architecture, the head of Dept. of Building Science
- Chair of China National Steering Committee for Education of Building Services Engineering
- Theme: Natural Ventilation and Dynamic Thermal Comfort

Peter Wouters

- Director development and valorization at Belgian Building Research Institute, Belgium
- Manager of INIVE EEIG, International Network for Information on Ventilation and Energy Performance
- Chairman of Marketing and Communication Committee of CIB (International Council for Building Research and Innovation)
- Theme: BUILD UP - The European portal for energy efficiency in buildings

07 Oral Sessions

Session 1A (October 26, 10:30~12:10)

Air Distribution

Venue Topaz (Renaissance Seoul Hotel 4F)
Chairs Yoshino Hiroshi, Geun Young Yun

1A-1

Year-round Energy Saving Potential for a Stratum Ventilated Subtropical Office

C.K. Lee(City University of Hong Kong)
Zhang Lin(City University of Hong Kong)
K.F. Fong(City University of Hong Kong)

Abstract

Stratum ventilation has been proposed to cope for elevated indoor temperature recommended by governments in East Asia. TRNSYS is used for computation of the space cooling load and system energy consumption. A typical Hong Kong office is investigated. Compared with mixing ventilation and displacement ventilation, stratum ventilation derives its energy saving potential largely from the following two factors: a reduced ventilation load and increased coefficients of performance (COP) for chillers. The year-round energy saving is found to be substantial at 25% and 44% when compared with displacement ventilation and mixing ventilation respectively.

1A-2

Numerical Prediction of Airflow and Temperature Distribution in Large-Scale Agricultural PVC Greenhouse

Keita Hattori(Graduate student, IGSES, Kyushu University, Japan)
Kazuhide Ito(IGSES, Kyushu University, Japan)

Abstract

Large-scale greenhouses are usually adopted to control the indoor climate conditions in agriculture. The envelope of agricultural greenhouses generally consists of a PVC (polyvinyl chloride) sheet, which produces a so-called greenhouse effect and protection from harmful insects. In winter, a supplementary heating device in greenhouses is needed because of the lower outdoor temperature and the non-uniform distribution of indoor temperature. Existing research concerning indoor environmental conditions formed in PVC greenhouses is insufficient and precise numerical predictions of airflow and temperature distribution in large-scale vinyl houses are important to develop effective designs from the viewpoint of energy-saving and the development of suitable indoor environments for agricultural products.

To this end, coupled numerical analysis of CFD (computational fluid dynamics) and air-conditioning system was also carried out and the sensor position in the greenhouse and operation of a stirred fan were confirmed to have great impact on energy consumption.

1A-3

Exposure Risk Assessment by Coupled Analysis of CFD and SIR model in Enclosed Space

Takayuki Fukuoka(IGSES, Kyushu University, Fukuoka, Japan)
Kazuhide Ito(IGSES, Kyushu University, Fukuoka, Japan)

Abstract

The indoor environment can play a significant role in the transmission and exposure of various contaminants. In some emerging aerial infections, such as influenza virus, tuberculosis virus, and other biological and chemical contaminants, the airborne route of transmission is thought to be important to evaluate exposure health risk. In this paper, first, we have presented the relationship between classic SIR model proposed by Kermack & Mckendrich and Wells-Riley model, and introduced the analytical procedure of coupled analysis of computational fluid dynamics (CFD) based prediction of unsteady contaminant concentration distribution and basic SIR model to predict exposure risk of residents in enclosed space.

The classic SIR model consists of three differential equations coupling the change in the population of susceptibles (S), the population of infectors (I) and the population of recovery to an immune state (R). Wells-Riley model can predict the number of susceptibles (S) as functions of infectious contaminant concentration and exposure time by respiration. Through the analysis of infectious contaminant concentration revel in large enclosure with CFD, the prediction of the number change of S, I and R become possible. The results of sensitivity analysis that changed ventilation rate and other parameters of infections for targeting simple geometry and large enclosure showed non-uniform distribution of S, I and R in enclosed spaces and represented strong dependence on unsteady and inhomogeneous contaminant distribution.

1A-4

Predicting Patterns of Contaminant Dispersal and Comfort in Passive House Designs

Paul Strachan(University of Strathclyde, UK)
Jon Hand(University of Strathclyde, UK)
Jaemin Kim(University of Strathclyde, UK)
Aizaz Samuel(University of Strathclyde, UK)
Paul Tuohy(University of Strathclyde, UK)

Abstract

Passive House, an emerging standard in low energy design, is based on a combination of design ideas and construction details. Mechanical ventilation with heat recovery plays a central role. The design goal is systems which are essentially silent, have relatively low flow rates and velocities and extremely low running costs.
A mixture of rules and analysis are used in the design phase. Overall occupancy is used to size system capacity, with air distributed to a number of source rooms, assumed to move through transition spaces and extracted in other rooms.
The assessment tools which are used in Passive House provide seasonal performance indicators for energy but do not address comfort, indoor air quality or the diversity of use in buildings. The focus of this paper is to investigate, via whole-building simulation and mass flow networks, the distribution over time of contaminants as sources and sinks change and occupants interact with the building. Dynamic simulation supports temporal diversity of occupants and explicit tracking of contaminant sources and sinks as well as the bulk air movement between spaces resulting from buoyancy, infiltration and mechanical ventilation. The paper compares different operational regimes as well as ducting layouts.
Passive House assessment tools assume that natural ventilation has a part to play but only allow approximations of window opening logic and the the influence of wind pressures. The paper reports how different window opening strategies impact comfort and air quality within buildings designed to this standard and the transition between mechanical ventilation and natural ventilation.

Session 1B (October 26, 10:30~12:10)

Chemical pollutants & Particles

Venue Universal (Renaissance Seoul Hotel 4F)
Chairs Carrie Francois Remi, Jaedong Chang

1B-1

Health Hazards in Indoor Air

Jennifer M. LOGUE(Lawrence Berkeley National Laboratory)
Max H. SHERMAN(Lawrence Berkeley National Laboratory)
Brett C. SINGER(Lawrence Berkeley National Laboratory)

Abstract

Indentifying pollutants that pose a potential hazard indoors is an important first step to reducing risks. We reviewed key published studies reporting measurements of chemical pollutants in residences. Summary results were compiled and used to calculate representative mid-range and upper-bound concentrations relevant to chronic exposures for over 300 pollutants and peak concentrations relevant to acute exposures for a few episodic activity-associated pollutants. For the over 100 pollutants with available criterions, the measured concentrations are compared to available chronic and acute health-hazard standards and guidelines. Fifteen pollutants are identified as potential chronic or acute health hazards for many homes. A subset of pollutants are identified as priority chemical pollutants and suggestions are made for effectively reducing indoor concentrations.

Keywords: Indoor air quality; hazard analysis; residential; criteria pollutants; VOCs; air toxics

1B-2

Experimental method for determining removal efficiency of house dust by mechanical ventilation

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Yoshino Hiroshi(Tohoku University, Japan)
Yonekura Hiroshi(Tohoku University, Japan)
Takaki Rie(Tohoku University, Japan)
Lu Yang(Tohoku University, Japan)

Abstract

Biological contamination has recently become an important issue in the residential indoor environment. In fact, one of the leading causes of allergic diseases is the presence of mold and mites in house dust that accumulates on the floors, near the breathing zone for infants and toddlers. In this research, experimental studies were carried out in order to examine particle removal efficiency in a room with two ventilation systems: a ceiling exhaust system and a slit exhaust system. The results indicated that there was no clear relationship between removal efficiency and two different outlet locations. It was found that the use of fluorescent particles to simulate house dust was effective for determining the removal efficiency of ventilation systems.

1B-3

Distribution of CO in 30 Homes with Unvented Gas Fireplaces

Paul W. FRANCISCO(University of Illinois at Urbana-Champaign, IL)
Jeffrey R. GORDON(University of Illinois at Urbana-Champaign, IL)
William B. ROSE(University of Illinois at Urbana-Champaign, IL)

Abstract

As part of a field measurement project of unvented gas fireplaces in 30 homes, portable carbon monoxide sensors were located in several places in each home. This was done to assess the degree

to which combustion by-products became distributed throughout the home. Portable sensors were located at the fireplace mantel, midway across the room in which the fireplace was located, at the opposite side of the fireplace room, in an adjacent room, and in a room distant from the fireplace room. This paper presents the results of this monitoring, with a comparison to published health-based guidelines and standards for allowable CO concentration. The sensors indicated that carbon monoxide levels began rising throughout the home almost immediately, at or near the one-minute sampling interval. The results show that, on average, the reading in the middle of the fireplace room was about 95% of the reading at the mantel. Readings throughout the rest of the home are comparable to each other and are between 70-80% of the reading at the mantel at peak concentrations.

These results indicate that carbon monoxide concentrations from unvented fireplace combustion spread rapidly and rather uniformly throughout the house.

1B-4

Numerical prediction of particle transport passed through ventilator by CFD with Lagrangian method

Nguyen Lu Phuong(Kyushu University, Japan)
Kazuhide Ito(Kyushu University, Japan)
Shigeki Onishi(Kyushu University, Japan / Mitsubishi Electric Corporation)

Abstract

The use of CFD technique for predicting the properties of airflow fields and particle movement is effective to carry out parametric study intended for a wide range of particle sizes. In this study, particle dispersions due to turbulent flow and thermophoretic effect were analyzed for a simplified ventilator model. Numerical results that comprise a classification of particle motion, temperature difference and particle diameter were reported. The residence time of particles in the ventilator was confirmed to depend on temperature differences and particle sizes under the condition of constant supply inlet velocity. Large particles (100 μm) were strongly affected by gravitational force and settling to the inlet opening located lower part of the ventilator while smaller particles (10 μm) tended to follow the convective air streamlines. Particle removal by gravitational settling has possibilities by optimizing the flow path and velocity in the ventilator as functions of the target particle size.

Session 2A (October 26, 14:20~15:10)

Health Indoor Air Quality and Productivity 1

Venue Topaz (Renaissance Seoul Hotel 4F)
Chairs Wouter Borsboom, Sumin Kim

2A-1

A Study on Indoor Environments Made by Thin Line Type Ventilators in Apartment Houses

Hyun-Jae CHANG(Hongik University, Korea)
Keun-Je CHO(Hongik Graduate School, Korea)
Tae-Hwoan CHOI(LG Hausys, Korea)

Abstract

Total heat recovery type ventilators that are connected to each room with ducts are mainly installed in Korea, but they raise concern over duct pollution. In this study, indoor environments made by thin line type ventilators installed in dwelling units of apartment houses are investigated by CFD. Results show the case that thin line type ventilators installed in each room - including kitchens - make the best indoor environment that maintains air velocity at under 0.25m/s, and evenly distributes the age of air in all areas.

2A-2

A study on eco friendly furniture for mitigation of the indoor air pollution

Hyunsun AN(Korea Institute of Construction Technology, Korea)
Yungyu LEE(Korea Institute of Construction Technology, Korea)

Abstract

Furniture can raise indoor air contaminants with toxic emissions of VOC and formaldehyde.. While furniture is classified as a subject of safety and has quality labeling, there is a lack of domestic regulations related to contaminant emissions with the exception of sinks. When looking at the analysis on environment-related patients related to the smell or odors from furniture every year, patients suffering from asthma, allergic rhinitis, and atopic dermatitis are on the rise. Likewise, because there was an urgent need to prepare control standards, there was a prior notice of legislation for the introduction of a contaminant emission labeling system from 2010 onwards. This study conducted an analysis on the emission characteristics of VOCs and formaldehyde, an

indoor air contaminant emitted from furniture. After an analysis was conducted on contaminant emission characteristics on conventional furniture versus eco-friendly furniture that can reduce harmful elements with closets, which are special-offer products, and office desks which are general market products, improvements were shown which indicate materials were working continuously to reduce indoor air contamination factors. Because of the comparative analysis on characteristics of the furniture of which has eco-friendly engineering against conventional furniture engineering, contaminants had been reduced in furniture using the eco-friendly engineering methods.

Session 2B (October 26, 14:20~15:10)

HVAC System 1

Venue Universal (Renaissance Seoul Hotel 4F)
Chairs Pierre Deroubaix, Youngshik Kim

2B-1

Rotary heat exchanger model for control and energy calculations

Bjørn R. SØRENSEN(Narvik University College, Norway)
Raymond RIISE(Narvik University College, Norway)

Abstract

Rotary heat recovery exchangers are widely used in ventilation systems, and the units are known for their high efficiency and almost maintenance-free operation. Temperature efficiencies above 80% are not uncommon.

Performing dynamical analyses of rotary heat exchangers are in many situations advantageous, especially in connection to installation of such equipment in VAV systems. Efficiencies and flows are varying parameters that are crucial for energy calculations, but also for control. The dynamical analysis can effectively be carried out by addressing a dynamical model.

This paper presents a simplified model for a rotary heat recovery unit that can be used both in CAV or VAV systems for control and energy analysis. The model is based on a further development of existing models, and is able to account for varying leakage, varying flows and temperatures. The model has been implemented in the Matlab Simulink environment. Simulations show that the results represent real conditions in an adequate way. This has been verified through comparison with measurements.

