Air Infiltration Review

a quarterly newsletter from the IEA Air Infiltration and Ventilation Centre

International Energy Agency - AIVC Vol 22, No 1, December 2000

21st AIVC Annual Conference - Report

Innovations in Ventilation Technology

Held at Steigenberger Kurhaus Hotel, Scheveningen, The Hague, The Netherlands, 26th - 29th September, 2000

Introduction

The 21st AIVC Annual Conference took place recently in The Netherlands at the Kurhaus Hotel, located in The Hague. Nearly 80 participants from 17 different countries attended the conference, which spanned four days and consisted of 56 paper and poster presentations. It focused on innovations in ventilation technology and their effects on the provision of ventilation in buildings. Included among the wide range of subjects discussed were ventilation strategies, calculation, measurement and design methods, standards, energy impact and occupant response. Summaries of a selection of the papers may be found below.

Keynote Address

The Keynote Speaker at the 21st AIVC Conference, Prof ir Hans Cauberg from the Technical University of Delft, explored the main driving forces behind recent changes in the Dutch Building Regulations. Principally, he thought, these contain a greater emphasis on sustainable development, energy performance standards and life cycle cost assessments, all of which have been or are currently being addressed in the Regulations. The Building Regulations and associated standards have all stemmed from research conducted on specific building elements over time. In the past this research has mainly focused on the reduction of energy use. However the concept of sustainability, including healthy indoor air quality and environmental impact, has become the key issue in ventilation research. This trend will affect the ventilation systems used in modern buildings. He foresaw that in the near future there would be a major shift away from developing components individually towards whole system concepts. Central to this shift, he proposed, would be the advance of hybrid ventilation concepts with an integrated approach for both commercial and residential buildings.

In this issue

Innovative Strategies and Hybrid Ventilation

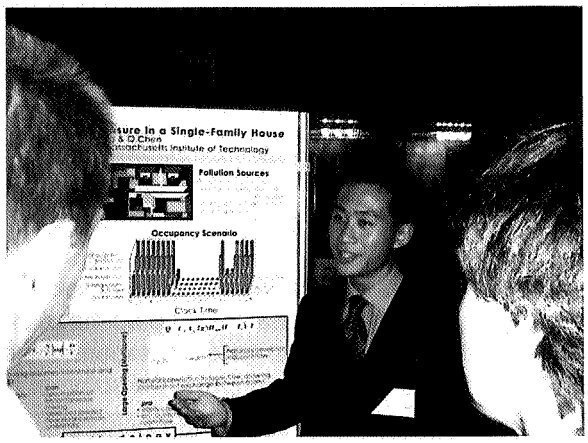
Several innovative strategies were presented and in particular, hybrid ventilation was a key topic. Peter Wouters (BBRI, Belgium) examined the major characteristics of hybrid ventilation systems, considering such systems as a whole range of associated strategies as opposed to a single concept. He suggested that future ventilation systems would inevitably be composed of hybrid solutions containing technologies such as low pressure ductwork, fans, and static heat exchangers, and would operate within current or improved energy and environmental targets. From The Netherlands, Willem de Gids (TNO) discussed the development of energy efficient and sustainable air distribution systems for mechanical ventilation (LeVent) as part of the EU TIPVENT project. The research dealt with the development of low resistance ductwork, fittings and air terminal devices, better controls and more efficient fans. He reported that the fan energy use in domestic ventilation could be decreased by a factor of between two and five. However, the costs of such improvements presently result in unrealistic payback periods.

A Japanese test house containing a full-scale hybrid ventilation system was described on behalf of the author. Results indicate that the addition of an electric fan for mild weather situations can augment any under ventilation with the airflow rate being fixable. Over ventilation can also be minimised with an additional damper control in cold weather. Mark Bassett (BRANZ, New Zealand) identified the need to develop such hybrid systems in New Zealand. While their building codes still allow residential ventilation provision based on openable window areas, these buildings are becoming increasingly more airtight, with a decreasing reliance on window opening. Thus, new ventilation strategies are required to ensure adequate ventilation is maintained. It is envisaged that a combination of natural and simple mechanical ventilation will provide an efficient and cost effective answer.

Implications of Demand Controlled Ventilation

Another important issue examined by several authors was the effectiveness of demand controlled ventilation (DCV). Helmut Weinläder (ZAE Bayern, Germany) compared the indoor air quality within classrooms ventilated by a DCV exhaust system and a natural ventilation system. The DCV system provided lower peak CO2 levels (>2500 ppm) than those measured in the classrooms ventilated naturally (4000 ppm). The higher air exchange rates associated with exhaust ventilation causes no measurable increases in heating demand and no noise or draught problems were experienced.

Two different DCV systems installed into meeting rooms were investigated by Anne-Marie Bernard (CETIAT,



Jeffrey Huang presents his poster "Modelling contaminant exposure and indoor air quality in a single family house".

France). The first system was controlled via a movement sensor located on terminal units and the second system incorporated a CO2 detector attached to the fan. Energy savings of over 70% were seen based on intermittent occupation and maintaining CO2 levels. The payback time for the French market and electrical power cost would be 2 years. In a study involving Danish dwellings, Niels Bergsoe (Danish Building Research Institute) examined the energy saving potential for DCV, in which the indoor humidity is the most important IAQ problem. Simulations indicate that basic ventilation in a typical Danish apartment under normal conditions can be reduced by 20% - 30% without compromising the indoor air quality.

Energy Implications

Based on the different ventilation rates stated in various European regulations, Vitor Leal (IDMEC-Pólo FEUP, Portugal) has identified their energy impacts. In fact, by using variable DCV based on CO2 and free cooling, large energy savings can be made. In terms of fan power use, the energy saving potential can be large and further enhanced by combing several techniques, representive energy savings of up to 70% can be made compared to a typical system.

Dipak Shah (Honeywell, USA) examined various residential ventilation methods required to achieve the ASHRAE recommended minimum ventilation level of 0.35 ach, using dynamic computer simulations. Results showed that single direction ventilation, partially compensates for high natural infiltration levels and saves half the energy cost of ventilating with a direction method without heat recovery. Continuous exhaust fan operation to provide 0.35 ach mechanical ventilation results in the lowest annual energy cost. In particularly airtight homes, two direction ventilation may be required. Simulation also shows that heat recovery ventilators significantly reduce the annual energy cost of two directional ventilation. Additionally, Augustino Binamu (Tampere University of Technology, Finland)

Martin Liddament Bids Farewell to the AIVC

After a twenty year association with the AIVC, the time has sadly come for me to say goodbye. I have had a very happy time at the Centre and therefore it is especially difficult to wrench myself away. However, the moment has come to accept new challenges.

Although leaving the Centre, I shall, nevertheless, play an active as role as is necessary to ensure its long term future and viability. Undoubtedly the funding structure will change. My belief has always been that the Centre should be an institution run by its users and available to all at a nominal cost. However, it is a vision that has, so far, not been possible to realise. I am confident, though, that the value of this approach will ultimately be seen.

As for my future, I intend to continue in the field and endeavour to reach the parts that have, for so long, been inaccessible to the AIVC. Among my new activities I have taken over the editorship of Ambient Energy - the international journal of renewable energy. I am also assisting in the work of the World Renewable Energy Network. Both activities are involved with the special needs of developing countries - an area that will form the centre stage for any workable global energy strategy. My speciality will remain ventilation and, to this end, I will be involved in the launch of a new international journal with the simple title 'The International Journal of Ventilation'.

