Air Infiltration Review

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The Use of Hall-Effect Sensors to Measure the Opening Position of Windows, Doors, Vents and Dampers

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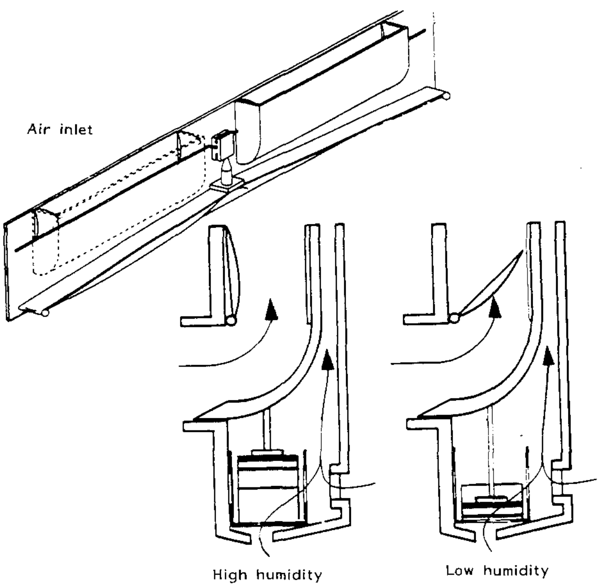
Introduction

Accurate measurement of the positions of windows, skylights, vents, dampers, etc., has always been a problem for researchers. Often open/closed switches are used which do not indicate the degree of opening which has occurred. The use of Hall-Effect sensors to measure such positions was first proposed by Nathan Sheaff, P.Eng., President of Sciemetric Instruments, Inc., for monitoring residential passive air inlets for the CANMET buildings group of Energy Mines and Resources, Canada. The specific application was the computerized monitoring of two houses with the Aereco humidity-controlled ventilation system. The Aereco inlet vents are controlled by a strip of polyamide (nylon) which stretches or contracts with the relative humidity of the room air. (See Figure 1). The operation is quite delicate, so it was necessary to devise a system to determine the vent's position without putting any load on its mechanism, or otherwise interfering with its operation. The problem was solved by glueing a small (10mm diameter by 3 mm thick) magnet to a lever which controls the operation of a shutter in response to movements of the strip, and glueing the Hall-Effect sensor to the inside case of the vent. The sensor's output voltage then varied with the distance between it and the magnet, and could be correlated with vent position. This approach would appear attractive to similar applications.

In this issue

Figure 1: The Aereco Humidity-Controlled Air Inlet (not exact).



The Hall-Effect Sensor

The sensor used in this application was a Texas Instruments TL173C Linear Hall-Effect Sensor. The dimensions of the sensor are approximately 5 mm by 4 mm by 5 mm. The supply voltage can be 10.8 to 13.2 Volts D.C. (VDC). With a supply voltage of 12 VDC, the sensor's output voltage will vary between 5.25 and 6.75 VDC as the magnetic flux varies from -50 to +50 millitesia (mT). At zero mT the output is 6.0 VDC. (All outputs are +/- 0.2 V).

The sensor is rated for 0 to 70 Deg. C and its sensitivity should not vary more than 5% between 25 Deg. C and these extremes. Thus, unless the sensor is directly exposed to outside air, temperature sensitivity should not be a problem in most applications. The storage temperature range is -65 to 150 Deg. C, so the sensor is unlikely to be damaged by extreme temperatures, even if accuracy may be lost.

Unfortunately, the TL173I, with a greater temperature range, is no longer available.

Applications

Hall-Effect sensors and magnets can be used to measure position in any situation in which a few centimeters of space is available, the motion is not too sensitive to allow the mounting of a magnet weighing one-half to two grams, and the range of motion being directly measured is not more than a few centimeters. The advantages of this technique include:

1. Small Size

The volume of the Hall-Effect sensor is less than 0.125 cubic centimeters (cc), and the magnets used in the Aereco houses were less than 0.25 cc. (These magnets were purchased in a hobby supply store; smaller, more powerful ones can no doubt be found.) Thus, the technique can be used within control mechanisms where very little space is available.

2. Minimal Interference with Operation

Except for the mass of the magnet, there is no load on, or interference with, the operation of the mechanism being measured. The magnets used in the Aereco job weighed less than two grams, and magnets weighing less than one gram can probably be used.

3. Tolerance of Temperature Variations

As mentioned above, the sensor's output should vary by 5% or less between 0 and 70 Deg. C, so temperature

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Editor: Janet Blacknell

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Conclusions and opinions expressed in contributions to Air Infiltration Review represent the author(s)' own views and not necessarily those of the Air Infiltration and Ventilation Centre.

should not be a problem unless the sensor must be in contact with outside air.

4. Low Cost

The manufacturer's suggested retail price for the Hall-Effect sensor, in quantities of one to one-hundred, is US$ 1.47. Magnets are also inexpensive, so the hardware costs for this technique should be insignificant.

The limitations of this technique include:

1. Short Range

With the magnets used in the Aereco houses, motion could no longer be detected once the magnet was about 25 mm from the sensor. If the magnet were sixteen times as strong, motion should be detectable to 100 mm, but it seems unlikely that the range could be extended much beyond that. Thus, there must be a point in the mechanism at which all motion is compressed into that range, and at which the sensor and magnet can be mounted.

2. Non-linear Output

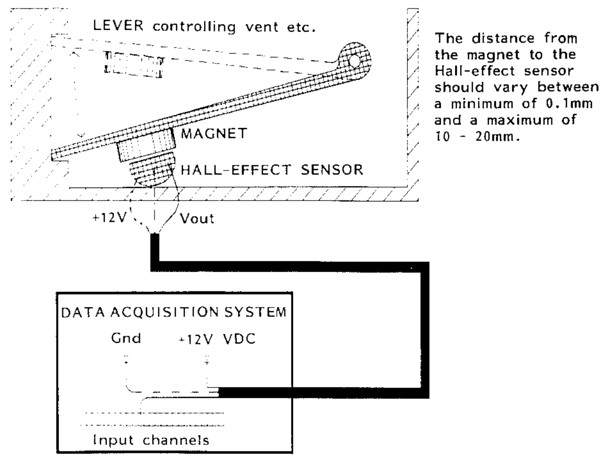
Although the sensor responds linearly to changes in the applied magnetic field, the field will vary as the square of the distance to the magnet. Furthermore, the position of interest, e.g., percent vent opening, may not vary linearly with the position of the mechanism on which the magnet is mounted. For these reasons, the relationship between output voltage and position of interest must be determined empirically, and a curve-fitting equation or look-up table may be required to interpret the raw data.

3. Need to Determine and Check the Correlation for Each Application

The +/- 0.2 VDC tolerance in the output of the sensor is a significant part of the change in output which will occur across the full range of motion, and the strength of magnets may vary over time. For these reasons, it will be necessary to correlate the output voltage to the position in question for each individual application, and to check this correlation from time to time.

Figure 2 shows the mechanical and electrical connections required for measuring position using Hall-Effect sensors and magnets.

Figure 2: Mechanical and Electrical Connections .



Call for Papers

5th Jacques Cartier Conference

Indoor Air Quality, Ventilation and Energy Conservation

To Be Held in Montreal, Quebec, Canada, 7-9 October 1992

Abstracts to be received no later than 1st October 1991

Send abstracts and all other enquiries to:

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Center for Building Studies,
Concordia University,
Montreal, Quebec H3G 1M8,
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20 Avenue Albert Einstein,
69621 Villeurbanne Cedex, France

News from the Building Environmental Performance and Analysis Club (BEPAC), UK

by John F Kendrick, Senior Scientist, AIVC

The UK BEPAC Controls Task Group met at the School of Architecture and Building Science at the University of Liverpool. The technical session held before lunch included presentations on two aspects of zone modelling. Mike Holmes (Arup R&D) described the use of a coupled heat transfer and air flow model to study the dynamics of zone temperature control. Ed Sowell (IBPSA President) described a model that provides a detailed treatment of the thermal interaction between artificial lights, the HVAC system and the zone itself.