2B-2

Model-based controlling of thermal zones in a small ventilated space

Ali Youssef(M3-BIORES: Measure, Model & Manage Bioresponses Katholieke Universiteit Leuven)
Vasileios Exadaktylos(M3-BIORES: Measure, Model & Manage Bioresponses Katholieke Universiteit Leuven)
Sezin E. Özcan(M3-BIORES: Measure, Model & Manage Bioresponses Katholieke Universiteit Leuven)
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Abstract

One of the main goals of ventilation is to create a favourable thermal condition inside a compartment. The efficiency of a ventilation system to achieve this goal depends on many factors such as: air flow rate, incoming air temperature, air flow pattern etc. For this purpose, there is need for a control system which can provide proper inlet conditions that result in the required output at a specific location. The main objective of this paper is to examine the possibility to control the temperature in a ventilated chamber in different spatial regions individually. Twenty two-dimensional spatially fixed and equal square cells in a small ventilated test chamber (0.70×0.65×0.4 m) are proposed. Step inputs in ventilation rate and inlet air temperature are applied and temperature responses at 30 sensor locations are recorded. First order transfer function data-based models are identified for modelling the dynamic behaviour of temperature in each of the 20 cells. A Proportional-Integral-Plus PID control system is designed based on the identified models to control the temperature in each of the 20 cells individually

Session 3A (October 26, 16:10~17:50)

Health Indoor Air Quality and Productivity 2

Venue TOPAZ (Renaissance Seoul Hotel 4F)
Chairs Ohba Masaaki, Janghoo Seo

3A-1

A Study on the field survey of the IAQ in the childcare center

Jung Ha PARK(Chung Ang University, Korea)
Jin Chul PARK(Professor, Chung Ang University, Korea)
Eon Ku RHEE(Professor, Chung Ang University, Korea)

Abstract

Child care center, one of the pChild care center, one of the

public facilities, has recently been increased. It is because of the government\'s childbirth policy. In particular, infants and children who use this place are frequently exposed in danger because of their biological characteristics. They stay in child care center over 7 hours a day in average. Therefore, the importance of the child care center\'s indoor air has been increased.

Thus, survey and investigation of the child care center\'s indoor air are conducted in this study. Moreover, preliminary data will be suggested for management of the child care center\'s indoor air quality. The measurement items are PM10, Asbestos, CO, CO2, NO2, VOCs, HCHO, Rn and Ozone. And fact finding was conducted in 30 child care centers. Moreover, the survey about the consciousness and administration of satisfaction and interest in indoor air quality targeting 161 teachers who worked in child care centers.

3A-2

Case-Control study for the Association Between Indoor Environmental Factors and Children's Health Problems in Japan-Part1 a nationwide questionnaire study among 1664 primary school students

Ando Naoya(Tohoku University, Japan)
Yoshino Hiroshi(Tohoku University, Japan)
Hasegawa Kenichi(Akita Prefectural University, Japan)
Abe Keiko(Institute of Environmental Biology, Japan)
Ikeda Koichi(Nihon University, Japan)
Kato Noriko(Researcher, National Institute of Public Health, Japan)
Kumagai Kazukiyo(California Department of Public Health, Environmental Health Laboratory Branch, USA)
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Mitamura Teruaki(Ashikaga Instutute of Technology Department of Architecture, Japan)
Yanagi U(Kogakuin University, Japan)
Matsuda Asako(Tohoku University, Japan)
Takamatsu Mari(Tohoku University, Japan)
Hamada Kensuke(Tohoku University, Japan)

Abstract

Recent studies show the number of people affected by biological contaminants have increased every year in Japan. An epidemiological investigation on 4th and 5th grade primary school students was conducted in order to clarify the relationship between indoor environment and children's health problems. A case-control study adopted ATS-DLD-American Thoracic Society-Division of Lung Diseases- questionnaire for evaluation of respiratory symptoms and allergies was conducted for 2574 primary school students (1664 responded) across Japan.

The visible presence of mold both living room and children's bedroom excluding window (such as wall, floor or closet) was observed to be significantly associated with bronchial hypersensitivity (OR=3.05 95% CI: 1.38-6.73). Also, the occurrence of respiratory symptoms and allergic symptoms were significantly associated in homes using humidifier.

These results showed that home environmental factors had serious risk factors for allergic symptoms. In particular, indoor mold and water stain were strongly influence on respiratory symptoms among children in Japan.

3A-3

Case-Control study for the Association Between Indoor Environmental Factors and Children's Health Problems in Japan – Part 2 Results of Measurements during Rainy Season and Winter

Hamada Kensuke(Tohoku University, Japan)
Yoshino Hiroshi(Tohoku University, Japan)
Hasegawa Kenichi(Akita Prefectural University, Japan)
Abe Keiko(Institute of Environmental Biology, Japan)
Ikeda Koichi(Nihon University, Japan)
Kato Noriko(National Institute of Public Health, Japan)
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Matsuda Asako(Akita Prefectural University, Japan)
Takamatsu Mari(Akita Prefectural University, Japan)
Ando Naoya(Tohoku University, Japan)

Abstract

In order to clarify the association between indoor environmental factors and children's health problems, indoor air quality was investigated during the winter and rainy seasons in Japan. The total of 209 houses was classified into case and control groups whether the child have allergy symptom or not. The number of the houses in case and control groups is 133 and 76, respectively. This survey included measurement of indoor temperature, humidity, the pollution of chemical compound and mite allergen (Der 1). These measurements were conducted in the living room and children's room. It was found that the excess rate of relative humidity 70% in the case group was higher than that of the control group. During rainy season, in most houses (87.5%) Der 1 concentrations exceeded the proposed thresholds of allergic sensitization. The Der 1 concentration of the case group was higher than the control group. It was concluded that the chemical concentration including HCHO was less than the recommended value in many houses. On the other hand, Der 1 exceeded the proposed thresholds of allergic sensitization in the winter and rainy seasons.

3A-4

A Study on Incomplete Ventilation in High-Rise Residential Building

Jungmin Seo(Sungkyunkwan Univ. Korea)
Sungmin Yoon(Sungkyunkwan Univ. Korea)
Joonghoon Lee(Institute of Technology/Samsung C&T Corporation, Korea)
Doosam Song(Architectural Sungkyunkwan Univ. Korea)

Abstract

Guideline for ventilation to improve indoor air quality in apartment housings in Korea was recently enacted and natural or mechanical ventilation system has become mandatory. Meanwhile, as the height of residential buildings goes up, the performance of ventilation system is influenced stack effect especially in winter. This study is to review how stack effect influences ventilation system of high-rise residential buildings through simulations.

Session 3B (October 26, 16:10~17:50)

HVAC System 2

Venue Universal (Renaissance Seoul Hotel 4F)
Chairs Li Angui, Jinwoo Moon

3B-1

Measured Duct Leakage and Resulting Envelope Pressure Differences

Paul W. FRANCISCO(University of Illinois at Urbana-Champaign, Building Research Council, Champaign, IL)
Scott PIGG(Energy Center of Wisconsin, Madison, WI)
Collin OLSON(The Energy Conservatory, Minneapolis, MN)
Bob DAVIS(Ecotope, Inc., Seattle, WA)

Abstract

As concern about IAQ has increased, forced-air distribution systems are being viewed as a potentially important factor in preventing the transport of indoor and outdoor pollutants. Duct leakage can be a confounding factor in attempts to use the forced-air system for this purpose. Leakage from outside into the return side of the system brings outdoor air directly into the distribution system through the leak. Supply leakage depressurizes the house which increases infiltration of outdoor air through the envelope. This paper presents results from three projects on field measurements of duct leakage, covering 77 homes in three regions of the U.S.: the Pacific Northwest, Wisconsin, and Central Illinois. These homes range in age from new to over 100 years old. Changes in house pressures due to duct leakage are reported. Duct leakage results are also compared to predicted changes in infiltration based on blower door results and infiltration models.

3B-2

Calculation of Dehumidification Coeffecients for Numerical Simulation of Desiccant Wheel

Yoshihisa MOMOI(Osaka University, Japan)
Ryuichiro YOSHIE(Tokyo Polytechnic University, Japan)
Akira SATAKE(Maeda Corporation, Japan)
Hiroshi YOSHINO(Tohoku University, Japan)

Abstract

In the previous study, a numerical method which simulates combined heat and moisture transfer process in solid desiccant materials was investigated. The calculation results successfully reproduced the cyclic process of the moisture adsorption and desorption. The validity of the numerical simulation method for the desiccant wheel was examined by the comparison between the experiment and the numerical simulation of the desiccant dehumidifier.

In this paper, it reports that the dehumidification performance of the desiccant wheel could be expressed as two dehumidification coefficients (effectivenesses of the dehumidifier) in the psychrometric chart, from the result of the air temperature and humidity before and behind the desiccant wheel. One is effectiveness for relative humidity, another one is effectiveness for enthalpy.

It was shown that the average temperature and humidity of the wheel outlet air were predictable without depending on the regeneration air temperature by using the effectivenesses of the dehumidifier.

3B-3

Development of a heat pump system with the heat source network model using solar, ground and air heat source

Yujin NAM(The University of Tokyo, Japan)
Shinsuke KATO(The University of Tokyo, Japan)
Ryozo OOKA(The University of Tokyo, Japan)

Abstract

In this research, a heat pump system with a heat source

network is suggested which utilizes outdoor air heat, solar heat and ground heat as heat source for cooling, heating, hot water and refrigerating. This paper describes the summary of the suggested system and the results of the annual energy simulation. The heating and cooling loads, the electric consumption and the COP were calculated by TRNSYS 16 and evaluated in the cases of different local conditions and different system compositions. In the results, the superiority of the suggested system has been quantitatively evaluated comparing with the conventional heat pump system using one heat source. Furthermore, it was more significant in cold climate, in which the heating COP was 64% up compared the air source heat pump system, than it in subtropical climate, 46% up.

3B-4

Energy Saving Potentials of Dedicated Outdoor Air System in High-rise Apartment Buildings

Kim Min-Hwi(Sejong University, Korea)
Kim Jin-Hyo(Sejong University, Korea)
Kwon Oh-Hyun(Sejong University, Korea)
Seok Yoon-Jin(Sejong University, Korea)
Jin Jeong-Tak(Sejong University, Korea)
Jeong Jae-Weon(Sejong University, Korea)

Abstract

The main thrust of this paper is to investigate the optimized supply air condition and energy saving potentials of a dedicated outdoor air system (DOAS) applied to a high-rise apartment building. For a typical 132-m2 apartment unit, it was assumed that two different systems, namely, a centralized DOAS integrated with ceiling radiant cooling panel (CRCP) and a decentralized energy recovery ventilator (ERV) operated with packaged air conditioner, were installed. The transient behavior and control characteristics of each system were modeled numerically using a commercial equation solver program and annual cooling coil load and heating load reduction potential of the two systems were compared. It was found in this research that a DOAS-CRCP system can reduce the cooling coil load by over 21% annually compared to the current energy recovery ventilator-packaged air conditioner pair. In addition, the use of DOAS can reduce the annual ventilation heating load by over 40% when the enthalpy wheel and the sensible wheel of the DOAS unit operate simultaneously. It was also found that the optimized dew point temperature of the DOAS supply air that accommodates the latent load of a space is 11–12°C.

Session 4A (October 27, 9:50~10:40)

Natural Ventilation 1

Venue TOPAZ (Renaissance Seoul Hotel 4F)
Chairs Sherman Max, Jaehun Jo

4A-1

Prediction of Heat Emission Effect at Small Single-sided Openings in Apartment Houses

Ayako Nishimura(The Tokyo Electric Power Company)
Masashi Imano(Assist. Prof, The Univ. of Tokyo)
Kei Ogino(The Univ. of Tokyo)
Keigo Nomura(The Univ. of Tokyo)
Yuzo Sakamoto(Prof, The Univ. of Tokyo)

Abstract

In this study, we propose a method for forecasting heat emission effect in a small single-sided slit opening. In order to make a heat flux forecasting model, we carried out field measurement, wind tunnel experiment, and CFD analysis. In the field measurement, we measured heat flux and grasped the relationship of heat flux of the opening and airflow around the building surface. In the wind tunnel experiment, we measured airflow around the opening and grasped turbulence characteristics. In the CFD analysis, we used RANS model of high Reynolds numbers type and considered optimum turbulence model by comparing with the results of wind tunnel experiment. Finally, we used standard k-ε model under non-isothermal conditions and calculated the coefficients of the heat flux forecasting model from the relationship of heat emission quantity at the opening and airflow around the building surface by CFD analysis.

4A-2

Design Method of Vertical Ventilation with Wind Chimney on Roof Driven by Wind and Buoyancy

Toshio Yamanaka(Osaka University, Japan)
Hisashi Kotani(Osaka University, Japan)
Yoshihisa Momoi(Osaka University, Japan)
Kazunobu Sagara(Osaka University, Japan)
Tomohiro Kobayashi(Ritsumeikan University, Japan)
Yuka Komatsu(Panasonic Electric Works Co., Ltd., Japan)

Abstract

The calculation system for vertical ventilation with wind chimney on the roof driven by wind and buoyancy is presented

and the necessary data is measured. The calculation system is based on the "pressure – airflow rate relationship (Pressure -Volume curve: P-V curve)" and the local velocity and static pressure at the point of chimney top. The P-V curves were measured by wind tunnel test for some typical shapes of wind chimney top. It is turned out that the effect of upper wind velocity can be eliminated by normalization of the pressure at chimney neck and airflow rate through the chimney. The number of tested models are six : simple outlet, two types of wind-break plates, two types of horizontal duct, rainproof type.

Session 4B (October 27, 9:50~10:40)

Computer Simulation 1

Venue SAPPHIRE+RUBY (Renaissance Seoul Hotel 4F)
Chairs Op t Veld Peter, Jin chul Park

4B-1

STUDY ON THE VENTILATION EFFICIENCY IN URBAN STREET CANYONS USING CFD ANALYSIS

Influence of the Configuration of Consecutive Street Canyons and Atmospheric Stability

Byoungchull OH(The University of Tokyo, Japan)
Ryozo OOKA(Professor, The University of Tokyo,Japan)
Takeaki KATSUKI(The University of Tokyo, Japan)
Hideki KIKUMOTO(The University of Tokyo, Japan)

Abstract

This research, based on Computational Fluid Dynamics (CFD) analysis, focuses on the wind characteristics and the ventilation performance in the consecutive street canyons produced by various building complex configurations. In this research, the buildings in the street canyon space were distributed in either staggered or normal arrangements and, in consideration of the varying distribution and height of different buildings, high-rise buildings, middle-rise buildings and low-rise buildings were all included. The air flow field and concentration distribution change were compared at various degrees of atmospheric stability. In order to examine the ventilation efficiency and purging flow rate (PFR), 3 different atmospheric conditions were analyzed - a stable case, a weak-unstable case and an unstable case. Based on the analysis results, it was found that in isothermal cases the best pedestrian effect and ventilation efficiency were achieved when buildings with different heights were laid out in a normal arrangement. In non-isothermal cases, the highest ventilation efficiency was found in unstable conditions.

