Air Infiltration Review

a quarterly newsletter from the IEA Air Infiltration and Ventilation Centre

International Energy Agency - AIVC

Vol 22, No 2, March 2001

Changes at the AIVC: A New Concept

The AIVC is the longest running annex within the IEA-ECBCS (Energy Conservation in Buildings and Community Systems) implementing agreement. Over the past 20 years the AIVC has served the community in dissemination of knowledge. The Centre is not only a dissemination vehicle for activities related to energy and ventilation, but most importantly, it has an international vanguard role for synthesising leading-edge practitioner-oriented technical activities. The AIVC is well known throughout the world and has a good reputation. The available budget for the Centre over recent years however has decreased substantially. As you may know the AIVC is a jointly funded 'annex' of the ECBCS, which means that the governments of member countries pay an annual contribution to the functioning of a central service. In recent times some of the larger countries have declared that they will no longer be able to subscribe at the present rate, which is currently determined on the basis of the individual country's GDP. As a result, a new funding structure has now become a necessity for the continuation of the Annex.

The majority of the participating countries believed that a new period for AIVC would be a challenge, since indoor air quality (IAQ) and ventilation related issues have still not all been resolved. The ECBCS Executive Committee took the decision at their Tokyo meeting in November 2000 to continue IEA Annex 5 - AIVC for a new three year period.

The future of AIVC will be different. Officially the Operating Agent running the annex on behalf of the participants will change from Oscar Faber Group UK Ltd to INIVE EEIG (International Network for Information on Ventilation). Although the changes will be significant, at the same time AIVC wants to assure the high quality level of information services and technical programme.

The proposed Annex for the new period will move towards a partly task shared and partly jointly funded activity. An Operating Agent will manage the annex. The new operating Agent will be INIVE. INIVE is a so-called European Economic Interest Group (EEIG). This is an existing legal entity within the EU. Although only EU countries can be members of an EEIG there are a

In this issue

number of possibilities for countries other than EU countries to participate in the EEIG. Peter Wouters from the Belgian Building Research Institute will be the manager of INIVE EEIG. INIVE is guaranteeing the deliverables to the participants in the annex. The full members of INIVE take the risk and responsibility for the proper execution of the annex. INIVE hopes to find sufficient financial means to make all information available at no cost or in any case costs which are substantially lower than the prices applied today. More about INIVE-EEIG and its strategy will be found in the next edition of AIR.

The technical programme is to be formulated through the Steering Group (SG). A three manmonth contribution to the AIVC as a task shared part of the annex is required from each participating country. Furthermore contracting out certain projects will be used to realise the technical programme. A contractor will operate the dissemination part of the Annex mainly consisting of the same kind of products. Negotiations are going on with Oscar Faber Group UK Ltd (the present Operating Agent) to ensure a smooth continuation of the dissemination work.

In the new operating period we anticipate addressing the following topics:

- appropriate ventilation, such as passive cooling and hybrid systems, to address the issue of climate change and sustainable development

- impact of ventilation on occupant performance such as productivity and learning skills in the non industrial built environment

- ventilation in the urban environment and strategies for a cleaner city of tomorrow

- the impact of ventilation and infiltration in the energy performance of buildings with respect to regulations

- guidance on product specifications for innovative development related to emerging codes, regulations and standards

- the role of the external envelope on rational energy use and moisture transmission through ventilation and infiltration

- simplified measurement techniques for commissioning and maintenance during system lifetime

In summary

The new concept is that the technical work will be done as a task shared annex and that the users of AIVC can access the information via low-cost products.

The AIVC used to be run by Oscar Faber, but INIVE will run it in the future. The Air Infiltration and Ventilation Centre still exists. The same services are intended to be available. All products will be available to anyone although prices will depend on the level of participation.

Because the contribution is no longer related to the GDP of a country we expect a wider interest of countries participating in AIVC.

Willem de Gids, AIVC Steering Group Chairman

International Energy Agency

Air Infiltration and Ventilation Centre

22nd Annual AIVC Conference

"Market Opportunities for Advanced Ventilation Technology"

Advance Registration and Call for Papers

Abstracts - Extended deadline - 12th April 2001

Hilton Bath City Hotel, Bath, United Kingdom

11th - 14th September, 2001

The 22nd Annual AIVC Conference will be held between 11th - 14th September 2001 at the Hilton Bath City Hotel in Bath in the West of England. The hotel is located in the heart of the city within easy walking distance of many historical sights. Regarded as one of the most beautiful cities in Britain, and a UNESCO World Heritage city, Bath is most famous for its Roman Baths and Georgian architecture.

Submissions are encouraged on the conference theme, "Market Opportunities for Advanced Ventilation Technology", and related topics. Areas of interest may cover residential, commercial or industrial buildings and include:

- innovations in components and control,
- integration with the building envelope,
- design procedures for innovative systems
- applicable measurement and simulation techniques,
- commissioning, operation and maintenance,
- overcoming perceived barriers,
- improving occupant understanding,
- the impact of codes and standards, and
- demonstration projects.

Abstracts of approximately 300-500 words are invited from authors and should be submitted by 12th April 2001. Confirmation of acceptance will given by 27th April 2001 and final papers will be expected by 27th July 2001. Up-to-date information about the AIVC Annual Conference may be found at the AIVC Web site, www.aivc.org.

Please send abstracts and/or registrations to:

Helen Shawcross, Conference Organiser, AIVC c/o Oscar Faber, Unit 3A, Sovereign Court, University of Warwick Science Park, Sir William Lyons Rd, Coventry, CV4 7EZ, United Kingdom

Tel: +44 (0)24 7669 2050, Fax: +44 (0)24 7641 6306, Email: airvent@aivc.org

Please note that the deadline for registrations at the lower rate (£699) is 15th June 2001 and the deadline for all accommodation bookings is 10th August 2001.**(See enclosed flyer for registration form.)**

Conference Report

An Alternative Approach to Infection Control

Symposium held 12th July 2000 at the University of Leeds, UK

A report by Mark Limb, AIVC

This multidisciplinary symposium was concerned with the reduction of infection brought about by airborne transmission of bacterial pathogens (including MRSA and Mycobacterium tuberculosis) in the clinical environment. Emphasis was placed upon the use of engineering control measures including mechanical ventilation, high efficiency particulate air (HEPA) filters and ultraviolet germicidal irradiation lamps.

The objective of this symposium was to raise awareness of the potential benefits of engineering measures within hospitals to control airborne pathogens. Also, to bring together infection control professionals, physicians, microbiologists and hospital engineers to discuss the relative benefits of such measures.

Nosocomial infection is a major problem, with approximately 1 in 10 patients acquiring an infection during stay in a UK hospital. This costs the UK National Health Service over 1 billion pounds per annum. Given the apparent limitations of conventional methods of hospital infection control to stem the rise in nosocomial infections, there is a pressing need to develop alternative approaches of control. The problem is compounded by the fact that many micro organisms responsible, such as MRSA, are multiply antibiotic resistant. Moreover, outbreaks of multiply drug resistant TB have occurred in several countries. The airborne route of transmission is thought to account for 10% of all cases of nosocomial infection. Whilst physicians and microbiologists have a good knowledge of the micro organisms involved, the understanding of the physical science associated with airborne transmission is more limited. The knowledge base on air disinfection is small, and there is a need to raise the general awareness of the potential benefits of engineering control measures. This symposium presented a multidisciplinary approach to the problem of controlling nosocomial infection.

