Air Infiltration Review

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International Energy Agency - AIVC

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A Selective Review of ROOMVENT '98

6th International Conference on Air Distribution in Rooms

by Malcolm Orme, AIVC

ROOMVENT '98, the 6th International Conference on Air Distribution in Rooms, was held recently between 14th and 17th June, 1998, at KTH, Stockholm, in Sweden. A brief selection (about 30) of the 250 papers presented at the conference are discussed in the following sections.

Invited Lectures

Professor Eimund Skåret of the Norwegian Building Research Institute and Professor P. Ole Fanger of the Technical University of Denmark gave the Invited Lectures at the conference. Professor Skåret outlined his view of future trends in room air distribution. This included a so-called "soft" approach to ventilation in general, with 'breathing buildings' and naturally driven air flows. He emphasised that solutions for work-place ventilation must be user-oriented, and also proposed that in future computational fluid dynamics (CFD) will become the main design tool.

Professor Fanger continued the theme of user-oriented solutions by stressing that air distribution in rooms must serve human occupants and that any measure of 'quality' should include the extent to which human requirements are met. He expressed the opinion that for the indoor environment, these requirements include:

- occupant perceived indoor air quality (IAQ),
- no negative health effects of IAQ,
- thermal neutrality,
- no draughts, and
- a low noise level.

Furthermore, he observed that people have differing responses, so a level of compromise must always be sought.

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Displacement Ventilation

Displacement ventilation is a strategy in which the intention is to 'partition' room air into upper and lower 'zones', trapping pollutants in the upper zone, and leaving the occupied zone below with a lower pollutant concentration. A person situated in the lower zone causes a thermal plume, and this assists transport of occupant-generated pollutants into the upper zone, from where air is extracted. Using this technique, excess heat gains to the space may also be efficiently removed.

Paul Cooper (University of Wollongong, Australia) discussed experimental work that he has conducted using saline solution ("salt box") scale modelling of a naturally displacement ventilated space with one vertical heated wall. He explained how the flow field has four main regions: a boundary layer, an ambient layer, a stratified layer and a gravity current. He hypothesised that air from the ambient layer is entrained into the thermal boundary layer and is then partially de-entrained into the stratified layer. A gravity current moves across the ceiling of the space towards the outlet vent. His conclusion was that the ambient layer depth is determined primarily by the non-dimensional effective vent area.

By means of computational fluid dynamics, Henrik Brohus (Aalborg University, Denmark) has examined the effect of an actively cooled ceiling on a displacement ventilation system. He found that although it has a strong influence on the flow field in the room, the consequent personal exposure was only mildly affected. Hong-wei Tan (Nippon Fläkt K.K., Japan) has also studied this type of hybrid system, indicating the range of the temperature gradient in the occupied zone should be between 2.0 °C/m to 2.5 °C/m to realise comfort and ventilation efficiency simultaneously.

Another variation of the strategy was the subject of a presentation by Esa Sandberg (Satakunta Polytechnic, Finland), who maintained that a two zone calculation model seems to be reasonable for an active displacement ventilation system under development in Finland. (This system is optimised for cooling applications.) As a consequence of an experimental study of displacement ventilation, Pierre Guitton (Electricité de France) concluded that representing several real heat loads by a single modelled one could give inaccurate results. In addition, Eimund Skåret (Norwegian Building Research Institute) identified certain criteria on which performance documentation of air diffusion devices could be based.

Particle Deposition

The results of an experimental investigation of dust deposition and resuspension were reported by Philip Lengweiler (ETH Zürich, Switzerland). This included the inference that surface orientation is the parameter which has the greatest influence on dust load. High air turbulence coupled with air velocity were also found to have large effects on dust load. The influence of turbulence intensity on both the dispersion of airborne contaminants and the sedimentation of germs was the topic of a presentation given by Frank Scheer (Engineering Company Scheer, Germany). Measurements were performed with the species Mi-

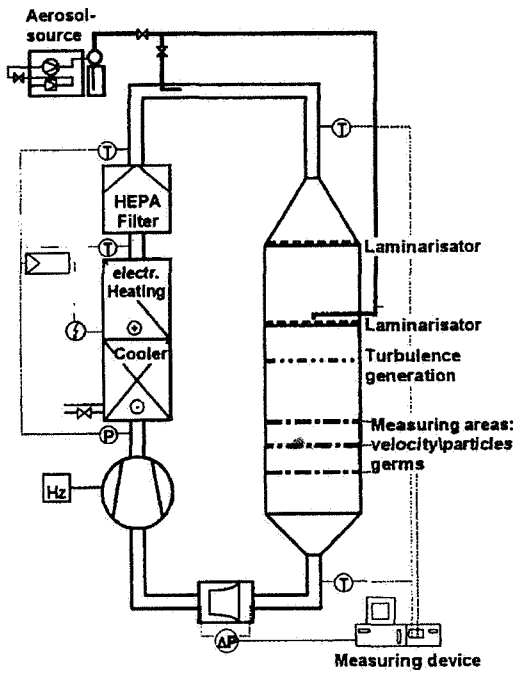


Figure 1 Schematic experimental set-up of the test facility, [1] p.326

Air Infiltration Review

Editor: Janet Blacknell

Air Infiltration Review has a quarterly circulation of 3,500 copies and is currently distributed to organisations in 40 countries. Short articles or correspondence of a general technical nature related to the subject of air infiltration and ventilation are welcome for possible inclusion in AIR. Articles intended for publication must be written in English and should not exceed 1,500 words in length. If you wish to contribute to AIR, please contact the Air Infiltration and Ventilation Centre. Please note that all submitted papers should use SI units.

crococcus Luteus (diameter 2 μm) and also with particles (diameters ranging from 0.3 μm to 2 μm, mostly less than 0.7 μm), introduced in the supply duct of a test chamber (see Figure 1). On the basis of this work, he proposed that reducing the turbulence intensity from 20% to 1% could halve the sedimentation rate of germs in operating theatres.