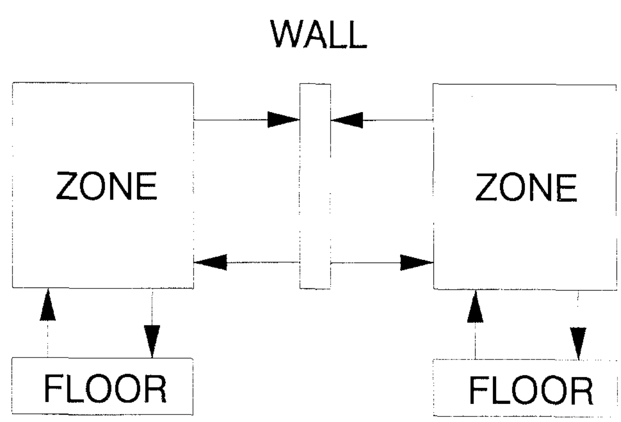
Mike Holmes outlined the drawbacks to be found when modelling heat transfer problems alongside computational fluid dynamics (cfd) simulations for thermal zone examples. The three forms of heat transfer to be considered within the dynamic thermal modelling are: convection, radiation and conduction. The latter is the simplest to model mathematically and convection can be represented by fixed coefficients, so the radiation problem has to be considered in detail. The presentation described the coupled use of a dynamic thermal model (R2D2, ROOM version 2, 2-dimensions) with a cfd system (AIRFLO) to simulate the thermal comfort and air distribution within an office space. The results compared well with previous measurements, namely with the temperature sensors within the extract system, a time dependent fluctuation of temperature occurred in the office space. The question to be answered was how should DTM and CFD be coupled, i.e. fully coupled or sequentially. The answer depends on the time scales involved, the accuracy required and the limit in run time although the dynamic thermal model will usually only make up .5% of the total run time.

Ed Sowell showed his work on the modelling of the interaction between lights and the room fabric. He demonstrated a modular approach for modelling the whole system. The advantage of this approach is the fact that zone models can be used to tackle the problem of many subfeatures within each zone, such as walls, lights and occupants as well as the application of many variations between zones, interiors, exteriors, carpets, furniture etc.

The previous zonal approaches can become oversimplified, complex zones in the past have been modelled using only a few nodes, so it is difficult to assign detailed properties and boundary conditions to this limited form. The latest version demonstrated here can be built from the various subfeature components to create a detailed model from a simple interface used to build the zones. The model being developed at Oxford University is a detailed nodal model using the code HVACSIM+ with an adapted user interface to give greater flexibility. Initially the zone is built from its various components, walls can be common (and massive) to more than one zone and the zone can contain as many nodes as the user feels is necessary.

The latest version has the advantage of allowing the user as many conduction/convection paths as required, non-linear convection coefficients, an arbitrary air circuit, short and long wave radiation, a lighting system, arbitrary distribution of heat gains and flexible outputs to suit the user. However there are limitations; mass and humidity networks are needed to fully model office situations. Also the code needs the addition of lighting level simulation, heat gain distribution, the problem of how to start up the program in an equilibrium condition. Work is being carried out to maximise the computational efficiency and develop a simpler user interface as the present code is used in a research context and is difficult to operate.

For further details please contact John Kendrick at the AIVC



Multiple Zone Representations

Air Quality Evaluated with the Human Nose

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Introduction

Complaints about indoor air quality in offices have increased over the years. The phenomenon "sick building syndrome" is often mentioned. In a Dutch study, in which 61 buildings were investigated, 45% of 7000 questioned office workers found the air quality unacceptable (1). In a Danish study, comprising 14 town halls, 36% of 3328 questioned persons complained about the indoor air quality (2). Complaints occur even when requirements on ventilation quantities are met and concentrations of specific pollutants are below the current threshold limit values (3). The ventilation requirements of today assume that the people are the exclusive polluters (4,5).

Chemical and physical measurements have frequently been unable to identify reasons for complaints about bad indoor air quality. In many cases the human senses are superior to chemical analysis for assessing how air is perceived. The striking factor of the olfactory sense is its extreme sensitivity to low concentrations of chemical substances and its ability to discriminate among them, as compared with the performance of physical/chemical instruments.

To be perceived, a molecule must be volatilized from its source, inhaled into the nasal cavity and dissolved in the protective mucous layer (epithelium). The nose comprises two nostrils with smelling organs. In each nostril one patch of yellowish tissue, the olfactory epithelium, is located in the dome of the nasal cavity. Two types of nerve fibres, the olfactory sense and the trigeminal nerve, whose endings receive and detect volatile molecules, are embedded in this tissue. The trigeminal nerve endings (common chemical sense) are located all over the nasal respiratory lining, not only in the olfactory epithelium. While the olfactory organ is sensitive to odorants, the trigeminal nerve endings are sensitive to irritants in the air. On being stimulated by pollutants, the olfactory nerve endings and the trigeminal nerve endings send signals to the brain where the signals are integrated and interpreted. This is called perceived air quality.

The traditional way to determine the air quality in existing buildings is to ask the people at their working place how they perceive the air. Confounding factors, like social communication, can however influence their opinion and make comparison of air quality judgements between several buildings complicated. The use of independent people who visit the investigated buildings is another approach. Panels of 50 to 100 subjects have been used to evaluate the air quality in office buildings (6).

Olf and Decipol

The two units, olf and decipol, were introduced to quantify air pollution sources and perceived air pollution with human bioeffluents from a standard person as the reference (7).

One olf is defined as the emission rate of air pollutants (bioeffluents) from a standard person. Any other pollution source may then be quantified by the number of standard persons (olfs) required to cause the same dissatisfaction as the actual pollution source. The definition is based on studies on bioeffluents from more than one thousand subjects at the Technical University of Denmark. 168 subjects evaluated the air polluted by bioeffluents (8,9). A second unit, decipol, was introduced to quantify perceived air quality by humans. One decipol is the perceived air pollution caused by one standard person (one olf) ventilated by 10 l/s of unpolluted air (Figure 1).

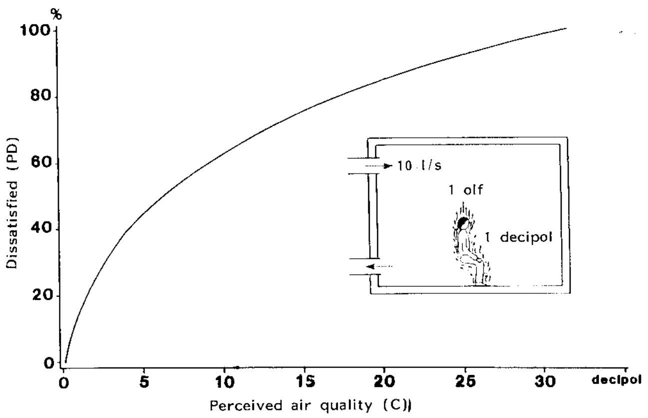

Figure 1 The relation between the percentage of dissatisfied and the perceived air quality in decipol. A standard person (1 olf) ventilated by 10 l/s unpolluted air causes a perceived air quality of 1 decipol.