Firstly Dr Stephen Barrett from St Mary's Hospital London, outlined the problems surrounding Methicillin resistant Staphylococcus aureaus (MSRA). Dr Davies of the Tuberculosis Research Unit at Liverpool University, then reported on the increasing concern and occurrence of tuberculosis. Then the symposium turned its attention to how these are currently controlled, and finally to the application of UV light for the control of airborne pathogens and spoilage organisms. The meeting concluded with a case study example of how this technology was currently being explored.

Mr Parkin, Chief Engineer with the UK National Health Service, discussed the importance of infection control within the NHS. He reports that approximately 75% of hospital acquired infections affect the urinary tract, surgical wounds, the lower respiratory tract, skin and the bloodstream the remaining 25% are due to person to person spread, environmental contamination and airborne transmission with this route seen as a minor one. The airborne route is mainly due to droplet nuclei (5 mm or smaller) which can be widely dispersed without settling. Larger droplets settling less than a metre are considered to be an extension of contact spread. The NHS commissioned a report into hospital ventilation and its impact on infection control, which it is investigating further. The report identified a number of important areas, such as isolation room design, theatre design, theatres for the future, testing and commissioning of operating theatres and reviewing maximum air flow requirements for theatres. The report concluded that ventilation systems themselves present little danger, however they have the ability to transmit pathogens around the hospital to large amounts of people. With the increased sophistication of ventilation systems in healthcare premises, patients and staff have a right to expect that such systems are designed, installed operated and maintained to appropriate standards. However ventilation is not the only solution to reducing hospital acquired infections. Two research projects are underway which are looking at two alternative approaches. Ultraviolet germicidal irradiation light (UVGI) and Air Ionisation. Research into the use of UVGI focuses on the control of specific pathogens Methicillin Resistent Staphylococcus Aureus (MRSA) and Mycobacterium Tuberculosis (MTB) and concentrates on the disinfection of airborne micro-oganisms in general within the hospital ward. The Air Ionisation study follows on from this investigation and complements the UV light project, being designed to investigate the impact of negative ionisation on the disinfection of air, and will involve both theoretical and hospital based field trial work.

Well-Designed Engineering Systems

Dr Clive Beggs from the University of Leeds who has been involved in this research outlined the engineering principles behind the control of airborne pathogens in hospitals. The airborne link in the chain of infection associated with diseases such as TB and aspergillosis is the "weakest link" and the one that gives hospital engineers and health care authorities the best opportunity to break the chain. Through the use of well designed engineering systems it is possible to control the spread of airborne pathogens. Dr Beggs examined the fundamentals of infection transmission via droplet nuclei through sneezing and coughs, which can be transmitted around the hospital primarily through the building's ventilation system. He examined the different systems used in hospitals including dilution, laminar and displacement ventilation, and also the use of airflow control by the creation of high and low pressure regions, used in isolation rooms. The major problem associated with providing negative pressures so as to trap the pathogens in a space, is the provision of a continual negative pressure. He cites work that shows that of isolation rooms in 5 US hospitals where it was found that over a 5 day period "none of the control ventilation parameters were met all of the time". And that all of the isolation rooms lost pressure at some point during the study, most commonly due to opening of doors. Many older hospitals rely on natural ventilation, which has been shown to be highly variable, difficult to control, and to enable pathogens from the outside to be widely distributed inside. Mechanical ventilation is not without its problems, in that poorly designed or maintained systems can fail to deliver the required air flow, or become contaminated with micro organisms, dust etc. Other technologies used to control airborne pathogens in hospitals include high efficiency particulate air (HEPA) filters, ultraviolet germicidal irradiation (UVGI) lamps and electrostatic filters. These devices are mounted within a room space and are designed to reduce the microbial level in the room air. They are relatively cheap and can be strategically placed to protect vulnerable patients and staff. Devices incorporating HEPA filters exhibit very high "single pass" efficiencies (99.9% for particles ³ 0.3 mm in diameter). Beggs cited work that showed that compared with a base condition of 2 ACH, the use of room mounted HEPA filters can achieve reductions in room droplet nuclei concentrations ranging from 30% to 90%. The single pass efficiency is not the same as its overall room effectiveness which will be much lower, simply because very little of the room air passes through the device. To improve this it is therefore essential to have as much air passing through the device as possible. Conventional low and medium pressure mercury discharge UV lamps have a strong spectral emission (253.7 nm) close to the peak of the action spectrum (260-270 nm) and is similar to the absorption spectrum of nucleic acids thus deoxyribonucleic acid (DNA) is the main target. This means they can be effectively used an a bacterial agent. UV light at this wavelength is absorbed by nucleic acids with the formation of pyrimidine dimers, resulting in damage to the DNA of the micro organisms which is lethal. UV lamps can be used to disinfect air in buildings by being installed in fan driven room mounted air cleaning devices, having the advantage over HEPA filters that they offer less resistance to airflow and so smaller and quieter fans can be used. They can be installed in return air ducts to purge the extract air of pathogens, and can be installed when retrofitting an existing mechanical ventilation system. They can also be used to produce an upper room UV field, through which pathogens may pass as a result of natural convection through the room space.

The application of ultraviolet light for the control of airborne pathogens and spoilage organisms was examined in greater detail by McClean. Who explained that each organism has a different susceptibility to UV, and the amount of UV, giving examples of the most common pathogens and their relative susceptibity (D10 values). For example Staphylococcus aureus has a D10 value of 26.0 10mJ/cm-2 compared to mould spores Aspergillus niger 1320.00 10mJ/cm-2. The latter are more difficult to de activate and therefore require a higher UV dose. The influenza virus has a low D10 and UV is highly effective at destroying it. The relative humidity of the ventilation air has a pronounced effect on its ability to transmit UV light, high RH leads to a marked reduction in the transmittance of the air, as too is the material that the duct is made of. Most plastics of PVC will fail when exposed to germicidal UV light, as UV at 240-280nm is absorbed by the PVC and damage known as "chalking" occurs which is irreversible and leads to failure. Aluminium with a treated surface has a reflectance of between 60-89%, whilst Stainless steel/tin plate only has a reflectance of between 25-30%. It is also important to shield operators from UV light since short term exposure can cause erythema (reddening of the skin) and conjunctivitis. McClean concluded by highlighting several examples of where such lamps had been successfully installed into a number of HVAC systems in a wide variety of different industries.

