Air Infiltration Review

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Research Report from Czechoslovakia

The Influence of Infiltration on the Heating of a Building

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Introduction

When designing a heating system it is necessary to estimate the probability of the design heat losses of the heated space being exceeded. Design outdoor weather statistics are collected and published for this purpose. Such statistics are usually in the form of dry bulb and wet bulb temperatures. In the case of sensible transmission and infiltration heat losses, however, it might be argued that outdoor temperature and wind speed are the most relevant climatic parameters. The extreme value of the heat losses can, theoretically, be reached at various combinations of outdoor temperature and wind speed, but for an accurate evaluation of the climate conditions, it is necessary to know the correlation between the outdoor temperature and the wind speed.

Besides the climatic parameters, the heating load calculation also influenced by the thermo-technical properties of the building (insulation and air-leakage of the building envelope, thermal mass of the building etc), the situation of the building, what part of the day it will be used, its internal load, and the nature of its occupancy. On the basis of these factors and of course in accordance with economical relations, the probability level of the heat loss exceedance is estimated. This is decisive for the selection of the design outdoor weather conditions.

The task of this study is not the analysis of these influences when calculating the heat losses. Instead the influence of wind and temperature on the total heat losses at 1% probability exceedance of the heat losses is being investigated. The calculation is based on the correlation of the outdoor temperature, the wind speed and its direction, the transmission coefficient correlation and the air-leakage of the curtain wall.

The necessity of the design outdoor temperature and the wind speed correlation has been proved.[1] The author has stated that the independent selection of the design outdoor temperature and the wind speed aims at considerable over-estimate of the heat loss. He has also proved that the peak value of the heat losses can be mostly reached at mild temperatures with higher wind speed. Therefore the common application of the low temperature in combination with the high wind speeds is not correct or economical.

Design weather conditions for the given locality are mostly unchangeable. It is possible that the heat losses in permeable walls will be greater on windy days with mild temperatures than on calm days with low outdoor temperatures. Therefore when selecting the design weather conditions, the mutual dependence of the transmission coefficient (U - value) and airtightness (F - value) must be considered.

Inside this issue:

Meteorological Data

For the selection of the outdoor design values, meteorological data covering a ten year period from 16 October until 15 April for a single site (Bratislava Airport)[2] was used. The information was based on the average hourly measurements during a whole day in open country at a height of 10m. On the basis of this data the joint cumulative distribution function of outdoor temperature ($+_o$) and the wind speed (v) for eight directions was produced.[3] From this function, using the least square method, the functional dependence between the outdoor temperature and the wind speed (which were exceeded for only 1% of the time) was found for all height directions. The best fit was expressed by the exponential function:

$$v_{\alpha} = a^{t_o} . b + c \qquad (1)$$

where a, b, c are equation coefficients and α is the wind direction.

Figure 1 presents the graphic expression of Equation 1 and the temperature $t_o = -13.0°C$, for which the probability to be reached or exceeded, independent of the wind speed, equals 1%.

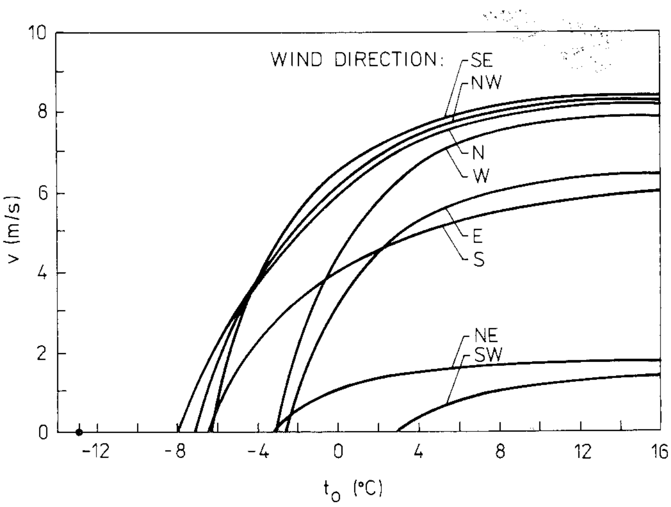

Figure 1: Wind temperature dependence at 1% time exceedance for various wind directions

Example Calculation

The heat loss of the room in a hypothetical residential building was calculated using the described procedure. The transmission heat loss was calculated assuming steady state conditions. The well known crack method was employed for the calculation of the infiltration heat loss, while the wind speed was expressed by Equation 1.

Supposing that the quality of the building, to suit the most suitable choice of outdoor weather conditions, is at 1% probability exceedance of the heat losses. The building is 56m high and 33 x 21m in plan, situated in an urban area characterised according to Table 1 in reference 4. The terrain class is IV. The curtain wall of the building consists of the segments 1.5m wide and 2.8m high.

We assumed in the example that the heat loss of the room, which is situated in the middle of the greater wall of the building, occurred only through the curtain wall consisting of two segments described above. The heat loss of the room was calculated in three different height levels of the building: N, SW, W and SW. The values of neutral pressure level (NPL) were used from reference 5, and the inside temperature $t_i = 20°C$ was assumed.

The peak value of heat losses for individual cases were calculated on a programmable pocket calculator. The results can be seen in Figure 2 which includes the percentage proportion of the infiltration and transmission heat losses on the total losses as well.