Industrial Ventilation

Industrial ventilation systems often differ substantially from those used in non-industrial buildings in that a requirement may be imposed on the system in addition to occupant requirements, i.e., suitable industrial process ventilation may be needed. In fact, sometimes only temporary occupancy is considered, for instance for maintenance or repairs to automated systems. In other cases, adequate ventilation is essential for the protection of occupants from process-originating pollutants.

At the Conference, Andrei Livtchak (Halton, Finland) outlined the operation and validation of a 'vortex' air distribution system for a boiler house, designed for removal of high heat loads from the air surrounding the boiler. As part of this, thermal stratification ensures that the hottest air can be used as a pre-heated source for combustion processes. In another presentation, a scale-model study on contaminant removal effectiveness of an industrial facility was explained by Nobuyuki Kobayashi (Tokyo Institute of Polytechnics, Japan). In this study, removal of point-source originating pollutants was achieved by a combination of 'hanging walls' to extract and fresh air supplied at floor level. Furthermore, Dieter Breer (EMPA, Switzerland) provided an analysis of the possibility of naturally ventilating an industrial laundry with high internal heat gains and Jean Georges Villenave (CSTB, France) gave an explanation of a theoretical and field study of air change in industrial buildings during a whole heating season.

Two presenters from the United Kingdom described techniques for efficiently modelling industrial local exhaust ventilation. Philip Trevelyan (University of Bristol) discussed his CFD investigation of flow inside a fume cupboard, the aim of which was to reduce the computation time by minimising the domain for which it is necessary to solve a fully turbulent flow model. In addition, Rachel Thomas (Loughborough University) described her mathematical model of air flow in a downdraft exhaust hood, requiring a fraction of the computational resources needed to solve a laminar flow model of the same situation.

Influence of the Surroundings on Humans

A number of presentations at the Conference dealt with computational simulations of air flows over the human body, in particular to study thermal comfort and air quality. This included work from Aalborg University in Denmark that highlighted the outcome of both an experimental and a computational study of contaminant transport between two breathing persons. By using the computational model to examine the sensitivity of the personal exposures to various parameters, convective heat output, cross-sectional exhalation area and pulmonary ventilation rate were identified as the most significant. An experimental study of air quality in the breathing zone of a displacement-ventilated test chamber, an account of which was given by Hazim Awbi (University of Reading, UK), indicated that the perceived air quality was 40% better for a seated person than the occupied zone average.

Shuzo Murakami (University of Tokyo, Japan) reported on progress in the development of a numerical simulation system combining air flow, thermal radiation and moisture transport (see Figure 2). In addition, Eusébio Conceicao (Universidade do Algarve, Portugal) presented work on a simulation of the human thermal system which predicts human body temperature under transient conditions. In a further contribution from Japan, Shizuo Iwamoto (Kanagawa University) explained how he has made a comparison of the SIMPLE and SIMPLER calculation methods applied to air flow around a seated person. The SIMPLER method was found to produce better convergence with a more stable solution. Also, a case study simulation was also performed that included a heated floor.

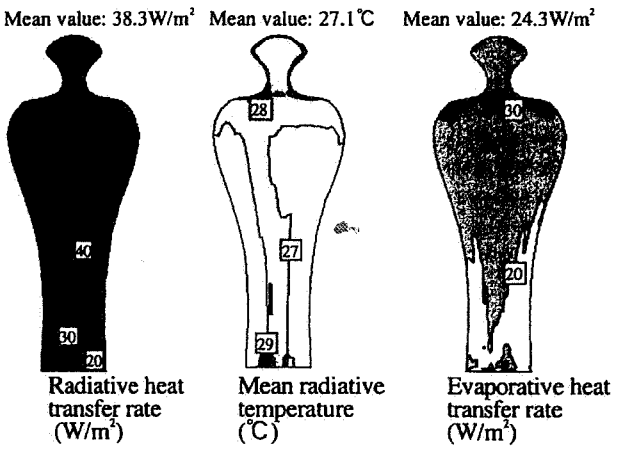


Figure 2 Thermal characteristics of the body surface, [2] p.147

Natural Ventilation

Natural ventilation for cooling was considered by presenters from both Australia and Japan. Richard Aynsley (James Cook University, Australia) reported on the use of monthly average dry and wet bulb temperature as well as wind frequency data for estimating natural ventilation cooling potential. By comparing estimates based on average data with typical measured data over a month long period, he concluded that the average data provided a good indication of the percentage of time when natural ventilation cooling would restore thermal comfort. The use of natural ventilation of attic spaces for solar heat removal was the subject of a presentation by Hiroshi Homma (Toyohashi University of Technology, Japan). In his experimental study he found that including an aper-

ture of a certain size (50 mm in this case) at the top joint of the inclined surfaces allowed the effective exhaustion of heated air, as well as cooling of the lower surface of the roof.