Beggs then reported on the ultraviolet germicidal irradiation field trials in a UK hospital. Two adjacent paediatric wards were used for the study. They were ventilated through separate supply and return air ducts which fed from a common pair of rising ducts. Initially the effectiveness of the UV lamps placed in the ductwork of the mechanical system was investigated then the effectiveness of shielded UV devices placed within the ward space was studied. During both experimental stages the microbial bioburden in the ward and ductwork were sampled, in order to assess the impact of the UVGI. It was not anticipated the Mycobacterium tuberculosis or any other pathogens would be encountered in the air sampling. The rationale behind the study was that if the UV lamps could disinfect a relatively benign microbial environment then they should be able to kill more harmful pathogens, which are equally susceptible to UVGI. Results from the first phase of the experiments show that the greater the UV irradiance, the greater the reduction in bacterial numbers. The percentage kill results obtained were lower than those predicted by the computer model, which predicted that a 100% kill of Staphylococcus aureus should be obtained when 2 lamps (i.e. 552 W UV power) were in operation. However the actual results revealed an average kill of 97.19%, although on a number of occasions a 100% kill was achieved. The second stage of the experiment studied the effectiveness of the shielded UV devices placed with the ward space. Five fan driven shielded "low pressure" UV devices were installed. (The actual devices were outlined in more detail by the manufacturers in another paper). These were installed at various locations with the ward. The background ventilation rate was approximately 3.25ACH. The lamps were switched on at least 72 hours before air sampling was undertaken. After 10 sampling days the lamps were turned off at least 72 hours before a further ten sampling days were undertaken. Results show that the level of bioburden was lower during the first sampling, when the lamps were one. However during the second phase the situation was reversed, with the bioburden being higher when the lamps were off. Large daily fluctuations in microbial levels were present. Most of the peaks and troughs occur at the same points in time. Beggs concludes that this pilot study produced much useful information. It indicated that the bioburden was relatively evenly distributed around the ward, with peaks and troughs tending to appear at the same point in time at various disparate locations. It also indicated that the bulk of the bioburden was generated within the ward space and that microoganisms shed in the ward were being transported along the return air ducts,. The first stage of the experiment showed that it was possible to kill many of the micro organisms that would otherwise be transported by the extract air stream by installing UV lamps in the return air ducts. However it was not possible to achieved complete air disinfection.

Hospitals are important places for the spread and incubation of potentially dangerous diseases. However, it is clear from this informative symposium that these problems are being addressed and innovative engineering solutions are being devised to provide much needed answers.

The proceedings of this symposium are available on loan from the AIVC Library.

Conference report

World Renewable Energy Congress 2000

Renewables, the Energy for the 21st Century

Hilton Metropole Hotel, Brighton, United Kingdom, 1 - 7 July, 2000

The World Renewable Energy Congress and Renewable Energy 2000 exhibition held at Brighton, UK attracted over 800 participants from 94 countries, including many from the developing world. In addition to the 150 invited papers, 450 papers were also selected from the 800 or so submitted papers for presentation, representing contributions from over 140 countries. Whilst the statistics are impressive, the large number of papers did however limit presentation time to approximately 5 minutes per paper, which in most cases was not nearly enough time to get a comprehensive feel for what had been undertaken, and more importantly, achieved. More than 100 organisations took part in the adjacent Renewable Energy 2000 exhibition, which itself attracted more than 3,000 visitors from all over the world.

The papers presented at the conference fall broadly into the categories outlined below:

1. Policy Issues

The main emphasis of many papers was the current "reality" and the need for more co-operation to ensure that renewable energy continues to contribute to future energy resources. The reality for most, however, is that new renewable energy developments have not been as great as was expected. Notable exceptions exist however, such as the surge of windpower capacity in Germany, the USA, Spain, and Denmark.

Although one part of the current reality has been the concern with human-induced global climate change, and the negotiation of the Kyoto Protocol in particular, this has so far failed to accelerate renewable energy diffusion to anything like the extent required.

A number of speakers urged a return to emphasising the broader goals of sustainable development and the role that renewables can play in that - and in the context of environmental issues, their contribution to raising indoor and outdoor air quality, and reducing acid deposition, as well as curbing greenhouse gas emissions. In the social context, the switch away from fuelwood collection and consumption can have both health benefits and improve the social conditions and educational opportunities for women and the young, in particular.

But other aspects of reality are that financial, institutional and legal obstacles remain severe. Absolute poverty and low incomes, and the unwillingness of the richer nations of the world to fulfil their agreed commitments to make additional financial resources and technologies available on preferential terms to the poorer, lie at the heart of the obstacles to economic development in general, and the global take-off of renewables in particular.

There are too few incentives, and too many disincentives, meaning that renewables still usually play on an uneven playing field. There is still much to be done. But despite the obstacles there are, nevertheless, more and more countries adopting energy efficiency and renewable energy programmes. Many interesting technologies are available, but one central issue is one of how to diffuse them faster and more widely. This can be achieved most effectively if supported by sound policy and rational regulatory frameworks.

2. Low Energy Architecture

Sessions focused on bioclimatic architecture, energy in the city, low energy architecture, daylighting, components and simulation and comfort and ventilation. An overall important observation was the continuing divergence between the approach of engineers and architects to the design process, despite an increasing number of exceptions. About half of all energy is used in the construction and servicing of buildings, particularly in the developed world. This makes the low energy architecture theme a vital one for any conference which considers Energy issues. In all this was considered a useful and optimistic congress for those whose concerns lie in this area. The Best Paper of this group was awarded to Dr Martin Liddament, of the ECBCS Annex 5 The Air Infiltration and Ventilation Centre, for his paper entitled "Making Ventilation Work for Cooling".

3. Photovoltaic Technology

Cell and module technology, systems components, on-grid field experiences, off-grid field experiences, rural applications, non-technical issues, building integrated PV and grid connection of PV were some of the topics covered by authors. The most interesting contributions focused on field experiences and rural applications, which gave recent news from around the world on what is happening in the field, and as was demonstrated, there was much to be learnt by sharing the positive and negative lessons learnt.

4. Solar Thermal Applications

Amongst the topics covered were collector technology, solar water heating, solar thermal electricity, thermal and hybrid applications, fundamentals of solar thermal energy and rural applications. Studies ranged from academic experimental and computer based modelling, field trials of systems and industrial development and manufacture of solar thermal devices. Some papers showed a need to simulate solar thermal systems using locally acquired climatic data, and also the fact that standard conventions for the orientation of solar thermal systems may be inappropriate for local climatic conditions, building orientation and load patterns.

5. Wind Energy Generation

World wind power generation now contributes approximately 14,000 MW of electricity each year to the global market place. The world annual growth rate of wind capacity is 38%, similar to the growth of the mobile phone business, representing an investment in wind farms around US$3.5 billion. Most capacity is currently in Europe, especially Germany and Spain. In the USA there has been a new burst of activity in California and in Texas with many other states exploring the potential of wind energy. Interest is still growing with most countries, which have some wind resource, increasing the number of wind turbines installed and programmes and incentives to encourage more. Still huge potential exists in China, India and South America, and great offshore potential around Europe where the first offshore wind farms are already in operation.

The low cost of wind power means that at some sites wind is already competing on cost with fossil power stations before any account is taken of the environmental cost of the greenhouse gasses produced. An example cited is a RES-built wind farm in Scotland, which will provide the cheapest wind power in the world at just 2p/kWh in a purely commercial project with no subsidies.