Training of Panels

For a long time panels have been used to evaluate food in the food industry, but have also been used in cosmetics, perfumery and the wine industry. Air quality has been evaluated by large panels of untrained subjects (6). An alternative is to use a smaller panel of trained subjects (10).

When a panel has to be trained to evaluate perceived air quality directly in decipol a reference is required. The units olf and decipol are based on the reference human bioeffluents. Human bioeffluents comprise a large number of chemical compounds and vary considerably from person to person. A reference that is easy to measure and to produce would be convenient.

A suitable gas to be used as a reference for quantifying perceived air pollution instead of bioeffluents was selected through a literature survey and laboratory tests. The gas 2-propanone was found to be the best candidate, since it is cheap, common and readily available, not unfamiliar to people, in the concentrations used. The production is based on passive evaporation and is introduced to the human nose by a constant airflow coming out of the so called decipolmeter (Figure 2). Before 2-propanone can be used as a reference a relation between the perceived air quality in decipol and the 2-propanone concentration in air is required. 265 persons, all students betweeen 18 and 30 years of age, were therefore invited. Each subject evaluated eight different levels of 2-propanone produced by eight different decipolmeters. The determined relation between the decipol and the 2-propanone concentration is presented in Figure 3. This relation can be used to train people in evaluating air quality directly in decipol.

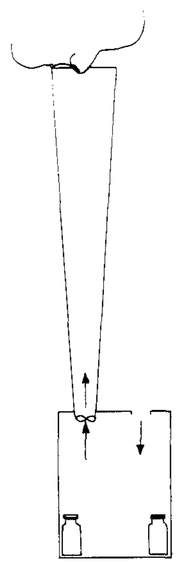

Figure 2 The decipolmeter. By varying the number of bottles with 2-propanone and the diameter of the hole in the top of these bottles different concentrations can be established.

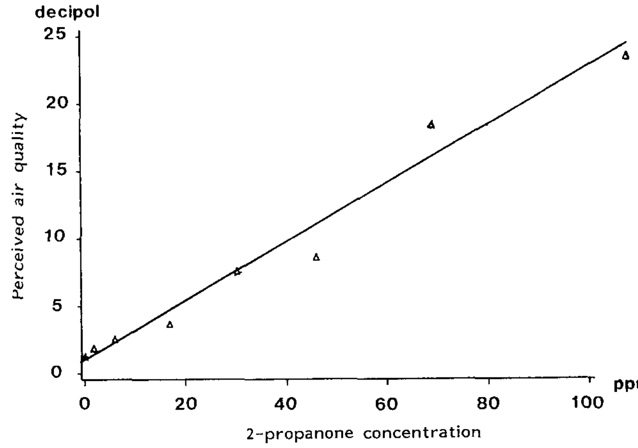

Figure 3 The relation between perceived air quality in decipol and 2-propanone concentration (ppm). Each point is based on votes of 265 untrained subjects. (decipol = 0.84 + 0.22xppm; R2 = 0.97)

Several selected panels have been trained to evaluate perceived air quality directly in decipol. Four different 2-propanone concentrations (2, 5, 10 and 20 decipol) generated by four decipolmeters, called the "milestones", served as the reference for the panel members. Several unknown decipol levels were evaluated several times using the four milestones as a reference. The procedure of judging was as follows (Figure 4): a panel member was exposed to an unknown level and asked to determine the decipol value of this unknown level by comparing to the milestones. The panel member was allowed to go back and forth between the unknown and the milestones as much as he or she wanted. However, one sniff had to be followed by at least two breathings of room air before another sniff was taken. The procedure should prevent the panel member from being adapted. After the evaluation the correct answer was given and the panel member was asked to go back to the unknown level to compare the correct answer with his/her own answer. During the training, the panel members were also exposed to other pollution sources than 2-propanone, comprising several common materials from buildings and ventilation systems.

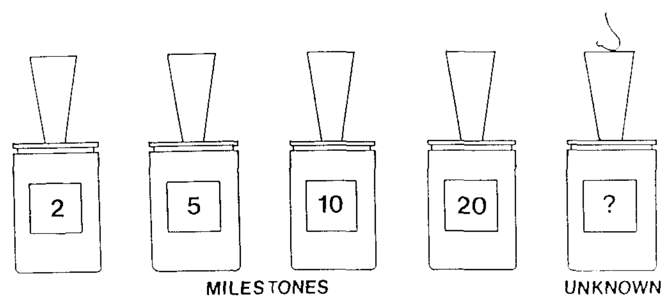

Figure 4 The set-up during the training procedure.

The Performance of Trained Panels

From studies with three panels of subjects it was found that training of a panel in groups of four requires at least 30 minutes per day during three days. Each panel member has to evaluate seven unknown 2-propanone levels per day and several other pollution sources. This finding was based on the performance of a panel expressed by the given decipol votes compared to the correct decipol values for the unknown 2-propanone levels, and by their reproducibility when exposed several times to other pollution sources.

The linear regression of all given votes versus the correct values indicates the performance. The ideal relation occurs when the vote is identical to the correct value. On the basis of this line the panel member can be instructed how to adjust his/her vote. Figure 5 shows an example of this relation for one of the trained panels. A regression line with an intercept of 1.3 and a slope of 0.81 was reached by a panel of eight persons after three days of training (7 unknown levels per day).

The performance index, defined as the mean difference between the voted decipol and the correct decipol value divided by the correct decipol value, for all evaluated levels per day, together with standard deviation, show how the votes were distributed around the line voted correct. Figure 6 presents the performance index, and the standard deviation lower than 40% was reached by a trained panel of eight persons after three days of training (7 unknown levels per day).

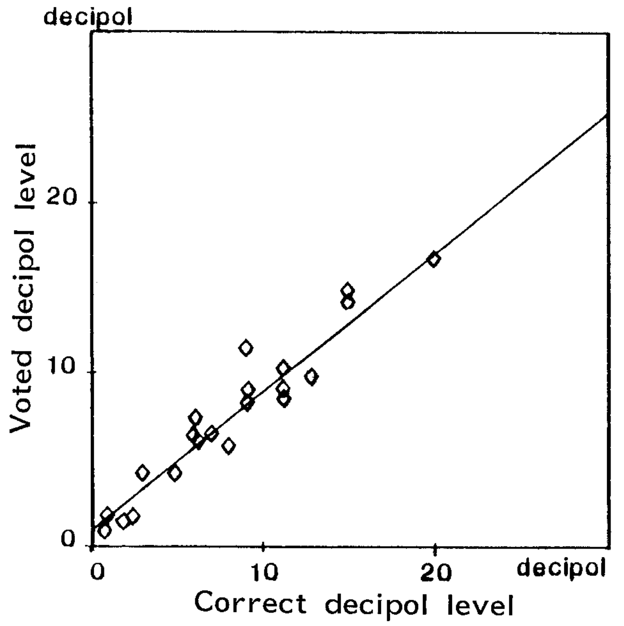

Figure 5 The relation between the given decipol votes and the correct decipol answers for the unknown 2-propanone levels. The data included in this figure comprise evaluations of a panel after that panel was trained.

