The air infiltration and ventilation center: The history and technical program of IEA Annex V

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ABSTRACT

The Air Infiltration and Ventilation Centre is operated under Annex V of the Energy Conservation in Buildings and Community Systems implementing agreement of the International Energy Agency. The primary objective of the AIVC is to provide a high quality international technical and information forum covering the areas of ventilation and air infiltration in the built environment with respect to efficient energy use, good indoor air quality and thermal comfort. The main drivers for this work are the national and international concerns in the areas of sustainable development, responses to climate change impact and healthy buildings.

The AIVC provides different services which can be grouped as follows:

- Technical forum for all relevant international and national ventilation and related activities.
- Synthesized leading edge research information to meet industry needs.
- Synthesized information to the research community, policymakers, industry with emphasis on the end-use and practice.
- Advice on cost-effective measures for energy efficient buildings and good indoor climate conditions.

The purpose of this paper is to review the efforts of the AIVC with particular emphasis in areas related directly or indirectly to sustainability.

1. INTRODUCTION

Although efficiencies of equipment can be made quite high and conductive loads through the building envelope can be made quite low, there will always be a need to provide adequate indoor air quality and for the foreseeable future that means ventilation. A low-energy building, therefore, must provide sufficient ventilation using such techniques as passive or hybrid ventilation, heat or moisture recovery, etc. Internationally the body that is most focused on these issues is the Air Infiltration and Ventilation Center.

In severe climates ventilation is a load on the heating or cooling system that must be designed for, but for many more mild climates ventilation during part of the day can reduce or remove the need for heating or cooling energy use. The multiple goals inherent in providing a good indoor climate require that a good understanding of infiltration and ventilation is necessary.

The Air Infiltration and Ventilation Center (AIVC) is one of the information centers of the International Energy Agency (IEA – www.iea.org). Its expertise is in the areas of infiltration and ventilation systems and their relationship to energy, Indoor Air Quality (IAQ) and other aspects related to indoor climate.

The AIVC was created in 1979 under the auspices of the Implementing Agreement (IA) on Energy Conservation in Buildings and Community Systems (ECBCS – www.ecbcs.org) under the End-Use Working Party under the Committee for Research and Development of the IEA. Effects such as the AIVC are created as tasks or annexes to the Implementing Agreement. ECBCS has created over 45 such annexes; the AIVC was created as Annex V and is the longest running annex.

The oversight of the AIVC is through a Steering Group, whose members are appointed

by the Executive Committee (ExCo) of the ECBCS Implementing Agreement. The Steering Group, which serves as its Board of Directors, is formally made up of the participating countries and reports through its Operating Agent (OA) back to the ExCo.

Annex V, the AIVC, began as a jointly-funded activity. Participating countries would provide an agreed upon contribution which the Operating Agent would use to run the Centre on behalf of and as overseen by the Steering Group..

Initially, the agreement was to last three years, because it was felt that the problem could be solved in that length of time. The AIVC has since been extended many times, usually in the traditional 3-year increments.

The first Operating Agent was Oscar Fabers of the UK, which is where the Centre was physically located. Now the Centre is operated by a European Economic Interest Group called INIVe, headquartered in Belgium. The Centre itself is almost virtual, with efforts spread out among participating countries.

All technical aspects of the AIVC and control of the copyright and joint fund are still under direct control of the Steering Group, but the operation and dissemination aspects of the Centre are run by INIVE, who raises separate funds through the dissemination of AIVC-generated information. This melding of a high-quality technical information generator with a market-driven dissemination activity positions the Centre for the future.

2. AIVC PARTICIPATING COUNTRIES

To be a formal member of the AIVC, one must be a signatory to the ECBCS Implementing Agreement and agree to those IEA terms and conditions. In general, it is countries not institutions that are signatories to the Agreement. Although there have never been more than 12 countries as members of the AIVC simultaneously, at one time or another the following countries have been AIVC participants: Belgium, Canada, Czech Republic, Denmark, France, Germany, Greece, Italy, New Zealand, Netherlands, Norway, Sweden, Switzerland, United Kingdom and the United States.