6. Biomass

Most papers covered the technical advances in biomass conversion technologies such as wood gasification, pyrolysis, biodiesel, anaerobic digestors, landfill gas, biofuels, Stirling engines, fuel cells and combustion modelling. Several success stories of bioenergy applications operating successfully in UK, Sweden, Croatia, New Zealand and Germany were described, as were other projects close to commercial operation, particularly for electricity generation but also for heat, CHP and transport fuels.

It was noted that a key barrier to the uptake of modern biomass is its poor image, stemming from its historically unacceptable atmospheric emissions and from the use of fuelwood from poorly managed and unsustainable forest practices particularly in India, S E Asia, and Africa. The other key barrier of difficulty to finance projects due to perceived risks were also identified. The use of sustainable biomass resources is already increasing in places such as India, Greece, UK, Portugal and Brazil, with particular emphasis on agricultural wastes, municipal solid wastes, and energy plantations. International trading of biomass is also underway, (for example briquettes between Croatia and Austria.

The overall pattern from the papers presented demonstrated an increased concern for smaller scale, off grid dispersed systems, of the type that used to be promoted for application in developing countries, but which were now seen as being equally relevant to the developed world. The other main focus was on funding mechanisms, with the Clean Development Mechanism (CDM) being the main concern.

7. Solar Energy Materials

Amongst the technologies outlined under this category are the use of thin film and low emittance coatings on glass which enable glazing and windows to be effectively used in all climates. The independent control of daylight levels via the total solar energy transmittance and the visible transmittance help either maximise solar gain in cold or heating dominated climates or reduce solar gain to avoid overheating and unnecessary cooling loads in warmer climates or even in commercial buildings in climates such as the UK.

Technologies such as the vacuum window have also been demonstrated as an emerging technology capable of producing a window with a thermal resistance equivalent to that of an opaque wall but with the added bonus of light and solar gain. A number of software design tools have also been demonstrated which well enable comparisons of performance, energy and costs to be undertaken by both engineers and architects.

Daylighting is receiving renewed interest, with the utilisation of natural light as an energy saving measure, for both interior and exterior spaces. Described too, was the multiwall translucent, graded transmittance roofing panels designed for use in the roof of the Sydney Olympic Stadium. The roof will affect lighting levels and glare in the stadium enhancing spectator and athlete visual comfort and proving better lighting conditions for television. Finally we were treated to a glimpse into the near future through the use of smart windows and switchable glazing in the form of the gasochromic and the thermotropic window, and an integrated photovoltaic/electrochromic device capable of powering itself into dark and clear states

8. Water Power

PV solar is clearly an emerging technology; those up and coming include wavepower and tidal current power. Offshore wave and tidal systems could be very useful in remote island sites in the developing world, as well in the industrialised world. The obvious concern of the environmental impact of these offshore systems should be less than that for most land based renewable systems.

And Finally

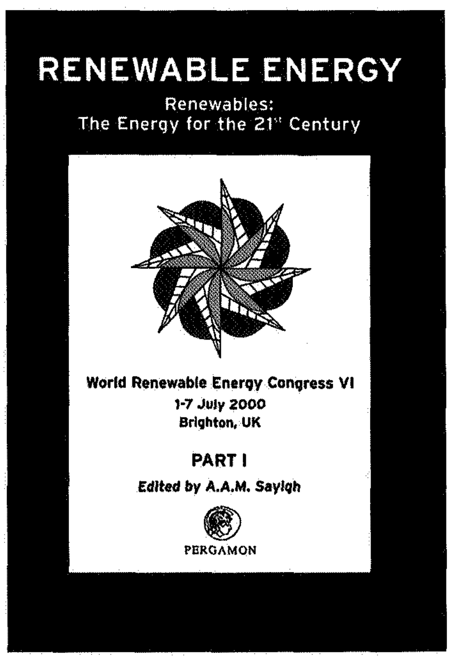
The World Renewable Energy Congress VI brought together a very wide range of papers and delegates from many renewable energy using countries. Renewable energy is now being recognised as a major element in combating climate change and global warming, as well as being the only way to alleviate chronic shortage of energy in all developing countries and some of the developed countries.

It is also hoped that, as has been demonstrated by the increase in wind energy utilisation, research into solar materials to develop more efficient and low cost devices in PV as well as glazing, can continue.

Initiatives such as the Kyoto Convention and the concept of using clean development mechanism (CDM) have had significant impact on these renewable technologies both in their development and perception and emergence into the market place of the 21st Century.

This article has been complied from the World Renewable Energy Congress VI final report obtainable at http://www.renuk.co.uk

The proceedings of this conference are available on loan from the AIVC library. Published by Pergamon/Elsevier ISBN 0 080 43865 2 (four volumes).



Award winning poster from "Innovations in Ventilation Technology", the 21st Annual AIVC Conference, The Hague, Netherlands, 26-29 September 2000

Air Quality and Ventilation Rates in Schools in Poland - Requirements vs Reality

Jerzy Sowa, PhD, Warsaw University of Technology, Institute of Heating and Ventilation, Poland

Synopsis

The relationships between indoor environment and health, well being and ability to acquire knowledge are unquestionable. These are the reasons why in many countries high level of indoor environment is required in school buildings. The goal of the paper is to compare real state of environment in classrooms in Poland with accepted requirements and standards. The evaluation of existing situation is based on indoor environment measurements in 28 classrooms in Warsaw.

1. Introduction

In many countries school buildings receive special care on the part of legislative and executive authorities as well as local governments. This is based on the assumption that children at school acquire not only systematised knowledge but also some solutions and behaviour patterns. Modern schools, where these solutions are applied, started to appear also in Poland. Majority of them, however, are housed in the buildings dating from the 1960s and 1970s which have been recently renovated. The purpose of such renovation works is often to conserve energy by means of thermal insulation of walls, replacing windows, modernising central heating systems and heat distribution units. Since some of these improvement works are believed to have negative effect on indoor air quality, it has been decided to check the actual indoor air quality and ventilation rates in the Polish schools and compare the results with requirements and tendencies in this respect.

2. Polish Requirements for the Indoor Air Quality in Schools

The Polish building law often stipulates requirements based on "wishful thinking". For instance, there is a provision, set out in § 309 of technical conditions for buildings and their location, which requires that "materials and products used for the construction of buildings as well as construction methods should not be hazardous for hygiene and health of their occupants or neighbours ..." [1]. Unfortunately, as it is usually the case of similar regulations there are no sufficiently detailed rules for implementation of these requirements.

Permissible values of concentration and intensity of factors hazardous to health, emitted in all living areas by building materials, equipment and furnishing, are set out in a Regulation of the Minister of Health and Social Care of 12 March 1996 [2]. This Regulation sets two categories of rooms, i.e. A and B. Classrooms belong to category A. The Regulation also specifies permissible concentration values (average 24 hrs) for 35 chemicals (Table 1). Unfortunately Polish Standards do not determine measurement methods for 11 of these substances. In result, such methods must be agreed with the State Institute of Hygiene individually. Moreover, in the case of 17 substances and their mixtures this Regulation sets limits (in many cases their application is generally forbidden) as for their content in building materials. It should be noted that smoking outside clearly marked smoking areas in schools and educational institutions is also legally forbidden in Poland.