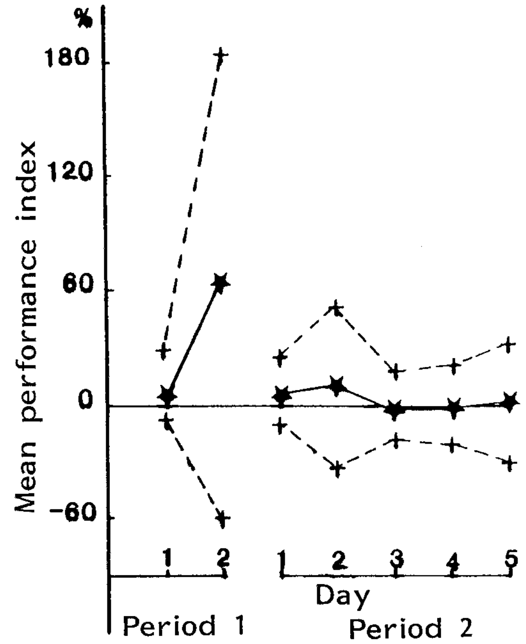

Figure 6 The mean performance index for a trained panel, per training day in two training periods (---*), and the corresponding standard deviation (+--- +). The performance index is defined as the voted minus the correct decipol level for an unknown 2-propanone level, divided by the correct decipol level.*

Several judgements of the same pollution source provide information on the reproducibility of a panel. The standard deviation around the mean of two or more replicas of a source divided by the mean vote of that source determines the reproducibility. The reproducibility for other pollution sources than 2-propanone was found to be about 8%.

The reason for using a trained panel instead of an untrained panel is that a trained panel requires less people than an untrained panel. It was found that to establish the same standard error on a mean vote with an untrained panel as a trained panel, at leath 8 times as many people are required.

The Use of a Trained Panel

A trained panel can be used as an instrument to determine the air quality. Besides that pollutants which can or have a health risk (radon, asbestos, carbon monoxide,...) have to be monitored as well. However, in a laboratory environment a trained panel can be very useful in determining the pollution level of a certain source or mixture of sources. Trained panels have already been used in two laboratory studies: a study in which the olf-values of a mixture of sources were investigated and a study in which the polluting effect of new and used filters was determined.

Addition of Olfs

The source strength of each material can be expressed in the olf unit. But what happens when various polluting materials occur in the same space? Can the combined effect of perceived air quality of different materials be predicted by simple addition of the olf values of each material in that space? A trained panel was used to investigate this simple addition method for several pollution sources (11). Figure 8 presents the relation between the measured olf-value of a mixture of sources and the predicted olf-value of the same mixture of sources by addition of the olf-values of the single sources. Addition of olfs from different pollution sources occurring in a space seems, as a first approximation, a good prediction of the total olf-load of that space.

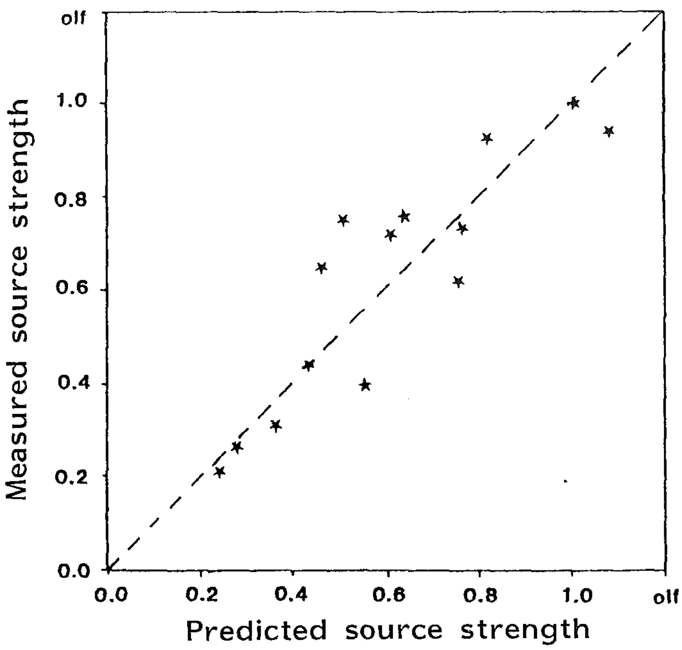

Figure 7 The relation between measured and predicted olf values for mixtures of materials.

Pollution Caused by Filters

Filters can be important sources of indoor air pollution (12). The polluting effect of several new and used fine bag filters was investigated with the use of a trained panel (13). The new filters did not pollute significantly. However, all used filters polluted the air instead of cleaning it, even when the filter had been used for only two months.

Olf-Catalogue

Future use of a trained panel may result in an olf-catalogue. In an olf-catalogue for each common building material and ventilation system component, an olf-value will be given. With the help of an olf-catalogue architects, designers and HVAC-engineers can then select materials and components that cause the "best" air quality.

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*A full account of the research performed in the above article can be found in the following document:

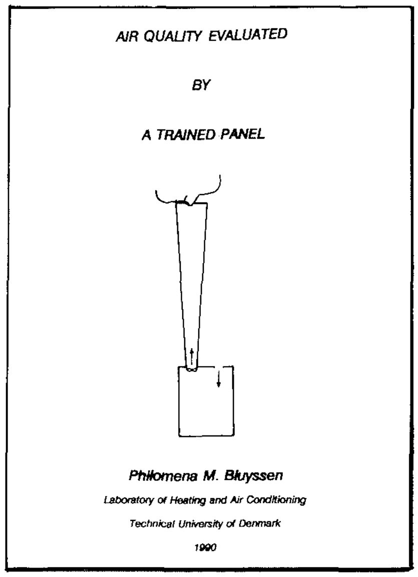
Air Quality Evaluated by a Trained Panel

by Philomena M Bluyssen

Ph.D. Thesis

for obtaining the Danish Ph.D. degree (licentiatus technices) at the Technical University of Denmark, Laboratory of Heating and Air Conditioning

31 October 1990



The AIVC's New Survey of Current Research into Air Infiltration, Ventilation and Indoor Air Quality

Survey conducted by Mark J Limb, Scientist, AIVC

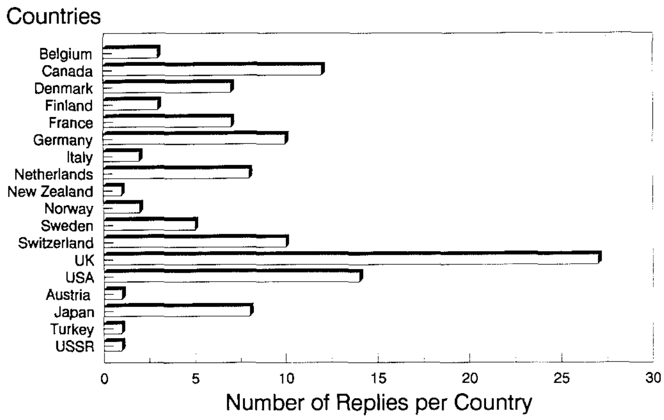
The main aim of the AIVC's worldwide survey of current research into air infiltration, ventilation and Indoor air quality is to provide organisations in participating countries with regularly updated information concerning ongoing research. In particular the major objectives are to encourage the international cross fertilization of research ideas and to promote co-operation between research organisations in different countries. The results of the first survey were published in 1980, and contained an analysis of 65 research summaries received from researchers in 14 different countries. Since then the number of replies has continued to increase, and last year the fifth survey of research was published. It contained a total of 233 replies, from 23 different countries. The fifth survey of research was for the first time also available in a database version, alongside AIVC's bibliographical database, AIRBASE. This aroused a great deal of interest, and has made regular updating much easier. In future this database will contain current research and details of activities scheduled for completion after 1990. As research tasks reach completion copies of relevant research reports will be included in AIRBASE wherever possible.

One hundred and twenty two updated entries from eighteen countries have been added to the database this year. The graph and table below show the origin and distribution of these replies.

Table 1. Origin and Distribution of Survey Replies.