4B-2

Energy Demand Prediction Method in the Operating Stage of the Office Building Using Real-Time Data

Young-Hoon Kwak(University of Seoul, Korea)
Sang-Moon LEE(Korea Conformity Laboratory, Korea)
Jung-Hho Huh(Professor, University of Seoul, Korea)

Abstract

Energy demand prediction is necessary critical for buildings in a community during thein operatingon stage as well as and in the planning stage. If the energy demand of buildings in operation is can be predictableed on an hourly basis, the energy efficiency of such buildings' energy utilization can be maximized, and thusan the efficient systemefficiency of local energy demand-supply systemdistribution can be established using a hybrid energy system. In this study, computer modeling and simulation an attempts waeres made to predict the energy demand of buildings in operation as opposed to those in the planning stage. In the previous studies, artificial neural networks in which energy demand prediction was well matched with actual energy consumption were used. With reference to the previous studies, aArtificial neural networks(ANNs) suitable for this study were configured, and energy demand prediction method was was applied to an office building s in operating operationstage using real-time data. We made a comparison between Compare the energy demand prediction demand data with real-time data(actual-energy-consumption data) and performed error analysis errors.

Session 5A (October 27, 10:50~12:05)

Natural Ventilation 2

Venue TOPAZ (Renaissance Seoul Hotel 4F)
Chairs Charvat Pavel, Han Hwataik

5A-1

Effect of Intermittent Operation of Ventilation System on Indoor Air Quality in Apartments

Cheol-woong Shin(Hanyang University, Seoul, Korea)
Hyung-Jun Kim(Hanyang University, Seoul, Korea)
Jun-seok Park(Hanyang University, Seoul, Korea)

Abstract

This study analyzed the effect of intermittent operation of ventilation system on changes of indoor air pollutants' levels through field measurements. The changes of indoor air pollutants' levels, such as, CO2, PM10, TVOCs, and HCHO were monitored during 24 hours at each ventilation condition. One group was the operation time: 2 hours, 8hours, and 24 hours. The other group was the changes of start time of ventilation, before noon, after noon, and night, while the ventilation was operated only two hours. From these results, it was found that the operation time of ventilation significantly affects the levels of pollutants. However, the start time of ventilation did not showed the significant differences between conditions, because of time variations of sources of pollutants. From these results, it is suggested that rational strategy for operation of ventilation system will be developed for indoor air quality and energy savings in the apartments.

5A-2

Development of Zonal Model for Predicting Temperature Distribution inside an Office Room with Hybrid Air-conditioning System

Eunsu LIM(Osaka University, Japan)
Toshio YAMANAKA(Osaka University, Japan)

Abstract

Recently, the hybrid air-conditioning system that used natural ventilation together with a mechanical air-conditioning was proposed. Hybrid air conditioning system is expected to be saving energy and maintain keep indoor thermal environment comfort.

The purpose of this study is to develop a simplified numerical model that predicts distribution of indoor air temperature when the office room is air-conditioned by hybrid air-conditioning. An office room with hybrid air-conditioning system with wind-driven ventilation as natural ventilation was used by object of this study. The temperature distribution can be calculated by solving the equations of air balance and heat balance in each zone. The results of CFD analysis are assumed to be a correct answer in this paper. The air temperature prediction of zonal model was compared with the results of CFD analysis to optimum solution.

5A-3

Modelling wind driven airflow rate with CFD and verification of approximation formulas based on wind pressure coefficients

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B. Piret(Division of Building Physics, Department of Civil Engineering, K.U.Leuven, Leuven, Belgium)
A. Tablada de la Torre(Division of Building Physics, Department of Civil Engineering, K.U.Leuven, Leuven, Belgium)
D. Saelens(Division of Building Physics, Department of Civil Engineering, K.U.Leuven, Leuven, Belgium)

Abstract

An isothermal CFD study was made of a building perpendicular to the wind direction. The building was modelled with a closed façade, and consecutively with one and multiple openings. The sensitivity was investigated for different turbulence models, meshes and near wall treatments, both in 2D and 3D. A large sensitivity was found to the modelling options with regard to the predicted wind pressure coefficients (Cp) distribution, but less with regard to the predicted flow rate through the openings. The distribution of Cp was compared to literature and the influence of the openings on the wind pressure coefficients is investigated. Openings have a large influence on local Cp on the windward side, but only limited on the leeward side. The simulated airflow rates were recalculated using theoretical approximation formulas. The calculated values showed better agreement to the CFD-simulations when the Cp in front of the openings were used, compared the Cp taken at a closed wall.

Session 5B (October 27, 10:50~12:05)

Computer Simulation 2

Venue SAPPHIRE+RUBY (Renaissance Seoul Hotel 4F)
Chairs Willem de Gids, Gyeong Seok Choi

5B-1

Solar Greenhouse and natural ventilation

Elena BIGELLI(University of Bologna, Italy)
Luca GUARDIGLI(University of Bologna, Italy)
Debora VENTURI(University of Bologna, Italy)

Abstract

The paper presents a study on the thermal behavior of a solar greenhouse set against one apartment of a residential sustainable building in a temperate climate. Particular attention was given to the analysis of the contribution of solar radiation in winter heating in relation to natural ventilation. This study

makes use of a transient energy simulation system named ESP-r (Environmentals System Performance - research).

The results so far have revealed that the preferred orientation of the greenhouse to maximize the solar collection in January and February (South) can cause overheating in March, as the temperature inside the room exceeds 25°C (limit of the comfort zone) for 5% of the hours, and in April when the discomfort is for 60% of the time. The final step of the study focuses on the contribution of natural ventilation to reducing the above mentioned percentage giving a criterion for sizing the openongs and identifing a design methodology that integrates low-energy concepts in the design process.

5B-2

Modularizing and Validating CFD Parts of Four-way Cassette Type Outlets

Hidekazu Tanaka(Affiliation, the University of Tokyo, Japan)
Masashi Imano(Affiliation, the University of Tokyo, Japan)
Yuzo Sakamoto(Affiliation, the University of Tokyo, Japan)

Abstract

In this paper, we created the CFD parts of four-way cassette type outlets for predicting easily the thermal environment of an office with packaged unit air-conditioning systems. At first we measured detail distributions of wind velocity around the cassette type outlets in two cases of angles of flap in an experiment room with particle image velocimetry (PIV).

Secondly we created the CFD parts of this type of outlets and performed CFD analysis. As a result of examining the correlation with measured velocity distribution around the outlets, we have confirmed the validity of these CFD parts.

5B-3

Fungal Growth Prediction on Building Materials by Reaction-Diffusion Model Coupled with Heat and Moisture transfer

Kazuhide Ito(IGSES, Kyushu University, Japan)

Abstract

A mathematical model that reproduces fungal proliferation and morphological colony formation was developed on the basis of a reaction diffusion modeling approach. In this modeling, fungus was separated into two states, active and inactive, and it was assumed that active fungus moves by diffusion and reaction while generating and producing inactive fungus. The effects of temperature and humidity on fungal growth were explicitly incorporated in the reaction term of nutrient consumption/generation of active fungus in this governing equation. The damping function, which reproduces the effects of temperature and humidity on fungal growth, was developed and explicitly based on the fungal index proposed by Abe. In order to estimate the sensitivity of the proposed numerical fungal growth model, fungal growth on the surface of building materials was analyzed for four types of building materials, and the prediction results were compared with the results of WUFI-Bio.

Session 6A (October 27, 13:30~15:10)

Natural Ventilation 3

Venue TOPAZ (Renaissance Seoul Hotel 4F)
Chairs Ito Kazuhide, Jae-weon Jeong

6A-1

The influence of stochastic modeling of window actions on simulated summer comfort in office buildings

Wout PARYS(Division of Building Physics, K.U.Leuven, Belgium)
Dirk SAELENS(Division of Building Physics, K.U.Leuven, Belgium)
Hugo HENS(Division of Building Physics, K.U.Leuven, Belgium)

Abstract

In Belgium, which has a moderate, heating-based climate, small or medium sized office buildings are often not equipped with full room conditioning in individual office cells: no active cooling or only basic cooling of the ventilation air is available. Instead, thermal comfort in summer is to be achieved by using operable windows. However, in recent years, a trend exists towards constructing office buildings with decreasing heating energy demands, which can lead to difficulties maintaining a good thermal comfort in summer without active cooling.

In this research, the fa?de design (insulation level, glazing type, window-to-wall-ratio, shading system) and the level of internal gains of a typical office building are varied. Dynamic building simulation of all building variants allows identifying these designs that can achieve satisfying summer comfort, according to the adaptive comfort theory, through manual use of operable windows. Furthermore, the influence of window-

opening on the heating energy use can be assessed. The dynamic simulations are performed using TRNSYS, coupled to TRNFLOW, an air flow nodal network model. The occupant control of the windows is implemented using a state-of-the-art stochastic behavioral model. A real-time coupling between TRNSYS and the behavioral module in MATLAB allows taking into account the adaptive actions on windows by the users. The uncertainty of the results due to the variability in user behavior is estimated by performing the building simulation for different distributions of so-called 'passive' and'active' users of windows.

6A-2

Influence of natural ventilation usage on cooling energy consumption and cooling capacity of an air conditioner

Hiromi HABARA(Hiroshima Institute of Technology, Japan)
Shigeki NISHIZAWA(National Inst. of Land and Infrastructure Management, Ibaraki, Japan)
Hisashi MIURA(National Inst. of Land and Infrastructure Management, Ibaraki, Japan)
Akinori HOSOI(University of Kumamoto Prefecture, Japan)
Takao SAWACHI(Building Research Institute, Japan)

Abstract

In Japan, natural ventilation through large openings has been used for cooling in summer and medium season. However, air conditioner has become popular recently, because it is hot and humid in summer in most parts of Japan. It causes cooling energy consumption to rise continuously. Nowadays, as global warming has become a serious problem, natural ventilation has been considered as a key method for cooling energy conservation. However, there is insufficient knowledge of natural ventilation effectiveness on cooling energy conservation quantitatively. Therefore, in order to verify the effectiveness of natural ventilation through large openings, we have been conducting experiments by automatically simulating various occupants' behaviors, namely cooking, lighting, usage of electric appliances and domestic hot water, operation of air conditioners, windows and curtain opening/closing. In this paper, we have performed experiments with additional several patterns, which have different thermal conditions for on operation of air conditioners, to our previous paper. And based on the experimental results, we analyzed the heat discharge by natural ventilation and the cooling capacity of air conditioner. The result suggests that though natural ventilation sometimes brings the gain of sensible and latent heat, it is not so much as to increase the daily cooling capacity of air conditioner.

6A-3

Implementation of measurement and quality frameworks in the french regulation for achieving airtight envelopes

F.R. Carrié(Centre d'Etudes Techniques de l'Equipement de Lyon, France)
S. Charrier(Centre d'Etudes Techniques de l'Equipement de Lyon, France)
V. Leprince(Centre d'Etudes Techniques de l'Equipement de Lyon, France)

Abstract

It is foreseen that the 2012 version of the French regulation will include a minimum requirement for the envelope airtightness of residential buildings, with two options to justify its treatment: a) measurement at commissioning or b) adoption of an approved quality management approach. This paper describes the qualification process for authorizing technicians to conduct airtightness measurement when the result is to be used in the EP-calculation method. It also discusses the requirements set for approved quality management approaches. These processes have started in 2008 which allows us to analyze the impacts of the measures taken on the supporting staff and on the market. Our analyses underline the importance of the qualification process to ensure homogenous measurement practice between technicians. They also show the limits of the controls that can be implemented if the process is not appropriately sized to absorb a large number of applications. Regarding the approved quality management approaches, their impact is increasing rapidly with builders engaged in that process who produce hundreds to several thousands of homes a year. Other market players also explore this option, namely industries and contractors.

Session 6B (October 27, 13:30~15:10)

Envelope Air Tightness Case Study Building

Venue SAPPHIRE+RUBY (Renaissance Seoul Hotel 4F)
Chairs Yun Gyu Lee, Hyuenjoon Moon

6B-1

Ventilation and RH control in museum showcases

Marco PERINO(DENER, Politecnico di Torino - Italy)
Chiara BONVICINI(ONLECO S.r.l - Italy)

Abstract

Museum showcases represent a peculiar confined space were

ventilation and indoor climate conditions play an important role. Conservation of the works of arts, in fact, requires a control of the environmental parameters, with a tolerance usually far tighter than that required for assuring the comfort of people.

A number of laboratory measurements have been performed on small experimental showcases to analyze the influence of air tightness and gas permeability on the passive control of the RH inside the container (pressurization tests, tracer gas measurements and temperature/relative humidity response tests have been performed). Furthermore, real showcases, operating under actual museum conditions, have been studied by monitoring, for medium long time, indoor/outdoor environmental parameters.

In the paper the set-up of the laboratory experimental procedure and the measurement results are presented and critically analyzed. These laboratory experiences are then compared against field measurement results.