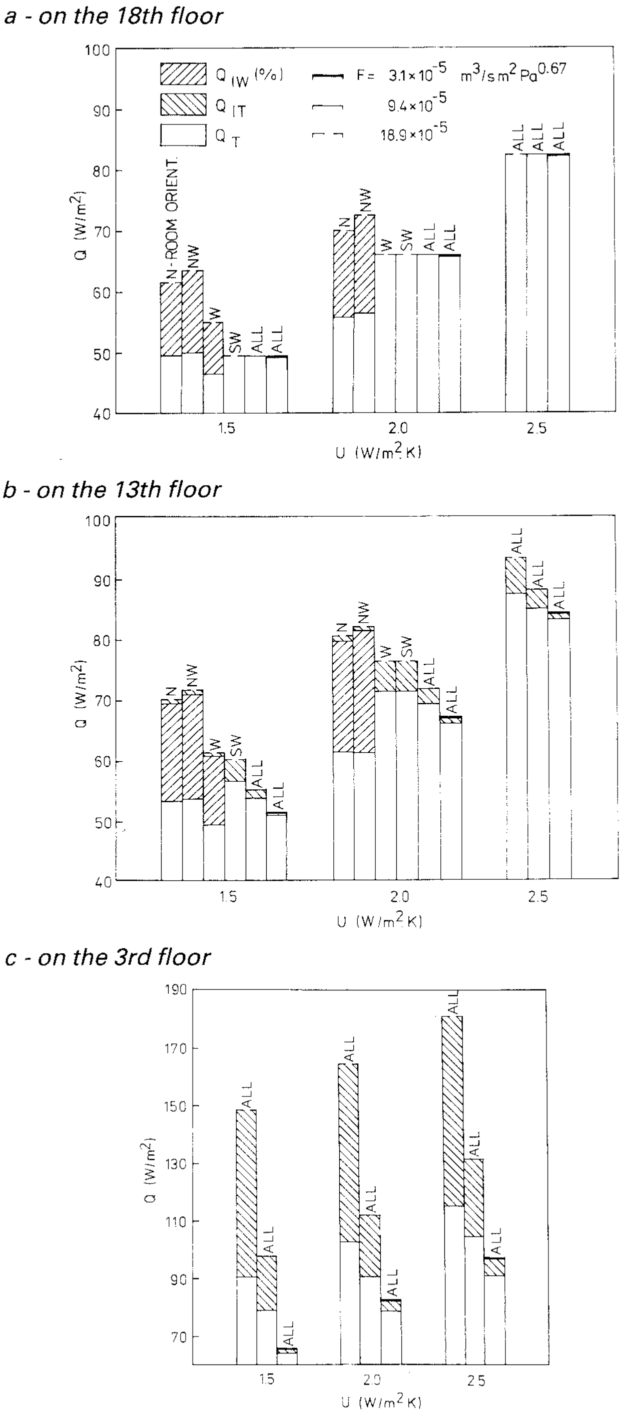

Figure 2: Room heat loss per 1m² of curtain wall and the percentage proportion of wind induced infiltration heat loss (Q_{IW}), stack induced infiltration heat loss (Q_{IT}) and transmission heat loss (Q_T)

Results and Discussion

The main findings of the preliminary analysis are as follows:

- the heat losses of the rooms above the NPL (18th floor) show that the losses are caused at the tight or average curtain walls only through conductive transmission. The infiltration effect is evident only with the loose curtain wall, except for the SW-orientation where higher wind speeds at lower temperatures are very rare.

- the heat losses of the rooms under the NPL (13th floor) show similar properties as above except that a certain small percentage also forms the stack-induced infiltration.

- for rooms situated well below the NPL (3rd floor), the heat losses in the total extent of U-values and F-values are only the function of the outdoor temperature.

It is obvious from the results of this example that for tighter curtain walls the infiltration heat losses are primarily caused by the pressure differences from stack effect. Therefore the heat loss value can be reached at minimum temperature in calm weather conditions when transmission and stack-infiltration heat losses are maximal. The wind effect is only evident at greater air leakage of the wall, or when the influence of the stack effect is negative or very small and only the vertical direction of the wind is important.

The proportion between infiltration and transmission heat losses is variable but it can generally be said that, at given air-leakage of the curtain wall, the proportion of the infiltration heat loss is reduced with the increasing transmission coefficient. The proportion increases with the lower position of the room according to the height of the building, ie together with the increasing importance of the stack effect.

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Proposed ASHRAE Standard on the Adequacy of Air Permeability

Report by Martin Liddament, AIVC, UK

A new ASHRAE standard is under consideration which is intended to provide a simple check on the adequacy of air permeability of naturally ventilated, single family dwellings. ASHRAE Standard 136P proposes a hybrid method in which the results of a pressurization test are used in conjunction with a simple air quality model to ensure that concentrations of typical residential contaminants comply with air quality requirements.

In calculating the air change rate, climate, terrain and surrounding shielding are taken into account so that the required level of airtightness can be tailored to suit the individual needs of each dwelling. It is anticipated that this standard will be especially useful in ensuring avoidance of excessive airtightness measures. Excluded from the proposals are dwellings insulated with urea formaldehyde foam insulation and those which are heated by unvented combustion appliances or which are not fitted with extract cooker hoods.

Other Standards

Other associated standards reviewed at the recent ASHRAE Annual Meeting, held in Nashville, USA, were Standard 119P on the air leakage performance of single family dwellings and Standard 62-81 on ventilation for acceptable indoor air quality. Standard 119P is concerned with the setting of airtightness values to eliminate the construction of excessively leaky buildings, while Standard 62-81 aims to define minimum ventilation rates and the necessary indoor air quality parameters to ensure a safe environment for occupants.

Technical Activities

A number of other technical activities related to the field of air infiltration and ventilation were also discussed. Of special interest was Technical Committee TC2.5 on air flow around buildings and Technical Committee TC4.2 on weather data. TC2.5 is sponsoring a project to determine pressure coefficients on typical residential buildings. This database is considered especially important for the calculation of wind-driven air infiltration, passive summertime cooling and the design of smoke and fire control systems. This committee is also sponsoring a seminar on ventilation modelling in wind tunnels, to take place at the Dallas ASHRAE Meeting in January 1988, and a symposium on wind pressure effects on ventilation at the ASHRAE Meeting in Ottawa, Canada, in June 1988.