Yuguo Li (CSIRO, Australia) related how a lower neutral pressure level is predicted in multi-zone models compared to CFD. He proposed that thermal stratification needs to be considered more precisely in zonal models. However, he found that flow rate agreement between the techniques is acceptable. A further paper, by the same author concerned upward flows in a multi-zone building with subfloor plenums and solar chimneys. On the theme of natural ventilation design, Karl Terpager Andersen (Danish Building Research Institute) has devised a set of formulae for the design of natural ventilation by thermal buoyancy with a linear temperature stratification and two openings. This formed the basis of his presentation at the Conference.

Velocity Measurements

Elisabet Linden (KTH, Sweden) related developments in particle streak velocimetry (PSV) for studying low speed room air movement. With this technique, images of illuminated particle trajectories (obtained using time-exposed photographic film) are digitised and then estimates are made of the particle velocities using stereo-photogrammetry. Also, Valentino Todde (KTH, Sweden) presented another aspect of the same project, concerning fiber film probe measurements of low speed air jet flow. His results included mean longitudinal velocity along the centreline of an air jet for a range of initial jet velocities. Moreover, in the first of these two presentations it was indicated that PSV systematically gave a lower velocity within an air jet than the second technique. The reason may be connected with the particle trajectories not closely following the air motion in PSV. In order to improve this, a particle type with more suitable physical characteristics than currently used is being sought (i.e. non-toxic with rough surfaces, diameter greater than 80 μm with a uniform distribution, and density less than 25 kg/m^3).

Additionally on the subject of PSV, Dirk Müller (RWTH-Aachen, Germany) explained how his particle streak tracking system, using a pair of CCD cameras and a novel arrangement of light sheets (which illuminate the particles with 2 distinct light frequencies) may be used for 3-dimensional velocity measurements. Further presentations on this topic were made by Arsen Melikov (Technical University of Denmark), who commented on accuracy requirements and limitations for low velocity measurements, and Zou Yue (KTH, Sweden), who indicated that an appropriate choice of sampling time for air jet velocity measurements is critical in producing accurate results.

References

1. Mundt E and Malmström T-G (editors), *ROOMVENT '98 - 6th International Conference on Air Distribution in Rooms*, Proceedings: Volume 1, held KTH, Stockholm, Sweden, June 14-17, 1998, KTH, Stockholm, Sweden, 1998.

2. Mundt E and Malmström T-G (editors), *ROOMVENT '98 - 6th International Conference on Air Distribution in Rooms*, Proceedings: Volume 2, held KTH, Stockholm, Sweden, June 14-17, 1998, KTH, Stockholm, Sweden, 1998.

Compulsory Ventilation Checks

by Lars Svenson, presented at the Save-duct Seminar, held June 10-11 1998, at the Belgian Building Research Establishment

One condition for a good indoor climate is ventilation that works properly. The link between poor air exchange and air pollution is self-evident. The actual performance of ventilation systems, their change and use of recirculated air are central issues with regard to a good indoor climate.

- Government bill 1990/91:145 Checks on performance
- The Swedish Code of statutes 1991:1273 ordinance on performance checks of ventilation systems
- The Swedish Board of Housing, Building and Planning's Code of statutes 1992:15 Regulations on performance checks of ventilation systems

Performance checks shall be carried out not only when a new installation is brought into use but also at regular intervals during the installation's lifetime.

Dates and Intervals for Regular Inspections

The following table indicates:

- the latest date for the first inspection of an installation brought into use before 1 January 1992
- intervals for regular checks
- approved authorisation level of the inspector

Comments on the table

The category day-care centres, schools and health care centres also includes: pre-school premises, secondary schools, leisure centres and old peoples homes.

The category does not include institutions for higher education (e.g. universities). These are included in the category "office buildings".

The category "blocks of flats and office buildings" includes: meeting rooms, shops theatres, cinemas, sport halls, terminals, museums, exhibition halls, hotels and garages.

Inspection Implementation

The following points shall always be included in a ventilation performance check.

An operation and maintenance instruction manual shall always exist.

Air change. If activity inside the building has changed after it was first brought into use, demands on the ventilation system should be adapted to the current use.

Humidity. Humidity results in the spreading of bacteria, mould and mould fungus. Particular attention shall therefore be given to the ventilation of areas with high moisture load.

Fans and air handling units. A ventilation performance check should start by ensuring that the performance and operation of all components of the air handling unit accord on inspection details.

Recirculated air. Especially important to assess that air quality in premises, supply air quality and outdoor air flows are satisfactory and the movement of foul smelling gases or substances from one room to another does not accrue.

Radon. Ventilation systems which have been installed to reduce radon gas concentrations are also covered by the inspection.

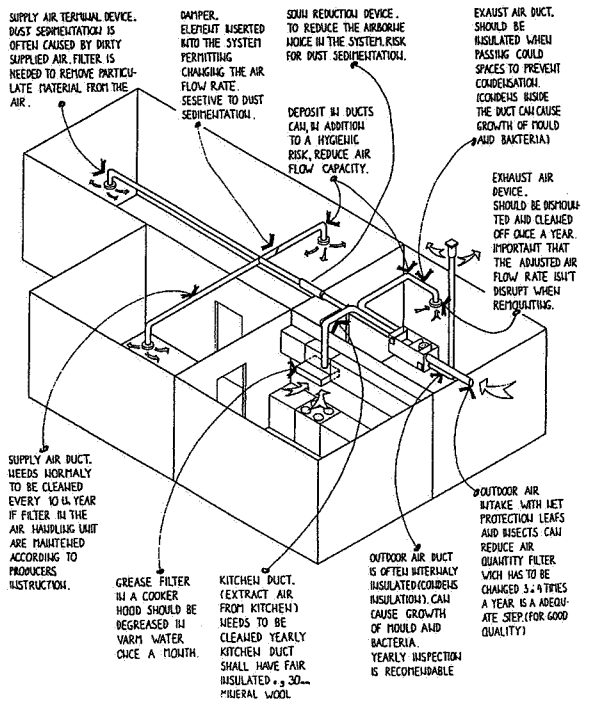
Deposits in ventilation ductwork. Deposits in ventilation ducts can, in addition to being a hygienic risk, reduce air flow capacity, affect fan performance and reduce heat recovery. Efficient filtration and maintenance of filters protects the ducts and components from deposits.