Table 1: Permissible values of concentration and intensity of factors hazardous to health, emitted by building materials, equipment and furnishing [2]

No	Substance	Maximum permissible concentration μg/m³ (24 hour average)	
		room category A	room category B
1.	Acryloamide	1	3
2.	Acrylonitrile	2	3
3.	Ammonia	300	300
4.	Benzene	10	20
5.	Butadiene	100	300
6.	Butyl alcohol	300	300
7.	Chlorobenzene	15	40
8.	Chlorophenoles (excl pentachlorophenol)	15	20
9.	Chlorophtalenes	15	30
10.	Cyclohexane	250	250
11.	Cyklohexanone	40	100
12.	Dichlorobenzene	30	50
13.	Ehtylbenzene	100	150
14.	Phenol	20	50
15.	Formaldehyde	50	100
16.	Dibutyl phthalate	100	150
17.	Phthalic anhydride	40	80
18.	Ethylene glycol	15	50
19.	Cresoles	25	50
20.	Xylene	100	150
21.	p.-Kumylophenol	40	80
22.	Maleic anhydride	50	100
23.	Naphtalene	100	150
24.	Butyl acetate	100	150
25.	Ethyl acetate	100	150
26.	Vinyl acetate	50	100
27.	Ozone	100	150
28.	Pentachlorophenol	5	10
29.	Mercury	1	3
30.	Styrene	20	30
31.	Carbon monoxide (30 min)	3000 (10000)	6000 (10000)
32.	Toluene	200	250
33.	Trichloroetane	75	150
34.	Trichloroetylene	150	200
35.	Vinyl chloride	5	10

Standards of air quality may also be indirectly established, for instance, by defining required ventilation rate. In Poland minimum flow of outdoor air in apartment houses, residential buildings and public buildings, which include schools, is specified in the Polish Standard PN-83 B-03430 [3]. This Standard requires at least 20 m³/h of outdoor air for each occupant in rooms permanently or temporarily occupied by people. The Standard does not specify the type of ventilation in school buildings leaving this decision to the architect. Practically almost all classrooms are ventilated in a natural way. It should be noted that, in exceptional cases, it is permissible to supply schools and kindergartens with up to 3 changes per hour of outdoor air under negative pressure, whereas in all buildings natural outdoor air supply may not exceed 2 air changes per hour.

3. Tests of Indoor Air Quality in Polish Schools

The concept of indoor air quality is quite broad. Therefore, complex quality tests of indoor environment may include numerous elements such as: surveys carried out among occupants, medical examination of occupants, psychological tests identifying potentially independent sources of their dissatisfaction, specification of the kind and values of concentration of gas, dust and microbiological contamination, examination of indoor microclimate, measuring of ventilation efficiency, measuring physical hazard (noise, quality of visual environment, ionising and non-ionising electromagnetic radiation). Such a broad scope of tests is very expensive and technically difficult even in the case of one room. It is difficult to avoid impact of very measurement procedure on test results. In majority of tests only some selected values are analysed. In order to assess quality of indoor air in Polish schools, a special measurement method was developed (Table 1). This method prefers automatic measurement, which limits work of research teams to periods in which classrooms are not used. Additional information about location of the classroom, its volume, ventilation system, furnishing, type of window, number of seats and many, many others has been collected in special questionnaire filled out by the measurement team.

Table 2: Simplified measurement procedure developed for assessment of indoor air quality in Polish schools.

During 7 weeks (February/March 2000), 28 rooms in 24 school buildings in Warsaw were tested. Schools were random chosen from the lists provided by local district authorities. In each school building typical rooms (in respect of size, furnishing, wear and tear, etc) were selected. Chemistry laboratories were excluded from the tests, which were performed in 16 classrooms in elementary schools, 4 classrooms in grammar schools and 8 classrooms in secondary schools. The area of these rooms varied from 43m² to about 74 m², whereas the height ranged from 2,7 m to 4 m. In full classrooms (all seats occupied) density ranged from 0,4 to 0,82 person per m². The lowest number of seats in the classroom was 24 and the highest 44.

Figure 1 presents an example of variable CO_2 concentration and air temperature in the classroom. It can be noticed that practically throughout the whole period in which the classroom was used, CO_2 concentration exceeded 1000 ppm, which is a standard permissible air quality value in many countries. Histogram showing maximum CO_2 concentration (Figure 2) indicates that in all tested classrooms permissible CO_2 concentration value was exceeded at times. Also the chart of air temperature in tested classrooms, presented in Figure 3, shows ineffective operation of the central heating control system.

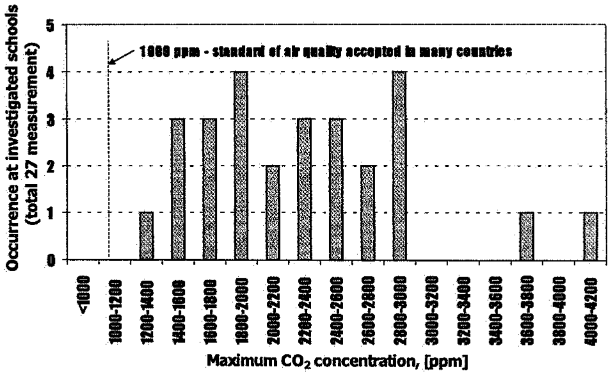


Figure 1: Variability of carbon dioxide concentration and air temperature, in one of examined classrooms.

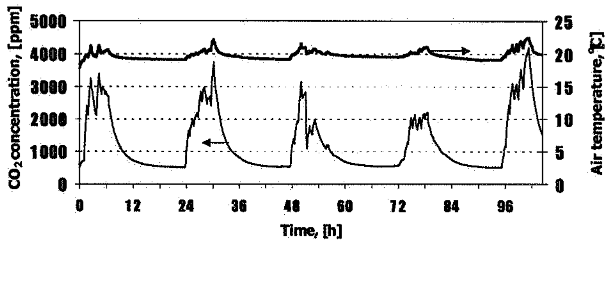


Figure 2: Maximum CO_2 concentration.

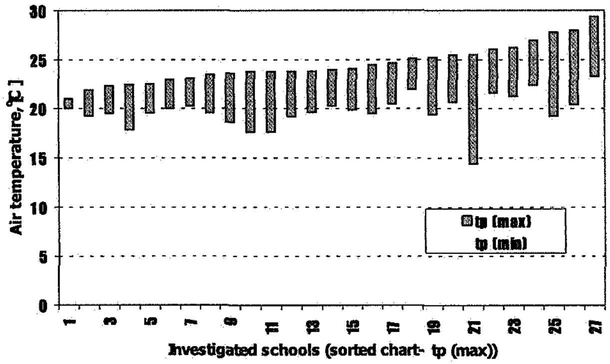


Figure 3: Maximum and minimum air temperature in investigated classrooms.