TC4.2 has released for tender a work statement on the determination of climate variation in metropolitan areas. This activity is aimed at addressing the problem of assessing the climate at a specific location using off-site climatic data. The intention is to develop algorithms relating physical features in and around metropolitan areas to climatic variations. It therefore has important applications in assessing the magnitude of the natural driving forces of infiltration.

For further details on any of these ASHRAE activities, please contact Martin Liddament at the Air Infiltration and Ventilation Centre.

Correspondence . . .

The Rule of the Power Law – an Alternative View

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Introduction

In a recent article in *Air Infiltration Review* entitled 'Power Law Rules – OK?', some calculations were presented which supported the premises that the power law equation is preferable to the quadratic equation for use in mathematical models of infiltration.

The aim of this present article is to put an alternative view by showing that the position is not as clear-cut as the calculations might suggest and that there are good reasons for preferring the quadratic.

Significance of the Calculations

Two sets of calculations were carried out in Ref. 1 with a mathematical model which used, respectively, the power law and the quadratic. Part of the CA2 data set in Ref. 2 was employed for the exercise and it was found that the power law gave the better agreement with the measured infiltration rates.

Although the exercise is interesting there are reasons for doubting the significance of the results. One reason is that assumptions have to be made about several important items of data which were not measured (Cp, V and opening distribution). The values chosen for this missing data in Ref. 1 are reasonable, but so are other values. It is probable that values could be chosen which would indicate that the quadratic is preferable to the power law. Support for this view can be seen in Ref. 2 where another mathematical model based on the quadratic equation gave good agreement with the CA2 data.

Another reason is that it is also assumed that the CA2 data set is of sufficient, and presumably higher, accuracy than some other data sets. It is not easy to demonstrate the validity of either of these assumptions. Regarding the first, it can be noted that a tracer decay technique was used to obtain the infiltration rates for the CA2 data. Decay techniques measure air change rates whereas mathematical models predict flow rates, and to relate these two quantities it is necessary to know the appropriate volume. It is not a trivial matter to measure accurately the appropriate volume of a complex building such as a dwelling. The constant concentration technique is preferable to the decay technique in such cases. Regarding the second assumption, it can be noted that the comparisons given in Ref. 3 show the power law to over estimate infiltration rates, and there is reason to believe that the quadratic equation would give better agreement for this data set.

The Influence of Pressure Fluctuations

In Ref. 1 the possibility is raised that the quadratic equation is indeed preferable to the power law for steady driving pressures. However, the power law is preferable in practice because it fortuitously compensates for fluctuations of the pressure component due to wind. The first part of this proposition is obviously acceptable here, and evidence for it is briefly discussed in the following section. The second part of the proposition is, however, questionable.

Pressure fluctuations due to wind have two effects (see Ref. 4), ie the flow through an opening becomes unsteady and flow reversal can occur. Assuming that the quadratic equation is valid for steady flow, it is easy to see that the power law is an unsatisfactory way of accounting for these effects.

Firstly, the fluctuations can be negligible, ie low wind speed, high $\triangle T$), and in such cases the power law would give an unnecessary correction. Secondly, the power law and the quadratic are in close agreement at high wind pressures, yet there is no reason to suppose that the effects of the fluctuations become smaller at high wind speeds. The fluctuation scale with wind speed in a similar way to the mean pressures. Thirdly, the power law cannot take account of important parameters such as the relative size of the fluctuating and mean pressures.

It is much better to use the quadratic equation in a mathematical model and take account of the effects of fluctuations in a more realistic way. This is the philosophy behind the method of Ref. 4 which, while retaining the quasi-steady flow assumption, used an empirical method of accounting for flow reversals.

Power Law and Quadratic for Steady Flow

When applying either equation in a mathematical model, it is assumed that their respective coefficients (k and n, α and ß) are constant over a wide range of flow Reynolds Number. There are reasons to believe that the quadratic is more likely to satisfy this requirement.

Firstly, there is experimental evidence from laboratory tests that the exponent n of the power law varies with Reynolds Number. This can be seen in Refs. 5 and 6. The paper of Ref. 6 has been described as supporting the power law, but the Discussion to the paper shows this to be an incorrect description. There is new experimental evidence from laboratory investigations (where low-pressure data is more readily obtained) which supports the quadratic equation, ie Refs. 7 and 8. Finally, there is theoretical support for the quadratic (Ref. 9) which seems to be lacking for the power law at the Reynolds Numbers of relevance to infiltration.

Concluding Remarks

The problem of whether the power law or the quadratic is to be preferred for representing the steady flow characteristics of openings is a complex one, which can probably only be resolved by considering a range of evidence from different sources. Although the results of Ref. 1 are interesting, one should not attach too much significance to them. There are good reasons for believing that the quadratic is preferable to the power law. If this preference is accepted for steady flow, it does not follow that the power law can be justified on the basis that it fortuitously accounts for the effects of pressure fluctuations. It fails to simulate even the simpler properties of these effects.

Acknowledgement

The permission of British Gas to publish this article is gratefully acknowledged.

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New Staff Member for the Centre

Emma Young, the AIVC clerical assistant, left the Centre in June to take up a new position with an advertising company as a junior secretary. Her place has been taken by Kim Wellington.

Kim (left) has joined the Centre as a school leaver from Brackenhale Comprehensive School in Bracknell. She will act as a general assistant to all members of the Centre staff, with particular responsibility for information and administrative services.

