Preview
A New Publication of the
Air Infiltration and Ventilation Centre

AIVC Guide to Ventilation

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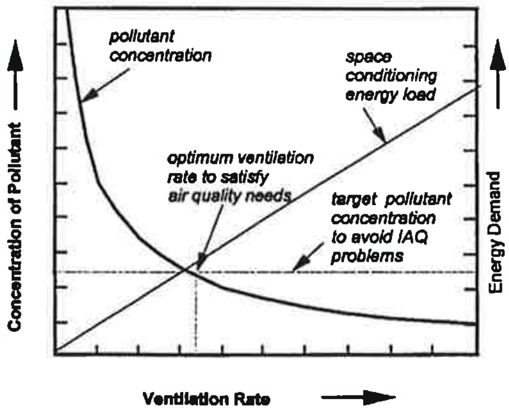
The purpose of the AIVC's new guide to ventilation is to review ventilation in the context of achieving energy efficiency and good indoor air quality. It is primarily concerned with providing an introduction to the topic and encapsulates the knowledge and experience derived from experts in all the participating countries of the Air Infiltration and Ventilation Centre. Numerical descriptions have been kept to a minimum, while emphasis is placed on describing ventilation and the decision making involved in selecting and planning for ventilation. By understanding this Guide, it is hoped that the reader will be able to make fundamental judgements about how much ventilation should be provided and how this should be accomplished for optimum cost and energy efficiency.

This guide is specifically aimed at the policy maker, architect, building services engineer, designer and building owners and occupiers who require a background knowledge to ventilation.

Structured in twelve chapters the first considers the role of ventilation. It looks at the need for ventilation to meet metabolic needs (oxygen and odour control), the minimum acceptable ventilation rate and at additional requirements to meet the (polluting) activities of occupants (e.g. smoking, cooking, unvented clothes drying etc.).

It is argued that too often it falls upon ventilation to accomplish tasks for which it is not intended.



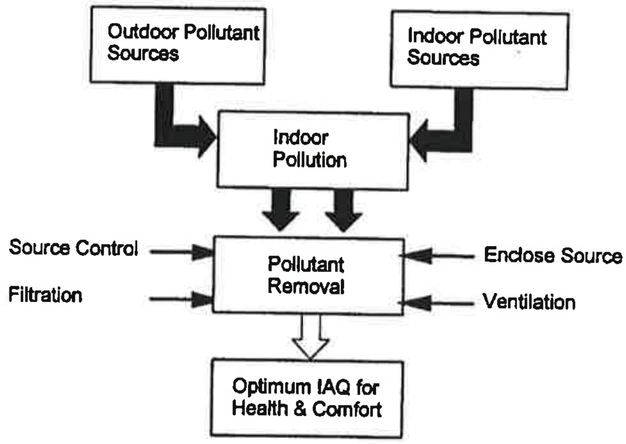
Pollutant concentration is reduced by ventilation. As the ventilation rate is increased, energy demand also grows.

Chapter 2 reviews indoor air quality. Good indoor air quality may be defined as air which is free of pollutants that cause irritation, discomfort or ill health to occupants. Thermal conditions and relative humidity also influence comfort and health. A poor indoor environment can manifest itself as a 'sick' building in which some occupants experience mild illness symptoms during periods of occupancy. More serious pollutant problems may result in long term and permanent ill-health effects. Since much time is spent inside buildings, considerable effort has focused on methods to achieve an optimum indoor environment, with particular emphasis on health, odour control, thermal comfort and energy efficiency.

Aspects of Indoor Air Quality are discussed with particular emphasis on providing an overview of indoor air quality in relation to:

- Sources of Pollutant
- Metabolism and Health
- Odour
- Sick buildings
- Comfort
- Reducing Pollutant Concentration

Above all a coordinated approach is needed to secure good IAQ as outlined in the figure below:



Securing good indoor air quality

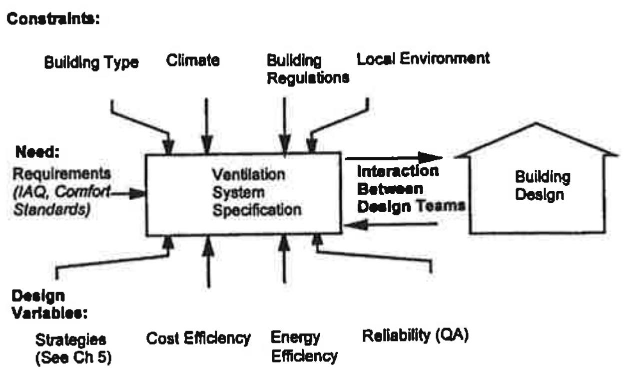
Aspects of energy impact are outlined in Chapter 3.