Finally, I cannot take my leave without expressing my gratitude to all my colleagues here at Coventry and to all of you for the support you have given me during my time at the Centre. To have been part of the AIVC has been a very special privilege.

Martin Liddament

Martin's homepage, which is devoted to ventilation and air quality technology, can be found at http://homepage.virgin.net/vent.air

has derived an equation making it possible to recalculate air change energy use to alternative base temperatures and hence make comparisons among different countries, using differing heating degree day base temperatures.

Technologies for Improved Thermal and Acoustical Comfort

The supply air ventilated window concept was examined by two authors. The first, Ryan Southall (University of Cambridge, UK) explained the principle whereby external air enters through a vent at the base of the window and this relatively cold air is heated by convection and conduction from the warmer inner pane. It then enters the room through a vent at the window top. The second author, Dolf van Paassen (Technical University of Delft, The Netherlands) discussed similar technology for double façades. The principle includes several different ventilation strategies and ways of interaction between the cavity, the interior and the exterior of the building. In a further contribution, Ian Matthews (University of Portsmouth, UK) examined how using fuzzy logic models, occupant preferences can be modelled to predict their preferred thermal and environmental conditions.

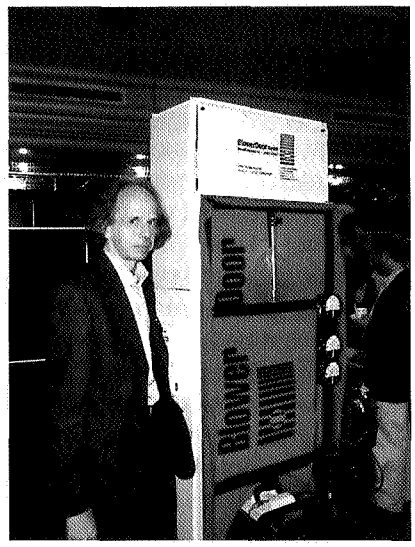
On the subject of acoustical comfort, Steve Sharples (Sheffield Hallam University, UK) presented a paper examining techniques for improving the acoustic properties of a natural ventilation opening located in an external wall. Maintaining typical air flow rates and natural pressure differentials, up to 9 dBA greater sound reduction index could be obtained by the insertion of a simple screen in front of the aperture, compared with a wall containing a single acoustic louvre. Preliminary application of active control has suggested that attenuation in excess of 7.5 dB to 8.5 dB can be achieved for traffic noise.

Innovative Technologies

A novel low maintenance, compact and energy efficient domestic ventilation heat recovery heat pump system was discussed by Mark Gillott (University of Nottingham, UK). This uses revolving heat exchangers instead of a fan impeller. The prototype system has a COP of up to 5 and an average of 2.5 over a range of conditions. A typical system provides 2 kW of heating for air supplied at 250 m3/h. The system can also be used for cooling by switching the air flows over the evaporator and condenser.

Olivia Noël (Gaz de France, France) outlined a ventilation system, developed under the JOULE III programme (NAVAIR project). This system can be installed at the end of existing ducts providing both ventilation and evacuation of combustion products from a natural gas boiler, and is therefore particularly relevant for retrofitted dwelling applications.

A new process to separate dehumidification and cooling by the utilisation of liquid desiccants was by explained by Sönke Biel (University of Essen, Germany). In this system the outdoor air is dehumidified by a liquid desiccant which is cooled by circulating water from the evaporative cooling system. Dehumidification and regeneration are separate and do not have to be carried out simultaneously. Its advantage is a clear reduction of electrical power input in the summer and reduced energy requirement in relation to systems with a compression refrigeration cycle.



Demonstrating the Minneapolis Blower Door

Modelling and Measurement

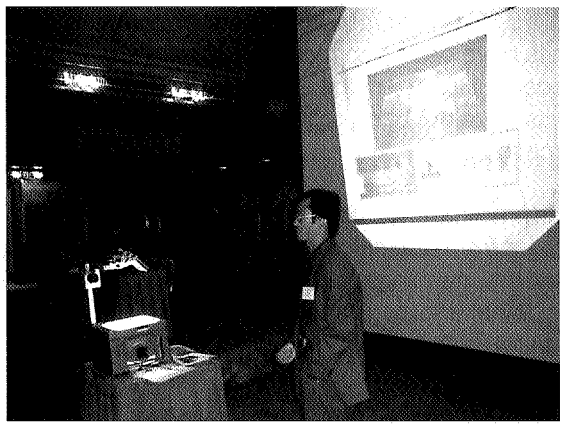
It is clear that prediction through modelling and measurement plays a key role in the development of new, and the improvement of existing, ventilation systems and their components. In a case study simulation and comparison against field measurements, Konstantia Papakonstantinou (University of Athens, Greece) outlined a study of an industrial building with displacement ventilation and a high thermal load. The main ventilation design problem is to ensure that the interface between fresh air zone and the hot air zone is located above the occupied region of the room. Also, Eoin Clancy (Coventry University, UK) outlined the development of a simple ventilation and thermal model, derived from experimental data for predicting ventilation rates and internal temperatures within an auditorium.

Hans Stymne (University of Gävle, Sweden) reported on a new homogenous pulse tracer gas technique which has not previously been experimentally validated. Pulses of tracer gas are injected into different zones, in proportion to the zone volumes, allowing pulses to be injected at any time path and making it possible to utilise integrating air samplers. His experiments have

shown that this technique compares well against the decay method.

Confirming earlier theoretical predictions, Alice Andersen (Windowmaster, Denmark) has found experimentally that under certain circumstances, a particular building geometry with a given heat source and a fixed wind speed may lead to more than one stable ventilation mode and, consequently, air flow rate. Depending on the initial conditions, she found that displacement flow or mixing flow may occur.

A physical model has been used by Gary Hunt (University of Cambridge, UK) to explain what happens at high Reynolds numbers as flow contract through a square edged opening. A small scale water tank using saline solutions to generate buoyancy forces was used. With this model, he observed that a discharge of buoyant fluid from a horizontal opening produces a plume-like flow, which may initially contract considerably in cross section as it rises. This contraction effectively reduces the usable area of the opening and gives rise to reduced values of discharge coefficient. Gary Hunt received the Conference "Best Paper" award for his paper.



John Zhai: "Integration of indoor and outdoor airflow study for natural ventilation design using CFD".

Design Criteria

The nature and quality of the source ventilation air should be the determining factor for the sizing of, for instance, fans sizes or ducts, proposed Mats Persson (Chalmers University of Technology, Sweden). In consequence, they should not be sized on the minimum ventilation rate requirements in standards. These may only result in the provision of minimum ventilation, which sometimes proves insufficient. Furthermore, Rik Vollebregt (Bureau Kent, Netherlands) suggested that as a consequence of improved airtightness and the use of self-regulating air vents, the design pressure difference in the Netherlands building regulations should be increased from 1 Pa to 2 Pa for new buildings. This should be regarded as a minimum level. The aforementioned changes have resulted in decreased energy losses, better ventilation patterns, improved air quality and occupant comfort.

Environmental and Occupant Surveys

An on-going survey of French ventilation and energy use within homes was presented by Marie-Claude Lemaire (ADEME, France). Her results indicated that the installation of a ventilation system had little bearing on the opening of windows, although in buildings with balanced systems, windows appeared to be opened for less time, compared to buildings with a simple mechanical system. Occupants in the latter open windows less often than those with natural ventilation systems. Whilst mechanical ventilation does appear to limit problems with mould, moisture and odours it does suffer from noise related problems.