Noise. In the cases where the ventilation system is regarded

Buildings	Last date for first inspections of existing building	Inspection intervals	Inspector qualifications class
1. Day-care centres, schools, health care centres, etc	31 Dec 1993	2 years	K
2. Blocks of flats and office buildings, etc. Balanced ventilation	31 Dec 1994	3 years	K
3. Blocks of flats, office buildings, etc. Mechanical exhaust ventilation	31 Dec 1995	6 years	N
4. Blocks of flats, office building, etc. Natural ventilation.	31 Dec 1995	9 years	N
5. One and two-dwelling houses. Balanced ventilation.	31 Dec 1995	9 years	N

as creating discomforting noise or exhibits very poor insulation against noise, the system should be checked according to the same documents as used for inspection purposes.

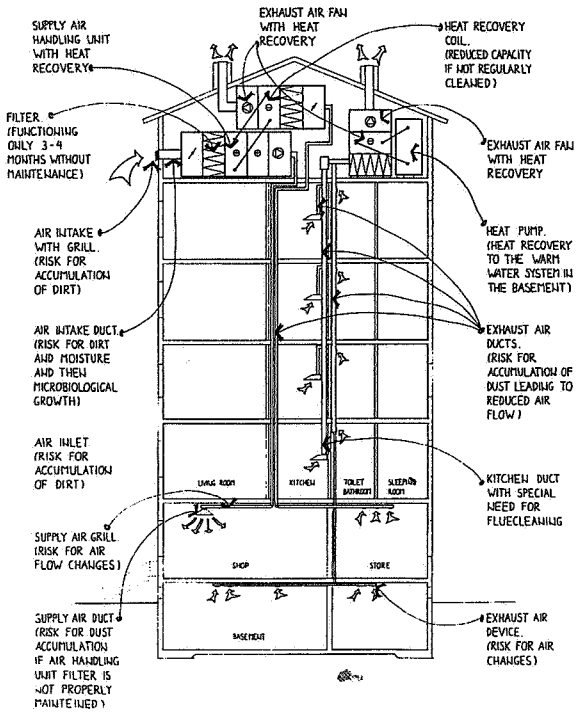
More detailed inspection. In many cases a more detailed inspection can demonstrate specific opportunities, e.g., improved heat exchange, more efficient use of energy and more precise adjustment of the installation.



One Family House with Balanced Ventilation

Results from other field studies can be summarised in the following recommendations:

- the operational function must be checked regularly
- maintenance staff must learn to use the theoretical basis for decision
- feedback must be used to improve the functions of the technical systems
- feedback must be used to explain and develop the interrelationship between the maintenance organisation and the technical system



Multi Apartment Building with Balanced and Exhaust Ventilation

Results and Experiences

Analysis of more than 8,000 reports from those inspections (collected in a database) shows that approved systems (37%) are divided into blocks of flats (25%), office buildings (43%), schools (37%), day-care centres (51%), and health care centres (32%).

Generally there are 4 minor and 2 grave faults per ventilation system. The common faults included the following: wrong air flow rate (61%), missing maintenance manuals (48%), deposits in fans (40%), defects in fans (30%), deposits in ducts (37%), control and guidance equipment (27%), deposits in filters (25%), defects in filters (20%), defects in supply and exhaust devices (23%), and deposits in supply air devices (22%).

The Swedish Board of Housing, Building and Planning

The Swedish Board of Housing, Building and Planning is a national government agency in the field of housing and the environment. The Board's main responsibilities are the built environment and the management of natural resources, physical planning, building and housing.

The Building Division is responsible for public requirements on buildings. These primarily concern health, safety, accessibility and energy management. The division also monitors developments in the construction field, coordinates Swedish building regulations with the EU and encourages appropriate construction and maintenance work.

Visit of Dutch Dwelling Projects by Belgian Delegation

On June 22, a Belgian delegation of 30 persons visited various dwelling projects in the Region of Rotterdam (Netherlands). The participants came from the Social Housing Society of the Walloon Region, the Walloon Ministry for Energy and Research and the Belgian Building Research Institute (BBRI). This technical visit took place in the framework of the Belgian participation of the Air Infiltration and Ventilation Centre and was organised by Willem De Gids (TNO-BOUW), Peter Wouters (BBRI) and Christophe Delmotte (BBRI).

