

AIR MOVEMENT & VENTILATION CONTROL WITHIN BUILDINGS

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POSTER 2

**A New Handbook on Measurement Techniques
Related to Airflow Patterns Within Buildings**

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Synopsis

A new handbook, describing in details the measurement techniques which could be used to better understand the infiltration and ventilation in buildings is presented. This handbook results from the cooperation between Annex 20 and Annex 5 of the IEA ECB program. It presents the techniques for detecting and measuring as well the air leakages as the air flows in buildings and in ventilation systems. Methods related to ventilation efficiency and effectiveness, like the measurement of the age of air, are also described.

Introduction

Improving comfort and indoor air quality as well as minimizing the pollution and energy consumption are of growing importance in many countries. For that purpose, the use of theoretical models and simulation computer codes is useful. Planning rules are also published to increase the quality of the construction and the performances of the ventilation systems.

The reality however does not always follows theoretical models, nor is the actual work always a perfect execution of the proposed design. This results sometime in uncomfortable or even sick buildings (too leaky or too tight envelope, too much contaminants), in dysfunction of the HVAC system (too much or not enough air, shortcuts, spreading of contaminants) or high energy consumption. On the other hand, some theoretical models or computer programs do not follow the reality, that is do not reproduce it in a satisfactory way.

In order to assess the reality, to control the building and ventilation system performances and to evaluate models and computer programs, measurements are of great help, if not unavoidable. Such measurement techniques are described in the literature, but, except the AIVC Measurement Guide^[1], no comprehensive review, describing the many techniques in much detail, was available.

As a result of a close collaboration between the Annex 20, subtask 2 contributors and the AIVC, a technical handbook was prepared, based on the AIVC Measurement Guide, but greatly extended to take into account the latest developments in measurement methods related to ventilation^[2]. It is concerned with the measurement of those parameters which are important in gaining an understanding of air infiltration and ventilation.

A short history

From the early beginning of the IEA-ECB Annex 20 "Airflow Patterns Within Buildings", it was decided, within the subtask 2 "Multizone Air Flows" to contribute to the development of new measurement techniques, adapted to the study of air flow patterns in multizone buildings. As usual in such international programs, it was intended to publish a report describing the methods developed in the frame of the Annex 20. These methods would be enhanced pressurization tests and multizone tracer measurement techniques.

Since the AIVC was interested in picking some information from this report to complete its Measurement Guide, it was proposed that the Annex 20 report would be several packs of sheets which could be inserted in the AIVC Guide. For that purpose, information was gathered as well from the literature (using AIRBASE) as from every Annex 20, subtask 2 participant. On that base, two reports, one on enhanced pressurization test methods and the other on multizone tracer measurement techniques, were drafted. Looking at these drafts, two facts were clearly seen:

- a) because of the particular structure of the AIVC guide, it would be difficult to integrate these drafts into the Guide, and,
- b) it might be interesting to extend the description as well to the techniques related to the age of air and to ventilation efficiency and effectiveness, as to measurement methods which could be applied to ventilation systems.

Therefore, the authors agreed with the Head of AIVC to make together a completely new edition of the AIVC Measurement Guide. Texts, figures and informations coming from the Guide were merged with the draft Annex 20 reports. This new, combined draft was completed with two more parts concerning measurement techniques related to indoor air quality and to ventilation systems and submitted to the Annex 20 participants and to the Steering Group of the AIVC.

At that time, it appeared that this new draft, if useful for the scientists going to make measurements in the field, might be too complex and too detailed for non specialists, or, in other words, that the new draft was not for the same public as the AIVC Guide. It was therefore decided in the Steering Group of Annex 5 that the new draft will be published as a new Technical Note and that the AIVC Guide will remain, with some additions prepared by the AIVC.

Content of the Handbook

This handbook is hence the result of a strong collaboration between the Annex 20, subtask 2 and the Annex 5. The latest developments in measurement methods related to ventilation were described by Annex 20 participants and large portions of the Measurement Techniques Guide first published in 1988 by the AIVC and describing the techniques already known at that time were reviewed and integrated, in order to make this handbook as comprehensive as possible.