In a paper that won the "Best Poster" award at the Conference, Jerzy Sowa (Warsaw University of Technology, Poland) compared 28 real classroom environments in Warsaw, against accepted requirements and standards. He found the main problem was overheating, with controls compensating for high heat gains, thus leading to excessive energy use and thermal discomfort. Also, inefficient ventilation causes high CO2 concentrations. Moreover, window opening is hindered in noisy urban areas. He proposed the only solution to this problem, while keeping to energy conservation and air quality requirements, would be the general application of more sophisticated (but easily still operated) ventilation systems with heat recovery and effective filtration.

Summing-Up

In his final duty as Head of the AIVC, Martin Liddament summed up the conference. In this, he observed how the work presented at the Conference related to the changes that have occurred in ventilation research and practice over the past 30 years.

Acknowledgements

The AIVC would like to thank the exhibitors, Blower Door GmbH (who demonstrated the Minneapolis Blower Door™) and Alusta (who exhibited their Vent-o-System® automatic natural ventilation system). Appreciation is also extended to all participants and contributors, who made the Conference so successful. The Proceedings of the 21st AIVC Conference may be purchased from the AIVC, priced £65 (excluding VAT).

Quality in Relation to Indoor Climate and Energy Efficiency

An Analysis of Trends, Achievements and Remaining Challenges

PhD Thesis by Peter Wouters

Faculté des Sciences Appliquées, Département Architecture et Construction (ARCH)
1999-2000

Background

The motivations for carrying out this PhD thesis were multiple:

1. Over the last twenty to thirty years, there have been major changes in emphasis with respect to discussions and priorities concerning energy and indoor climate in buildings. Examples are:

- In the seventies and eighties, energy conservation for heating was the key issue of concern in most climates . Today much more attention is paid to global energy use in buildings, including energy for cooling, lighting, appliances, hot water, etc.

- Whereas in moderate and cold climates, the maximisation of passive solar gains was the priority until the eighties, much more attention is now paid to developing a balanced view which focuses on the optimisation of solar energy in buildings.

- During the nineties, there has been increased interest in the type of finishing materials and ventilation systems used in buildings and this due to concerns with respect to the indoor air quality of buildings.

- Ventilation systems have always been classified as 'mechanical' or 'natural'. In recent years, the concept of hybrid ventilation systems has emerged. Why is this and how can we identify this technology with respect to indoor climate and energy efficiency?

- Until the beginning of the nineties, summer comfort was not really an issue of concern in mild climates. Today, and especially for office type buildings, it is considered a top priority. Is this because of increased comfort standards or because of other reasons?

This thesis aims to obtain a better understanding of the underlying reasons for these changes of emphasis and to place them in a global context.

2. The analysis of certain procedures applied in daily practice leads to some interesting observations. Examples are:

- The dimensioning rules for natural air supply devices vary substantially between different countries: the dimensioning pressures range from 1 Pa to 20 Pa, in some countries the supply openings MUST be closable whereas in other countries they MAY NOT be closable.

- Thermal insulation performances of glazing units have been improved substantially over the last decade. However, the edge losses through glazing units have not been reduced at all in practice. Is this acceptable?

3. In practice, one quite often finds performances which are far from optimal. Examples are very poorly insulated new dwellings, very leaky buildings and ductwork, etc. What are the reasons? Are these reasons common for various technologies? For various countries, etc?

4. Achieving a built environment with better indoor climate conditions and better energy efficiency seems a justified objective. A better understanding of the whole process may lead to a better identification of the required actions for realising this objective.

The thesis aims to achieve a substantial improvement in the understanding of these various issues as well as exploring the challenges, advantages and disadvantages of certain approaches. It also gives suggestions for improving the situation.

Summary

The thesis focuses on a global analysis in terms of indoor climate quality, energy efficiency and the interaction between the two. Particular attention is paid to trends, achievements and remaining challenges.

In Chapter 2, the discussion focuses on the notion of 'quality', whereby quality is defined by the stated and implied needs of the customer and of society. Within the framework of this thesis, the general quality objective is described as follows: 'To accomplish a built environment which achieves appropriate indoor climate conditions for the users of these buildings, at the same time requiring only limited energy use.'

In Chapter 3, attention is paid to some major developments in history. From this analysis, it is clear that the increased complexity of the built environment and of building technology in combination with new factors (new building technology, energy efficiency, the increased importance of building promoters, etc) makes the use of implied needs less evident, so that stated needs become more important.

Because of the increased importance of the stated needs, the discussions in Chapters 4 and 5 are concentrated on major developments and challenges in relation to the stated needs concerning indoor climate (Chapter 4) and energy efficiency (Chapter 5). The analysis clearly indicates that there are major developments in the stated needs, whereby performance prediction is becoming more and more important.

In line with these observations, Chapter 6 focuses on the challenges in relation to performance prediction, whereas Chapter 7 deals with standards and regulations and project specific requirements. From this analysis, it is clear that an optimal representation of the customer and societal needs is not evident.

In Chapter 8, there is a review of critical technical and non-technical boundary conditions. In Chapter 9, the attention is drawn to the potential importance of local conditions whereby, as an illustration, the Belgian context is analysed.

A crucial aspect of the thesis is the analysis of the interaction between the built environment and building technology. In Chapter 10 and in the annex report on technologies, some 14 building technologies are analysed (thermal insulation of opaque and transparent components, solar control, sunspaces, natural and mechanical ventilation for indoor air quality control, night ventilation, ventilation in the Horeca, airtightness of building and ductwork, lighting and hybrid photovoltaic energy. From this analysis, it is clear that there are a whole range of potential barriers to achieving quality. In Chapter 11, Energy Performance Regulation (EPR) is critically reviewed and the attention is focused on the challenges. In case these challenges are correctly handled, the author believes that an EPR has the potential for giving a substantial contribution to the achievement of the general quality objective.

General Conclusions

During the last 25 years, the overall context with respect to indoor climate and energy efficiency of buildings has radically changed. The result is a much more complex design challenge for buildings and products and the need for a coherent integration of many challenges in a single project. The latter is not evident at the moment.

The analysis of the present situation clearly indicates that although in a number of areas, and especially at component level, a remarkable improvement has been achieved, there are many areas where in daily practice a substantial progress in performances is required and possible. This is valid for aspects of indoor climate as well as energy efficiency in buildings.

Given the fact that in many cases the performances in relation to indoor climate and energy efficiency are not evident to be correctly assessed, there is often an important difference between 'achieving the general quality objective' and 'achieving works which are accepted by the customer' with quality being related to the stated and implied needs of the customer. This is probably the key concept of the whole thesis.

It is evident that the individual actors alone (architects, consulting engineers, material producers, building contractors, government, research organisations, etc) are unable to realise the substantial improvement in performance which is necessary. Therefore, the key challenge is first of all to create a framework which unambiguously defines the expected performances (what kind of 'quality') and, secondly, to set up a coherent framework allowing the various actors to achieve these performance requirements.

The author believes that an Energy Performance Regulation has the potential for becoming an excellent tool for creating such a framework. However, a whole range of challenges have to be handled before success can be guaranteed.

As far as the Belgian situation is concerned, there are many areas for a substantial improvement. Fortunately, an increased awareness and goodwill for collaboration is already apparent, and one might therefore expect significant improvements during the coming years.