Contacting the AIVC

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Book Reviews

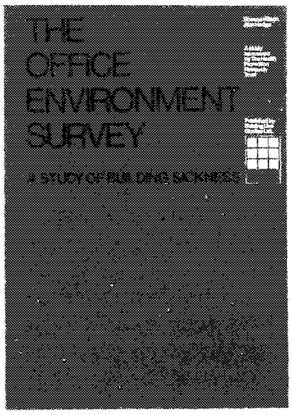
The Office Environment Survey – A Study of Building Sickness

A study sponsored by the Health Promotion Research Trust and published by Building Use Studies, 1987

This report presents findings from the first stage of a two-stage research project into the incidence of building sickness in office buildings. The current document covers fieldwork conducted for the first phase of the project started in March 1985 and completed in the following heating season, March 1986. A further report is planned to cover work carried out in the heating season of 1986/1987.

The survey describes a national study of office workers' perceptions of comfort and health. It reports on a questionnaire survey of 4373 workers in 46 buildings. These buildings were of varied age and quality and were selected to cover a range of ventilation systems. The organisations taking part included local and central government, professional consultancies and large private companies.

Building sickness, using the World Health Organisation definition, describes general, non-specific symptoms of malaise, in particular irritation of nose, throat and eyes, lethargy and headache. These are experienced by people during the time they are in the building and cease shortly afterwards.



In the survey workers were asked to report on the experience of a set of ten symptoms, and on whether or not these symptoms persisted on days spent away from their office building. Overall a 92% response rate was achieved. The main purpose of the survey was to establish across a wide sample of buildings:

- the prevalance of building sickness symptoms
- whether or not rates of complaint are consistently higher in certain types of building.

The survey analyses the questionnaire results in a variety of ways, ie according to type of job, type of building and type of organisation, with a final discussion comparing the 'best' and 'worst' buildings and a list of key issues for further research.

Copies are available from:

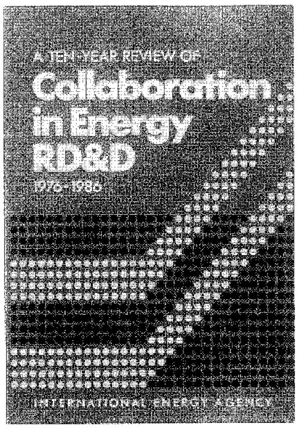
Building Use Studies Ltd,
14/16 Stephenson Way,
Euston,
London NW1 2HD
Tel: 01-387 3332
Price: £75

Collaborative projects in energy research development and demonstration: a ten year review 1976–1986

International Energy Agency, Paris, France, 1987

Soon after its inception in November 1974, the International Energy Agency embarked upon the task of promoting increased emphasis on energy research, development and demonstration (RD&D) in its Member countries, as part of the Agency's objectives to reduce dependency upon oil, and to achieve improved long-term security of energy supplies.

The promotional effort took two basic forms; firstly the creation of greater awareness of the nature and scale of national energy RD&D effort and a mechanism for critique; and secondly, the sponsoring of joint programmes and collaborative projects covering many facets of energy RD&D in the four technology areas which, other than 'conventional' nuclear energy, are generally considered to cover the field; notably, fossil fuels, renewable energy forms, controlled thermonuclear fusion and equally important, technology applications in the end-use sector which would achieve more efficient use of energy, sometimes referred to as 'energy conservation'.



Progress with these programmes and projects has been reported on a regular basis in published summary reports, the last of which appeared nearly three years ago. This publication draws up a ten year review of what has been achieved by this joint effort, with a view to providing guidelines for the planning of future energy RD&D to be undertaken both internationally and nationally.

The publication reports on 74 individual projects operating under 41 separate Implementing Agreements, and an extensive bibliography is to be made available shortly.

Since a good percentage of these projects are still underway, and at least a dozen new projects are being prepared, this ten year review is to be considered as an interim report on the achievement of IEA energy RD&D collaboration.

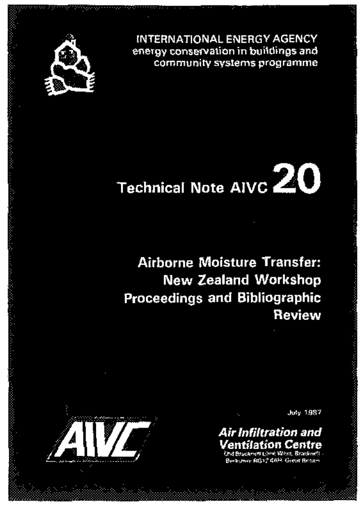
The main sections of the report are as follows:

- Energy end-use technology
- Fossil fuel technology
- Renewable energy
- Controlled thermonuclear fusion
- Energy technology systems analysis.

For further information, contact:

International Energy Agency
2 Rue Andre-Pascal
75775 Paris Cedex 16
France

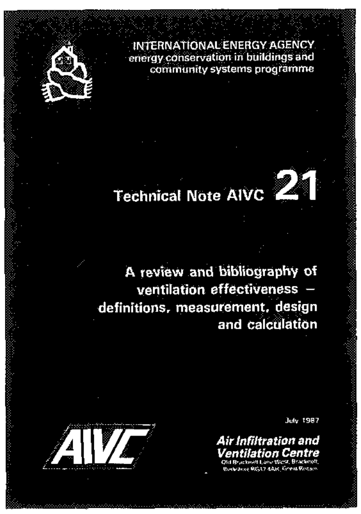
New Publications from the AIVC . . .



AIVC-TN-20-87
Airborne Moisture Transfer: New Zealand Workshop Proceedings and Bibliographic Review

This document presents the proceedings of the AIVC's Moisture Workshop, held at the Building Research Association of New Zealand (BRANZ) on 23 March 1987. It includes the opening address by the Hon. Margaret Shields, Associate Minister of Housing, New Zealand, and the full text of the ten papers presented, together with a record of the discussion.

The second section presents a review of literature on the subject and a bibliography taken from papers in the AIVC's bibliographic database, AIRBASE.