The complete book is 286 pages thick, the relative importance or the various parts can be seen in Table 1. Its content is summarized below.

Table 1: Number of pages, figures and tables in the various parts.

Part	Pages	Figures	Tables
I	18	4	11
II	74	42	11
III	92	28	6
IV	24	3	5
V	18	7	0
Appendices	56	23	15
Index	4	0	0
Total	286	107	48

The introduction provides a general overview of infiltration and ventilation in buildings. Ventilation studies are discussed and the aims of the guide outlined.

Part I defines the parameters which are important, presents the reasons why they should be measured and gives a guide to the selection of techniques for particular applications. Summaries of the main techniques available are presented, which are cross referenced with the main body of the guide. This part intends to help answering the question: *"Which measurement technique should I use to get the value I require?"*. This part contains the following chapters:

1. Structure of the Handbook
2. Introduction
3. Selecting a Technique

Part II, **Air Leakage Measurement Methods**, presents the theory and practice of measuring the airtightness of the building envelope and its components as well as of the internal partitions within the building. In general, this part answers the question: *"How could I quantify airtightness of a building as a whole, of particular zones or particular building components and how could I detect or visualize leaks?"*.

One chapter is dealing with the measurement of the two basic physical variables in the representation of air leakage, namely pressure and air flow rate. A large number of currently available techniques and equipments for the actual determination of overall airtightness and components leakages, both qualitatively and quantitatively, are presented, often accompanied by an example from practice. The global structure is:

1. Introduction
2. Principles of the Pressurization Techniques
3. Pressure and Air Flow Measurements
4. Current techniques
5. Treatment of Results
6. Equipment
7. Airtightness Measurement Techniques Standards

Part III, **Air Flow Measurement Methods**, presents the theory and practice of measuring air exchange rates and the related contaminant flow rates, as well in single zone as in multizone buildings. Air exchange between a building and the external environment is examined, as is the air exchange between the various internal spaces of a building. This part is for those which have the following questions: *"I would measure air flow rates within single and multi-zone buildings. Which are the methods? Which instruments could I use? How could I measure and interpret the results?"* The answers are found in the chapters listed below:

1. Introduction, Objective of Measurements
2. Basic Equations
3. Principles of Different Methods for Determining Outdoor Air Flow Rates into a Building and Interzonal Air Flow Rates
4. Treatment of Results
5. Components of a Tracer Measurement System
6. Examples of Systems
7. Comparisons of Methods
8. Standards

Part IV, **Measurement Methods Related to Efficiency**, presents some measurement methods which may be useful to qualify the indoor air and the efficiency of the ventilation system. This part however does not describe the techniques for the measurement of contaminant concentrations. It will only help people which wonder *"How old is my fresh air? Where are the dead zones? Does the contaminants stay long in my breathing area?"*. The addressed matters include the following:

1. Introduction
2. Definitions
3. Local Age of Air
4. Planning of Mapping Experiments
5. Room Mean Age of Air and Air Exchange Efficiency
6. Measurement Methods Related to Ventilation Effectiveness

Part V, **Measurements on Ventilation Systems**, describes measurement methods able to qualify a system, namely to measure the flow rates in the ventilation network and to control its tightness. As well the simple measurement of the air flow rate in one duct as techniques allowing to assess all the flows in a ductwork are described. The answered question is here: *"How could I control if my (mechanical) ventilation system works as planned?"*. The following chapters are found in this part:

1. Introduction
2. Measurement of the Air Flow Rate in a Duct
3. Air Flow Rates in a Ventilation Network
4. Efficiency of the Ventilation System
5. Measurement of Air Tightness of a Duct or Network

Appendices are provided either to give informations on general tools or to lighten the main text from informations which may be useful only to specialists. These are:

- A 1. Unit Conversion Tables
- A 2. Error Analysis
- A 3. Identification Methods
- A 4. Example of Multizone Pressurization in a Realistic Case
- A 5. Strength of the Passive PFT Sources
- A 6. Algorithm to Control a Constant Concentration System
- A 7. Glossary

An index with some 430 entries is located at the end of the book, to help users in looking for the good information.