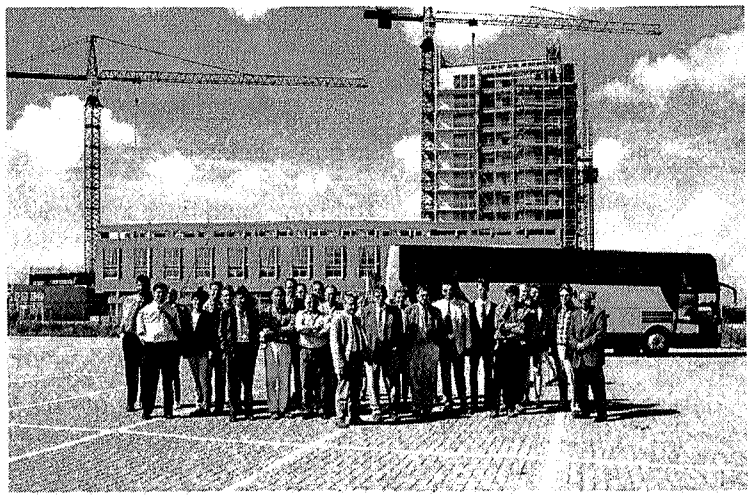
In the morning, there was a visit to a few older housing estates and to a very recent housing estate close to a new highway. The visit made very clear that the majority of older dwellings have small openable windows that are effectively used.

Lunch was offered by TNO-BOUW and a presentation of the activities of the organisation was given, including an overview of the on-going activities in the area of ventilation and indoor air quality.

In the afternoon, two projects were visited in depth. First, a new low-energy office building was visited in which innovative natural supply grills are used. There grills have an in-built detector allowing a more or less constant air flow and, moreover, avoid reverse flow. Central control as well as individual control by the users is possible. The grills are placed in the facades at the height of the false ceiling. Large grills between the false ceiling and the offices guarantee a correct air flow pattern without draught risk.

The second visit was to a renovation project south of Rotterdam. The gas-heating boiler and the balanced ventilation unit are combined allowing to have also heat recovery of the combustion gases.

Many participants were very pleased with the visit and were surprised by the very important differences in building tradition and ventilation market between Belgium and the Netherlands. Given the very positive results, similar visits to e.g. France and Germany might be considered. Perhaps also AIVC countries might envisage such exchange...



Passive Ventilation Air Quality Control in Houses

James Axley, Professor at Yale University School of Architecture, USA, carried out a ten-week research project over the summer to investigate natural ventilation systems in domestic buildings.

A brief summary of his findings is presented below. A paper, "Introduction to the Design of Natural Ventilation Systems Using Loop Equations" will be presented at the 19th AIVC Annual Conference in September 1998, and an AIVC Technical Note exploring the subject in more detail will be published next year.

The design of natural, including passive, ventilation systems assumes one of two generic forms: the "nasty" design problem where the designer seeks to size ventilation openings given climatic conditions and thermal comfort criteria or the "nice" design problem where the designer seeks to size ventilation openings given climatic conditions, indoor temperature distributions, and specified airflow rates – presumably determined from separate thermal or air quality considerations. The "nasty" form of design demands consideration of the complex dynamic coupled interaction of a building's airflow systems, thermal characteristics and airflow and thermal excitations – a challenge that only the most advanced simulation programs have been able to address and one where few, if any, can claim real expertise at this time. The "nice" form of ventilation design, on the other hand, is quite tractable and may be approached using existing, relatively simple and intuitively direct theory. Yet it is commonly perceived to be of a "nasty" character demanding iterative and approximate techniques for its solution.

The conference paper presents an "exact" approach to the "nice" design problem that may be considered to be a more complete formulation of the approximate approach recently published in the CIBSE Application Manual AM10:1997 The approach presented is based on so-called "loop equations" that are commonly used in flow network simulation in the hydraulics field but have been largely ignored in the building ventilation field. It allows direct sizing of a variety of airflow components and the direct and unambiguous consideration of both stack-driven and wind-driven flows without resorting to simplifying approximations. Yet the approach is developed in such a way as to enable building designers to identify a full range of feasible design configurations so that other, non technical design constraints may be included in the process of seeking a design solution – an example of such a design scenario will be presented.

The paper outlines the basic tasks of natural ventilation design and presents an approach to the sizing of ventilation components based on the formulation of pressure loop equations, that is: exact – i.e., based on fundamental theory without the need for simplifying assumptions; complete – i.e., allowing the complete and unambiguous consideration of wind and buoyancy effects and enabling the design of ventilation flow paths assembled from a variety of different flow components including but not limited to orifice, linear, power law, ducts and fittings, and, possibly, assist fans; and inclusive – i.e., allowing non technical considerations to be included in the selection of components, recognizing ventilation design has no unique solution in general.

The completed technical note, "A Practical Guide to Passive Ventilation Air Quality Control in Houses" will present additional worked examples, means to account for infiltration, recently developed self-regulating inlet vents , and assist fans, and will present an approach to deal with the more challenging "nasty" design problem.

Now Available

Proceedings - 19th AIVC Conference Ventilation Technologies in Urban Areas

Published by AIVC, September 1998, Price £65.00

The 19th AIVC Conference has taken place in Oslo, Norway at the end of September 1998. The proceedings, contained in one volume, with a forthcoming supplement of extra papers, are available from the Centre, price £65.00.