Finally, the fact that there is all too often a lack of good performance is not due, in the majority of the cases, to a lack of technological capabilities, or to high life cycle costs. In the main, poor performance are due to non technical reasons. Therefore, fundamental improvements are only possible in most cases by improving these non technical boundary conditions. Accordingly, future actions should give sufficient attention to non-technical aspects.

Arkito: Architectural Form and the Stack Effect - Natural Ventilation in Housing

by Rob Marsh, Architect MAA PhD, Assistant Professor in Sustainable Architecture & Design, Aarhus School of Architecture, Denmark

Whilst there has been considerable development in relation to the natural ventilation of buildings, there has been a tendancy to focus on technical solutions. There are however several aspects of natural ventilation that require a conscious architectural input in order to be successful, for example in relation to the spatial organisation of a building in both plan and section. The succesful design of naturally ventilated buildings therefore requires a cross-disciplinary design approach involving arhitects and engineers. The aim of this Danish project is therefore to use a cross-disciplinary approach to develop prototypical naturally ventilated housing where architectural form and spatial disposition are used to promote the natural forces that drive natural ventilation. In this way it is hoped to achieve an integrated synthesis of form and function, so that the architectural quality is improved.

Theoretical and practical investigations show that natural ventilation has energy-saving and environmental advantages in comparison to both mechanical extract ventilation and mechanical ventilation with heat recovery when one also takes into account the electrical consumption to the ventilators. It has also been shown that natural ventilation can achieve a satisfactory air change rate and give a good indoor climate. However, a house's spatial disposition and the design of the ventilation openings have a critical influence on the exploitation of the natural forces that drive ventilation. The project therefore has the following phases:

Phase 1: Literature survey

A collection and analysis of existing knowledge in relevant areas. One of the aims here is to promote a cross-disciplinary understanding by analysing and presenting the architectural aspects of natural ventilation to the engineers involved in the project, and by analysing and presenting the engineering aspects of natural ventilation to the architects involved in the project.

Phase 2: Development and architectural design of prototypical houses

2.1 Architectural and engineering design of typical apartments, terraced houses and detached houses.

The design will focus on the development of architectural solutions where the housing's form and spatial disposition in plan and section promotes natural ventilation by the stack effect.

2.2 Design of ventilation openings.

A study of the design of ventilation openings to assess comfort and indoor climatic aspects and to help the development of the prototypical housing designs. The study will especially focus on how a modified type of double facade that is suitable for housing can be developed.

With a cross-disciplinary approach to the activities, the aim is to refine the prototypical housing designs in an iterative process, so that the architectural and technological solutions are constantly improved in relation to each other.

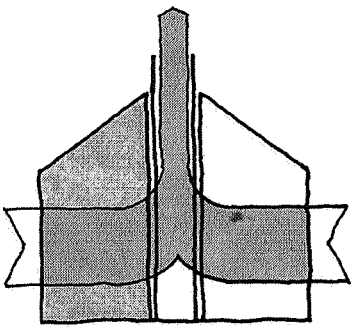


Figure 1a: The chimney used as spatial element: chimney placed centrally in the house's plan with outlet above the roof's ridge.

Phase 3: Dissemination

The project results will be widely disseminated to all actors involved in the housing and construction sectors, but with a focus on architects and engineers to promote cross-disciplinary design approaches.

Project Group

The project is sponsored by the Danish Energy Agency's Energy Research Program 2000 and runs from July 2000 to June 2002. The project group consists of:

Aarhus School of Architecture (Project leader: Rob Marsh Architect MAA PhD); Department of Building Technology, Aalborg University; Danish Building Research Instisute; Bæk Simonsen and Aaris Architects; Birch & Krogboe Engineers; WindowMaster A/S; Viborg Housing Association.

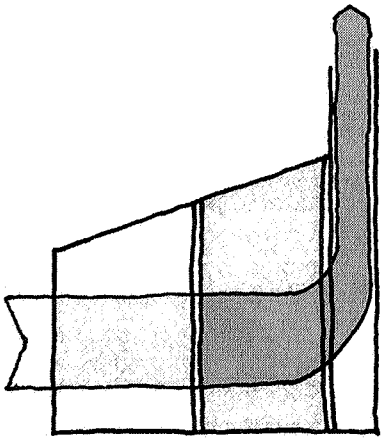


Figure 1b: The chimney used as spatial element: zoned house in plan and section with tall chimney placed along the roof's ridge.

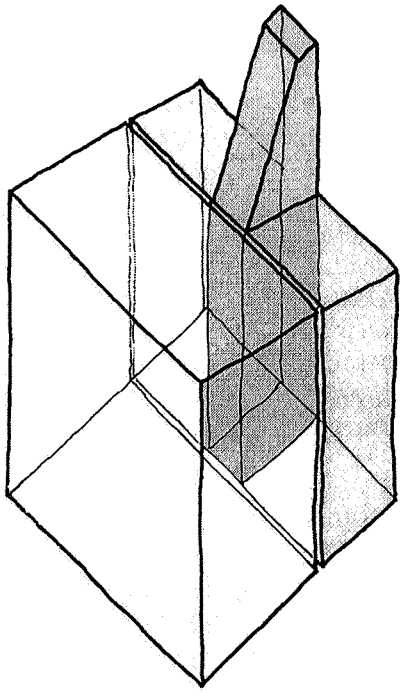


Figure 2: The chimney as a ventilation element used to spatially organise the house; vertical and without bends, and with the kitchen and bathroom located around the chimney.

Report on the International Conference Roomvent 2000

9 – 12 July 2000, The University of Reading, UK

Hazim B. Awbi, Department of Construction Management & Engineering, The University of Reading, UK, Tel: +44 118 931 6786, Fax: +44 118 931 3856

The 7th International Conference on Air Distribution in Rooms was held at The University of Reading, UK for the period 9-12 July 2000. Reading was the first UK venue for this well-established conference. The theme of the Conference was Ventilation for Health and Sustainable Environment.

The Conference was attended by around 200 delegates representing mainly developed countries from every continent, where there is considerable interest in ventilation, comfort and indoor air quality issues.

The Opening Session included the Opening Address by the Chairman of RoomVent 2000, Dr. Hazim Awbi of The University of Reading which was followed by a Welcome to Reading address by the Mayor of Reading, Councillor Bob Green and then the Vice-Chancellor, Professor Roger Williams welcomed the delegates to the University.

The proceedings continued by an address by Professor P. Ole Fanger, the President of SCANVAC (Scandinavian Federation of Heating, Ventilating and Sanitary Engineering Associations in Denmark, Finland, Iceland, Norway and Sweden), which is the organisation that initiated this Conference and sanctions the chairmen and venues of the RoomVent Conferences. This was followed by an address by Mr. David Wood, the President of the Chartered Institution of Building Services Engineers who emphasised the relevance of sustainability in building design and operation.

The first Keynote Address then followed by Professor Fanger, an international authority on indoor environment, which was titled 'Provide good air quality for people and improve their productivity'. In his address, Professor Fanger proposed the concept of personalised air supplies to provide fresh air directly to the occupants of a building rather than to the whole space.

In the four day programme of the conference there were 198 papers by authors from 31 countries. The papers have been reviewed by leading world experts and they report on the latest research in the field. Presentations were either in the form of a short oral presentation and a poster or a longer oral presentation. The conference has attracted a large number of excellent papers; some addressing the fundamental problems of room air distribution, modern computer analysis and simulation techniques (particularly CFD), the effect on health and comfort of room air, efficient room air distribution, recent advances in natural ventilation research and papers dealing with numerous applications in real buildings. The papers were grouped under the following subject areas: Indoor Environment, Predictive Methods, Air Distribution, Ventilation Strategies, Ventilation System Efficiency, and Applications. They were presented in seven Technical Sessions and five Keynote addresses by distinguished researchers and practitioners from the participating countries. The Proceedings are published in two hard-cover volumes as well as CD-ROM.