Participating AIVC Countries	
Belgium	3
Canada	12
Denmark	7
Finland	3
France	7
Germany	10
Italy	2
Netherlands	8
New Zealand	1
Norway	2
Sweden	5
Switzerland	10
United Kingdom	27
U S A	14
Non-Participating AIVC Countries	
Japan	8
Austria	1
Turkey	1
USSR	1

Origin and Distribution of Survey Replies (AIVC Participating and Non-Participating Countries)



Survey forms are available from the AIVC on request and are divided into 3 main sections, the first outlines the project title, and information about the researcher; their address and telephone/fax numbers etc. The second section allows the main aims, objectives and specific details of their projects to be outlined. The survey form concludes with a bibliographic section, were any important reports or publications can be detailed.

The main areas of research in this year's survey have continued to be indoor air quality, airflow modelling and studies relating to infiltration and ventilation systems. In many cases a single project has several themes, for example a project investigating the installation of a new ventilation system into a building, may also study the indoor air quality and airflow aspects of the resulting indoor environment. Thus projects may fall into several of the categories outlined below.

New investigations into the indoor air quality of buildings so far amounts to 35 replies. Projects have several basic themes. There are those concerned with the indoor air quality implications of installing specific heating or ventilation systems into new and existing buildings via assessment and modelling, while others try to identify an array of indoor pollutants likely to have detrimental effects on occupants, discussing the likely health and comfort implications. Evaluations of the indoor air quality are either by a series of questionnaires, for occupant or researchers to complete, or by simply observing occupant behaviour. Other projects use mechanical devices to identify high pollutant levels in buildings. Buildings under investigation include hospitals, schools, residential, commercial and industrial type buildings.

Investigations of airflow form the major number of survey replies. This section includes the physics of air movement and the cause and/or effects of infiltration (23 replies) and ventilation both natural (13 replies) and mechanical (23 replies). The transportation of heat, moisture and pollutants around the internal environment and resulting consequences for the occupants and the indoor air quality (20 replies) are also included. Other research includes the design, specification and installation of heating and ventilation systems (42 replies), and the modelling of movement of air inside and outside of buildings. Scale models in wind tunnel experiments (4 replies) give detailed information with regards to outside airflow patterns, while tracer gas studies (29 replies) and mathematical modelling (27 replies) provide data for the prediction of air flow paths with rooms and buildings. Pressurisation and the determination of building tightness levels (7 replies) go hand in hand with the modelling of indoor air movement, and the resulting indoor air quality and energy implications (34 replies) of better insulation and improved tightness levels.

Several recent research studies are attempting to combine theoretical modelling with expected occupant behaviour while others are trying to assess the interaction between ventilation systems and occupants' behaviour (14 replies). Several projects aim to contribute to or improve current ventilation, airtightness and/or indoor air quality codes or standards (10 replies). Other projects are involved with the development of databases (5 replies), compiling ventilation and infiltration related data, such as leakage values and pressure coefficients, while two recent replies have been received from researchers trying to develop expert systems which will enable the easy access of complicated computer models.

It can been seen from the new survey replies that the trends identified in last year's detailed analysis continue. Research on ventilation and heating systems and strategies accounts for many of this year's replies. Similar trends are identified by the large number of indoor air quality and airflow simulation replies.

Entries into the new survey will run along side AIRBASE, and it is hoped that the survey of research will continue to arouse much interest and to expand. If you have not yet contributed to the AIVC's New Survey of Current Research into Air Infiltration Ventilation and Indoor Air Quality, it is still not too late, survey forms are available from the AIVC on request. We look forward to receiving your replies.

Copies of AIRBASE and the latest survey are available from the AIVC.

Control of Substances Hazardous to Health (COSHH)

A seminar held at the Institution of Mechanical Engineers, London, 29th May 1991

by John F Kendrick, Senior Scientist, AIVC

In October 1989, the initial stages of the UK Control of Substances Hazardous to Health (COSHH) Regulations were implemented. In January 1990 the full regulations were made compulsory for all situations related to possible worker exposure to hazardous substances. This one day seminar was designed to show how the regulations have been implemented and need to be further developed in various working environments.

Approximately 30 representatives from a broad base of industries in the public and private sector attended the seminar. The day was centered around seven presentations from consultants discussing the control of the regulations to the practical methods of measuring and assessing hazardous situations.

The seminar was introduced by Mrs C.E. Smith who is the chairman of the IMechE's Environmental Engineering Group. Mrs Smith emphasised the need for the regulations and for a continual assessment of the changing requirements for employers in the implementation of the COSHH.

The first speaker was Mr A. Rickman the Managing Director of Hinton Higgs Ltd, who introduced the topic of the practical considerations required when assessing the risk to workers' health. The presentation centered around a slide show demonstrating possible problems and the need for an independent assessment of hazardous procedures. Mr Rickman stressed the requirement for research into suitable ventilation techniques related to the understanding of flow in the breathing zone of employees as well as a comprehensive study of the behaviour of contaminants within flows in occupied zones. There are many potential pollutant sources and contamination routes; ingestion, absorption and inhalation. Locating, assessing and removing the hazard are the prime concerns. The simple alternative of providing personal protection equipment should be the final alternative as its use is open to human error and complacency.

After identifying the problems and receiving the details of hazardous substances from the manufacturers, an assessment of the hazard can be made. The next speaker Mr C. Hammond of Michelin Tyre plc explained how a centralised occupational hygiene team within a large multiplant industrial organisation can achieve a COSHH assessment for each workpost in cooperation with the Safety Manager and Industrial Engineers at each location. Mr Hammond described the procedure for assessing a typical work station on a single comprehensive information sheet and introduced a system of exposure categories which determine the actions required under the regulations. The subject of physically making the COSHH assessment brought about a lengthy discussion on how to assess the potential hazards involved when dealing with the unidentifiable by-products of combustion such as for example in the aircraft crash investigation industry.

To follow the ideas of the implementation of the COSHH regulations, a basic idea of the sampling techniques available is required as well as the standards to be applied when measuring the pollutants in the area of the worker. This subject was tackled by Mr David Mark from the Pollution Abatement Division of Warren Spring Laboratory. In order to measure the exposure of employees to inhalable hazards it is necessary to set out standards for the definition of aerosols. The presentation outlined the new standards concerning the grading of aerosols from the potentially harmful consequences of the size of contaminant particles. Mr Mark then described the techniques currently available for the measurement of airborne particles. The new standards apply to personal measurement systems as well as the stationary detectors used to measure contamination in the overall working environment. The measurements were compared to models in a wind tunnel using mannequins to simulate the worker in various ventilation situations.

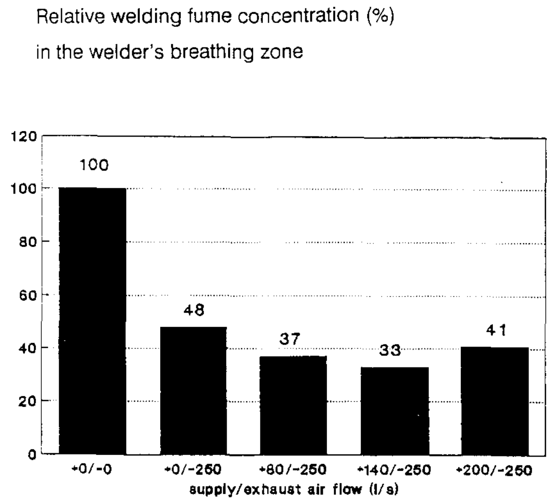
The discussion that followed centered around the problems faced when attempting to measure the levels of contamination in the working region. There are, for example, various difficulties involved with the use of dummies to simulate human intake of pollutants. With the recent update in the standardisation of measurement devices the problem should effectively be removed.