Divided into six full sessions, the proceedings cover:

- *Modelling and Control Algorithms*
- *Equipment and Envelope Characteristics*
- *Ventilation Performance and Building Airtightness*
- *Ventilation Strategies and Pollutant Transport*
- *NATVENT (TM) – Overcoming Technical Barriers*
- *Cooling and Indoor Air Quality in Commercial and Public Buildings*

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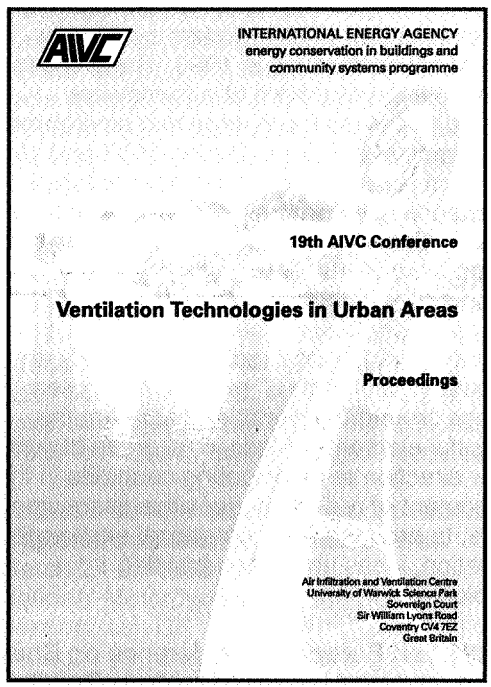

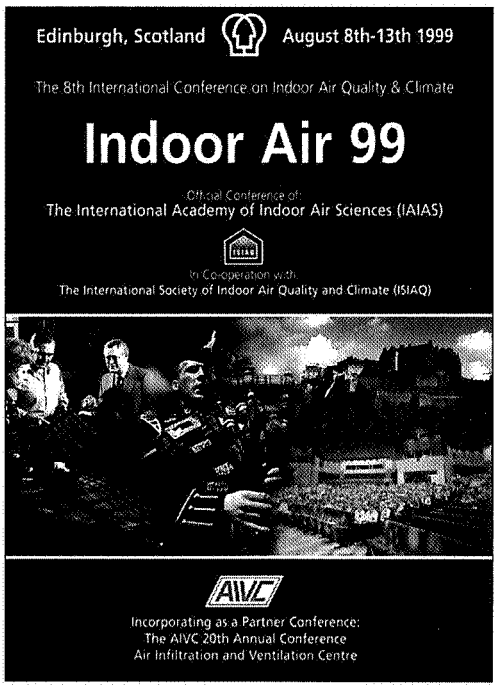

Scottish Venue for 20th AIVC Conference

The 20th AIVC Conference is to be held as a partner conference with Indoor Air 99, on August 8th – 13th 1999 in Edinburgh, Scotland.

For up to date information, including how to submit your abstract, please consult the Website at: www.ia99.org, or the Conference Secretary Mrs Claire Aizlewood, BRE, Garston, Watford WD2 7JR, UK, Tel: +44 1923 664123, Fax: +44 1923 664443

Forthcoming Conferences

World Renewable Energy Congress V Renewable energy climate change and the environment
20-25 September 1998
Florence, Italy
Prof A A M Sayigh, World Renewable Energy Network, 147 Hilmanton, Lower Earley, Reading RG6 4 HN, UK, Tel: +44 0118 961 1364, Fax:+44 0118 961 1365
Topics: solar and low energy architecture; photovoltaic technologies; solar thermal applications; wind energy generation; biomass conversion; energy resources; wave and tidal energy; hydrogen and storage; economics and financing; institutional issues; geothermal and ocean thermal; climatic and environmental issues; renewable energy: manufacturing.

Intelligent Buildings: Realising the Benefits
6-8 October 1998
Watford, UK
Angela Mondair, The European Intelligent Building Group, BRE Events, BRE, Garston, Watford WD2 7JR, UK, Tel: +44 (0)1923 664 775, Fax: +44 (0)1923 664 688, email: mondaira@bre.co.uk
Topics: why intelligent buildings matter; intelligent building technologies; overcoming the challences; the future of buildings.

4th International Renewable Energy Asia-Pacific '98 Conference & Exhibition (REAP '98)
14-16 October 1998
Shanghai Worldfield Convention Hotel, China
Alternative Development Asia Ltd (ADA Ltd), 1406 Leader Commercial Building, 54-56 Hillwood Road, TST, Kowloon, Hong Kong, Fax: +852 2574 1997, email: info@adal.com, Tel: +852 2574 9133, Web: www.adal.com

CIBSE National Conference 1998 Harnessing technology for sustainable development
18 - 20 October, 1998
Bournemouth International Centre, Bournemouth, UK
Web: http://www.cibse.org/solved/style/confer/events/98conf.htm
The intended scope includes: Specification issues, client needs; social and business developments; design issues; operational issues.

IAQ & Energy '98: Using ASHRAE Standards 62 and 90.1 to Provide Acceptable Indoor Air Quality and Energy Efficiency
October 24-27, 1998
Radisson Hotel, New Orleans, USA
ASHRAE Meetings, 1791 Tullie Circle, NE, Atlanta, Georgia 30329-2305, USA, Tel: 404 636 8400, Fax: 404 321 5478
The purpose of the seminar is to provide practically-oriented tutorials on the details of the standards to those who use them. In addition, technical sessions will be held to describe some of the research behind the standards to discuss options for implementing the requirements in the standards. Researchers will have the opportunity to present and discuss the strategies they are using and will use in the future to provide acceptable indoor air quality and energy efficiency within the context of Standards 62 and 90.1.