Indoor Environment

There were a total of 26 papers under this category covering thermal comfort and indoor air quality. The general observations are that there is now a better understanding of the fundamental mechanisms governing the interaction of the occupants with the indoor environment. Modelling of this process is becoming more accurate and computer models have become essential tools in thermal comfort analysis. Refinement of computer models for specialised applications is being carried out by a number of researchers. Other papers dealt with IAQ, particularly investigating the movement and distribution of solid, organic and gaseous particulates in mechanically ventilated spaces as well as the effect of exposure to these on humans.

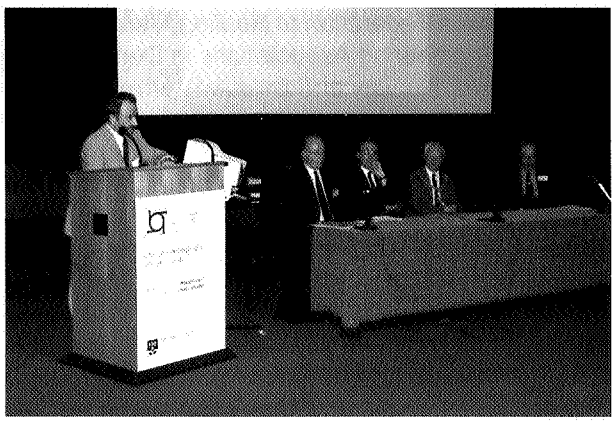


Photo: Dr. Hazim Awbi delivering the opening address of RoomVent 2000 Seated are Mr. David Wood, President of CIBSE, The Vice-Chancellor, Professor Roger Williams, The Mayor of Reading, Mr. Bob Green and Professor Ole Fanger, President of SCANVAC

The main conclusions are that both experimental and numerical methods are required to improve our predictions of the indoor environment. Experiments are needed for providing more accurate boundary conditions for heat and mass transfer studies as well as for validation of computer models. In addition, CFD and other modelling techniques are required for improving our understanding of the interaction between humans and the environment.

Predictive Methods

There were a total of 52 papers categorised under predictive methods covering physical models, analytical models and computational methods. Physical models used water with salt solution or local heating to produce the density differences, or full-scale test rooms using air. Analytical models were applied for studying the airflow and heat transfer in a single-zone or multi-zones for natural and mechanical ventilation systems. The majority of computer modelling was CFD based. Results have shown that the predictive accuracy improved when the large eddy simulation (LES) turbulence model was used instead of the standard k-ε model.

Small-scale water models were used to study jet flows and gravity currents in buoyancy-driven flows. Full-scale airflow models (environmental chambers) were used to study the effect of Reynolds number on room airflow, cooled/heated beams and novel air supply and air extract devices.

Simple analytical models studied the effect of air inlet openings' location on room air movement, solar-driven ventilation devices and the consideration of multiple solutions in naturally ventilated enclosures. Advanced multi-zone models based on the loop equations for pressure and airflow paths were presented. A number of investigators found that the quadratic zonal flow equation ($\Delta p = \alpha Q + \beta Q^2$) predicts the inter-zonal flow better than the power law ($\Delta p = k Q^{1/n}$).

CFD was used either as the only means of predicting the airflow or in conjunction with experimental and/or simplified analytical models. A number of commercial as well as proprietary codes have been used for the simulations.

Air Distribution and Ventilation Strategies

There were a total of 53 papers under the categories of air distribution and ventilation strategies. Topics included air diffusers, jets and plumes, air supply devices, air curtains, gravity currents, chilled ceilings, under-floor air distribution, displacement ventilation, personal and local exhausts/fume-hoods and natural/hybrid ventilation.

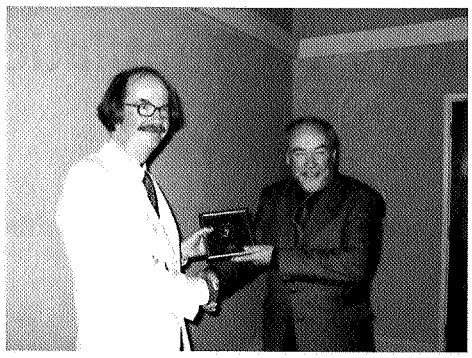


Photo: Professor Mats Sandberg receiving the first John Rydberg gold medal from Professor Ole Fanger

The main conclusions here were that ROOMVENT still focuses on the development of new methodologies for air distribution which was more prominent at this Conference in the areas of displacement and natural ventilation systems.

Recommendations for future studies under these areas include investigations of ventilation system performance beyond the traditional airflow and thermal conditions to good IAQ and energy efficiency and to develop practical guidelines for the building industry. Although the knowledge in displacement ventilation is steadily improving there is still a great deal to be done in exploring the design, performance and applications of natural ventilation for wider implementation.

System Efficiency

The topics covered under this category were ventilation efficiency for contaminant control and heat removal and energy efficiency of ventilation systems. There were 18 papers on topics such as: air change efficiency for supply and exhaust systems, the effect of air re-circulation on ventilation effectiveness, the impact of ventilation rates, passive systems such as night cooling and double skin facades, active systems such as chilled ceilings employing cooling towers, and stochastic prediction of ventilation system performance.

Applications

There were 45 papers under this category covering theory, measurements and computer simulation using zonal models and computational fluid dynamics (CFD). Most of the measurements were carried out in full-scale and some measurements were carried out to provide boundary conditions for more detailed CFD analyses. The main topics covered here were thermal comfort, inddor air quality, bulk flows (heat and mass transfer), flow fields, air change rates, ventilation efficiency and measurements and simulations of the ventilation efficiency and the mean room age of air. Natural ventilation, mechanical (including air-conditioning) and hybrid ventilation systems were investigated. The spaces considered ranged from single-zone dwellings, multi-family dwellings, office buildings, classrooms, to large enclosures. Although the majority of papers dealt with the internal environment, some papers considered the external environment and the interaction between the internal and the external environments.

Conclusions

The main conclusions of the Conference are:

The ROOMVENT Conferences still focus on the development of new air distribution methodologies based on measurements, computer modelling and performance evaluation on site.

There is a definite link between productivity in offices and indoor air quality.

It pays to provide much better air quality in office buildings than present standards prescribe. This can be accomplished by systematic selection of low polluting building materials and by increasing ventilation.

Natural ventilation can be effective in a number of different climates if careful design considerations are considered. However, there is still a lot of work to be done in the development and applications of natural ventilation systems for large buildings to become as common as mechanical ventilation is.

Advanced air distribution systems can improve the air quality for people at moderate cost and energy consumption.

Future studies should focus on ventilation systems performance beyond the traditional airflow and thermal conditions to include good IAQ and energy efficiency and to develop practical guidelines for the building industry in these areas.