The role of the COSHH consultant? That was the question to be answered by the following speaker, Mr Jeffrey Hind who presented his personal experiences in the preparation of COSHH assessments, air sampling and local exhaust ventilation system checks.

The next speaker Mr Brian Fletcher of the Health and Safety Executive described in general some of the techniques available for the examination and testing of local ventilation systems. Local exhaust systems are designed to capture the contaminant as close as possible to its point of production, preventing it entering the air of the workplace whilst moving a minimum amount of air to achieve the result. The examination of equipment should involve the regular inspection for signs of wear as well as an assessment of the potential loss in efficiency of the extract device due to a lack of regular maintenance. To measure the flow within ventilation systems various measurement techniques are available, including pitot static tubes, hot wire anemometry and rotating vane anemometers. Each method has a specific application in various areas according to convenience and restrictions in space. Vane anemometers for example are bulky but fairly robust, while hot wire anemometers although small in size are delicate and can be easily damaged in airflows with high dust content such as to be found in typical extract systems. With all measurement devices and techniques an account has to be taken of the accuracy and the limitations involved.

The next speakers, Mr. Eloranta of Halton oy, Finland and Mrs. I. Welling from Lappeenranta Regional Institute of Occupational Health, Finland presented a paper on the development of a local ventilation system and its testing in various working environments. The working booth is designed to provide a local work station for the welding and solvent industries, relying on feeding air into the working zone and extracting the pollutants next to source. The paper demonstrated the effectiveness of the input and extract system with various ratios of air supply to extract rate to maintain a clean environment for the employee. The critical parameter becomes the ratio of extract to input rather than using the maximum available supply air.

The final presentation of the day was made by Mr. Sam Awolesi of A and K Associates. Mr. Awolesi discussed the results from measurements and computational fluid dynamics (cfd) simulations for the airflow within a workshop carried out with the view of examining the performance of its current ventilation system. The investigation involved the measurement of smoke paths within the workshop to demonstrate the limitations in the existing ventilation system. The cfd simulation then simulated the previously measured smoke patterns with an acceptable degree of accuracy. The cfd simulation was then implemented to see what adjustments could be made to the ventilation system for maximum contaminant removal.



Relative welding fume concentration in the welder's breathing zone to the supply and exhaust air flow rates

The closing discussion centred on the problems of making COSHH assessments in a working environment. The regulations are designed to be continually updated to apply to improving working methods.

The proceedings of this seminar are available on loan from the AIVC

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New Centre for Airflow Measuring Equipment at Loughborough University, UK

By Dr Saffa Riffat, Loughborough University of Technology, UK

The UK Science and Engineering Research Council (SERC) has provided substantial funding for the establishment of a Central Facility for Airflow Measuring Equipment. The Centre will be based at the Department of Civil Engineering, Loughborough University of Technology, UK and its objectives will include:

i) provision of direct support for research work carried out by institutions concerned with air movement and air quality in buildings.

ii) detailed measurement of ventilation and air movement in buildings to obtain data which could be used to establish standards for airflow measurement techniques.

iii) provision of support for researchers engaged in experimental work designed to examine the validity of computational fluid dynamics (CFD) codes and airflow algorithms.

iv) provision of training and seminars on the use of airflow measurement equipment.

v) assist implementation of the Control of Substances Hazardous to Health (COSHH) Regulations and Clean Technology Programme.

Ventilation, air movement and air quality in buildings are important topics of widespread interest. The establishment of the new Facility will alleviate the need to set up often costly measurement equipment at every institution requiring use of this type of equipment and so will allow more efficient use of available resources.

Equipment available at the new Centre will include: Perkin-Elmer FID/ECD gas chromatographs, thermal desorption systems, Miran and Binos infrared gas analysers, Bruel and Kjaer tracer-gas systems. Other equipment available for research includes: pressurisation equipment, instrumentation for measuring climatic parameters, thermographic and helium bubble visualisation systems, hot wire and vane anemometers.

The Centre will also provide single and two-zone environmental chambers and a large wind tunnel. Measuring equipment will be housed in a new laboratory and will be available for use at the Department of Civil Engineering, or in the field.

The Central Facility will be managed by Dr S B Riffat. A steering committee, whose members will include leading academics and representatives from industry, will be established to review research objectives as well as to ensure a productive relationship between the Facility and users. The Centre will be opened in 1992.

ATD-50 thermal desorber/gas chromatograph system

Miram IB2 gas analyser

For details contact Dr Riffat, Loughborough University, Civil Engineering, Loughborough, LE11 3TU, UK

Annex XIV
Condensation and Energy

Final Report in Four Volumes

Volume One: Sourcebook

Volume Two: Guidelines and Practice

Volume Three: Catalogue of Material Properties

Volume Four: Case Studies

The idea to start an Annex on mould, surface condensation and energy grew in 1984-1985. In September 1985 a workshop was organised at the Leuven University in Belgium which focussed on the state of the art in different countries. This workshop revealed a real lack of overall knowledge and understanding on the levels of data, modelling and measuring.

The Annex objectives were formulated as follows:

- Providing architects, building owners and practitioners as well as researchers with a better knowledge and understanding of the physical backgrounds of mould and surface condensation, including the critical conditions for mould growth and the influencing material properties;
- To introduce better calculation models, taking into account air, heat and moisture transfer in order to predict properly the phenomena of mould and surface condensation and to validate possible solutions;
- To develop energy conserving and cost effective strategies and complementary design methods, techniques and data for avoiding mould and surface condensation in new buildings or preventing further degradation in problem buildings.

Five countries, Belgium, Germany, Italy, Netherlands and the UK joined together for three years of intensified research on mould and surface condensation. The shared work included case studies, common exercises and the draft of a source book, a catalogue of material properties and a guidelines booklet. Also the national research efforts were scheduled in accordance with the Annex 14 scheme and the results brought together and used as a base for the Annex publications.

Seven working meetings of three days each were held, the first to build up a common knowledge, the last to discuss research and reports and to elaborate a common performance philosophy.

Contents

Volume One: Sourcebook

Classification of HAM models and levels of complexity

State of art of combined modelling

Concepts for moisture storage modelling

Model and input data requirements

Case studies and field experiments

Parameter study

References

Chapter 6: Boundary Conditions

Introduction

Moisture balance of a room

Influence of occupant behaviour

Influence of heating system

Influence of ventilation system

Meteorological conditions

Measuring techniques

References

Volume Two: Guidelines and Practice

Chapter One: Performance Description

Chapter Two: Links with Rational Use of Energy

Chapter Three: Mould Performance Checks for New Design

Chapter Four: Solving Existing Mould and Surface Condensation Problems

Volume Three: Catalogue of Material Properties

Chapter 1: Standard Lists

Chapter 2: Database

Building materials

Insulating materials

Finishing materials

Vapour retarders

Components

Others

Volume Four: Case Studies

1: Zolder (Belgium)

2: Ruhrgebiet (Germany)