How to use this handbook?

There are many measurement techniques which could be used to study the air flow patterns within buildings. Remember however that measurements are often time consuming and expensive. They generally require sophisticated instruments which are not always immediately available. For all these reasons, measurements should be carefully planned and performed only when required. Measurement is the answer, but what is the question?

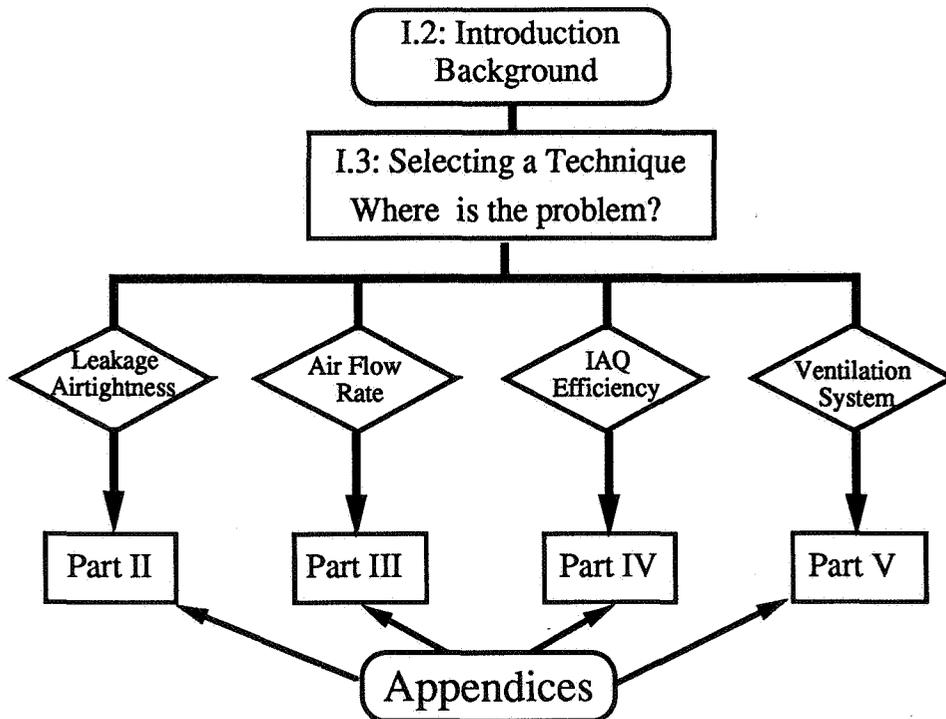


Figure 1: Structure of the Handbook.

To use this handbook (as any measurement technique) efficiently, one should first answer the following basic questions, in the following order:

- 1) What is the problem to be solved?
- 2) Which physical data may be useful to solve my problem?
- 3) Out of these data, which could be simply guessed and which ones should really be measured?
- 4) Which technique could be used to measure the required data?
- 5) How should I use that measurement technique?
- 6) How should I interpret the results to answer my questions?

After, and only after answering these questions, the experiment can be defined, the instruments installed, the measurement performed, the results treated and the problem solved.

The presented handbook only helps answering questions 4) to 6), as it is shown in Figure 1, which represents the structure of the book.

Conclusions

This publication intends to help scientists wanting to make measurements in the field of air infiltration and ventilation in buildings. It should be used as a handbook and can be opened when required at the pages of interest. The index and detailed tables of content may help in finding the proper information.

For some specialists, parts of the handbook will seem too simple, while newcomers may require some basic teaching before reading the details of some interpretation methods. It is impossible to prepare a text which is at the ideal level for any reader, but we nevertheless hope that every reader will find the necessary information.

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References

- 1] Charlesworth, P. S.: Air Exchange Rate and Airtightness Measurement Techniques - An Application Guide. *Air Infiltration and Ventilation Centre (AIVC), Warwick (UK), 1988, AIRBASE #3292.*
- 2] Roulet, C.-A. and Vandaele, L: Airflow Patterns Within Buildings, Measurement Techniques. *Technical Note, Air Infiltration and Ventilation Centre (AIVC), Warwick (UK), 1991*