Prizes and Awards

There were prizes awarded to the best poster in each poster session and these were given to:

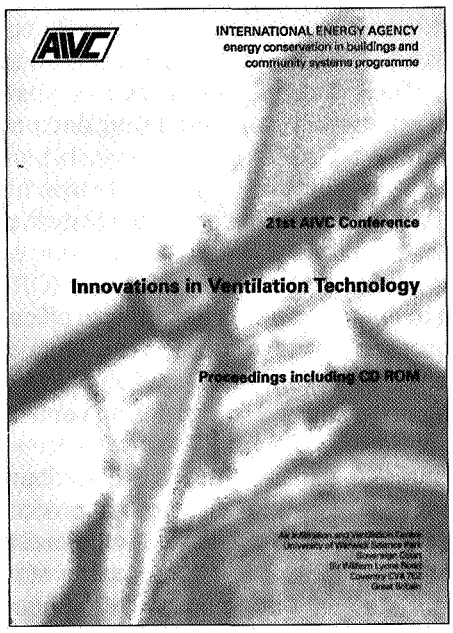
Linden E., Cehlin M. and Sandberg M. from Sweden for the poster paper titled "Temperature and velocity measurements on a diffuser for displacement ventilation with whole field methods".

Gubler D. and Moser A. from Switzerland for the poster paper titled "Reinforced extraction system: Evaluation of optimized operating parameters using CFD". (Continued on page 14...)

AIVC and Other Publications on Ventilation and Related Topics

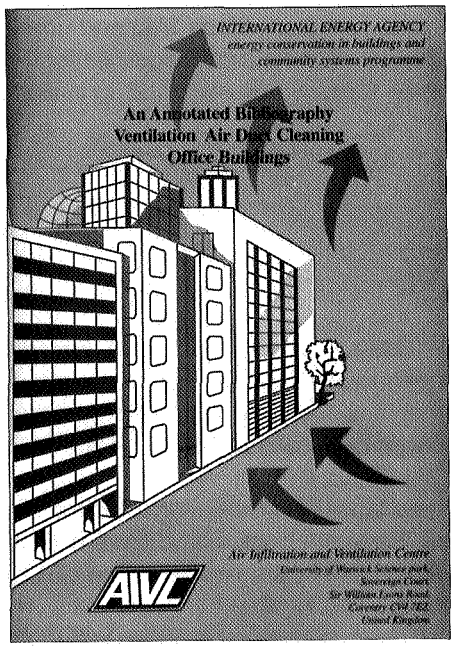
Innovations in Ventilation Technology

The 21st AIVC Annual Conference Proceedings on CD with printed abstracts and indexes, £65 +VAT, Order Code CP 21
Website www.aivc.org



An Annotated Bibliography on Ventilation Air Duct Cleaning in Office Buildings

by Mark J Limb, £22.50 (£15.00 AIVC Member countries), Order Code BIB 10
Website www.aivc.org

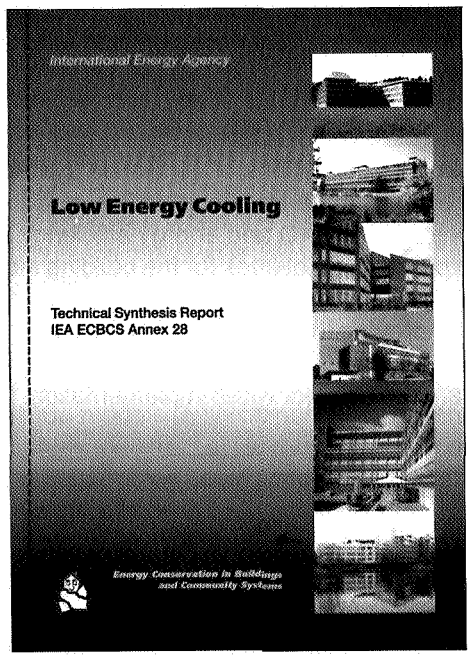


Low Energy Cooling: Technical Synthesis Report

by Martin Liddament

Summary of the ECBCS Annex 28 work, £20.00, Order Code ANN 28 TSR 07

Website www.ecbcs.org

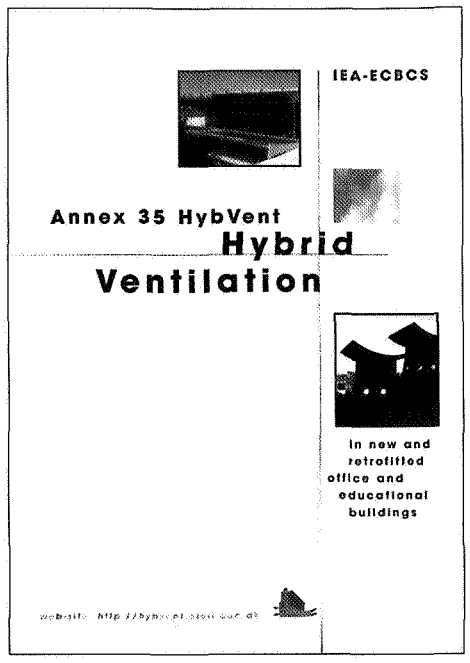


HybVent brochure and CD with State of the Art of Hybrid Ventilation

a report of the ECBCS Annex 35 project.

The brochure and CD contain a review of hybrid ventilation technologies which covers the following topics: Introduction expressing expectations for hybrid ventilation in the participating countires; a survey of existing buildings with hybrid ventilation systems; barriers to or opportunities for hybrid ventilation in building codes and standards; control strategies for hybrid ventilation; analysis tools for hybrid ventilation. The CD contains the full State-of-the-Art report as well as descriptions of 12 pilot study buildings and more than 20 papers related to the solution of hybrid ventilation problems.

Website: http://hybvent.civil.auc.dk



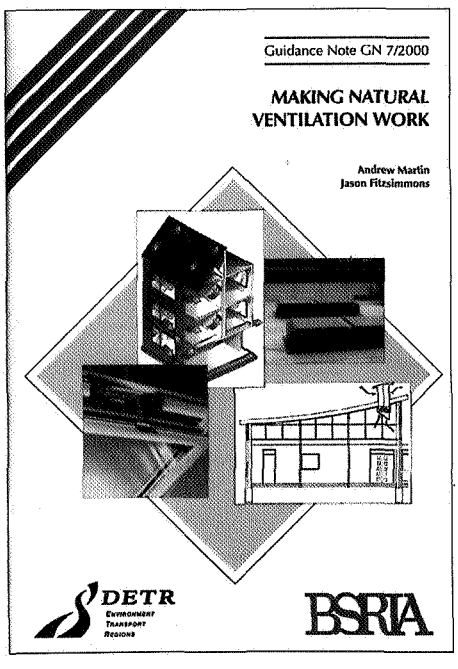
Making Natural Ventilation Work

by Andrew Martin and Jason Fitzsimmons

UK Building Services Research and Information Association (BSRIA), Guidance Note GN 7/2000

Covers understanding natural ventilation; general operational issues; restricted ventilation and stagnant areas; overcooling and draughts; non-operation of vents; and overheating.

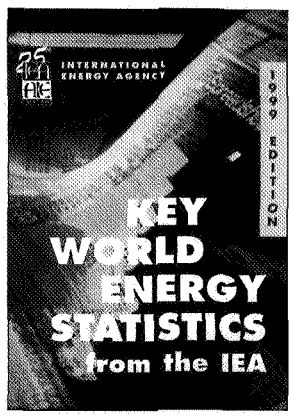
Website www.bsria.co.uk



Key World Energy Statistics from the IEA

Covers supply, transformation, consumption, energy balances, prices, emissions, outlook, energy indicators, and conversion factors.