A considerable proportion of the energy consumed in buildings is lost by ventilation and air infiltration. This has important implications both at the consumer level, where the cost must normally be met, and at the strategic level, where it contributes to primary energy need and environmental pollution. Since ventilation is so closely linked to concern about indoor air quality, there is the further problem of identifying how much ventilation is needed to provide for a healthy indoor environment.

Since it is difficult to assess the energy impact of ventilation, the context of air change in relation to energy use is often undefined. As a consequence, no adequate datum exists from which strategic planning for improving the energy efficiency of ventilation can be developed. This difficulty stems from the enormous complexity of the task, which needs to accommodate wide variations in factors such as climate, building air tightness, occupancy patterns and approaches to ventilation. Efforts to overcome these difficulties are progressing and an attempt is made in Chapter 3 to outline the results of present progress.

Chapter 4 focuses on ventilation design criteria. A ventilation system must be designed to satisfy the required demand. In meeting this need it is necessary to consider a wide range of criteria, varying from meeting the needs of Building Regulations to planning for maintenance and replacement (Figure 2). It is also necessary to integrate the ventilation system itself into the overall design of the building, especially in relation to air tightness, room partitioning and accessibility.

Since such a wide range of parameters is involved, there is rarely a unique solution to a particular ventilation design. Instead the designer must base a judgement on the individual needs of each building. Ultimately a robust solution is needed which ensures the health and comfort of occupants. Ventilation needs must be based on criteria that can be established at the design stage of a building. To return afterwards in an attempt to mitigate problems as they arise may lead to considerable expense and failure.



Design Criteria are subjected to many parameters

Strategies for ventilation are reviewed in Chapter 5. A wide range of systems and techniques is available to meet the needs of ventilation with each having its own set of advantages, disadvantages and applications. Sometimes choice is dictated by local climate conditions or building type. Frequently, price competitiveness and an unwillingness to deviate from the minimum specification of relevant Building Regulations or Codes of Practice can further restrict choice and also limit the opportunity for innovation. To justify a complex strategy, it is usually necessary to demonstrate advantages in terms of improved indoor climate, reduced energy demand and acceptable 'payback' periods. Strategies reviewed cover both natural and mechanical systems.

Chapter 6 looks at the potential for ventilation heat recovery. Considerable energy is lost from a building through the departing air stream. When air change is dominated by infiltration, little can be done to re-capture this energy. On the other hand, if exhaust air is centrally collected, a variety of methods for recovering or recycling the waste heat become possible. In view of the scale of ventilation energy loss, considerable effort has been devoted to the design and development of ventilation air heat recovery systems.

While the heat recovery process can be shown to be extremely efficient, benefits must always be equated against the (primary) energy needed to drive the process and capital and maintenance costs. Various hidden losses such as air infiltration must also be thoroughly understood.

Ventilation and cooling is reviewed in Chapter 7. Cooling is needed when the indoor environment becomes excessively hot or humid. This may occur as a result of high outdoor temperatures or as a consequence of excessive solar or internal heat gains. High internal gain is particularly a problem in large non-domestic buildings.

When the need for cooling is dictated by internal heat gains rather than outside temperature and humidity, much can be accomplished to reduce the need for or eliminate altogether active cooling systems. Solutions depend on climate but include cooling by ventilation (passive cooling), designing for reduced solar gains, the use of thermal mass and restricting internal heat loads.

The role of filtration to clean ventilation air is explored in Chapter 8. Filtration is a method by which particulates and, sometimes, gaseous pollutants may be removed from the air. Pollutants are intercepted by a filter while allowing clean air to pass through. This method of air cleaning is especially necessary when high concentrations of particulates are present or when the source of pollutant is derived from outside the building. Potential benefits can include improved air quality, reduced dependence on ventilation and improved energy efficiency. Filtration is not a substitute for the ventilation needed to meet the metabolic requirements of occupants.