AIVC-TN-21-87
A Review and Bibliography of Ventilation Effectiveness, Definitions, Measurement, Design and Calculation by M.W. Liddament

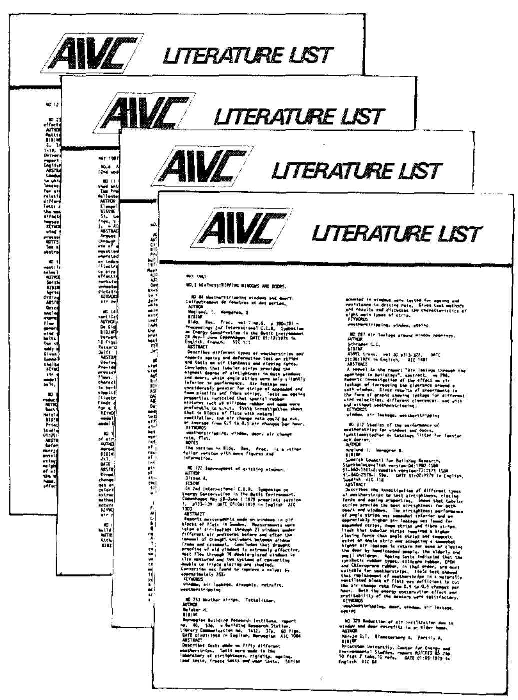
The objective of this report is to review the various definitions associated with ventilation efficiency studies and to outline the physical concepts, measurement methods and calculation techniques. A detailed bibliography gives references to articles useful for more detailed research. An appendix presents the country of affiliation of authors referenced in the bibliography, in order to assist in comparing the needs of different countries or climatic regions.

Literature List Updates . . .

Four of the AIVC' literature lists have now been updated:

No. 3 Weatherstripping windows and doors (30 references).
No. 4 Caulks and sealants (30 references).
No. 6 Air infiltration in industrial buildings (51 references).
No. 12 Windbreaks and shelterbelts (30 references).

Updates of the remaining literature lists are currently being prepared. As always, the AIVC welcomes suggestions for additional subject areas for new lists.



Conference Report

Room Vent '87 Stockholm, Sweden 10–12 June 1987

P.J. Jackman
Programme Advisor, AIVC, UK

A new unit of measurement, novel techniques of extract ventilation, demonstrations of displacement ventilation, developments in mathematical modelling of air flow patterns, applications of physical modelling techniques . . . all were featured at this international conference on the specialised subject of air distribution in ventilated spaces.

Held in Stockholm from 10–12 June 1987, the Conference incorporated 60 technical papers, some presented in parallel sessions.

It was attended by 130 delegates from 13 countries with over half from Scandinavia – a reflection not just of the location but of the high level of current interest in this subject in Sweden, Norway, Denmark and Finland. Other countries represented included Belgium, France, West Germany, Switzerland, Poland ,Japan, China and the UK.

The new unit of measurement was introduced by Prof. Ole Fanger (Denmark), who had been invited to present the opening paper. The 'olf', a unit related to olfaction and, so it was claimed, not to the author's name(!), was proposed as a measure of the emission of odour where 1 olf = rate of bioeffluent pollution by one person. He stated that the results of recent studies had shown that levels of olfactory dissatisfaction were influenced more by buildings and their systems than by their occupants.

The experimental technique used was called the 'picnic method'. In this, 50 volunteers were taken by bus to sample the air quality in 20 rooms (offices and conference rooms) in various buildings by indicating their reaction to the smell on entry. Three visits of about five minutes were made to each room: one with the rooms empty, another with the rooms empty but with the ventilation systems operating, and another with occupants present.

Based on the average of 20 rooms, 40% of the volunteers were dissatisfied with the empty rooms, 20% with the empty rooms ventilated and 20% with rooms ventilated and occupied. There was no correlation of these results with the measured concentrations of airborne organics. It was concluded that emissions from the building fabric and the ventilation systems were each at least equivalent to that from the occupants, so a ventilation rate of three times the rate necessary to deal with body odour was required to minimise dissatisfaction with the indoor air quality. These data are not in the proceedings of this Conference but are due to be published shortly (Indoor Air-87).

The novel technique of extract ventilation is known as the Aalberg principle and has been patented by its Danish inventor. The impact of an exhaust opening has been found to be enhanced by the entrainment effect of a supply air jet discharging perpendicular to the extract flow. Two papers describe for example, that with a radial supply slot added to a circular exhaust opening, the range of capture extended from 340mm to 840mm at the same extract flow rate. Several industrial applications were discussed including use in open areas as well as in association with work benches.

Displacement ventilation is gaining popularity as an effective method of introducing fresh air into a space. The principle involves the discharge of air at very low velocity at low level in the room. With the incoming air just slightly lower in temperature than the room air, it gently 'fills' the lower parts of the room with little mixing with the air at higher levels that may be 'polluted' with heat or contaminents rising from the occupied zone. Several papers were presented on this subject (Per-Olov Danielsson – Session 4b, Skaret – Session 5, Sandberg – Session 3) and a demonstration was given in Bahco's test laboratory. Examples of its application to cinemas, theatres, factories and department stores were also illustrated. This principle seems suitable for use in the cooling mode but is clearly unsuitable for heating. Its effectiveness in conjunction with conventional heating systems was not made clear.

To achieve the main features of upward displacement flow but with the supply at high level, Gottschalk (Session 2b) proposed the use of vortex rings (equivalent to smoke rings) as a method of penetrating down through stratified layers with the minimum disturbance. Much further work needs to be done to demonstrate the practicality of such a method.