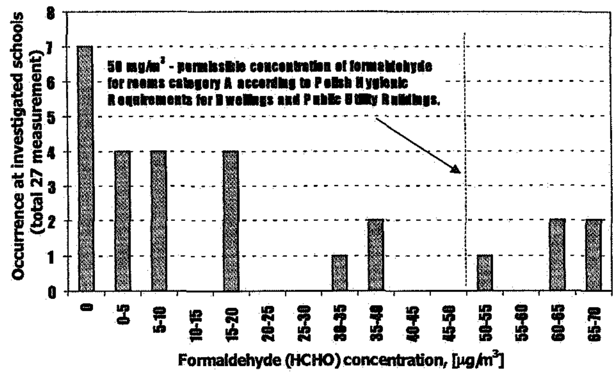


Figure 4: Formaldehyde concentration.

Figure 4 presents results of measurement of formaldehyde concentration. It exceeds the permissible value for category A rooms (50 μg/m³) in 5 out of 27 tested classrooms.

Figure 5 illustrates the frequency of occurrence of the assumed ranges of total amount of volatile organic compounds in tested schools. The compounds most often identified from among 4-5 main air polluting substances were: toluene (in 21 classrooms), xylenes (in 17 classrooms), decane (in 15 classrooms), undecane (in 11 classrooms), pentane (in 8 classrooms) as well as acetone, hexane, heptane and isopropyl benzene (in 6 classes). At the same time the research team often noticed stale air or strong chemical odour in the classrooms. Relevant remarks were made in the reports concerning the tested classrooms.

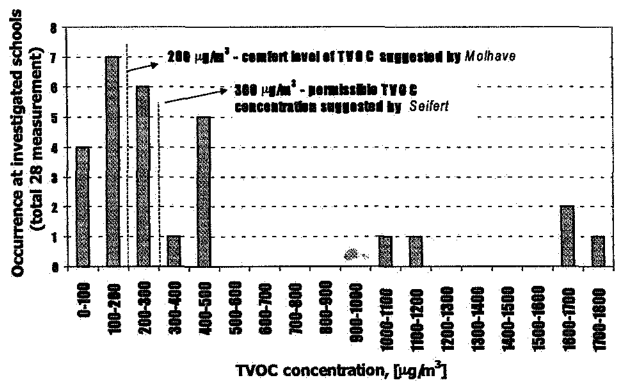


Figure 5: TVOC concentration.

A method of interpretation of variable CO_2 concentration [4] (test of tracer gas concentration decay) was applied to assess air change rate in the classrooms. Average air change rate after the pupils left the classroom is shown in Fig. 6. This is usually determined on the basis of 4 CO_2 decay schemes. Absolute majority of classrooms had air change rate below 1 h^{-1} (range from 0,325 h^{-1} to 3,18 h^{-1}).

Assuming that classrooms were full (all seats were occupied), in test conditions the airflow rate per person would range from 1.2 to 9.6 m³/(h person), and only in one exceptional case clearly deviating from the other ones it would be 21.5 m³/(h person), Figure 7.

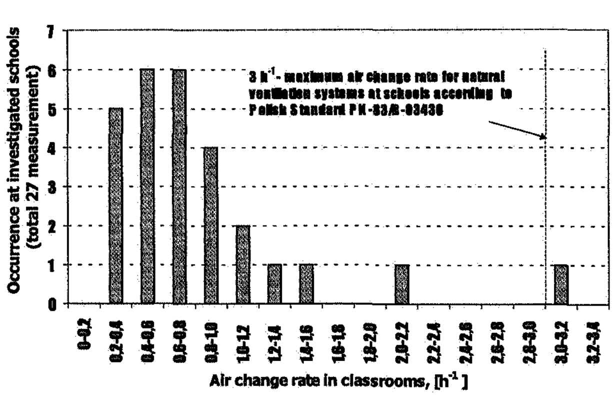


Figure 6: Air change rate.

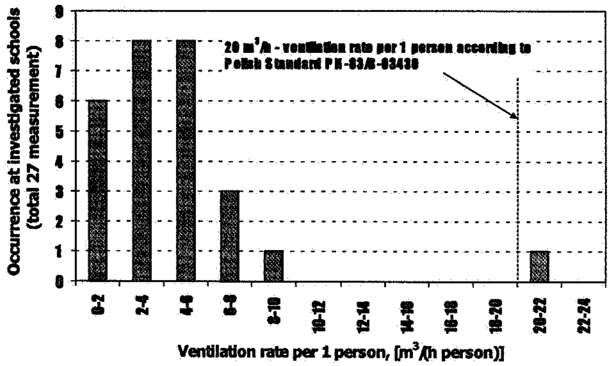


Figure 7: Ventilation rate per person.

4. Conclusions

The tests performed in schools have shown that classrooms are generally overheated. Central heating control systems do compensate heat gains coming from persons, electric lighting or solar radiation. This causes excessive energy consumption and possible thermal discomfort and creates conditions increasing possible negative symptoms resulting from air quality, such as: headaches, problems with concentration, eye irritation, etc.

We can conclude that natural ventilation systems applied in all schools were not able to ensure proper ventilation rate. If we take into consideration airflow estimated per 1 person (assuming that all seats are occupied), only one school - built before the Second World War - would meet the requirements. Inefficient ventilation systems result in very high CO_2 concentration in the classrooms throughout most of the time in which classes are held. This is naturally accompanied by lower oxygen content (%) in the air, in extreme cases reduced by about 0,3%.

In the tested ventilation systems the only practical possibility to increase ventilation rate is to open the windows. Unfortunately in many schools situated in busy town areas it is impossible to open windows during the classes due to traffic and street noise. Moreover, in cooler seasons, open windows could cause discomfort for pupils sitting near the windows. Airing classrooms during breaks is a certain solution. Analyses of variable CO_2 concentration have shown that classrooms were periodically aired during the tests. In many cases it prevented carbon dioxide and oxygen content (%) to reach the values which cause acute health effects.

In view of the above comments on ventilation rate, the problem of polluting classrooms with chemicals emitted by building materials or furnishing is a secondary one. If ventilation rate was intensified to reach the required conditions (2-10 times), formaldehyde and TVOC concentration would come down to the permissible level. This suggests that school furniture manufactured nowadays does not emit excessive formaldehyde whereas emission from old furniture has lowered to the permissible level with time. We should be more careful when interpreting measurement results of general concentration of volatile organic compounds. The author of TVOC Mølhave index proposed comfort level of 200 µg/m³. He also stated that up to the level of 3000 µg/m³ negative effects for room occupants may occur in the presence of other adversary factors. However, due to different toxicity of individual chemicals Seifert proposed permissible concentration values for separate groups of chemicals, where the total of all volatile organic compounds should not exceed 300 µg/m³. In the tests discussed in this paper 11 out of 28 classrooms had TVOC concentration lower than 200 µg/m³, and 17 classrooms - lower than 300 µg/m³. Without separate detailed measurement we can never exclude that air has very low concentration of very toxic compounds.

To sum up, all Polish regulations on indoor air quality not only drop behind similar regulations in developed countries as far as their rigidity is concerned, but also, generally, are not observed. The increase of ventilation rate (number of air changes) may have the key role in improving indoor air quality in schools. It seems that the only solution to this problem, while keeping to energy conservation and air quality requirements, is general application of more sophisticated ventilation systems (easy to use) with heat recovery and effective filtration.