6B-2

Effective flow area estimation method using a gas

Koji Fujita(Kobe Univ, Japan)
Ken Iwamoto(Kobe Univ, Japan)
Takayuki Matsushita(Kobe Univ, Japan)

Abstract

The objective of this paper is to present a new method for estimating effective flow areas not only in the external wall of a house but also in the internal walls between rooms using only one type of tracer gas. The discharge coefficient of each wall and the pressure in each room—which are unknown variables—are determined using nonlinear simultaneous equations, which consist of balance equations for the air mass and tracer-gas concentration in the rooms. To verify the validity of this method, we performed a numerical experiment. We defined the values of the discharge coefficient of each wall, and then simulated changes in the temperature and tracer-gas concentration. We then estimated the discharge coefficient of each wall from the simulated temperature and concentration values using the method. Because it was confirmed that the estimated values were equivalent to the defined values, the validity of this method was verified.

6B-3

Development of Infiltration Modeling Parameters for a SIPs Building

Erwin Roijen(Cauberg-Huygen Consulting Engineers, the Netherlands)
Peter Op 't Veld(Cauberg-Huygen Consulting Engineers, the Netherlands)
Ad van der Aa(Cauberg-Huygen Consulting Engineers, the Netherlands)

Abstract

Reduction of infiltration in the Equinox House, a residence under construction in Urbana Illinois, has been characterized through a series of blower tests as different joints and seams in the building were sealed. Equinox House is constructed with 30 cm thick SIPs (Structural Insulation Panels) wall and roof panels consisting of a Styrofoam core and oriented strand board sheathing on interior and exterior surfaces. Blower door tests were performed as each type of seam in the house was sealed. Wall to foundation connections, wall to roof connections, panel to panel connections, and miscellaneous gaps were examined. The effect of adding wall surfaces (drywall) to the building are also presented. The results show strong correlations between level of infiltration and the amount of labor and the amount of sealant used to lower the infiltration. The house infiltration was reduced to 0.37 ACH at 50 Pa. The correlation parameters, while specific to this type of construction, demonstrate how costs related to infiltration reduction can be formulated and utilized for optimal building design analyses.

6B-4

Analysis on CO2 Emissions Reduction Effect of Zero Energy Multi-famiy Housing to cope with UNFCCC

Yong-Sang Yoon(Korea Institute of Construction Technology)
Sun-Hye Mun(Korea Institute of Construction Technology)

Abstract

Korean government established a target to reduce greenhouse gas ("GHG") emissions to 30% by 2020 to cope with the United Nations Framework Convention on Climate Change (UNFCCC) and secure its national competitiveness, and prepared a roadmap to develop this project. Especially, the government set up the objective of Zero Energy Consumption for the newly constructed multi-family housings by 2025 to reduce CO2 in the building sector.

This Study is aimed at the analysis of CO2 emissions reduction effect when introducing the component technology for implementing zero-energy multi-family housing building by reflecting this trend at home and abroad. In order to do this, CE3

- Building Energy Performance Evaluation Program was adopted.

Session 7A (October 27, 15:50~17:30)

Natural Ventilation 4

Venue TOPAZ (Renaissance Seoul Hotel 4F)
Chairs Shen Henggen, Myungsouk Yeo

7A-1

Field Measurement and Numerical Simulation for a Naturally Ventilated Building by Coupling Multi-zone Model with CFD

Gang Tan(University of Wyoming, USA)
Christine Walker(Massachusetts Institute of Technology, USA)
Leon R. Glicksman(Massachusetts Institute of Technology, USA)

Abstract

Large openings and open spaces are usually constructed in naturally ventilated buildings in order to reduce air flow resistance. Because of the well-mixed and uniform distribution assumptions in multi-zone model, re-circulating airflows at large openings or within open spaces may not be accurately predicted. This paper couples multi-zone model with CFD simulation to improve simulation of indoor airflow's circulations in a naturally ventilated building. Field measurement to this naturally ventilated building, including ventilation rates and CO2 concentration, is presented. A simplified multi-zone model program for natural ventilation is used to calculate whole-building's ventilation performance. Results from multi-zone model's calculation are compared against the measurements. With the external coupling method, a detailed CFD model for a large open-space has been developed by implementing velocity boundaries from multi-zone model results. The detailed CFD simulation visibly explains the specific circulation airflow patterns observed during the field measurement.

7A-2

Velocity Measurement Inside and Outside a Cross-Ventilated Building by Means of PIV

Hisashi KOTANI(Osaka University, Japan)
Tomohiro KOBAYASHI(Ritsumeikan University, Japan)
Kaori ASAI(The University of Tokyo, Japan)
Yasue TANAKA(Kanomax Japan, Japan)
Yasuhiro SHIOZAKI(Kanomax Japan, Japan)

Abstract

Cross-ventilation is regarded to be beneficial control method to obtain thermal comfort in a hot summer without using mechanical devices. Since it is complicated flow phenomenon, details of flow characteristics have not been sufficiently known. The final goal of this work is to establish a new prediction method of flow rate based on energy balance within the stream tube passing through or around the building. To validate numerical results obtained by CFD, they need to be compared with experimental results. This paper presents wind tunnel measurement of flow characteristics inside and outside a cross-ventilated model. Velocity and pressure were measured along the central line of the stream tube for internal flow, and velocity distribution of the external flow was measured by Particle Image Velocimetry (PIV).

7A-3

Building simulation on utilization of roof window in detached house by using cross-ventilation

Masaaki OHBA(Tokyo Polytechnic University, JAPAN)
Kenji TSUKAMOTO
Takashi KURABUCHI(Tokyo University of Science, Japan)
Toshihiro NONAKA(Tostem Corporation, Japan)

Abstract

The effects of roof window on ventilation flow rates and reduction of cooling loads in densely populated areas were investigated by using building simulations. In May of the intermediate season, when utilizing roof window, the cumulative number of air exchanges increased by 9 % to 12 % compared to that when the windows at side walls remained open only during the daytime. When the building coverage ratio increased from 0 % to 20 %, the cumulative number of air exchanges decreased and the cumulative cooling loads increased. However, when the building coverage ratio increased from 20 % to 40 %, the cumulative number of air exchanges and cooling loads remained almost the same.

7A-4

The climatic potential for a double skin facade integrated with cross ventilation

Won-Jun Choi(University of Seoul, Korea)
Jae-Wan Joe(University of Seoul, Korea)
Jung-Ho Huh(Professor, University of Seoul, Korea)

Abstract

When it comes to natural ventilation performance for large space cooling during summer time or intermediate seasons, double skin facade(DSF) integrated with cross ventilation(CV) exhibits more energy efficiency than single-side ventilated DSF. In this case, ventilation performance is remarkably affected by climatic conditions. Therefore, it is important to analyze micro climatic conditions before applying this passive technique.

To date, many studies have been done regarding DSF, however, there are very few studies pertaining to feasibility have existed in Korea. In this paper, a case study of four models with weather data of Seoul was conducted based on the following criteria: existence of DSF, opening/closing modes of the DSF openings, and ventilation types. The results showed that the annual cooling load of the cross-ventilated DSF was less than that of the single-side ventilated DSF by 7.9%, and the ACH of the cross-ventilated DSF was 1.2~6.2 times more than that of the single-side ventilated DSF.

Session 7B (October 27, 15:50~17:30)

Others

Venue SAPPHIRE+RUBY (Renaissance Seoul Hotel 4F)
Chairs Sun Sook Kim, Jaedong Chang

7B-1

Robustness and True Performance of Demand Controlled Ventilation in Educational Buildings – Review and Needs for Future Development

Mads Mysen(Oslo University College, NORWAY / SINTEF Forskningsveien 3b, NORWAY)
Peter Schild(SINTEF Forskningsveien 3b, NORWAY)
Finn Drangsholt(Oslo University College, NORWAY)

Abstract

Although theoretical studies show that energy use for ventilation purposes can be reduced by more than 50% with DCV compared to CAV, evaluation of real energy use demonstrates that this potential is seldom met. DCV-based ventilation systems must become more reliable to close the gap between theoretical and real energy-performance. This unfortunate experience with DCV seems to have many causes, including: unclear placement of system responsibility, inadequate specifications and hand-over documentation, balancing report not suitable for DCV, communication errors and lack of knowledge about DCV-systems among decision makers, designers and operators etc. Identified key factors for improvement so far are adequate specifications, hand-over documentation and balancing report for DCV and a clearly defined and placed responsibility for the overall functionality. This paper presents a recently started project that will last until 2013 and aims to develop and disseminate knowledge on systems with improved robustness.

7B-2

Energy Requirements of a Multi-Sensor Based Demand Control Ventilation System In Residential Buildings

Nam Chul Seong(Kyoungwon University, Seoul, Korea)
Sung Min Hong(Kyoungwon University, Seoul, Korea)
Dong Won Yoon(Kyoungwon University, Seoul, Korea)

Abstract

In Korea, in 2006, the building regulation was revised to apply 0.7 ACH (Air Change Rate) ventilation systems to improve indoor air quality in residential apartment housing. The purpose of this study is to evaluate energy requirement and indoor contaminant level characteristics for residential building applying with sensor-based DCV (Demand Control Ventilation) system. It has been simulated both in a setting of the constant volume of 0.7 ACH intakes as recommended by the Korean Indoor Air Act and in a sensor-based DCV system controlled with CO2 and chemical material such as TVOC (Total Volatile Organic Compound).

Our study demonstrates that the DCV system is energy efficient and maintains better indoor air quality because the indoor contamination level is reduced by controlling the outdoor air intakes. DCV system consists of a hardware module of sensor units and a control algorithm that implements several integrated ventilation strategies to meet the ventilation requirements.

In this study, the energy requirements have been evaluated with two ventilation control strategies; one for the conventional ventilation type and the other for a sensor-based DCV system. DCV is a real time, occupancy and contamination level based ventilation approach that can lead to significant energy saving over the traditional fixed OA (Outdoor Air) intake ventilation system. Our approach enables the incorporated system to maintain proper IAQ (Indoor Air Quality) at all times in a space where adequately ventilated to reduce the indoor pollutant level and thus improves the air quality in an indoor environment.

7B-3

Experimental Evaluation of the Moisture Buffering Effect of Hygrothermal Material

Hiroaki SUZUKI(Tohoku University, Japan)
Hiroshi YOSHINO(Tohoku University, Japan)
Kenichi HASEGAWA(Akita Prefectural University, Japan)
Huibo ZHANG(Tohoku University, Japan)
Ayaka IWATA(Akita Prefectural University, Japan)

Abstract

Residential buildings newly constructed in Japan are well insulated and airtight for energy conservation. However, the indoor environment of these houses can suffer from high humidity in the summer and low humidity in the winter. In order to mitigate this problem, hygrothermal materials are installed in some Japanese houses. The test method for small samples of hygrothermal material is prescribed in the Japanese Industrial Standards (JIS). However, the moisture buffering effect of the hygrothermal materials adopted in actual houses is unclear. The purpose of this study was to clarify the effect of hygrothermal material on indoor moisture control. A series of experiments was carried out in two identical rooms. In the room installed with hygrothermal material, variations in relative humidity were controlled and compared with the room without hygrothermal material. This material demonstrated good performance for moisture buffering effect in an actual-scale room.

7B-4

Air Curtain: Bridge between Entrainment Flow and Displacement Flow

Angui LI(Xi'an University of Architecture & Technology, China)
Haiguo YIN(Xi'an University of Architecture & Technology, China)
Wangda ZHANG(China Jingye Engineering Corporation Limited, Beijing, China)

Abstract

The air distribution characteristics formed by air curtain jet is investigated in detail. The CFD results and airflow visualization of the characteristics of air curtain jet are reported in this paper. An experimental study has been carried out to understand the properties of the air curtain jets. The air lake created by air curtain jets resembles displaced air movement in some extent. Air Curtain, is regarded as a bridge between entrainment flow and displacement flow. In fact, it is a hybrid method of entrainment flow and displacement flow. The Coanda effect of air curtain jets is also investigated. The predicted air temperature, velocity and concentration field characteristics of air curtain jets are presented, respectively. Additionally, the airflow visualization of air curtain jets and Air Lake spreading over the floor in a room are demonstrated

Session 8A (October 28, 09:40~10:55)

Post Occupancy Evaluation and Surveys in Building Ventilation

Venue TOPAZ (Renaissance Seoul Hotel 4F)
Chairs Wouter Peter, SeungMin Lee

8A-1

Potential of the Solar Thermal Desiccant Cooling in Asia-Pacific Region

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K. MIZUTANI(Environment Group, Wind Engineering Research Center, Tokyo Polytechnic University)
H. YOSHINO(Laboratory for Building Environmental Engineering, Tohoku University)
R. YOSHIE(Environment Group, Wind Engineering Research Center, Tokyo Polytechnic University)
A. MOCHIDA(Laboratory for Building Environmental Engineering, Tohoku University)

Abstract

The solar thermal desiccant cooling system was numerically investigated for application in the Asia-Pacific Region (East Asia and South East Asia). The system was modeled in transient system simulation (TRNSYS) program and applied in a hypothetical office building. The typical meteorological year (TMY) was used as the basis for the climatic conditions. The system was applied in the region's sixteen major cities covering the temperate, sub-temperate/sub-tropical and tropical climates. The results showed the required flat plate collector area was bigger in the tropical climate compared to temperate climate. The needed air flow rate was higher in tropical climate compared to temperate climate. However, in general, it was shown the potential and applicability of the solar thermal desiccant cooling system in the Asia- Pacific Region.