Each participating country joins the AIVC because it is in their national interest to take part in such an international collaboration. For the most part each country has a growing or established national program in the area of infiltration and ventilation and seeks to leverage and validate it through the AIVC.

Many countries—or the organizations within them—use AIVC as an information resource and dissemination mechanism. While the AIVC has been increasing its dissemination activities, the core strength of the annex is its technical expertise.

3. VENTILATION AND LOW ENERGY SYSTEMS

Before there were buildings humans were ventilating their dwellings to improve the quality of their environment. Early humans understood better than we do today that bad air was principally a problem of the indoor environment, which could be mitigated by ventilating. While the built environment of hominids has changed substantially over the past 10,000 years, their biology has not; poor indoor air quality creates health risks and can be uncomfortable.

In the last quarter of a century the western world has become increasingly aware of environmental threats to health and safety. People are sensitive to environmental toxins such as pesticides, smog, lead, oil spills, dioxin, etc. During the latter parts of the 20th century people psychologically retreated away from the hazards outdoors to the seeming security of their homes. As has become more apparent over the past few years with issues such as mold, sick-building syndrome and formaldehyde, the indoor environment is usually not healthier than the outdoor environment, although it may still provide necessary shelter.

Throughout time, humans have either put up with their existing indoor environments or made changes to improve their environments. Looking in the archeological records, we can find several examples of how houses were built to accommodate ventilation and improve indoor air quality. The earliest of may be the discovery of fire and subsequent use of fires inside stone-age dwellings. Humans have found, over time, that it is essential to manage the indoor environments of their homes.

Probably the first and still most robust ventilation designs must be credited to the colony

builders of the insect world. Bee colonies use wing power to regulate pollutants and airflow in their hives. Termite mounds built by the Macrotermes natalensis termites are highly engineered and are constantly modified, using a series of conduits and arteries, for proper mound ventilation). This early form of low energy cooling cannot be matched in today's buildings, but the principles used can teach us much.

Burrowing mammals must also consider ventilation for their tunnels. Natural selection gave these species the ability to properly ventilate their homes. Such a pace is not acceptable to modern man, who develops technology to assist him instead. Humans need to be able to adapt to demands that change quickly compared to the evolutionary time scale.

The specific driver for ventilation has changed over time, but has usually been associated with a particular set of pollutant sources that are causing health or comfort problems. Historically, these sources have been heat, combustion, people and their activities, and the buildings themselves. These sources are still important but improvements in technology and hygiene have made them less so compared to some of the newer environmental concerns from mold to toxic chemicals. Depending on the outdoor climate ventilation can improve indoor thermal conditions or make it worse.

Many current ventilation systems are heavily dependent on electricity to both provide ventilation and to condition the air, but there are opportunities to make use of natural driving forces and passive materials to provide needed ventilation. The use of natural driving forces is required to achieve sustainable ventilation. Passive and hybrid ventilation systems are in use today and with development such sustainable options can be used in a wider and wider variety of situations. One of the long-term goals of the AIVC is to facilitate the implementation of low-energy ventilation strategies that provide quality indoor environments.

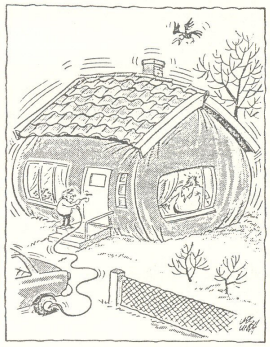
4. EVOLUTION OF AIVC'S TECHNICAL PROGRAM

In 1978 during a workshop of IEA in Paris the big knowledge gap in the energy balance of buildings was the energy penalty due to infiltration and natural ventilation. This was the main reason to propose a new Annex that would become the AIVC. There was an international need for cooperation and further research in this field. Annex V, first called the Air Infiltration Centre, was created. Considering the technical program of the AIVC over the last years one can see a variety of aspects all related to air transport around and through buildings and the energy penalty caused by infiltration and ventilation. In a later stage indoor air quality (IAQ) and comfort came in the picture so the name of the centre was changed in Air Infiltration and Ventilation Centre.