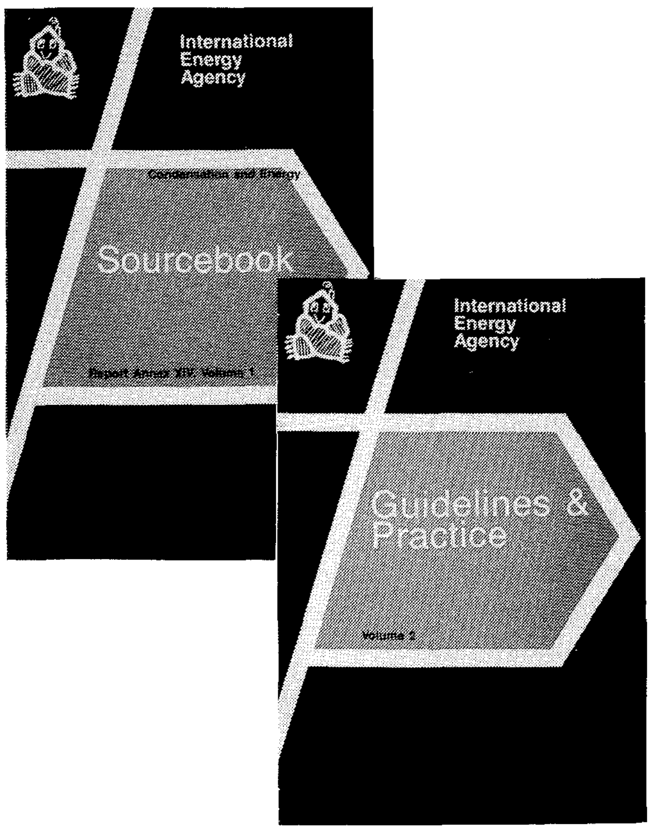
3: IACP-Torino (Italy)

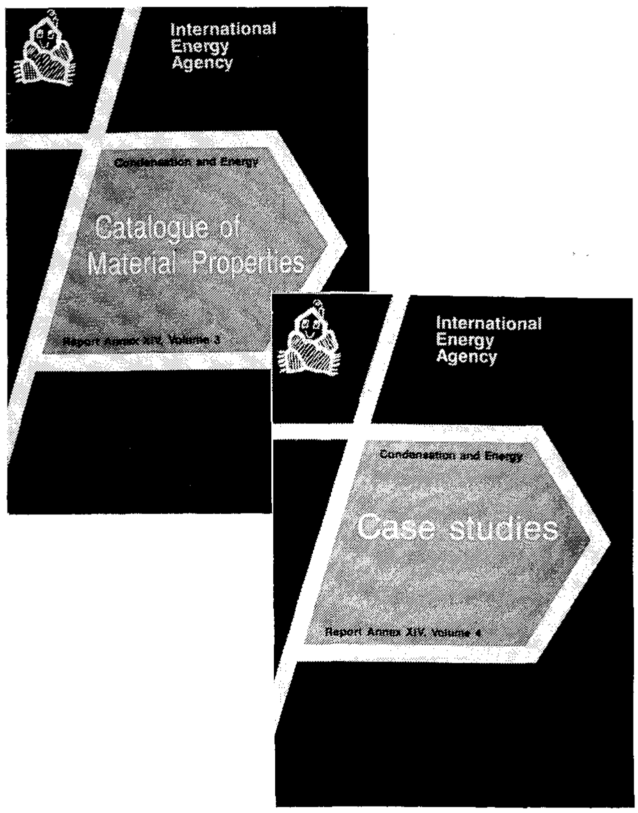
4: Pijnacker (Netherlands)

5: Alexanderpolder (Netherlands)

6: Edinburgh (United Kingdom)

Volumes 1 - 4 of this report are available from the AIVC, or from Professor Hens, Laboratory of Building Physics, University of Leuven, Kasteel van Arenberg, B-3030 Leuven-Heverlee, Belgium





Predicting Wind-Induced Indoor Air Motion, Occupant Comfort, and Cooling Loads in Naturally Ventilated Buildings

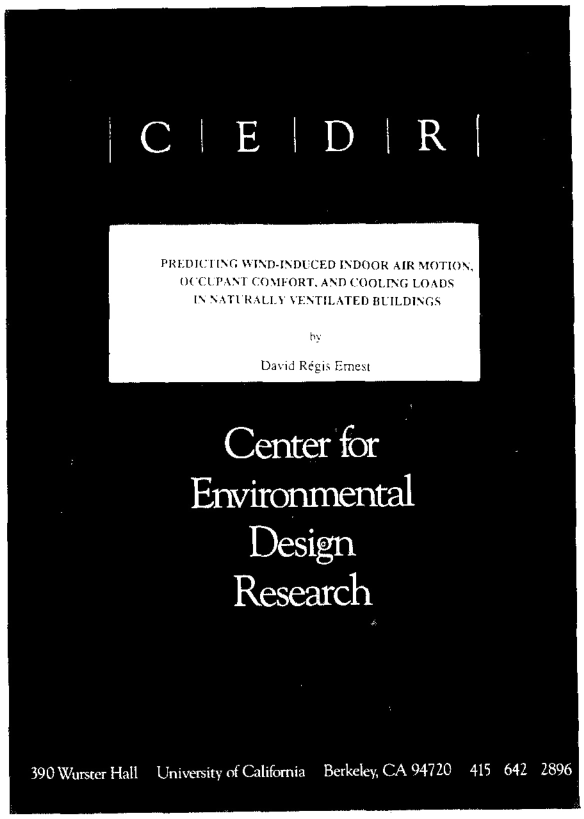
by David Regis Ernest

Dissertation submitted in partial satisfaction of the requirements for the degree of Doctor of Philosophy in Architecture in the Graduate Division of the University of California at Berkeley

1991

In many warm climate regions, wind-driven natural ventilation can be used to improve human thermal comfort and reduce cooling energy use in buildings. In addition to offsetting solar and internal gains, and cooling down the structure of the building itself, wind-induced natural ventilation also has the potential to cool building occupants directly by increasing indoor air movement. To design effective naturally ventilated buildings, evaluation tools are needed to assess the performance of each aspect of natural ventilation. In the past, due to the lack of simple and reliable methods to predict wind-induced indoor air motion, such evaluation tools have been difficult to develop. The primary goal of this dissertation was to develop a design tool for the evaluation of the performance of naturally ventilated buildings using wind-induced indoor air motion for occupant cooling. The development of this tool was divided into two phases. First, an empirical model for the prediction of wind-induced indoor air motion in naturally ventilated buildings was developed. Second, a procedure coupling the empirical prediction method to a human comfort model and a building energy simulation program was formulated.

The model was based on correlations developed from a large set of experimental pressure and velocity data collected from architectural models in a boundary layer wind tunnel. To develop this model, the approach used was to assess how, and to what extent, the information required for evaluation (indoor velocities and turbulence intensities) could be derived from knowledge already available to the designer (external surface pressure distributions measured on sealed models and simple building design variables). To do this, a large number of architectural configurations were investigated. These were selected to cover a wide range of possible building-airflow interactions, and included building orientation, upwind obstructions, building shape, external building projections, interior partitions, window size, and window location.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PREDICTING WIND-INDUCED INDOOR AIR MOTION, OCCUPANT COMFORT, AND COOLING LOADS IN NATURALLY VENTILATED BUILDINGS

by

David Régis Ernest

Center for Environmental Design Research

390 Wurster Hall University of California Berkeley, CA 94720 415 642 2896

The evaluation tool was used to assess the impact of wind-induced indoor air motion on thermal comfort and energy consumption in naturally ventilated buildings for a number of case studies. The results indicated that, under certain conditions, improved thermal comfort and reduced cooling loads can be obtained.

Copies of this report are available from CEDR Publications Program, Center for Environmental Design Research, 390 Wurster Hall, University of California, Berkeley, CA 94720, USA. Telephone 415 642 2896.