8A-2

Dynamic Insulation System applied to Window Frames (Part 1) Evaluation of the thermal insulation efficiency of the proposed window frames

Sihwan Lee(The University of Tokyo, Japan)
Miho Tanaka(The University of Tokyo, Japan)
Shinsuke Kato(Professor, The University of Tokyo, Japan)

Abstract

In order to insulate buildings more efficiently, many insulation methods have been proposed and successfully applied to the building envelope, including areas such as walls and windows. However, it is also important to insulate window frames efficiently because they usually contribute the greatest heat loss. The authors propose a new dynamic insulation system for window frames, with an active ventilation function and a heat pump for heat recovery. This system is composed of three parts: window frames that use a porous material for dynamic insulation, a mechanical ventilation system, and a heat-recovery heat pump system. This paper describes a computational simulation study of the technical feasibility and the thermal insulation efficiency of the porous material in the proposed system. First, a window frame was designed containing a porous material such as a packed bed of particles (i.e. glass wool, mineral wool, aluminum particles, etc.). Then, to verify its thermal insulation efficiency, the temperature contribution of the window frame was evaluated using computer fluid dynamics with different coupled conditions, such as the indoor/outdoor pressure difference. In addition, to verify the effect of moisture condensation, the relative humidity in the porous material was calculated based on conditions such as the outdoor air temperature, humidity ratio, indoor/outdoor pressure difference, and porosity of the insulation material. The calculated results show the thermal load was inversely proportional to the indoor/outdoor pressure difference. Moisture condensation in the insulation material depends on the outdoor temperature, humidity ratio, and porosity.

8A-3

Dynamic Insulation System applied to Window Frames (Part 2) Energy saving effects of the proposed system in residential buildings

Miho Tanaka(The University of Tokyo, Japan)
Sihwan Lee(The University of Tokyo, Japan)
Shinsuke Kato(Professor, The University of Tokyo, Japan)

Abstract

This paper describes the energy-saving effects of the proposed system with an active ventilation function and a heat pump for heat recovery. First, the temperature of the air supplied through the porous material versus the outdoor temperature was calculated using computational fluid dynamics to set the boundary conditions for the energy simulation. Then, the cooling/heating loads of a typical residential building in Japan were calculated and comparisons were made with and without the proposed system installed. In addition, in order to evaluate the energy-saving rate under different climatic conditions, the annual air-conditioning loads in several areas (Tokyo and Sapporo in Japan, and Seoul in the northwest of South Korea) were calculated. As expected, dynamic insulation applied to window frames was effective from the point of view of its insulation efficiency. The calculated results indicate that residential buildings making use of the proposed system could achieve energy savings of 14~34%. Especially it is more effective when the outdoor temperature is low in winter. In summer, the energy saving potential depends on the performance of an installed heat pump. A comparison of different climatic conditions showed that the energy-saving rate was especially high in areas with a large annual temperature difference between the indoor and outdoor environment.

Session 8B (October 28, 09:40~10:55)

Sustainable Technologies for Building Ventilation

Venue SAPPHIRE+RUBY (Renaissance Seoul Hotel 4F)
Chairs Schild Peter, Lee Keon Ho

8B-1

Natural Ventilation in Thai Hospitals: A Field Study

Vorapat INKAROJRIT(Chulalongkorn University, Thailand)

Abstract

Natural ventilation has been appraised as the main strategy in environmental control of airborne infection in resource-limited healthcare facilities. While natural ventilation offers a low-cost alternative in diluting and removing contaminated air, its' performance in actual settings is not fully understood. This paper reports a cross-sectional field study of six hospitals in Thailand with an emphasis on ventilation performance of naturally-ventilated hospital wards and AII rooms. The results showed that ventilation rates of 3-26 ACH could be achieved in hospital wards. Higher ventilation rates of 16-218 ACH were found in AII rooms. Our measurements also showed that a few locations within hospital wards had little or no air movement due to existing hospital ward designs. This study concludes that natural ventilation is suitable for resource-limited hospitals in tropical climates when windows are opened and exhaust

fans are installed. Design guidelines that promote natural ventilation were discussed.

8B-2

Study on Optimum Air-Conditioning Control System for Energy Conservation Field Assessment of the Thermal Comfort of Occupants in Office

Ryushi KIMURA(Sendai National College of Technology, Japan)
Yasuo UTSUMI(Sendai National College of Technology, Japan)
Kazuyuki KAMIMURA(Asia Nature Symbiosis Study Group, Japan)
Syuzo KISHIMA(Asia Nature Symbiosis Study Group, Japan)
Tsuyoshi FUJITA(Asia Nature Symbiosis Study Group, Japan)
Hideaki NAKANE(Asia Nature Symbiosis Study Group, Japan)

Abstract

One of the most effective methods to reduce energy consumption in buildings is to install the advanced HVAC equipments and to control them properly, and it must consider the influence of thermal property of the building envelope, occupants' schedule, heat generation from the OA apparatus, etc.

To achieve the target, it may be pursued by the embedded system, BACFlex, including BEMS, predictive simulation and related control systems, as often mentioned in the future of the building simulation. Also the monitoring, the simulation and the measurement in terms of cost, CO2 emission, PMV, etc, are important to show the result to the users in order to feedback from their opinions to improve the system performance.

The surveys such as questionnaire, monitoring and interviewing concerning to thermal comfort, clothing, etc. were carried out with occupants in office under optimum air-conditioning control by BACFlex system in summer period.

The PMV was calculated based on the measurement data to compare the optimum clo value between the measurement and simulation.

The major results of survey were bellow;

- When the indoor temperature was over 27 degree, there were some complaints about discomfort from occupants with heavy clothing.
- The occupants can work comfortably under the condition of indoor temperature 26 degree and 0.5 clo by the simulation result.

As the outlook of the study, the viewer as the interface that considers the opinion of occupants is necessary to indicate what the optimum clothing, to moderate thermal discomfort and to conserve energy as the result.

8B-3

Measurement of temperature distribution and CO2 concentration in a space-heated classroom

Shuzhao Liu(Tohoku University, Japan)
Hiroshi Yoshino(Tohoku University, Japan)
Akashi Mochida(Tohoku University, Japan)

Abstract

The winter thermal environment and indoor air quality in classrooms has been reported to be very poor in Japan. In this study, an air-conditioned, mechanically ventilated classroom was surveyed. Air temperature, globe temperature and the concentration of CO2 were monitored before, during and after the three-hour occupancy by 35 adults. Airtightness and airflow rates of the ventilation system were also measured. With the outdoor air of about 0°C and the thermostat temperature setting of 30°C, the vertical difference in air temperature exceeded 10°C, while the horizontal difference was under 2.5°C. After half an hour of occupancy, CO2 concentration exceeded 1500 ppm in the respiration zone, and it reached 2500 ppm from the respiration zone to the middle of the room height for a consecutive 1.5-hour. The concentration decay showed that the air change rate was 0.82 ach. It was far from the national criterion of 2.2 ach.

A Air Distribution

A-1

EXHAUST EFFECTIVENESS BASED ON RESIDUAL LIFETIME OF CONTAMINANT IN A VENTILATED SPACE

Hwataik Han(Kookmin University, Seoul, Korea)
Kyung-Jin Jang(Samgong Ltd., Gyeonggi-do Korea)
Si-Hyung Lim(Kookmin University, Seoul, Korea)
Jungkyung Kim(Kookmin University, Seoul, Korea)

Abstract

Exhaust effectiveness indicates how effectively contaminated air can be removed from a space, whereas air change effectiveness indicates how effectively distribute fresh air into the space. It is intended to describe the exhaust effectiveness based on the residual-life-time of contaminant in the context of logical extension of supply effectiveness based on LMA. It is proved theoretically that the room-mean values of LMA and LMR are identical, even though their local distributions are different from each other depending on inlet/outlet configurations.

It is necessary to define ventilation effectiveness clearly so as to distinguish supply and exhaust effectiveness in describing local distributions in a room. Overall ventilation effectiveness, however, need not be distinguished, since both of the room averages of supply and exhaust indices are identical. They are dependent on the airflow pattern only, but not on the contaminant distribution in the space.

A-2

Improvement of Temperatures Stratification caused by Air-conditioner by means of Ceiling Fan in Classroom

Natsuka Wakamatsu(Osaka University, Japan)
Yoshihisa Momoi(Osaka University, Japan)
Toshio Yamanaka(Osaka University, Japan)
Kazunobu Sagara(Osaka University, Japan)
Hisashi Kotani(Osaka University, Japan)

Abstract

This paper discusses on the indoor thermal environment controlled by the air-conditioners and the ceiling fans under the heating condition. An experiment which measured the temperature and the indoor wind velocity was conducted in the classroom with the ceiling fans. The preset temperature was 24oC, and the airflow direction of the ceiling fans was upward. The rotational speed of the ceiling fans were changed (90-300rpm). Questionnaires to the occupants were also conducted to figure out the problem when the ceiling fans were used in the classroom. As a result, followings are shown: (1) It is confirmed that the ceiling fan is beneficial to moderate the vertical temperature difference. (2) If several ceiling fans are installed symmetrically in the classroom, there might be an increase in air velocity at the center of the classroom. (3) When the rotational speed of the ceiling fan is ordinary, noisiness does not matter.

B Health Indoor Air Quality and Productivity

B-1

Experimental Assessment of Humidity Controlling the Performances of Moisture Adsorbing/Desorbing Building Materials

Hea-Jeong Kim(Hanyang University, Korea / Korea Institute of Construction Technology, Korea)
Yun-Gyu Lee(Korea Institute of Construction Technology, Korea)
Kyoo-Dong Song(Hanyang University, KOREA)

Abstract

The climate of South Korea is that of high temperatures and high humidity in the summer season and low temperatures and low humidity in the winter. Humidifiers and dehumidifiers are used to create a cool indoor environment, and the demand for building materials with moisture adsorption/desorption functions is increasing. To investigate the performance of moisture adsorption/desorption new mineral fiber boards, a chamber test and mock-up test were performed and compared to mineral fiber boards. As a result of the chamber test and mock-up test, the new mineral fiber board showed the effect of maintaining indoor humidity regularly through humidity adsorption/desorption by the chamber test and mock-up test.

B-2

Characteristics on indoor air pollutant emission from wood-based flooring by environmental-friendly natural adhesive using CNSL

Jeong-Hun Lee(Soongsil University, Korea)
Sumin Kim(Soongsil University, Korea)

Abstract

To discuss the reduction of formaldehyde and volatile organic compound (VOC) emissions from engineered flooring, cashew nut shell liquid (CNSL)-formaldehyde (CF) resin and CF/PVAc resin were applied for the maple face of the veneer bonding on plywood. The CF resin was used to replace urea-formaldehyde (UF) resin in the formaldehyde-based resin system in order to reduce formaldehyde and VOC emissions from the adhesives used between the plywoods and fancy veneers. For the CF/PVAc resins, 5, 10, 20 or 30% of PVAc was added to the CF resin. The CF/PVAc resins showed better bonding than the commercial natural tannin adhesive with a higher level of wood penetration. The standard formaldehyde emission test and a VOC analyzer were used to determine the formaldehyde and VOC emissions, respectively, from the engineered floorings. The CF resin and CF/PVAc resin systems with UV coating satisfied the E1 and E0 grades of the Korean Standard. TVOC emission was slightly increased by the PVAc addition.

B-3

Environment-friendly Hwangtoh composites using water soluble resin for interior materials

Jisoo Jeon(Soongsil University, Korea)
Sumin Kim(Soongsil University, Korea)

Abstract

The objective of this research was to develop environment-friendly Hwangtoh binder for application of Hwangtoh for interior wall finishing materials in the housing. To mix with Hwangtoh powder, water soluble MPU resin with EVA, PVA, CaCO3 and inorganic fillers were designed. Far infrared ray irradiation, TVOC emission behavior, surface bonding strength and surface crack behavior were studied by comparing to epoxy/Hwangtoh blend as control. To utilize the advantage of Hwangtoh such as high absorbency, self-purification, deodorizing, sanitizing properties and radiation of far infrared rays in the filed of modern housing, this study was the foundation to develop environment-friendly binder for Hwangtoh.

B-4

Adaptation process of human olfactory under continues exposure to odor of ethyl acetate based on subjective estimation of odor intensity

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Abstract

This study was aimed at making a model which predicted olfactory sensation. Firstly, it was conducted the experiment, which odor was exposed to subjects constantly and subjects evaluated odor, to investigate the olfactory adaptation process. As a result, it was turned out odor intensity decreasing exponentially as time. Secondly, validity of the previous theoretical model (Osako,1991) was investigated by comparing the evaluation. As a result, it was found out that the validity of the previous model might be better in the case discriminating the adapting intensity from the after adapted.

C Natural Ventilation

C-1

Experimental Investigation and Accuracy Study of CFD Analysis for Airflow around Cross-Ventilated Building

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Abstract

In predicting flow rate of a building ventilated by wind, the orifice equation is usually used. This conventional method cannot work for the building provided with large openings. Therefore, the final goal of this study is to establish a new prediction method of the cross-ventilation rate, which is based on energy balance inside the stream tubes passing through/around a building. In determining stream tubes, it is beneficial to use CFD. In this study, the accuracy of CFD analysis is studied. Three turbulence models are used in the simulation; i.e. Standard k-e Model Reynolds Stress Model, and Large Eddy Simulation. As a result, we can state the accuracy of Large Eddy Simulation is better than other CFD models.

C-2

Thermal Environment Generated by Occupant's Opening Control of Window at Naturally Ventilated Building

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Abstract

A field survey in a natural ventilated school building was carried out. The purpose of this study is to figure out the occupant's evaluation of thermal comfort as the result of opening control, which seems to be affected by the outdoor and indoor air condition.

Occupant's active use of natural ventilation system instead of air conditioner is a key to the performance for energy saving of building. The analysis of the data shows that windows were more actively controlled as occupant's knowledge about natural ventilation system increased. The result of this study suggests that understanding about the system leads more active control of window and less use of air conditioner, which play a grate role in saving energy.

C-3

Passive Evaporative Cooling System With a Wet Textile Mesh

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Abstract

Mechanical refrigeration systems demand during the summer season consumes large amounts of energy that could be reduced using evaporative cooling passive systems on medium and low humidity climates.