References

POLISH BUILDING CODE: Rozporzadzenie Ministra Gospodarki Przestrzennej i Budownictwa z dnia 14 grudnia 1994 r. w sprawie warunków technicznych jakim powinny odpowiadac budynki i ich usytuowanie, (tekst jednolity) Dz. U. Nr 15,1999 poz. 140. (in Polish)

POLISH HYGIENIC REQUIREMENTS FOR DWELLINGS AND PUBLIC UTILITY BUILDINGS: Zarzadzenie Ministra Zdrowia i Opieki Spolecznej z dnia 12 marca 1996 r. w sprawie dopuszczalnych stezen i natezen czynników szkodliwych dla zdrowia, wydzielanych przez materialy budowlane, urzadzenia i elementy wyposazenia w pomieszczeniach przeznaczonych na pobyt ludzi, Monitor Polski nr 19 z 1996 poz. 231.(in Polish)

Polish Standard PN-83/B-03430 Ventilation in dwellings and public utility buildings. Specifications. (in Polish)

Sowa J., An evaluation of room air exchange intensity based on the interpretation of the variability of the carbon dioxide concentration, Zeszyty Naukowe Politechniki Warszawskiej, Inzynieria Srodowiska, z. 31 str. 23-46, (1999).(in Polish)

AIVC Bookshop Publications

The AIVC Bookshop has an extensive stock of AIVC and other publications. Browse the AIVC Website on www.aivc.org to view the complete collection with summaries and tables of contents. To order any of the publications you see here, simply contact us with the order code and title, and your name, address and payment details, or order online using the shopping basket system.

In the following list, Order Codes appear in brackets e.g., (TN 54), prices for customers in AIVC non participating countries are listed first, followed by the discount price in brackets, e.g., £22.50 (£15.00). The discount price applies to customers in AIVC participating countries only, as listed on page 16 of this newsletter. Please note that some items are restricted to AIVC participants only.

QUARTERLY JOURNALS

Available in print and online

Air Infiltration Review. Quarterly newsletter containing topical and informative articles on air infiltration research and application. Web: www.aivc.org/air.html (AIR) £25.00 (Free)

Recent Additions to AIRBASE. Quarterly listing of the latest 200 or so items added to AIRBASE, AIVC's bibliographic database, and the AIVC Library. Web: www.aivc.org/publications_password.html (RA). See below for the full version of "Airbase". £10.00 (Free)

AIRBASE

The AIVC's bibliographical database, containing over 12,500 records on air infiltration, ventilation and related areas, is available on CD ROM. Enquirers in AIVC member countries also have access to the AIVC's extensive library, which runs alongside. (AB) £150.00 + VAT (£100.00 + VAT)

WORLD WIDE WEB

The AIVC's home page is at www.aivc.org.

GUIDES AND HANDBOOKS

Improving ductwork: a time for tighter air distribution systems, Carrie F R, Andersson J, Wouters P (eds.) (TP 1999:4) £45.00 (£35.00)

Guide to Energy Efficient Ventilation, Liddament M W, 1996 (GV) £60.00 (£40.00)

Air Infiltration Calculation Techniques: an Applications Guide, Liddament M W, 1986, (CT) £22.50 (£15.00)

Air Infiltration Control in Housing: Handbook, Elmroth A, 1983 (HNBK) £22.50 (£15.00)

TECHNICAL NOTES

(Code TN)

Validation and comparison of mathematical models, 1983 (TN 11) £22.50 (£15.00)

Wind pressure data requirements, 1984 (TN 13) £22.50 (£15.00)

Wind Pressure Workshop Proceedings, 1984 (TN 13.1) £22.50 (£15.00)

Leakage Distribution in Buildings, 1985 (TN 16) £22.50 (£15.00)

Ventilation Strategy - A Selected Bibliography, 1985 (TN 17) £22.50 (£15.00)

Airborne moisture transfer: workshop proceedings, 1987 (TN 20) £22.50 (£15.00)

Review and bibliography of ventilation effectiveness, 1987 (TN 21) £22.50 (£15.00)

Inhabitants' behaviour with regard to ventilation, 1988 (TN 23) £22.50 (£15.00)

AIVC Measurement Techniques Workshop, 1988 (TN 24) £22.50 (£15.00)

Minimum ventilation rates, IEA Annex IX 1989 (TN 26) £22.50 (£15.00)

Infiltration and leakage paths in single family houses, 1990 (TN 27) £22.50 (£15.00)

A guide to air change efficiency, 1990 (TN 28) £22.50 (£15.00)

A guide to contaminant removal effectiveness, 1991 (TN 28.2) £22.50 (£15.00)

Reporting guidelines for airflows in buildings, 1991 (TN 32) £22.50 (£15.00)

A review of building air flow simulation, 1991 (TN 33) £22.50 (£15.00)

Air flow patterns: measurement techniques., 1991 (TN 34) £22.50 (£15.00)

Advanced ventilation systems, 1992 (TN 35) £22.50 (£15.00)

Airgloss Air Infiltration Glossary, Limb M J, 1992 (TN 36) £22.50 (£15.00)

A Strategy for Future Ventilation Research and Applications, Liddament M W, 1992 (TN 37) £22.50 (£15.00)

A Review of Ventilation Efficiency, Liddament M W, 1993 (TN 39) £30.00 (£20.00)

An Overview of Combined Modelling of Heat Transport and Air Movement, Kendrick J F, 1993 (TN 40) £30.00 (£20.00)

Infiltration Data from the Alberta Home Heating Research Facility, Wilson D and Walker I, 1993 (TN 41) £30.00 (£20.00)

Current Ventilation and Air Conditioning Systems and Strategies, Limb M J, 1994 (TN 42) £30.00 (£20.00)

Ventilation and Building Airtightness: an International Comparison of Standards, Codes of Practice and Regulalions, Limb M J, 1994 (TN 43) £30.00 (£20.00)

Numerical Data for Air Infiltration and Natural Ventilation Calculations, Orme M S, 1994 (TN 44) £30.00 (£20.00)

Air-to-Air Heat Recovery in Ventilation, Irving S, 1994 (TN 45) £30.00 (£20.00)

1994 Survey of Current Research, Limb M J, 1995 (TN 46) £30.00 (£20.00)
Energy Requirements for Conditioning of Ventilation Air, Colliver D, 1995 (TN 47) £30.00 (£20.00)
The Role of Ventilation in Cooling Non-Domestic Buildings, Irving S J, 1997 (TN 48) £30.00 (£20.00)
Energy Impact of Ventilation: Estimates for the Service and Residential Sectors, Orme M S, 1998 (TN 49) Restricted to Participants only (£20.00)
Introduction to Ventilation Technology in Large Non-Domestic Buildings, Dickson D, 1998 (TN 50) Restricted to Participants only (£20.00)
Applicable Models for Air Infiltration and Ventilation Calculations, Orme M S, 1999 (TN 51)

ANNOTATED BIBLIOGRAPHIES

Aim to review and technically assess current literature and provide a concise but in depth overview of a variety of subjects. (Code BIB)