Website www.iea.org

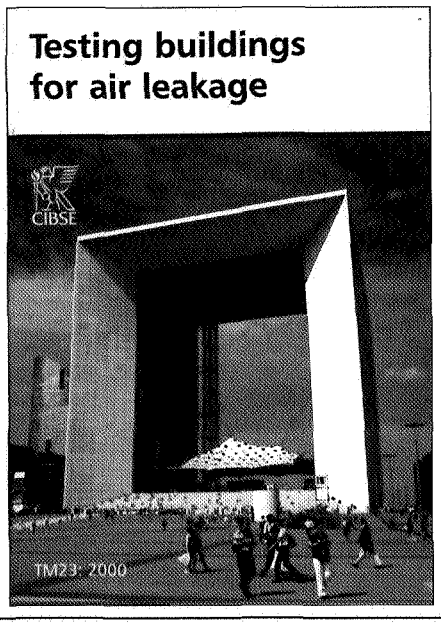


Testing Buildings for Air Leakage

UK Chartered Institution for Building Services Engineers, CIBSE Technical Memoranda TM23: 2000,

Sets out to describe how users can comply with the European test standard (prEN 13829) for pressure testing of buildings, and provides some guidance on levels of airtightness to aim for and how these might be achieved.

Website www.cibse.org



Contact the AIVC for further information about all of these publications, via the details on page 16.

3rd Brazilian Congress on Indoor Environment and Indoor Air Quality
International Meeting on the Indoor Environment, Ventilation, Health and Comfort
First International Exhibition on Indoor Sciences and Technology for Indoor Environments
25 – 28 March 2001
Rio de Janeiro – Brazil

Introduction

It is with a great pleasure that BRASINDOOR announces its 3rd congress concerning the environment and indoor air quality – INDOOR 2001. This time we will also be organising, in cooperation with the International Society for Indoor Air Quality (ISIAQ) and our first International Congress. Since our first congress in 1995, a growing number of researchers and technicians have been routinely working in many aspects related to the indoor environment, keeping in mind the issues of indoor air quality.

Following this search for a better environmental quality, BRASINDOOR has now sought the exchange of know-how with the international community.

Scientific Committee

Prof. O. Fanger, CIEE, DN/IAIAS
Prof. F. R. Aquino Neto, LADETEC-IQ/ UFRJ,BR,BRASINDOOR
Dr. W. F. de Gids, TNO, ND/ AIVC
Dr. M. Kork, CEPIS, OPS/WHO, VE
Prof. L. F. G. Siqueira, FSP/USP, CONTROLBIO, BR, BRASINDOOR
Dr. M. Maroni, ICPS, IT/ISIAQ
A. H. Miguel, UCLA, USA
M. Orme, AIVC, UK
M. H. Sherman, LBNL, USA/AIVC

Topics

These are the related issues:
Pollutants: Nature; Standards; Evaluation and Control
Symptoms: Occupational Hygiene; Occupational Medicine; Allergy, Asthma; Epidemiology
Architecture and Decoration: Materials; Linings; Indoor Landscape; Acoustic; Ergonomics; Illumination; Furniture; Project
Air Conditioning: Duct Cleaning; Energy Conservation; Air Renewal; Filtering; Projects and Maintenance
Other Related Issues: Surface Hygiene; Space Use; Indoor Environment Management

Further Information

For further information visit the Indoor 2001 web site at www.brasindoor.com.br
Congress fees: Price reductions apply for early registration.

(...Continued from page 11) Ove Arup and Partners awarded a prize for the best paper by a young scientist or engineer and this was given to Sanches Lam from Hong Kong for his paper titled "Characterization of VOCs, Ozone, and PM_{10} emissions from office printers in an environmental chamber".

SCANVAC has established the John Rydberg Gold Medal, which is a new medal to be awarded in acknowledgement for outstanding scientific contributions within the field of room air distribution and ventilation. The medal was awarded for the first time in RoomVent 2000 and the winner was Professor Mats Sandberg from Sweden.

Many papers from this conference are available from the AIVC library.

Forthcoming Conferences

ASHRAE Symposium: Experimental Validation of Multizone Network Airflow Models
27 - 31 January 2001
Atlanta, GA, USA
Amy Musser, 100 Bureau Drive Stop 8633, Bldg. 226 Rm. A313, Gaithersburg, MD 20899-8633, USA, Fax: +1 301 975 5144, email: amy.musser@nist.gov

Indoor Air Health: Second NSF International Conference. Trends and Advances in Risk Assessment and Management
January 29-31, 2001
Miami Beach, Florida, USA
Cherrie Bacon, NSF International, 789 North Dixboro Road, Ann Arbor, MI 48105, USA, Tel: +1 734 827 6865, Fax: +1 734 827 6840/6831

Brasindoor 2001
International Meeting on the Indoor Environment, Ventilation, Health and Comfort
25-28 March 2001, Rio de Janerio, Brazil
R. Tabapua, 821, cj. 77, Sao Paulo, SP-CEP (ZIP) 04533-013 Brazil, Tel/Fax: 55 11 3849-9334, ***www.brasindoor.com.br***
Deadline for abstracts 16th October 2000. In cooperation with Brasindoor, AIVC and ISIAQ. The topics are pollutants, symptoms, architecture and decoration, air conditioning.

International Conference on Monitoring Indoor Air Pollution
18-19 April 2001
Manchester Metropolitan University, UK
Dr Ivan Gee, Monitoring Indoor Air Pollution, ARIC, Dept Environmental and Geographical Sciences, Manchester Metropolitan University, Manchester M1 5GD, UK, Tel: +44 (0) 161 247 1592, Fax: +44 (0) 161 247 6332, email: I.L.Gee@mmu.ac.uk

The International Conference on Building Envelope Systems and Technologies (ICBEST)
26-29 June 2001
Westlin Hotel, Ottawa, Canada
Ms Monique Myre, Institute for Research in Construction, International Conference on Builidng Envelope Systems & Technologies - 2001, National Research Council Canada, Ottawa, Ontario, Canada K1A 0R6, Tel: 613 993 0435, Fax: 613 952 7673, icbest@nrc.ca, www.nrc.ca/icbest

Clima 2000
8th World Congress
15-18 September 2001
Naples, Italy
Clima 2000 Secretariat, via Fogazzaro, 36 - 2015 Milano, Italy, Tel: +39 02 551934446, Fax: +39 02 54116526, email clima@clima200.it
The topics will include: sustainable building design; equipment and technology; construction, retrofitting, management and operation.