The present paper presents a system developed by ABIO research group, Polytechnic University of Madrid. First it was necessary to make a climatic characteristics study and to find the possible applications of direct and indirect evaporative cooling to the Spanish country. Because of that, it was possible to catalogue the Spanish regions efficiency of evaporative cooling percentages. Secondly it was designed an industrialized direct and passive facade gaps evaporative cooling system. This system consists of a mobile vertical panel that works like insects filter. It is made of glass fiber that drain recirculated water through a system bomb and a small deposit. In this way it minimizes the cost of water and it reduces the cost of the system. Outside air crosses this filter by ventilation natural or forced from the dry rooms to the wet rooms and it damp load moisture from the screen reaching the wet bulb temperature and approaching the internal stay comfort status.

This system is an efficient, cheap and attractive method to complex installations cooling and mechanical solutions. It is also a solution to architectural retrofitting because of constructive simplicity and its dimensional flexibility.

C-4

Modular and technical wall for bathrooms

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Abstract

The technical wall for bathrooms it's a module that optimizes instalations in housing. It provides natural lighting, greywater treatment for reuse in wc flushing and an energy recovery ventilation system associated to mechanical ventilation.

The system has been designed to develop a compact and industrialized module, increasing util area in the bathrooms and providing an optimal organization of the ventilation, natural lighting, plumbing and grey water treatment instalations. The incorporation of the enthalpic recuperation system in the roof, improves its benefits and optimize the energy efficiency of the

building.

The spanish housing legislation regulates all housing projects to ventilate by mechanical or hybrid systems, exterior airflows are captured and interior vicious airflows are extracted from wet rooms like bathrooms.

The integration of the energy recovery ventilator besides letting us follow the Spanish housing legislation (CTE, Codigo Tecnico de Edificacion) for higienic ventilation it saves energy. During winter the outlet flow pretreatment reduce the thermal sensible and latent loads therefore, the demanded loads required are reduced. On summer conditions the heat exchange between the exterior and interior flows reduces the required demand of cooling loads.

The integration of all systems on one technical, industrialized and compact wall represents an environmental benefit by reducing the consumption of water, electrical energy for lighting and prime energy for cooling and heating.

C-5

Study of cross- ventilated indoor air flow characteristics by frequency analysis

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Abstract

In Japan where is located at the hot humid climate region, houses have been built considered hot summer life from ancient times. It is said that comfortable and cool feelings by cross-ventilation were more important. However, the characteristics of cross-ventilated air flow are unclear, and that it has yet to be revealed how they affect the psychological and physiological factors that influence comfortable feeling. So, in this study, time-series data of cross-ventilated indoor air flow velocity were measured by field measurement at the actual detached house in Japan. Various turbulence statics of cross-ventilated indoor air flow were investigated by with frequency analysis (FFT). As a result, they were observed that wind velocity, eddy size and power spectrum configuration are different in and out of the cross-ventilated air flow pathway.

C-6

The effect of ventilation rates and window areas on building energy use

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Abstract

Natural ventilation is an effective method for energy conservation while potentially improving indoor air quality. Furthermore, a window has a significant impact on energy consumption. The purpose of this study is to reduce building energy use by changing ventilation rates and window areas. We analyzed the energy consumption and CO2 emissions according to ventilation rates and window areas through using a computer program, HEED 3.0. The reference model had two windows of 1.2m×1.5m, and assumed there was no ventilation except for the minimum ventilation rate of 0.35 ACH. In order to determine the combined effects of changes in ventilation rates and window areas, three ventilation rates; 1.0 ACH, 5.0 ACH, 20.0 ACH, and three window areas were studied. The findings were as follows: annual energy consumption was reduced by 10.6%, CO2 emissions by 16.7% compared with the reference model by changing ventilation rates and window areas.

C-7

Performances of new innovative domestic ventilation systems in combination with low temperature floor heating

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Abstract

In extended laboratory measurements, the combination of new innovative domestic ventilation systems with low temperature heating is investigated, using the advanced EnoTemp measurement equipment. These measurements took place in the framework of a large Dutch demonstration project for these innovative domestic ventilation systems. The main conclusion of the laboratory measurements is that self-regulating façade grilles form a good combination with low temperature heating in terms of thermal comfort. The air flow is regulated in such a way that moderate air velocities in the living zone are created with substantial lower air velocities in comparison with conventional grilles.

D Mechanical Ventilation

D-1

Prediction of Plume above Residential Cooking Range by means of CFD analysis

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Abstract

Recently, Island kitchen is installed in many houses in Japan. In the island kitchen, the cooking range is placed on the island unit, and the center hood is located above the cooking flow in the room. In such a kitchen environment, there is a possibility that cross winds or other disturbing flow may reach the cooking zone. For this reason, pollutant fumes from the cooking range may be diffused to residential zone. CFD analysis is an effective measure for comprehending such a diffusion of the thermal plume. In comprehending the diffusion of the thermal plume above the cooking range by CFD analysis, a variety of plume models are proposed as boundary conditions. In this study, “Pot-side wall jet model” is proposed. The velocity and temperature around the pot side are measured, and the profiles are regressed to formula of two-dimensional jet flow. This means that the thermal plume with high temperature from the gas cooking range is modeled. This paper aims to demonstrate the usefulness of Pot-side wall jet model in analyzing the thermal plume in the large laboratory where a gas cooking range with a pot is only installed. In this paper, the results of CFD analysis are compared with the experimental results.

D-2

Influence of Partition Curtain on Vertical Profile of Temperature and Contaminant Concentration in Sickroom with Displacement Ventilation

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Abstract

For patients, the sickroom is a place where they receive medical treatment and also a living space where they spend most of time in a day. Therefore, good indoor air quality and comfort should be kept in sickroom.

We propose to use the displacement ventilation as a means of obtaining high indoor air quality in sickrooms. The purpose of the study is to examine the validity of this system. This paper shows the experiment results and CFD analysis results to examine the effect of partition curtain in the displacement-ventilated room.

D-3

CFD Analysis on Capture Efficiency in Commercial Kitchen using Low Radiative Cooking Equipment with Concentrated Exhaust Chimney

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Abstract

In a commercial kitchen, a large ventilation rate is needed and energy consumption can be large because a large amount of effluence of heat and moisture need to be removed. To improve kitchen environment and to save the energy, low radiative cooking equipment with concentrated exhaust chimney was developed. Although a ventilation rate may be decreased by using this equipment, the effluence needs to be captured well. To predict indoor air and thermal environment of commercial kitchen using this equipment, CFD analysis is useful. In the previous study, the capture efficiency of the hood was measured when this new equipment is used. In this paper, CFD simulation was carried out in order to analyze capture efficiency of the equipment with reproducing the measurement. CFD results of various conditions were compared with measured ones. CFD results were agreed well with measured ones for many cases.

E Hybrid Ventilation

E-1

A Proposal of Hybrid Ventilation System Using Stack Effect in High-rise Buildings

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Abstract

Recently with rising demands for environmentally friendly building and indoor air quality, the hybrid ventilation that combines natural and mechanical ventilation has been noticed both home and abroad. Hybrid ventilation can overcome the troubles of conventional ventilation systems and guarantee proper ventilation rate in each target space while reducing energy consumption for ventilation. In this respect, hybrid ventilation is being actively applied and researched.

Meanwhile, as building height increases, the stack effect has become a remarkable and greatly influence the ventilation performance of each floor. However, stack effect is generally not considered during the design phase of ventilation systems.

Also, many troubles of mechanical ventilation system caused by stack effect are being reported.

This study proposes the hybrid ventilation system using stack effect as a driving force in high-rise residential buildings. In this paper, the air flow characteristics caused by stack effect in high-rise building will be analyzed by simulation. And the hybrid ventilation system configuration will be suggested. The suggested hybrid ventilation system performance will be analyzed by simulation.

F HVAC System

F-1

Simple error reduction in tracer-gas field-measurements of air handling units

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Abstract

Tracer gas measurements are an unparalleled means of measuring air recirculation, leakage, and air flow rates in air handling systems [1-5]. However, such measurements are subject to significant measurement uncertainty in field conditions. A common problem is imperfect mixing of tracer gas.

One method of error minimization is to use a constrained regression model based upon mass conservation equations. This technique is widely used in multizone tracer gas studies. The method reported in this paper uses robust regression (least trimmed weighted squares) to solve the mass flow rates in air handling units (AHU) for balanced ventilation, including any recirculation/leakage in the AHU, external short-circuiting, and ex-/infiltration caused by imbalance. The method is simple enough to implement in spreadsheet software, and works even when measurement data from one or more of the sampling points, or one of the two dosing points, has to be rejected as erroneous.

F-2

Investigation of the Usage of Ground Source Heat Pump System on Wall Heating

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• H. Karakoc(Anadolu University, Turkey)

Abstract

Wall heating systems are more preferable heating systems than other conventional systems due to their low temperature operating ranges. These systems are equipped with heating serpentines or panels where the water is circulated and the serpentines are mounted on the walls of rooms. Ground source heat pump systems are todays one of the useful renewable energy based heating systems.

In this study, daily analysis of a wall heating (radiant heating) system fed by a vertical type ground-coupled heat pump system is investigated and parameters of the system in a month (Feb. 2010) are recorded in 1 second intervals. As a result, temperatures of the wall heating system are investigated with inlet and outlet temperatures of the heat pump system. The mean heat transfer rate to the TEST room is found 1.017kW where 4.28 kW is the inlet energy rate and 3.26 kW is the outlet energy rate.

F-3

Thermostat/Hygrometer vs ANN-Based Predictive/ Adaptive Environmental Control Strategies

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Jae D. Chang(University of Kansas, USA)

Abstract

This study tested the feasibility of employing artificial neural network (ANN)-based predictive and adaptive control logics to improve thermal comfort and energy efficiency through a decrease in over- and under-shooting of control variables. Three control logics were developed: (1) conventional temperature/ humidity control logic, (2) ANN-based temperature/humidity control logic, and (3) ANN-based Predicted Mean Vote (PMV) control logic. Analysis of the thermal chamber tests revealed that the ANN-based predictive temperature/humidity control logic provided greater periods of thermal comfort than that of the conventional logic by 0.3 to 5.1 percentage points for air temperature and 0.2 percentage point for humidity as well as a reduction in over-shoots and under-shoots. In addition, the ANN-based PMV control logic provided significantly better PMV conditions than both temperature and humidity based control logics. In most cases, ANN-based controls demonstrated a reduction in electricity consumption by 11.3% to 14.0% compared to non-ANN-based control logics, resulting in reduced fan usage and air circulation.

F-4

A Study on the Hybrid Air-conditioning system Coupled with Radiant Floor Cooling and Ventilation System

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Joo Wook Kim(Sungkyunkwan University, Korea)
Doosam Song(Sungkyunkwan University, Korea)

Abstract

As an energy saving strategy, in this study, the Hybrid Air-conditioning system will be proposed. This system consists of radiant floor cooling and hybrid ventilation system with dehumidification. In this paper, the concept of hybrid air-conditioning system will be described. And the feature of cooling load removal performance of hybrid air-conditioning system will be analyzed by experiment. Based on the experiment results, the coefficient of convective and radiant heat transfer rate will be calculated. The results come from this study can be used to design the hybrid air-conditioning system in actual application.

F-5

Energy-saving Effect of Thermal Energy Storage Using Introduced Outdoor Air

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Abstract

Recently, buildings with thermal energy storage system have increased because of its economic advantage. In thermal energy storage system using introduced outdoor air, building masses are used as thermal storage media and cooled by outdoor air introduced by a mechanical fan in night-time. In spring and autumn, the cooled building masses can work to reduce cooling load in day-time. In this study, the stored heat was calculated by using simple heat transfer models for various building masses, and the energy performance of this system was evaluated quantitatively by system simulation. It was found that the optimized flow rate of outdoor air can be obtained by comparing the electric power consumption by a mechanical fan with the reduced cooling load because the mechanical fan is the only device requires electric power in night-time.

F-6

Field Survey on Indoor Thermal Environment in Small to Medium Sized Building with Packaged Air Conditioners

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Abstract

Recently, a lot of multiple packaged unit system is adopted in small to medium sized buildings in Japan. This system enables to control each packaged air conditioner (PAC) individually because multiple packaged units are placed decentrally. However, it is not clarified sufficiently how indoor environment is formed when PAC is working. This paper shows the measurement results of indoor thermal environment in a medium sized building with PAC in all season for the purpose of clarifying the current status of indoor environment and its issue. In indoor thermal

environment, there was no issue throughout the year though measurement conditions made difference in temperature and humidity distribution. In indoor units operation, it was clarified that supply air temperature of PAC is different from each PAC and way. In addition, it was clarified that short circuit of supply air from PAC to inlet of the ventilation devices happen.

G Case Study Building

G-1

School Eco-Renovation Method for Improvement of Thermal Environment in Large Workshop of High School without Air-Conditioning System

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Saori YASUI(Osaka University, Japan)

Abstract

In recent years school buildings, containing the workshop in high school, are old in Japan. Therefore most of them need renovating. Any air-conditioning systems are not often installed in the workshops. Workshops without air-conditioning systems often have bad indoor thermal environments. Since bad thermal environment is exhausting and likely to cause some accidents, eco-renovation method for improvement of thermal environment is required. In this paper, various kinds of eco-renovation methods are examined by CFD simulation. The examined methods are insulation of the PC roof and the walls to decrease the surface temperature, and utilization of more ventilation rate in summer.