New Air Infiltration Publications

Passive Ventilation to Maintain Indoor Air Quality

by D J Wilson and I S Walker

Department of Mechanical Engineering, University of Alberta, Edmonton, Canada

Departmental Report Number 81

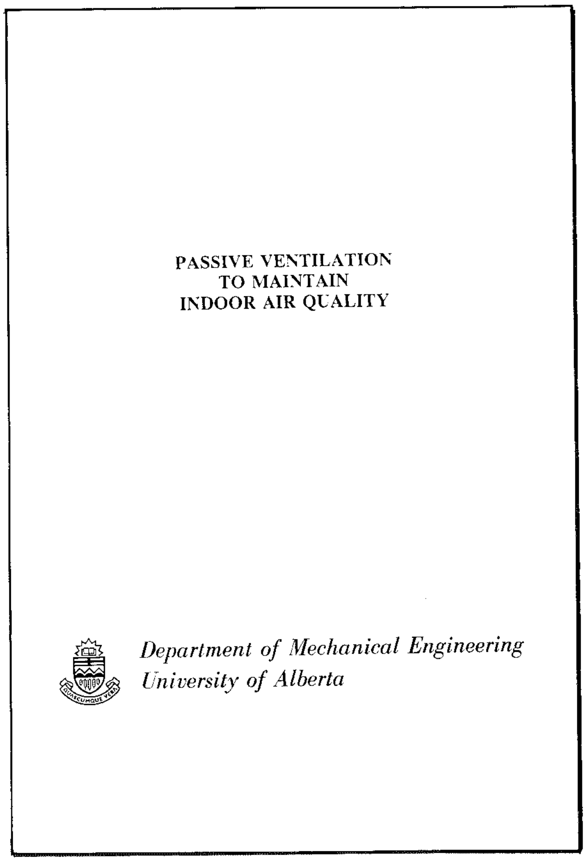
March 1991

This report describes the results of a three year project that made direct measurements of the effectiveness of passive ventilation from strategically placed air inlets and exhaust outlets on houses. The feasibility of using passive ventilation was studied to provide a simple maintenance-free alternative to the mechanical ventilation systems that are required by CSA and ASHRAE standards to maintain acceptable indoor air quality for occupants.

Before ventilation standards for indoor air quality were introduced by ASHRAE and CSA in 1989, the only ventilation requirements were to provide sufficient combustion make-up air for gas and oil fired furnaces and water heaters, and to have a furnace flue to exhaust combustion products. Fortunately, the combination of a combustion air intake and a furnace flue exhaust was usually enough to provide adequate ventilation for indoor air quality. However, during spring and fall when outdoor air is cold enough for occupants to keep windows closed, there is often insufficient natural ventilation and combustion air make-up to provide adequate ventilation. In these spring and fall shoulder seasons the conventional wisdom has been that occupants are intelligent enough to open windows when indoor air becomes "stuffy". Unfortunately, the regulators who developed the Canadian standard make no allowance for occupant intelligence (or passive ventilation) and require all fresh air to be provided by mechanical supply and exhaust fans.

The current ASHRAE standard for residential ventilation requires an overall exchange rate of 7.5 litres per second for each occupant, or a total building rate of 0.35 air changes per hour (ACH). The fresh air may be provided by a combination of natural ventilation through the building envelope, and mechanical ventilation from exhaust and supply fans. For houses with ventilated basements the ASHRAE requirement of 7.5 litres per second per person can be met by 0.2 to 0.3 ACH when the basement is included in the active air exchange volume.

The CSA standard is much more restrictive, and requires an air exchange rate of 0.3 ACH PROVIDED BY MECHANICAL VENTILATION ALONE, with no credit given for natural ventilation through passive inlets, and


PASSIVE VENTILATION
TO MAINTAIN
INDOOR AIR QUALITY

Department of Mechanical Engineering
University of Alberta

air infiltration through building envelope leaks. The present study was undertaken to determine if passive ventilation is a viable alternative to the mechanical ventilation system required by the CSA standard.

Chapter Headings are as follows:

Extended Summary

Part 1 Passive Versus Mechanical Ventilation

Part 2 Predicting Passive Ventilation Flow

Part 3 Passive Ventilation Measurements

Part 4 Computer Model Validation

Part 5 Case Studies of Passive Ventilation Performance

References

Forthcoming Conferences

1991

November 5-8

Building Services Asia '91 - Environmental Quality The 4th International Building Services, Electrical, Plumbing, Air Conditioning, Heating, Security and Fire Services Exhibition for Asia
Hong Kong Convention and Exhibition Centre Themes are: Indoor Air Quality, CFCs, Environmental Futures

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Busines and Industrial Trade Fairs Ltd., 28/F Harbour Centre, 25 Harbour Road, Wanchai, Hong Kong, Tel: 5 756333, Fax: 5 8345373, 5 8341171

December 3-7

International Conference on Human-Environment System, ICHES '91
Tokyo, Japan

Further details from:

Yutaka Tochihara, Secterary General, ICHES, c/o Department of Physiological Hygiene, The Institute of Public Health, 4-6-1 Shirokanedai, Minato-ku, Tokyo 108, Japan, Tel: +81 3 3441 7111 ext. 240, Fax: +81 3 446 4635

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April 28-30

IAI Indoor Air International Quality of the Indoor Environment
Athens, Greece

Further details from:

Conference Secretariat, Quality of the Indoor Environment, Unit 6, 2 Old Brompton Road, London SW7 3DQ, UK. Tel: +44 71 823 9401, Fax: +44 81 780 9894

May 18-22

CIB '92 World Building Congress
Montreal, Canada
Themes are: 1. New Materials and Systems, 2. Rehabilitation and Restoration, 3. Environment, 4. Globalization, 5. Computers and Robotics.

Further details from:

Congress Secretariat, CIB '92 World Building Congress, National Research Council Canada, Ottawa, Canada K1A 0R6

July 22-24

ISRACVE International Symposium on Room Air Convection and Ventilation Effectiveness
University of Tokyo, Japan

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Professor S Murakami, Chairman of ISRACVE, Institute of Industrial Science, University of Tokyo, 7-22-1, Roppongi, Minato-ku, Tokyo, 106 Japan, Tel: +81 3 3402 6231 ext. 2575, Fax: +81 3 3746 1449

October 7-9

5th Jacques Cartier Conference, Indoor Air Quality, Ventilation and Energy Conservation, Montreal, Quebec, Canada, Call for Papers - Abstracts to be received by October 1st 1991
Further details from:

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TN 23 (1988) Dubrul,C. 'Inhabitants' behaviour with regard to ventilation.
TN 24 (1988) 'AIVC Measurement Techniques Workshop: Proceedings and Bibliography'
TN 25 (1989) Blacknell,J. 'A subject analysis of the AIVC's bibliographic database - AIRBASE',
TN 26 (1989) Haberda,F and Trepte,L. IEA Annex IX 'Minimum ventilation rates and measures for controlling indoor air quality.
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AIVC CONFERENCE PROCEEDINGS

1st 'Instrumentation and measuring techniques',Windsor, UK,1980.
2nd 'Building design for minimum air infiltration', Stockholm, Sweden, 1981.
3rd 'Energy efficient domestic ventilation systems for achieving acceptable indoor air quality', London, UK, 1982.
4th 'Air infiltration reduction in existing buildings', Elm, Switzerland, 1982.
5th 'The implementation and effectiveness of air infiltration standards in buildings', Reno, USA, 1984.
6th 'Ventilation strategies and measurement techniques', Het Meerdal Centre, Netherlands, 1985.
7th 'Occupant interaction with ventilation systems' Stratford-upon-Avon, UK, 1986.
8th 'Ventilation technology - research and application', Uberlingen, West Germany, 1987.
9th 'Effective Ventilation' Ghent, Belgium, 1988
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7) Air flow through building entrances.
8) Air infiltration in commercial buildings.
9) Air infiltration in public buildings.
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