Ventilation Efficiency and the process of air mixing is outlined in Chapter 9. Indices of ventilation efficiency characterise the mixing behaviour of air and the distribution of pollutant within a space. These two aspects may be subdivided into indices of air change efficiency and pollutant removal effectiveness respectively. Ventilation efficiency is based on an evaluation of the 'age', of air and on the concentration distribution of pollutant within the air. Some indices are based on room averaged values, while others refer to specific points or locations. This has important consequences because while room values provide some guidance to the overall performance of a ventilation system, point values indicate regions where localised poor ventilation might occur.

Chapter 10 looks at maintenance issues. Maintenance is needed to ensure the reliability of the ventilation system and to secure the economic operation of the ventilation plant. Evidence suggests, however, that maintenance is often inadequate and that the need for maintenance may even be ignored in the course of building design. Typical problems include worn gaskets, dirty fans and grilles, and ill-fitting and clogged filters. This concern has resulted in much more specific guidelines being developed for the maintenance of ventilation systems, some of which are discussed in Chapter 10. Only by correct functioning can a ventilation system be relied upon to meet the indoor air quality needs of a building.

Measurement methods are reviewed in Chapter 11. Measurements are needed to verify the performance of ventilation systems and to test the integrity of the building shell. They are essential for commissioning, diagnostic analysis, design evaluation and research. In addition, measurement results provide the fundamental means for understanding the mechanics of ventilation and air flow in buildings. Measurement data are also needed to provide background information for parametric studies on building air leakage characteristics, indoor air quality and ventilation system performance. Many measurement techniques have been developed with each having a specific purpose. An analysis of principal measurement techniques and applications is presented.

Finally, Chapter 12 reviews recent developments in calculation techniques. Calculation techniques and numerical models are essential for any design process. They provide the means by which the designer can develop and investigate an idea before being committed to the final product.

Typical design aspects cover system sizing, performance evaluation, indoor air quality prediction, energy impact assessment, and cost benefit analysis. A calculation technique or model is used to analyse the interaction of design options with fixed constraints. Such a process is necessarily iterative, with adjustments made to parameters over which control is possible, until an optimum design solution is achieved.

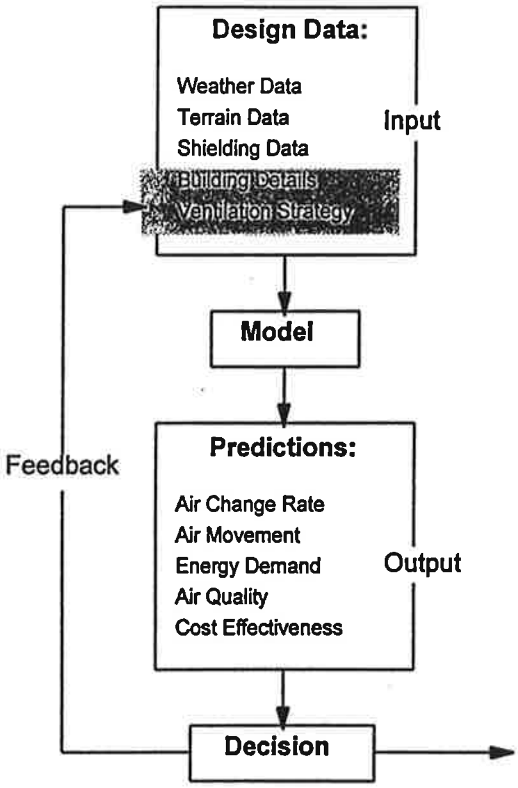
A wide range of methods of varying complexity have been developed with no single method being universally appropriate. Selection varies according to the required level of accuracy, the availability of data and the type of building under investigation.

As designs have become more complex and performance tolerances more demanding, it is increasingly important for the designer to be able to understand and use calculation techniques. This need has resulted in the development of improved algorithms and wider availability of design data.

Techniques cover methods to determine:

- air change rates in buildings and rooms.
- the flow rate of air through infiltration and purpose provided flow openings (network methods).
- air flow pattern in a space (computational fluid dynamics).

Subsidiary calculations cover pollutant transport, energy analysis and the evaluation of driving forces (wind and stack effect).



Calculation techniques are used for design and decision making

A series of appendices provide numerical support to Chapter 12 including data and a simple ventilation calculation algorithm.

The AIVC Guide to Ventilation is soon to be available from the AIVC, please send enquiries to the address listed on the back page.