Ventilation and infiltration characteristics of lift shafts and stair wells, 1993 (BIB 1) £22.50 (£15.00)
Garage ventilation, 1994 (BIB 2) £22.50 (£15.00)
Natural ventilation, 1994 (BIB 3) £22.50 (£15.00)
Air intake positioning to avoid contamination of ventilation air, 1995 (BIB 4) £22.50 (£15.00)
Heat pumps for ventilation exhaust air heat recovery, 1996 (BIB 5) £22.50 (£15.00)
Ventilation in Schools, 1997 (BIB 6) £22.50 (£15.00)
Ventilation and Acoustics in Buildings, 1997 (BIB 7) £22.50 (£15.00)
Passive Cooling Technology for Office Buildings in Hot Dry and Temperate Climates, 1998 (BIB 8) £22.50 (£15.00)
Impact of Urban Air Pollution on the Indoor Environment, Limb M J, 1999 (BIB 9) £22.50 (£15.00)
Ventilation Air Duct Cleaning of Office Buildings, Limb M J, 2000 (BIB 10) £22.50 (£15.00)

AIVC CONFERENCE PROCEEDINGS

Papers from earlier AIVC Conference Proceedings are also available. Contents pages can be forwarded on request. (Code CP)

'Ventilation System Performance' Belgirate, Italy, 1990 (CP 11) £35.00 (£35.00)
'Air Movement and Ventilation Control within Buildings', Ottawa, Canada, 1991, 3 volumes (CP 12) £50.00 (£50.00)

'Ventilation for Energy Efficiency and Optimum Indoor Air Quality', France, 1992 (CP 13) £50.00 (£50.00)
'Energy Impact of Air Infiltration and Ventilation', Denmark, 1993 (CP 14) £50.00 (£50.00)
'The Role of Ventilation', Buxton, UK, 1994 (CP 15) £50.00 (£50.00)
'Implementing the Results of Ventilation Research', Palm Springs, USA, 1995 (CP 16) £50.00 (£50.00)
'Optimum Ventilation and Air Flow Control in Buildings', Gothenburg, Sweden, 1996 (CP 17) £50.00 (£50.00)
'Ventilation and Cooling', Athens, Greece, 1997 (CP 18) £65.00 (£65.00)
'Ventilation Technologies in Urban Areas', Oslo, Norway, 1998 (CP 19) £65.0 (£65.00)
'Ventilation and Indoor Air Quality in Buildings', Edinburgh, Scotland, 1999 CD ROM with printed abstracts and indexes. (CP 20) £65.00 + VAT (£65.00 + VAT)
'Innovations in Ventilation Technology', The Hague, Netherlands, 2000, CD ROM with printed abstracts and indexes (CP 21) £65.00 + VAT (£65.00 + VAT)

LITERATURE LISTS

Contact AIVC for full list. (Code LL)

Computational fluid dynamics (LL 20) £2.50 (Free)
Displacement ventilation (LL 21) £2.50 (Free)
Moisture and condensation (LL 22) £2.50 (Free)
Sustainability (LL 23) £2.50 (Free)
Passive cooling (LL 24) £2.50 (Free)
Passive solar design (LL 25) £2.50 (Free)
Effects of outdoor air pollution on indoor air (LL 26) £2.50 (Free)
Kitchen ventilation (LL 27) £2.50 (Free)
Crawlspaces (LL 28) £2.50 (Free)
Design for fire/smoke movement (LL 29) £2.50 (Free)
Use of vegetation to clean indoor air (LL 30) £2.50 (Free)

IEA ENERGY CONSERVATION IN BUILDINGS BOOKSHOP

IEA Energy Conservation News Subscription free of charge.
Energy Conservation Bookshop Publications Catalogue A list of over 100 bookshop publications is available free of charge
Website: www.ecbcs.org

Forthcoming Conferences

International Conference on Moving Thermal Comfort Standards into the 21st Century
5-8 April 2001
Cumberland Lodge, Windsor, UK
Fergus Nicol, Oxford Centre for Sustainable Development, Oxford Brookes University, Gipsy Lane Campus, Headington, Oxford, OX3 0BP, UK, Tel: +44 (0)1865 483 226, Fax: +44 (0) 1865 483 298, Email: windsor@brookes.ac.uk
Deadline for abstract 30th Sep 2000, full paper: 31st Dec 2000

The XIIth Global Warming International Conference & Expo: Kyoto Compliance Review Year 2001 Conference
8-11 April 2001
Cambridge University, UK
GWXII Secretariat, PO Box 5275, Woodridge IL 60517 USA, Tel: +1 630 910 1551, Fax: +1 630 910 1561, Email: gw12@globalwarming.net, Homepage: http://GlobalWarming.Net

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

Energy Management in Industrial Buildings. Seminar focusing on the Value Chain of Energy Conservation, and Climate Control in Automotive Plants.
20 April 2001
Stockholm, Sweden
VVS Tekniska Foreningen (SWEDVAC), Jeanette Brinkman, Tel: +46 8 783 83 80, Fax: +46 8 660 39 44, email: brinkman@siki.se

The Ventilation Hygiene Conference and Exhibition
23-24 May 2001
National Motorcycle Museum, Solihull, Birmingham, UK
Marie Payne, PO Box 299, Chesham HP5 1FP, UK, Tel: +44 (0)1494 791 222, Fax: +44 (0)1494 792 223, Email: vent@eruopeancleaning.com

International Conference on Airborne Infectious Diseases: Prevention by Indoor air Hygiene
8-9 June 2001
Hungarian Culture Foundation, Budapest, Hungary
Conference Secretariat: Congress and Hobby Service, PO Box 1022, H-6071, Szeged, Hungary, Tel: +36 62 484 531, Fax: +36 62 450 014, Email: congress@mail.tiszanet.hu
Organising Committee: ISBE, 32A Mill road, Buckden, Cambs PE19 5SS, UK, Tel: +44 (0)1480 810 687, Fax: +44 (0)1480 810 468
Deadline for papers: 1 May 2001

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

CIBSE National Conference 2001 (The Chartered Institution of Building Services Engineers, UK)
1-3 July 2001
University of Southampton, Southampton, UK
CIBSE Services, Tel: +44 (0)20 8675 5211

2001 ACEEE Summer Study on Energy Efficiency in Industry: Increasing Productivity through Energy Efficiency
24-27 July 2001
Hilton Tarrytown, Tarrytown, New York, USA
Rebecca Lunetta (Conference Manager), PO Box 7588, Newark, DE 19711-17588, Tel: +1 302 292 3966, Homepage: http://www.aceee.org
Deadline for abstracts: 27 October 2000

Market Opportunities for Advanced Ventilation Technology
22nd Annual AIVC Conference
11-14 September 2001
Bath, United Kingdom
Helen Shawcross, Conference Organiser, AIVC c/o Oscar Faber, Unit 3a Sovereign Court, University of Warwick Science Park, Sir William Lyons Road, Coventry CV4 7EZ, United Kingdom, Tel: +44 24 7669 2050, Fax: +44 24 7641 6306, email: airvent@aivc.org

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 6841 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@jw.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