IAQVEC 2001
Indoor Air Quality, Ventilation and Energy Conservation in Buildings
Fourth International Conference
2-5 October 2001
Changsha, Hunan, China
Abstracts should be sent to: Dr Tin-Tai Chow, Division of Building Science and Technology, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong SAR, China, Fax: 852 27889716, bsttchow@cityu.edu.hk, www.chinahvacr.com/iaqvec2001

IAQ 2001 Moisture, Microbes and Health Effects: Indoor Air Quality and Moisture ASHRAE Conference
November 2001
San Francisco, California, USA
ASHRAE, Manager of Technical Services, 1791 Tullie Circle, NE, Atlanta, GA 30329, USA, Fax: 404 321 5478

Performance of Exterior Envelopes of Whole Buildings VIII: Integration of Building Envelopes
December 2-6, 2001
Sheraton Sand Key Resort, Clearwater Beach, FL, USA
Mia D Hogan, Oak Ridge National Laboratory, Post Office Box 2008, Building 3147, Oak Ridge, Tennessee 37831-6070, USA, Tel: 865 576 7942 Fax: 865 574 9331, email HoganMD@ornl.gov, www.ornl.gov/ORNL/BTC/tectrans.htm

Roomvent 2002 Air Distribution in Rooms
Eighth International Conference
8-11 September 2002
Copenhagen, Denmark
Scientific Secretariat
Roomvent 2002, DANVAK, Danish Society of Heating, Ventilating and Air Conditioning Engineers, Oerholmvej 40 B, DK 2800 Lyngby, Denmark, Tel +45 45 87 76 11, Fax +45 45 87 76 77, info@danvak.dk, www.roomvent.dk
Conference Secretariat
Roomvent 2002, DIS Congress Service Copenhagen A/S, Herlev Ringvej 2c, DK-2730 Herlev, Denmark, Tel: +45 44 92 44 92, Fax: +45 44 92 50 50, roomvent@discongress.com, www.roomvent.dk
Abstract deadline: 1st October 2001

Representatives and Nominated Organisations

Belgium

*P. Wouters, Belgian Building Research Institute (WTCB/CSTC), rue de la Violette,21-23, 1000 Brussels, Belgium. Tel: +32 2-655-7711 Fax: +32 2-653-0729, email: peter.wouters@bbri.be

P. Nusgens, Université de Liège, Laboratoire de Physique du Bâtiment, Avenue des Tilleuls 15-D1, B-4000 Liège,Belgium. Tel: +32 41 66 56 74 Fax: +32 41 66 57 00

Denmark

*Dr Per Heiselberg, Department of Building Technology and Structural Engineering, Aalborg University, Sohngaardsholmsvej 57, DK 9000, Aalborg, Denmark, Tel: +45 96 35 85 41, Fax: +45 98 14 82 43, email i6per@civil.auc.dk

Bjorn Hafstrom, Danish Energy Agency, Head of Section, Energy R&D, 44 Amaliegade, DK-1256 Copenhagen K, Denmark, Tel: +45 33 92 75 55, Fax: +45 33 92 68 67, email bhk@ens.dk

Finland

*Jorma Sateri, FiSIAQ, Finnish Society of Indoor Air Quality and Climate, PO Box 25, FIN-02131 Espoo, Finland, Tel: +358 9 4355 560, Fax: +358 9 4355 5655, email jorma.sateri@sisailmayhdistys.fi, www.sisailmayhdistys.fi

FiSIAQ, Finnish Society of Indoor Air Quality and Climate, PO Box 25, FIN-02131 Espoo, Finland, Tel: +358 9 4354 2055, Fax: +358 9 452 3610, email fisiaq@innopoli.fi

France

*Marie-Claude Lemaire, ADEME - Département Bâtiment et Collectivités, 500 Route des Lucioles, Sophia Antipolis, F- 06560 Valbonne, France Tel: +33 4 93 95 79 56 Fax: +33 4 93 65 31 96, email Marie-Claude.Lemaire@ademe.fr

Ph. Duchêne-Marullaz, CSTB, 84 Ave. Jean Jaurès, BP 02 Champs sur Marne, 77421 Marne la Vallée, Cedex 2, France Tel: +33-1 64 68 83 13 Fax: +33-1 64 68 83 50

Germany

*Prof. Dr.-Ing. F. Steimle, Universität Essen, Universitätsstr. 15, 45141 Essen, Germany, Tel: +49 201 183 2600, Fax: +49 201 183 2584, email: fritz.steimle@uni-essen.de

J. Gehrmann, Projektträger BEO - Biologie, Energie, Okologie, KFA Jülich, Postfach 19 13, 52425 Jülich, Germany Tel: +49 2461 614852, Fax: +49 2461 613131

G Mertz, Fachinstitut Gebäude Klima e.V., Danziger Strasse 20, 74321 Bietigheim-Bissingen, Germany Tel: +49 7142 54498 Fax: +49 7142 61298, email fgk-ev@t-online.de

Greece

*Dr Matheos Santamouris, Building Environmental Studies, Applied Physics Section, Department of Physics, University of Athens, University Campus, Building Phys/5, 15784 Athens, Greece Tel: +30 1 727 6934 Fax: +30 1 729 5282 email: msantam@cc.uoa.gr

Netherlands

**W.F. de Gids, TNO Building and Construction Research, Division of Building and Systems, P.O. Box 49, 2600 AA Delft, Netherlands, Tel: +31 15 2695300 (Direct: +31 15 2695280) Fax: +31 15 2695299, email: w.degids@bouw.tno.nl Web www.bouw.tno.nl

New Zealand

*M. Bassett, Building Research Association of New Zealand Inc (BRANZ), Private Bag, Porirua, New Zealand. Tel: +64-4-2357600 Fax: +64 4 2356070, email: branzmrb@branz.org.nz

Norway

*J.T. Brunsell, Norwegian Building Research Institute, Forskningsveien 3b, PO Box 123, Blindern, N-0314 Oslo 3, Norway. Tel: +47 22-96-55-00 Fax: +47-22-965725, e-mail jorn.brunsell@byggforsk.no

H.M. Mathisen, SINTEF, Energy Research, Refrigeration and Air Conditioning, N-7034 Trondheim, Norway, Tel: +47 73593870, Fax: +47 73593950, email Hans.M.Mathisen@energy.sintef.no

Sweden

*J. Kronvall, J&W Consulting Engineers AB, Slagthuset, S-21120 Malmo, Sweden, Tel: +46 40108200, Fax: +46 40108201, email johnny.kronvall@malmo.jacwid.se

Nina Dawidowicz, Swedish Council for Building Research, PO Box 12866, SE-112 98, Stockholm, Sweden, Tel: +46 8 6177300, Fax: +46 8 6537462, email nina.dawidowicz@bfr.se

UK

*MDAES Perera, Environmental Systems Division, BRE Building Research Establishment Ltd, Garston, Watford, WD2 7JR , UK Tel:+44(0)1923 664486, Fax: +44(0)1923 664796, e-mail pererae@bre.co.uk

M W Liddament (Operating Agent), Oscar Faber Group UK Ltd, Marlborough House, Upper Marlborough Road, St. Albans, Herts, AL1 3UT, Great Britain. Tel: +44(0)20 8784 5784, Fax: +44(0)20 8784 5700

USA

*M. Sherman, Indoor Air Quality Division, Building 90, Room 3074, Lawrence Berkeley Laboratory, Berkeley, California 94720, USA. Tel: +1 510/486-4022 Fax: +1 510 486 6658 email: MHSherman@lbl.gov

A. Persily, Building Environment Division, Center for Building Technology, Building 226, Room A313, National Institute for Standards and Technology, 100 Bureay Drive, Stop 8633, Gaithersburg MD 20899-8633, USA. Tel: +1 301/975-6418 Fax: +1 301 975 4409, email apersily@nist.gov

J. Talbott, Department of Energy, Buildings Division, Mail Stop Ce-131, 1000 Independence Avenue S.W., Washington D.C. 20585, USA. Tel: +1 202/586 9445 Fax: +1 202 586 4529/ 8134

*Steering Group Member

+Steering Group Chairman

AIVC

Published by

Air Infiltration and Ventilation Centre
University of Warwick Science Park
Sovereign Court
Sir William Lyons Road
Coventry CV4 7EZ, UK

ISSN 0143 6643
Tel: +44(0)24 7669 2050
Fax: +44(0)24 7641 6306
airvent@aivc.org
www.aivc.org

Operating Agent for AIVC is Oscar Faber Group Ltd