GBC '98 Green Building Challenge '98
26-28 October 1998
Hyatt Regency Hotel, Vancouver, Canada
Darinka Tolot, GBC '98 Conference Secretariat, CANMET Energy Technology Centre, NRCan 13/F, 580 Booth Street, Ottawa ON K1A 0E4, Canada, Fax: 613 996 9909, email darinka.tolot@nrcan.gc.ca
Green Building Challenge '98 is a two-year process of international building performance assessments that will be marked by a major international conference in 1998. The process involves the development of a framework designed to assess the energy and environmental performance of buildings. During 1997 and 1998 the system is being used to prepare detailed performance assessments of about 24 of the best green buildings from the participating countries. The goals are to test new methods of assessing building performance; to establish international benchmarks for building performance while respecting regional and technical diversity; to showcase "best practice" examples of green buildings around the world; to document the successful elements of individual green buildings; to offer direction to participating countries in the development of regionally-sensitive assessment models; to promote an international exchange of information, ideas and green building technologies.

EPIC '98 2nd European Conference on Energy Performance and Indoor Climate in Buildings and 3rd International Conference on Indoor Air Quality, Ventilation and Energy Conservation in Buildings
19-21 November 1998
Eurexpo Congress Centre, Lyon, France
Conference Secretariat, Laboratoire des Sciences de l'Habitat, Departement Genie-Civil et Batiment, CNRS D 1652, Ecole nationale des Travaux Publics de l'Etat, Rue Maurice Audin, F-69518 Vaulx-en-Velin, France Tel: +33 4 72 04 70 27 Fax: +33 4 72 04 70 41 email secretariat.lash@entpe.fr http://epic.entpe.fr
Topics: Indoor air quality, health and safety; ventilation and ventilation efficiency; thermal, visual and acoustical comfort; low energy retrofitting for better indoor climate; advance technologies and computer aided control and energy management; solar control and advanced windows; daylighting and energy efficient artificial

lighting; design and simulation tools; experimental techniques and validation; standardisation, energy policy and educational aspects.

1998 System Simulation in Buildings Conference
14-16 December 1998
Liege, Belgium
Michele Deprez, Laboratory of Thermodynamics, University of Liege, Campus du SART-TILMAN, Batiment B49 - Parking P33, B-4000 Liege, Belgium, Tel: +32 4 366 4800, Fax: +32 4 366 4812, email thermoap@ulg.ac.be, web: http://www.ulg.ac.be/labothap
Organised in close cooperation with the IEA ECBCS programme and ASHRAE TC 4.6 "Building Dynamics" and TC 4.7 "Energy Calculation". It will serve to conclude the work done for the IEA Annex 30 "Bringing simulation to application" and to deal with the subject developed in the IEA Annex 34 "Practical applications of fault detection and diagnosis techniques in real buildings." The following topics will be considered in priority: Building and HVAC component modelling; Practical use of simulation tools at the different stages of the building life cycle (design, commissioning, operation, retrofit); Practical use of simulation tools for fault detection and diagnosis; Practical use of simulation tools for optimal control.

World Renewable Energy Congress 1999
10-13 February 1999
Murdoch University, Perth Western Australia
Dr Kuruvilla Mathew, Environmental Science, Murdoch University, Murdoch WA 6150, Australia, Tel: +61 8 9360 2896, Fax: +61 8 9310 4997, email mathew@essun1.murdoch.edu.au, Website: http://wwwphys.murdoch.edu.au/acre/

VHExCo 99 The International Ventilation Hygiene Conference and Exhibition
March 24-25 1999
National Motorcycle Museum, Solihull, Birmingham, UK
VHExCo 99, Criterion Publishing Ltd, 2 Darsham Walk, Lums Yard, 32 High Street, Chesham, Bucks HP5 1EP, Great Britain, Tel +44 (0)1494 791 222, Fax: +44 (0)1494 792223

Intelligent and Responsive Buildings CIB Working Commission WO98 International Congress
March 29-30 1999
Brugge, Belgium
Mrs Rita Peys, Conference Manager, Ingenieurshuis - K VIV, Desguinlei 214, B-2018 Antwerpen, Belgium, Tel: +32 3 216 09 96, Fax: +32 3 216 06 89, email: buil@conferences.ti.kviv.be, http://www.ti.kviv.be/conf/buil.htm
Conference Objectives: The objective of the conference is to enhance and disseminate research and new developments in the area of intelligent and responsive buildings. Conference Topics: Papers covering (but not limited to) the following topics will be accepted: intelligent and responsive buildings; buildings for the aging society; accessibility of buildings for elderly and handicapped people; law, politics and regulations for intelligent and responsive buildings; international inventory of "Best Practices" in the field of intelligent and responsive buildings; the zero emission buildings; creating the productive workplace; integration of Building Automation in the Intelligent Building; demand side management in the intelligent building.

ISES 1999 Solar World Congress
July 4-9 1999
Jerusalem, Israel
ISES 1999 Solar World Congress, PO Box 50006, Tel Aviv 61500, Israel, Tel: 972 3 5140031, Fax: 972 3 5140077 or 5175674, email: ises99@kenes.com, Web: http://tx.technion.ac.il/~meryzse/ises99.html
Topics: renewable energy in buildings, direct solar collector technology, direct solar systems and applications, indirect solar technology and applications, storage and fuels, resource assessment, non-technical aspects.

Indoor Air 99 The 8th International Congress on Indoor Air Quality and Climate
8-13 August 1999
Edinburgh, UK
Prof G J Raw (Indoor Air 99) Building Research Establishment, Watford WD2 7JR, UK Fax: +44 1923 664088 email aizlewoodc@bre.co.uk
A wide range of subjects will be covered, including: all types of indoor air pollutant plus thermal and moisture problems; health, comfort and human performance in relation to the indoor environment; ventilation, infiltration, and building services; building design and materials; measurement, modelling and research methods; the scientific basis of policy and regulation.