G-2

Indoor Thermal Environment and Vertical Temperature Gradient in Large Workshop of School without air-conditioning

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Kazunobu SAGARA(Osaka University, Japan)
Hisashi KOTANI(Osaka University, Japan)
Yoshihisa MOMOI(Osaka University, Japan)
Junya YAMADA(Osaka University, Japan)

Abstract

The purpose of this study is to figure out the characteristics of thermal environment in a workshop at school in Japan and to propose the improvement method of the thermal environment without air-conditioning systems. In this paper, measurement results of thermal environment in the workshop and calculation results of vertical temperature gradient are shown. In the measurement results, indoor air temperature became very high in summer. Solar radiation was the main factor raising the temperature of PC roof, and large vertical temperature gradient was formed. The calculation results of zonal model shows the good agreement with the measurement results for vertical temperature gradient. Then some improvement methods of the thermal environment was investigated with the calculation model, and the investigations showed that insulating PC roof is effective method to decrease indoor air temperature.

G-3

A Study of Design principle and Technology performance applied in Passive House

- Focused on cases of the apartment type of Passive Houses in European -

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Yong-Sang Yoon(Korea Institute of Construction Technology, Korea)
Sung-Ok Lee(Korea Institute of Construction Technology, Korea)

Abstract

Recently, the role of the architecture which is corresponding to climate change and saving energy has been important. This study drew factors about design principle, technology performance on passive house, focusing on apartment and multi-family house cases in Europe. The dwelling type of Korea and climate, however, are different from the European styles, and therefore it is necessary to develop energy efficient design, technology and details that is applicable to Korea's apartment. Under this circumstance, this study aims at providing the fundamental data for drawing design principle, technology performance, details applicable to domestic apartment and climate condition for passive house in Korea. Therefore, this case study is intended to explain three topics: strategy, energy performance, and details.

H Chemical pollutants & Particles

H-1

Prediction of mass transfer rate on the surface of tested building material using CFD analysis

Janghoo SEO(Chosun University, Korea)

Abstract

We developed an airflow control unit for small chambers for uniformly controlling airflow on the surface of tested building material in the small chambers. We will present the mass transfer rate on the surface of tested building materials corresponding to an actual building in order to exactly evaluate the performance of the reduced amount and concentration of released chemical materials with the small chambers. We measured the airflow velocity on the surface of building materials in the small chamber with the developed airflow control unit and the fan speed for airflow control. We reviewed the distribution of water vapor concentration in the small chamber by means of CFD (Computational Fluid Dynamics) and estimated the mass transfer rate on the surface of building material to confirm test reliability.

H-2

Sensitivity Analysis of Parameters affecting Indoor Air Quality related to HCHO and TVOC Reduction

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Jin Chul Park(Professor, Chung-Ang University, Seoul, Korea)
Eon Ku Rhee(Professor, Chung-Ang University, Seoul, Korea)

Abstract

The objective of the study is to analyze the relative performance of factors affecting indoor air quality in multi-residential buildings in Korea. A study of the factors affecting indoor air quality is essential for establishing indoor air quality management strategies effectively. To observe the indoor air quality response following a modification of a given parameter sensitivity analysis was performed. The factors examined for the analysis include; wall+ceiling paper, adhesive for wall/ceiling paper, floor material, adhesive for floor material, and ventilation rate. The experimental design system which offers main effects among the design parameters with a few experiments was used to decrease the number of experiments. The simulation for indoor air quality was undertaken using a validated equation. Then, ANOVA(Analysis of Variance) was performed to evaluate the relative importance of each parameter affecting the indoor air quality. The result of the study indicates that the indoor air quality may be influenced most by adhesive for wall/ceiling paper, followed by ventilation rate and adhesive for floor material.

I Computer Simulation

I-1

Analytical estimation of optimal minimum airflow for air circulation

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Young-Hum Cho(Kumoh National Institute of Technology, Korea)
Dong-Ho Choi(Catholic University of Daegu, Korea)
Jeong-Hoon Yang(Yeungnam University, Korea)

Abstract

Space conditions are directly controlled by terminal boxes in variable air volume (VAV) air handling unit (AHU) systems. The terminal box either modulates airflow or adjusts discharge air temperature. Conditioned space will have thermal discomfort by less air circulation if the airflow and discharge air temperature are not suitable. The objective of this study is to estimate an optimal value of the airflow and discharge air temperature, which maintains room thermal comfort. This paper is conducted to determine the optimal room airflow and discharge air temperature and verify the impact of room airflow and discharge air temperature on thermal stratification through CFD (Computational Fluid Dynamics) simulations.

I-2

Evaluation on the Daylighting performance of 'generative facade components' In the digital simulation

Hwang Yi(SAMOO architects & engineers, Korea)

Abstract

The aim of this study is to find out a role of the computer simulation on sustainable design projects and development of façade elements with results of daylighting simulation

and energy performance. 3D components of façade modeling get to realized in Rhino 3d with some help of Paracloud encoding. With simulation program of Ecotect and eQuest, thus, the result will show influencing factors of each generative components on the radiation & dayligthing factors. And not only that, the result will move to further arguments which is how many factors are related in design of generative skin and which factors should be mainly considered in development façade elements of a sustainable building.

J Air Filtering for Ventilation

J-1

Filtering technology for air purification in HVAC

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Yiren WU(DongHua University Shanghai, China)

Abstract

This paper is mainly present the filtering technology for air purification in the process of ventilation and air conditioning. By the means of reviewing the related research we have made in this area, several effective programs for PM10 filtration are introduced from the view of experimental testing and practical applications. However, the selection and screening of fiber filter material has yet to be standardized, and the development of new multi-functional and energy efficient fiber filter material is pressingly required. So in the conclusion part, several views are proposed to provide new ideas for the further development of filtering technology in the process of ventilation and air conditioning.

J-2

Effective flow area estimation test using CO2

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Takayuki Matsushita(Dept. of Architecture, Kobe, Japan)

Abstract

We developed a method for estimating effective flow areas not only in the external wall of a house but also in the internal walls between rooms using only one type of tracer gas. This method is based upon the following hypotheses: (1) the temperature and tracer-gas concentration in the room is homogenous, (2) the air in the room is in a windless state, (3) there is no error in the measurement of tracer-gas concentration. However, we know that in reality, these hypotheses are not entirely true. To check the effects of discrepancies between the hypotheses and actual conditions on the estimated results, we set up a miniature model experiment. As a result of this experiment, it was clarified that the present estimation method yields a reasonable estimate of the discharge coefficient even when there is a certain amount of discrepancies between the hypotheses and actual conditions.

J-3

PCM cold storage under various ventilation conditions

Pavel CHARVAT(Brno University of Technology, Czech Republic)
Milan OSTRY(Brno University of Technology, Czech Republic)

Abstract

Cold storage is a way to deal with peak cooling loads. Cold storage integrated with building structures is independent of the approach used for building cooling – it can be used with passive cooling as well as mechanical cooling. High thermal storage capacity in a narrow temperature interval makes phase change materials (PCMs) a suitable medium for cold storage in built environments. A set of experiments was performed with the aim to investigate performance of PCM cold storage in building structures under various ventilation strategies. The experiments were carried out in two identical test rooms located in an attic of a building. The main problem of PCM cold storage in building structures is the discharge (rejection) of heat. Three ventilation strategies were used to reject heat from cold storage. These strategies were: natural ventilation, mechanical supply of unconditioned outdoor air and mechanical supply of air-conditioned air.

J-4

Study on the Feasibility of Heat Pump Desiccant System Combined with Cogeneration System in Heating and Humidification Mode

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• Sihwan Lee(The University of Tokyo, Japan)
• Shinsuke Kato(Professor, The University of Tokyo, Japan)
• Yujin Nam(JSPS Research Fellow, The University of Tokyo, Japan)

Abstract

Recently, in order to reduce energy consumption in the building sector, many air-conditioning systems have been proposed and applied to real buildings. Of particular note, air-conditioning systems that treat sensible and latent loads separately have been assessed as efficient in hot and humid climates. In this study, a highly efficient desiccant system combined with a cogeneration system and a heat pump desiccant system has been developed. The main concept of this system is to utilize the waste heat from the other systems, namely the cogeneration system and the solar heat system, to assist the desiccant material to recover, and to function in concert with the desiccant and heat pump systems. This paper describes a feasibility study into the proposed system, which was conducted based on an annual energy simulation, and assessed the system's performance under various conditions. The case studies were conducted using an energy simulation tool, TRNSYS 16, with comparison to a general ventilation system, a heat recovery ventilator and a heat pump desiccant system, respectively. The sensible and latent loads, indoor air temperature and relative humidity in all cases were calculated using an energy simulation. It was found that the proposed system could save more energy than these other conventional systems through its more efficient use of waste heat.

J-5

Air Leakage Tests for the requirements of the LEED in two high-rise residential buildings

• Hyun Kook Shin(Chungbuk National University, Korea)
• Hyun Cho(Chungbuk National University, Korea)
• Kwan Woo Kim(POSCO E&C Corp., Incheon, Korea)
• Hoi Soo Se(Chungbuk National University, Korea)

Abstract

Air leakage test was carried out according to ASTM E779-03, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization to meet the requirements of the LEED-NC v2.2(EQp2). Air leakage tests for quality assurance can be performed once all work on the air barrier has been completed and all windows and doors have been installed in two high-rise residential buildings. Test units selection was carried out in accordance with the following guidance, California's 2001 Energy Efficiency Standards. That is, 1 in 7 dwelling units was sampled, and dwelling units were grouped for testing according to unit size and type. Finally, we completed pressurization and de-pressurization tests for 240 residential units and the final readings were a level of 0.87 square cm per square meter of surface area or less.

• Venue Introduction

Renaissance Seoul Hotel

Discover one of the world's most interesting cities at the luxurious Renaissance Seoul Hotel. Perfectly located in the bustling center of the Gangnam business district, our central Seoul hotel is near the COEX convention center and within walking distance to the subway station, fashionable stores, restaurants, and entertainment.

676 Yeoksam-dong Gangnam-gu, Seoul, 135-915 South Korea
Tel. + 82 2 5550501 Fax. + 82 2 5538118

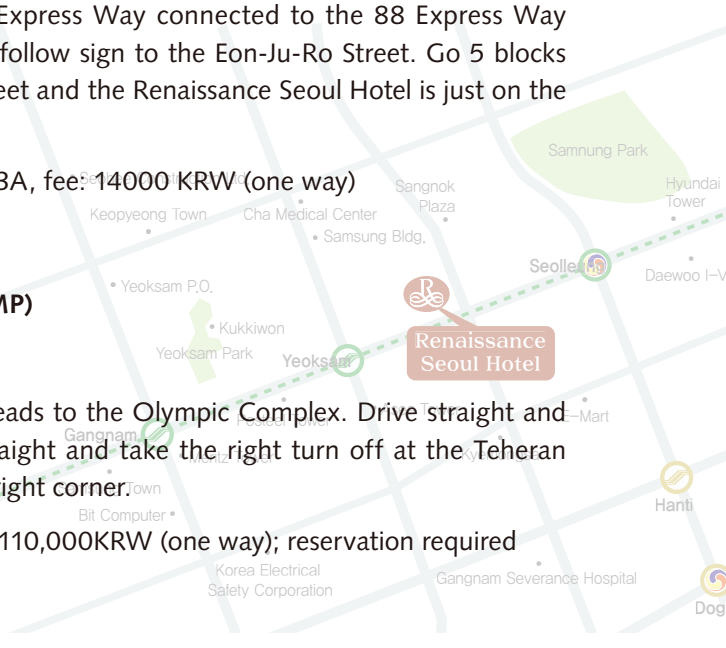
How to get to the Renaissance Seoul Hotel from the Airport

From the Incheon International Airport (Airport Code: ICN)

- Hotel direction: 40.4 miles E
- Driving Directions: Take the New Incheon Airport Express Way connected to the 88 Express Way leading to the Olympic Complex. Drive straight and follow sign to the Eon-Ju-Ro Street. Go 5 blocks straight and take the right turn off at the Teheran Street and the Renaissance Seoul Hotel is just on the right corner.
- Alternate transportation: KAL Limousine Bus - Line # 3A, fee: 14000 KRW (one way)
- Estimated taxi fare: 90,000KRW (one way)

From the Gimpo International Airport (Airport Code: GMP)

- Hotel direction: 21.7 miles E
- Driving Directions: Take the 88 Express Way which leads to the Olympic Complex. Drive straight and follow sign to the Eon-Ju-Ro street. Go 5 blocks straight and take the right turn off at the Teheran Street and the Renaissance Seoul Hotel is just on the right corner.
- Alternate transportation: Deluxe Taxi- Black cab, fee: 110,000KRW (one way); reservation required
- Bus service, fee: 3,000KRW (one way)
- Estimated taxi fare: 75,000KRW (one way)



Secretariat Room

AIVC 2010 Secretariat Room Lily(23F) will be operated at the venue during the Conference.

For any help and request during the Conference, please come to the Secretariat Room.

09 Conference Information

Internet Access

How to use internet at hotel

- You can buy a wireless internet card at the Business center in the lobby.
- Price: KRW 23000(exclusive of VAT)

* 24hours of access within a 90-day period after your first log-in.

Registration

It is recommended that all participants stop by the registration desk upon their arrivals at the venue to take the Conference. Our staff will be pleased to help with all the participants' inquiries.

Operating hours of the registration desk will be:

- 08:00~18:00. October 26(The), 2010 (Venue : Renaissance Seoul Hotel)
- 08:00~18:00. October 27(Wed), 2010 (Venue : Renaissance Seoul Hotel)
- 08:00~11:00. October 28(Thu), 2010 (Venue : Renaissance Seoul Hotel)

Social Program

Welcome Party

Free to registered delegates and registered accompanying persons.

It will provide the delegate with an opportunity to socialize in relaxed atmosphere and enjoy the warm welcome from the organizing.

- Date & Time: October 26th, 2010 / 18:00 ~ 20:00
- Venue: Diamond, Renaissance Seoul Hotel (3th Floor)
- Menu: Standing Buffet

Banquet Information (Optional)

Banquet, the official gala dinner of AIVC2010 International Conference, will take place at the Diamond Ballroom on October 27th (Wed). The program will consist of an official ceremony and dinner. During the official ceremony, you will have good opportunity to make relationship with participants.