Session 3 of the Conference concentrated on mathematical models for the prediction of air flows in rooms. It would appear that, without exception, the codes described were derivatives of TEACH or CHAMPION using the k- turbulence model. The application of one such 3D program named TRIO developed at the French Atomic Energy Commission was described (Berne). However, it required a CRAY-1 computer. One paper in another session (Qingyan – Session 4a) was particularly relevant to this subject. Although there is considerable international interest in mathematical modelling, quantitative validation seems to be still in its infancy.

There were papers on physical modelling both in full and reduced scale. In addition to examples based on air, there were several papers concerning the use of water models to represent air movement. In one, the buoyancy effects were simulated by temperature differences (Sandberg – Session 3) while in another, this was achieved by the use of saline solution (Lane-Serff – Session 2a). In yet another, only isothermal conditions were studied (Fontaine – Session 3), and Gardin (Session 4a) studied containment dispersion using the injection of saline solution.

In addition there were several interesting experimental techniques described at the Conference. For example, the study of the patterns of convection flow over the human body was carried out using infra-red photography of a thin sheet of paper hanging within the convection stream. To achieve this the profile of the person under test was cut out of the paper sheet so that it fitted closely around the body. Very colourful representations of the flow (temperature) patterns were provided by this method. The same author (Homma – Session 2a) also described a method of assessing the velocity of flow by producing a narrow 'string' of smoke and measuring its movement by photography in intermittent lighting. The string of smoke was produced by igniting instantaneously a mixture of kerosene and paraffin over an electrically heated wire.

Other instrumentation and measurement techniques described included a low speed anemometer (Olesen – Session 2b), ventilation measurement by CO_2- indicator tubes (Sateri – Session 2b), by Freon-12 (Klobut – Session 4a) and by multi-tracer gas techniuqes (Niemela – Session 2b, Edwards – Session 4a, Helenius – Session 4a). The possible use of the same type of tracer gas to determine ventilation rates in individual rooms in multi-cellular buildings was discussed by Jensen (Session 4a).

Abstracts of selected papers from this conference will appear in the AIVC's quarterly bulletin, Recent Additions to Airbase.

Copies of the full proceedings (produced in seven volumes) are available from:
National Swedish Institute for Building Research, Box 785, S-80129, Gavle, Sweden.

News from COMIS

Helmut Feustel

Background

Commencing in October 1988, the Energy Performance of Buildings Group at Lawrence Berkeley Laboratory, California, USA, will host a one-year joint research project entitled COMIS (Conjunction of Multizone Infiltration Specialists) to develop a multizone infiltration model.

A number of computer programs have been developed to calculate infiltration-related energy losses and the resultant air flow distribution in buildings. Awareness of the air flow pattern in a building is particularly important when determining indoor air quality problems for the different zones in a building (with a given pollutant source), smoke distribution during a fire, and the calculation of space conditioning loads for energy consumption. The correct sizing of necessary space conditioning equipment is also dependent upon accurate air flow information. In order to determine the impact of infiltration and air flow pattern within buildings, engineers and architects need multizone infiltration model.

To treat the true complexity of air flows in a multizone building brought about by climactic variables, extensive information regarding flow characteristics and pressure distribution inside and outside a building is essential. Mainframe computers are still the standard hardware utilized to host models that solve the set of nonlinear equations caused by air flow patterns through building components. Although multizone models exist, the vast majority are not readily available to the end user. These models are also written as research tools.

A literature review performed in 1983/84[1] showed the existence of quite a few multizone models. However, almost all programs found were either operating on mainframe computers or are being used as research tools, and therefore are not at all user-friendly. In most cases, they are not even available to third parties. Further restrictions apply to the air flow mechanisms described by these models. Most of them deal only with simple crackflow, not taking flows due to temperature stratification into account. None of the models were able to account for single-sided ventilation.

The task for the COMIS workshop is to develop a detailed multizone infiltration model. The main differences compared to existing models are the user-friendliness of the input/output with different levels of support, the different air flow mechanism for the different opening characteristics, the use of Personal Computers, the validation of the model, and the necessary extensive documentation of the model.

Task Groups

The plan is for COMIS to develop a model for a modular base. To develop the different modules, small task groups will be formed to work on a particular problem. Each COMIS team member will then work on several task groups and be responsible for one or more of them.

The following are potential topics for the task groups:

- user friendly input/out arrangements
- input requirements
- efficient algorithm to solve the non-linear equation system
- building description
- air flow through cracks
- air flow through large openings
- air flow through ventilation systems
- single-sided ventilation
- envelope permeability (zones, whole buildings)
- wind pressure distribution
- temperature stratification in rooms with large vertical dimensions
- stack effect
- validation measurements using multiple tracer gases
- pollutant transport models (infiltration driven pollutants and ventilation rate independent pollutant sources).

The above list is not necessarily exhaustive but the full list of task group topics will be finalised before the start of the workshop.

Model Validation

The Energy Performance of Building Group at Lawrence Berkeley Laboratory has just developed a multigas tracer measurement system using a mass spectrometer for the detector. The hardware of the measurement equipment is being tested under laboratory conditions and will be used in the field after finishing the control software. This equipment will be used by COMIS to validate the model, especially when determining the interzonal flow in multizone structures. Extensive measurements will be performed in multizone buildings. Envelope permeability will be measured using blower doors and wind tunnel measurements of surface pressure distribution will also be made.

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Thermodynamics Division
I-21020 ISRPA/Varese
Italy
Telex: 380042 EUR I

Reference

1. Feustel, H.E. and V.M. Kendon
   Infiltration Models for Multicellular Structures – A Literature Review
   Energy and Buildings, 8 (1985), pp.123-136.