PLEA 1999 Sustaining the Future Energy-Ecology-Architecture The 16th International Conference on Passive and Low Energy Architecture
September 29 - October 1 1999
Brisbane, Australia
Conference Secretariat (Sally Brown), ICTE Conferences, The University of Queensland, Brisbane, Australia 4072, Tel: 61 7 3365 6360, Fax: 61 7 3365 7099, email: sally.brown@mailbox.uq.edu.au
Will embrace the following subjects: policy, planning, legislative and regulatory issues; energy conservation and the use of solar and renewable energy in architecture; building physics, modelling, thermal and daylighting simulations; compulsion or persuasion, advice and design tools; architectural and urban design that expresses the spirit and also works.

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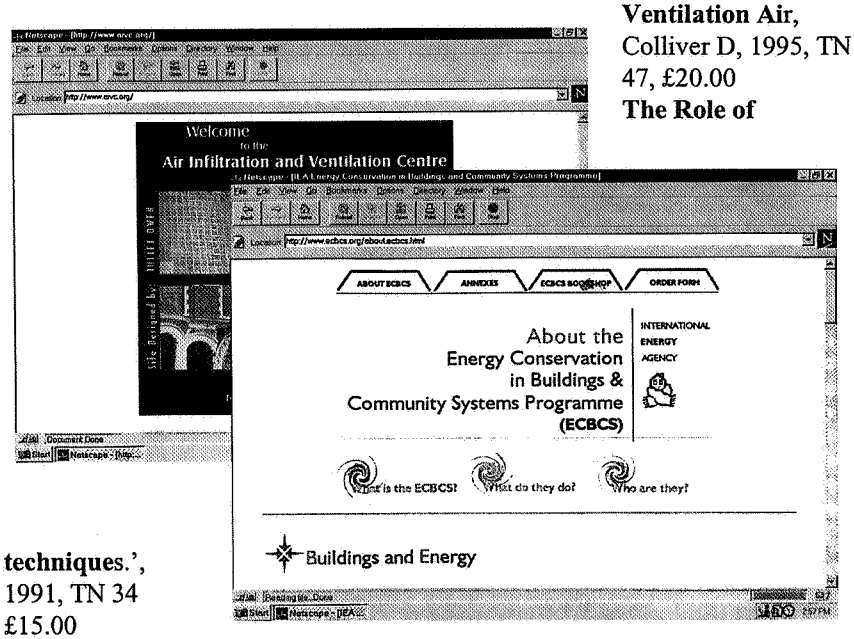

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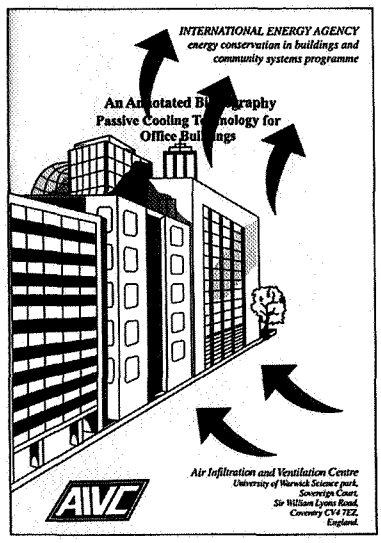

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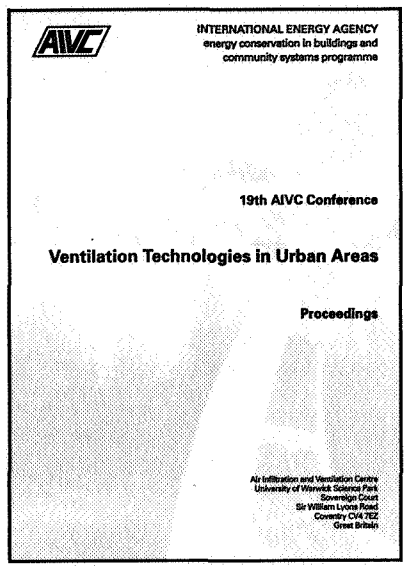

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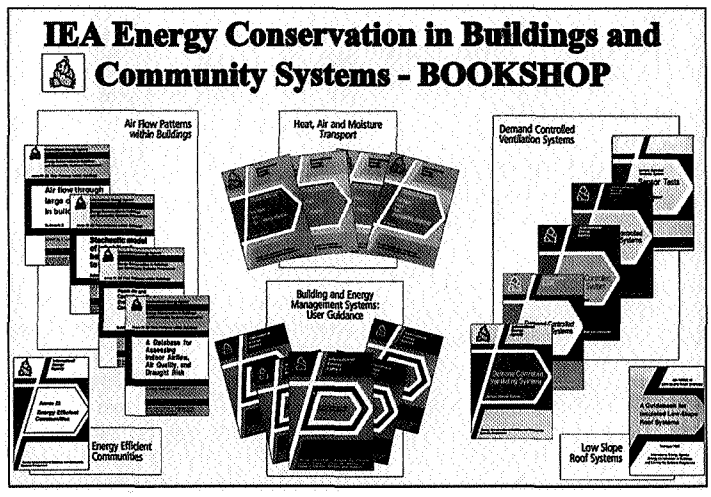

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