- Date & Time: October 27th, 2010 / 18:00 ~ 20:00
- Venue: Diamond, Renaissance Seoul Hotel (3th Floor)
- Menu: Western Course Menu
- Participation Fee: USD 50.00

• Republic of Korea & Seoul

Republic of Korea

The Korean peninsula's location lies adjacent to China and Japan. The national Korean flag is called "Taeguekgi" in Korean and the national flower of Korea is the mugunghwa, rose of Sharon. Korea's gross domestic product (GDP) has come to the 12th largest in the world. Also Korea has attained the highest Digital Opportunity Index among the 180 nations assessed for the second consecutive year, reaffirming Korea as the leading information-communication society. Most noteworthy, perhaps, in terms of gaining a world-class sports recognition include Korea's co-hosting of the FIFA World Cup Finals in 2002 with Japan and the hosting of the 24th Summer Olympic Games in Seoul in 1988. Also the cultural phenomenon known as the "Korean Wave" has left an indelible mark throughout Asia from 2004, fanning optimism about the country's potential as a culture powerhouse.

Seoul

Seoul has been the capital of Korea for about 600 years, since the time of the Joseon Dynasty (1392-1910). Seoul has developed into a bustling metropolis, acting as the hub for political, economic, social, and cultural matters. The Han River runs through the heart of the city. The river divides the city in two; the northern part of the city is a focal point for culture and history, while the southern part is well known for its business district. Seoul has hosted many international events including: 1986 Asian Games, 1988 Olympic Games and 2002 Korea/Japan FIFA World Cup. The success of these events has shown people that Korea is truly an international city. In Seoul you can find ancient palaces and Royal Shrines of the Joseon Dynasty, as well as Seoul World Cup Stadium, Han River, Namsan, Bukhansan Mountain National Park, Insa-dong, Itaewon, Myeong-dong, Namdaemun and Dongdaemun Markets.

• Tourist Attractions in Seoul

Royal Palaces

The five major palaces of the Joseon Dynasty are Gyeongbokgung, Changdeokgung, Changgyeonggung, Gyeonghuigung and Deoksugung. Among them, the architectural beauty and historical importance of Jongmyo (Royal Shrine) and Changdeokgung ("gung" means palace) have gained international recognition with their inclusion on UNESCO's list of World Cultural Heritage sites. Palaces were built without destroying or disturbing their natural environments and, as a result, these palaces still boast an unspoiled natural beauty around them, just as they did 600 years ago.

Dongdaemun Market

Ever since its opening in 1905, Dongdaemun Market has been one of the major markets in Korea. Specializing in wholesale clothing, the market has grown large, having more than 20 shopping malls. A full range of fashion items that cover head to toe, are found in Dongdaemun Market at inexpensive prices.

Insa-dong

Almost all foreign visitors to Korea make a trip to Insa-dong. This is because it is the place where "HAN brand," the traditional culture of Korea as a whole, can be found. At the heart of HAN brand is the intangible nature of culture accumulated over a long course of history. In Insa-dong, every alley and store has something traditionally Korean to show off. Known initially as an antique district, Insa-dong was designated as a bastion of traditional culture in 1988, when an array of modern art galleries joined the area.

COEX

A daily average of 140,000 people (250,000 in a weekend) visit COEX, located at the heart of Gangnam, the center of new Seoul. Every year, more than 200 exhibitions and 2,500 international meetings and events take place in COEX, the leader of the Korean exhibition and convention industry. And COEX Mall, the biggest shopping mall in Asia, is located on the underground floor of COEX. Countless stores and hundreds of restaurants and food court kiosks fill a space 14 times bigger than the Olympic Stadium. There is not enough time in a day for you to enjoy a meal, watch a film, visit the aquarium, and shop here.

Namsan

Namsan is a witness to the 600 years of Seoul as the capital of Korea. Indeed, Namsan holds Seoul's history. The Seoul Fortress Wall that crosses Namsan and the Namsan Bongsudae demonstrate that Namsan was once a long serving strategic military point. When the parts of the Seoul Fortress Wall and Bongsudae that have been lost are rebuilt, Namsan will become an even more historically valuable place.

• From Inchon International Airport to the Hotel

If you arrive at Inchon International Airport, you can go to the hotel by bus or airport railroad both. However we recommend you to take a limo than railroad. It will drop you off exactly in front of the Renaissance Seoul Hotel. See the below.

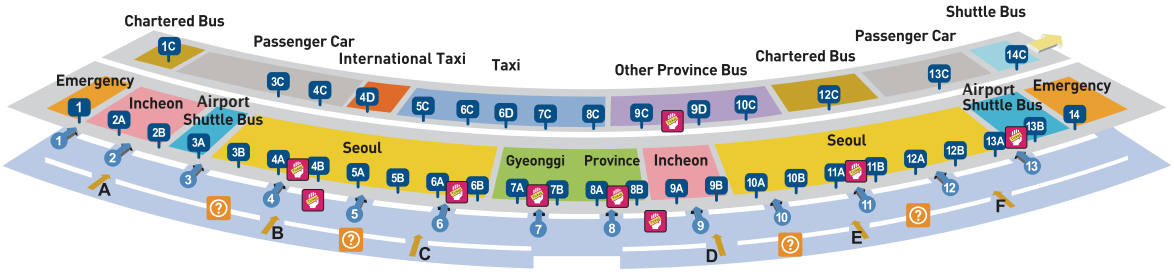
Webpage > http://www.airport.kr

Inchon International transportation

Ground Transportation (1st Floor)

Bus Information

Please go to the nearest Bus Information Counter for more Information.
(Tel. 032-741-6400)



A ~ F Arrival Exit
1 ~ 14 Passenger Terminal Exit No.
Airport Information Center
Outside Ticket Office

Taxi

5C	Deluxe Jumbo Taxi	6C	Taxi for Seoul City		
6D	Taxi for Gyeonggi Province	7C	Taxi for Incheon	8C	Taxi for Deluxe
4D	International Taxi				

Use information of Airport Shuttle Bus (Free of charge)

Direction	Bus Stop No.	Station	First/Last	Interval Time	The Time Required
Cargo Terminal	Departure Floor (3F) Exit 3, 12	Vehicle Maintenance Lot, AOC, Logistics Complex, Cargo Terminal B, Cargo Terminal C, Customs Office, Cargo Terminal Station, Cargo Terminal A, IIAC, Passenger Terminal	05:40/ 23:08	10min	45min
Long-term Parking Lot	Arrival Floor (1F) Exit 3A, 13B	Passenger Terminal, Long-term Parking Lot	04:40 ~Next Day00:58	8min	5~8min
Night) International Business Center	Departure Floor (3F) Exit 3, 12	Passenger Terminal, IBC, Hotel Hyatt	23:50, 00:10, 00:30	20min	5~8min

Airport Railroad

Item	Railroad Course	First train / Last train Time	Service Frequency
Commuter Train	Incheon Airport ~ Gimpo Airport	05:39 / 23:46	12.0
Express Train	Incheon Airport ~ Gimpo Airport	05:27 / 21:00	60.0

Facilities for Disabled
- Station : Exclusive restroom for the handicapped, Elevator, Information map, Braille induction guide block, Voice induction guide
- Train : Every train is equipped with a space designated for a wheel-chair.

Information on Airport Railway
- Tel : (032) 745-7788

Railroad Lost and Found (Gimpo Airport Station)
- Tel : (032) 745-7777

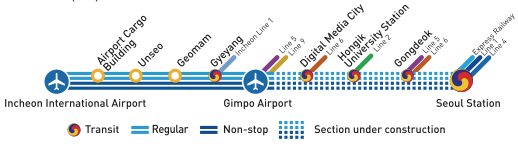
Information on airport train reservation
- www.arex.or.kr

Emergency phone number
- Tel : (032) 745-7303

Approximate Express Train Time to the destination / (unit : minute)

Commuter Train Time to the destination

Incheon International Airport						28.0
3.0	Airport Cargo Building					
7.0	3.5	Unseo				
21.0	17.5	13.5	Geomam			
26.5	23.0	19.0	5.0	Gyeyang		
33.0	29.5	25.5	11.5	6.0	Gimpo Airport	



Express Railway (KTX)

Please, go to the KORAIL Desk next to the Exit No.7 on the first floor (032) 741-7788

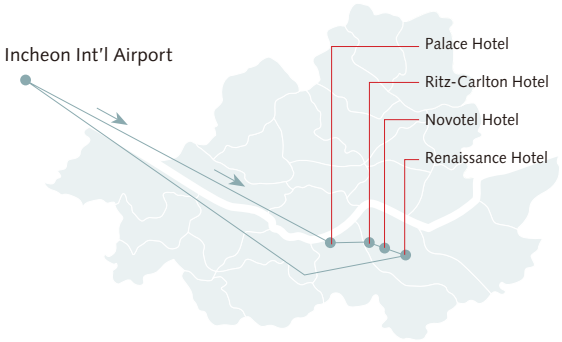
By bus…

You can buy Limousine and Premium Bus tickets, and also can get information at the following Bus Ticketing Office Exit 4 and 9(indoors) & Exit 4, 6, 7, 8, 11, 13, and 9C(outdoors)

6703(Gangnam Yeoksam)

Direction Route : Inchon Int' Airport – Gangnam Yeoksam 6703 (Gangnam Yeoksam)

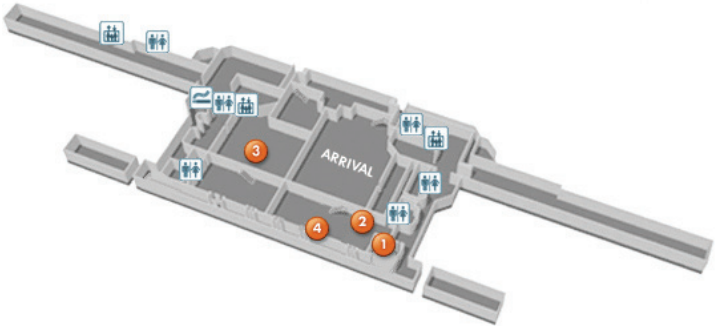
Bus type		Limousine (Deluxe)
Interval		30
Travelling Time		80 min
First Bus	to Airport	5:25
	to Gangnam Yeoksam	05:15
Last Bus	to Airport	19:00
	to Gangnam Yeoksam	22:20
Fees		KRW 15,000
Vendor Name		KAL
Contact		02-2667-0386
Time line of departing Buses		
Route & Time Table		

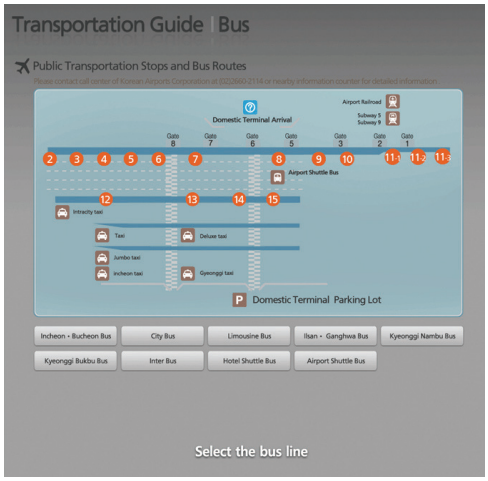


From Gimpo International Airport to the Hotel

If you arrive in Seoul through Gimpo International Airport, you can go to the hotel by Limousine bus at bus stop. Please take a bus No. 6000 and get off the bus at LG DACOM (Renaissance Hotel). It takes about 50 minutes by bus from airport to the hotel.

Webpage> http://www.airport.co.kr/doc/gimpo

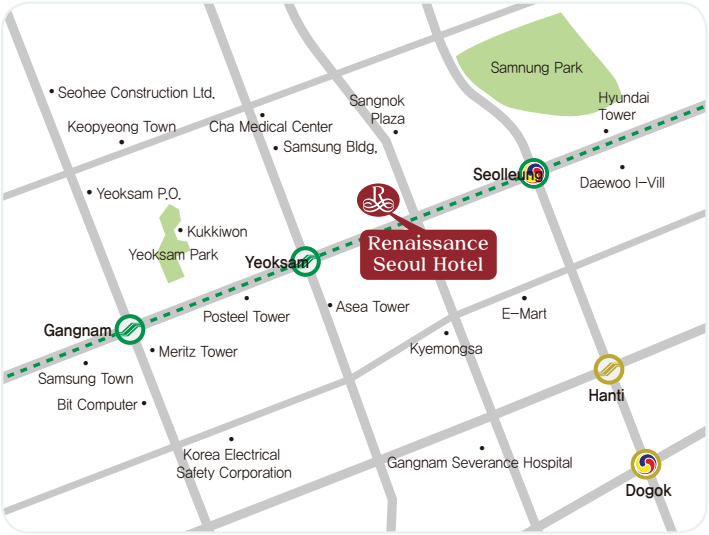




10 Transportation

Category	Bus Name	Bus Stop
Limousine	To Jamsil Station(6000)	Gimpo Int'l Airport-Songjeong Station-Balsan Station-Naebalsan Tourist Shopping Center-88 Gymnasium-Hotel Nostalgia-Deungchon Middle School(Green World Hotel)-Gangseo gu Community Health Center-Yeomchang Station-Express Bus Terminal-Banpo Station-Nonhyeon Station-Gangnam Station-Yeoksam Station-LG DACOM(Renaissance Hotel)-Seolleung Station-Samseong Station-Sincheon Station-Jamsil Lotte World-Jamsil Station

There is a mark on the map. The mark indicates LG DACOM. The bus will drop you off there and you can go to the hotel by walk. It takes just few minutes from bus stop to the hotel. The mark <H> indicates the Renaissance Hotel. See the below.



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