Forthcoming Conferences

1. Indoor Air '87
Berlin (West), Germany
17–21 August 1987

Further details from:

Conference Secretariat
Indoor Air '87
c/o CPO Hanser Service GmbH
Schaumburgalee 12
D–1000 Berlin 19
Federal Republic of Germany
Tel: (030) 305 31 31
Telex: 186 11 cpo d

2. Building Physics in the Nordic Countries
Nordiskt Symposium i Byggnadsfysik
Lund University, Sweden
24–26 August 1987

Further details from:

J. Kronvall
Byggnadskonstruktionslara
Lunds Universitet
Box 118
S-221 00 Lund
Sweden
Tel: 046-107273

3. 8th AIVC Conference
Ventilation Technology – Research and Application
Park Hotel St. Leonhard, Uberlingen, Federal Republic of Germany
21–24 September 1987

Further details from:

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4. ICBEM '87
Third International Congress on Building Energy Management
Lausanne, Switzerland
28 September – 2 October 1987

Further information from:

ICBEM '87 Secretariat
p.a. Prof. Andre P. Faist
EPFL – LESO Building
CH 1015 Lausanne
Switzerland
Tel: 021 47 11 11
Telex: 24478

5. VVS & Indoor Clima 87
Gothenburg, Sweden
23–28 October 1987

Further details from:

HEVAC Technical Association
and The Swedish Trade Fair
PO Box 5222
S-402-24 Gothenburg,
Sweden
Tel: 46-31 200 000
Telex: 20 600
Telefax: 46-31 160 330

6. HVAC-DAYS – VVS DAGENE
Sjolyst Centre, Oslo, Norway
28–31 October 1987

Further details from

Skarland Press A/S
PO Box 5042
Maj 0301 Oslo 3
Norway
Telefax: (02) 60 36 50
Tel: (02) 60 13 90

7. Housing for the 90's
Meeting the Challenges of a Changing Market
Sheraton Tacoma Hotel, Tacoma, Washington, USA
2–5 November 1987

Further details from:

Energy Business Association
420 Maritime Building
911 Western Avenue
Seattle,
Washington 98104
USA
Tel: (206) 622-7171

8. PLEA '88
Passive and Low Energy Architecture
'Energy and Buildings for Temperate Climates'
A Mediterranean Regional Approach
Porto, Portugal
27–31 July 1988

Further details from:

PLEA '88
Av. Antunes Guimaraes, 102-1 Sala 7
4100 Porto
Portugal
Tel: (02) 67 85 88
Telex: 27323 FEUP P

9. Healthy Buildings '88
CTB Conference in Stockholm, Sweden
5–8 September 1988

Further details from:

CIB/Healthy Buildings '88
c/o Stockholm Convention Bureau
PO Box 6911
S-10239 Stockholm
Sweden

10. Ventilation '88
2nd International Symposium on Ventilation for Contaminant Control
Imperial College of Science and Technology, London, UK
20–23 September 1988

Further details from:

Ventilation '88
British Occupational Hygiene Society
1 St. Andrew's Place
Regent's Park
London
NW1 4LB
UK

AIVC Publications List

PERIODICALS

Air Infiltration Review
Quarterly newsletter containing topical and informative articles on air infiltration research and application. Also gives details of forthcoming conferences, recent acquisitions to *AIRBASE* and new AIVC publications. *Unrestricted availability, free-of-charge.*

Recent Additions to *AIRBASE*
Quarterly bulletin of abstracts added to *AIRBASE*, AIVC's bibliographic database. Provides an effective means of keeping up-to-date with published material on air infiltration and associated subjects. Copies of papers abstracted in 'Recent Additions to *AIRBASE*' can be obtained from AIVC library. *Bulletin and copies of papers available free-of-charge to participating countries* only.*

GUIDES AND HANDBOOKS

AIC-AG-1-86 – Liddament, M.W.
'Air Infiltration Calculation Techniques – An Applications Guide'
A loose-leaf handbook divided into six chapters covering empirical and theoretical calculation techniques, algorithms, references and glossary of terms. *Available free-of-charge to participating countries* only, via your national Steering Group representative.*

HANDBOOK – Elmroth, A., Levin, P.
'Air infiltration control in housing. A guide to international practice'
An international guide to airtightness design solutions of great practical value to all those concerned with the design of pollution – free dwellings with low energy demands. *Unrestricted availability. Price £12.50 hard copy. Also available in microfiche £10.00.*

TECHNICAL NOTES

AIC-TN-5-81 – Allen, C.
'AIRGLOSS: Air Infiltration Glossary (English edition)'
Contains approximately 750 terms and their definitions related to air infiltration, its description, detection, measurement, modelling and prevention as well as to the environment and relevant physical processes. *Available free-of-charge to participating countries.* Price: £10 to non-participating countries.*

AIC-TN-5.1-83 – Allen, C.
'AIRGLOSS: Air Infiltration Glossary (English-German/Deutsch-Englisch) Supplement'
Available free-of-charge to participating countries. Price £7.50 to non-participating countries.*

AIC-TN-5.2-84 – Allen, C.
'AIRGLOSS: Air Infiltration Glossary (English – French/Français – Anglais) Supplement'
Available free-of-charge to participating countries. Price £7.50 to non-participating countries.*

AIC-TN-5.3-84
'AIRGLOSS: Air Infiltration Glossary (Italian Edition)'
Available free-of-charge to participating countries. Price £10 to non-participating countries.*

AIC-TN-6-81 – Allen, C.
'Reporting format for the measurement of air infiltration in buildings'
Produced to provide a common method for research workers to set out experimental data, so assisting abstraction for subsequent analysis or mathematical model development. May be used directly for entering results and as a useful checklist for those initiating projects. Example of use of format is included as an appendix. *Available free-of-charge to participating countries.* Price: £6 to non-participating countries.*

AIC-TN-10-83 – Liddament, M., Thompson, C.
'Techniques and instrumentation for the measurement of air infiltration in buildings – a brief review and annotated bibliography'
Four-section bibliography contains review papers, information on tracer gas techniques, pressurization methods and miscellaneous approaches. In addition the report contains a list of manufacturers of instrumentation currently being used in air infiltration investigations. *Available free-of-charge to participating countries.* Price: £15.00 to non-participating countries.*

AIC-TN-11-83 – Liddament, M., Allen, C.
'The validation and comparison of mathematical models of air infiltration'
Contains analysis of ten models developed in five participating countries. These range in complexity from 'single-cell' to 'multi-cell' approaches. Also contains numerical and climatic data for fourteen dwellings compiled to produce three key datasets which were used in model validation study. *Available free-of-charge to participating countries.* Price: £15.00 to non-participating countries.*

AIC-TN-12-83 – Liddament, M.
Superseded by TN19 (see below).

AIC-TN-13-84 – Allen, C.
'Wind Pressure Data Requirements for Air Infiltration Calculations'
An up-to-date review of the problems associated with satisfying the wind pressure data requirements of air infiltration models. *Available free-of-charge to participating countries.* Price: £20.00 (price includes copy of TN-13.1) to non-participating countries.*

AIC-TN-13.1-84
'1984 Wind Pressure Workshop Proceedings'
Report of written contributions and discussion at Workshop held in March 1984, Brussels. *Available free-of-charge to participating countries.* Also available to non-participating countries (see note at TN-13 above).*

AIC-TN-14-84 – Thompson, C.
'A Review of Building Airtightness and Ventilation Standards'
Lists and summarises airtightness and related standards to achieve energy efficient ventilation. *Available free-of-charge to participating countries* only.*

AIC-TN-16-85 – Allen, C.
'Leakage Distribution in Buildings'
Examines those factors which can influence leakage distribution, including building style, construction quality, materials, ageing, pressure and variations in humidity. *Available free-of-charge to participating countries* only.*

AIC-TN-17-85 – Parfitt, Y.
'Ventilation Strategy – A Selected Bibliography'
Review of literature on choice of ventilation strategy for residential, industrial and other buildings. *Available free-of-charge to participating countries* only.*

AIC-TN-18-86 – Parfitt, Y.
'A subject analysis of the AIC's bibliographic database – *AIRBASE*.' 4th Edition
Comprehensive register of published information on air infiltration and associated subjects. The articles are indexed by subject and full bibliographic details of the 2,000 papers are given. A list of principal authors is also included. *Available free-of-charge to participating countries* only.* Being updated – now available in micro-fiche only.

AIC-TN-19-86 – Charlesworth, P.
'1986 Survey of current research into air infiltration and related air quality problems in buildings'
Fourth worldwide survey by AIVC containing over 200 replies from 19 countries. Produced in two sections: an analysis in tabular form of survey results, followed by reproduction in full of research summaries and list of names and addresses of principal researchers. *Available free-of-charge to particpating countries* only.*

AIC-TN-20-87
'Airborne moisture transfer: New Zealand workshop proceedings and bibliographic review'
This document presents the proceedings of the AIVC's Moisture Workshop, held at the Building Research Association of New Zealand (BRANZ) on 23 March 1987. It includes the opening address by the Hon. Margaret Shields, Associate Minister of Housing, New Zealand, and the full text of the ten papers presented, together with a record of the discussion. The second section presents a review of literature on the subject and a bibliography taken from papers in the AIVC's bibliographic database, *AIRBASE. Available free-of-charge to participating countries* only.*

AIC-TN-21-87 – Liddament, M.W.
'A review and bibliography of ventilation effectiveness – definitions, measurement, design and calculation'
The objective of this report is to review the various definitions associated with ventilation efficiency studies and to outline the physical concepts, measurement methods and calculation techniques. A detailed bibliography gives references to articles useful for more detailed research. An appendix presents the country of affiliation of authors references in the bibliography, in order to assist in comparing the needs of different countries or climatic regions. *Available free-of-charge to participating countries* only.*

LITERATURE LISTS – Listing of abstracts in *AIRBASE* on particular topics related to air infiltration.

No. 1 Pressurization – Infiltration Correlation: 1. Models (17 references).
No. 2 Pressurization – Infiltration Correlation: 2. Measurements (26 references).
No. 3 Weatherstripping windows and doors (30 references) - updated.
No. 4 Caulks and sealants (30 references) - updated.
No. 5 Domestic air-to-air heat exchangers (25 references).
No. 6 Air infiltration in industrial buildings (51 references) - updated.
No. 7 Air flow through building entrances (22 references).
No. 8 Air infiltration in commercial buildings (28 references).
No. 9 Air infiltration in public buildings (10 references).
No. 10 CO_2 controlled ventilation (13 references).
No. 11 Occupancy effects on air infiltration (15 references).
No. 12 Windbreaks and shelter belts (30 references) - updated.
No. 13 Air infiltration measurement techniques (27 references).
No. 14 Roofs and attics (34 references).
No. 15 Identification of air leakage paths (23 references).

Available free-of-charge to participating countries only.*

CONFERENCE PROCEEDINGS

No. 1 'Instrumentation and measuring techniques'.
Unrestricted availability. £35.00 sterling.
No. 2 'Building design for minimum air infiltration'.
Unrestricted availability. Price: £15.00 sterling.
No. 3 'Energy efficient domestic ventilation systems for achieving acceptable indoor air quality'.
Unrestricted availability. Price: £23.50 sterling.
No. 4 'Air infiltration reduction in existing buildings'.
Unrestricted availability. Price: £16.00 sterling.
No. 5 'The implementation and effectiveness of air infiltration standards in buildings'.
Unrestricted availability. Price: £22.00 sterling.
No. 6 'Ventilation strategies and measurement techniques'.
Unrestricted availability. Price: £16.00 sterling.
No. 7 'Occupant interaction with ventilation systems'.
Unrestricted availability. Price: £25.00 sterling.

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