The types of products produced by AIVC over the years include: Guides and Handbooks; Technical Notes; Technote); Databases and Literature reviews.

5. EVOLUTION OVER 25 YEARS

The first years of the technical program were completely focused on infiltration and building leakage mainly of dwellings and tools to better measure and predict them. Also the titles of the yearly conferences during that period reflect the focus on air tightness and modeling. The first guides of AIVC were dedicated to airtight design, measurement and prediction of infiltration and ventilation. The Scandinavian countries with their cold climates were at that time far ahead compared with the rest of the world. The title of the third conference had for the first time the theme Indoor Air Quality in it. Everyone started to realize that at least acceptable IAQ was a prerequisite for convincing people to build tight, even in milder climates. Some years later the control of natural ventilation became the focus point of a lot international research. At the same time work went on determine how much to ventilation when the building was tight. The slogan "Build tight - Ventilate right" is from that period.



Slowly the world recognized that not only new buildings should be airtight and ventilated well, but improvement of the existing building

stock was at least as important. Refurbishment of buildings became the topic for a conference. Later policies and standards on infiltration, ventilation and energy performance were subject of studies. Another role of AIVC was to guide international research so progress and trends in ventilation research resulted in a series of technotes. At the time that reduction of infiltration was not any longer the focus of the program, research started on control of ventilation, including demand control ventilation (DCV). For some years innovation of components and systems for ventilation had attention in the program. A Technote was the result. Almost all technotes (58) has a direct relation with energy consumption due to infiltration and ventilation.

Air movement (related to comfort and pollution transport), heat recovery and noise were for sometime in the technical program. Passive cooling and urban aspects are the focus point for the running program. Thee technical program evolves from infiltration and air leakage to control of ventilation optimized for energy and comfort.

6. COMMUNICATION BETWEEN RESEARCH COMMUNITIES

Part of the technical program has always been devoted to understand each other better. In the early days such basic understanding as using the same technical terms was lacking. A technote "Glossary of terms" in different languages was produced in several languages: English, German, French, Italian, and Dutch.

As the field progressed communication became more than just language issues and progressed into conceptual issues. Clarification in the field about terms and definitions for ventilation efficiency, ventilation effectiveness, pollutant removal effectiveness etcetera resulted in a technote.

Standards and regulations in terms of policies and strategies was regularly subject of study. Finally from the beginning the literature database including literature reviews on the necessary subjects was a big part of the AIVC work. Currently three databases exist: Literature (almost 16.000 articles); Numerical Data (245 MB); and Standards (264 references).

7. INTERACTION WITH OTHER AIR RELATED ANNEXES WITHIN ECBCS

During the 25 years of its existing, the AIVC has been the portal as well as the stimulus for a wide variety of air related annexes. The AIVC has served to coordinate some of these activities and often disseminate much of their results. The tasks that AIVC has played a significant role in include:

- Annex 8 Inhabitants behaviour with respect to ventilation.
- Annex 9 Minimum ventilation rates.
- Annex 14 Condensation.
- Annex 18 Demand Controlled Ventilation.
- Annex 20 Air flow patterns.
- Annex 23 Multi Zone Models (COMIS).
- Annex 26 Ventilation in large enclosures.
- Annex 27 Evaluation of Domestic Ventilation Systems.
- Annex 35 Hybrid Ventilation in Offices and Schools.

Most results of these annexes are covered by a technote and/or theme of the yearly conference.

8. FUTURE TECHNICAL WORK

Some of the latest developments in the field are looking towards demand controlled hybrid ventilation (Annex 35 and EU project Reshyvent). These efforts are looking to provide sustainable ventilation; not only is transport energy minimized but the delivered air flow is controlled on demand by several sensor and control strategies.

Integration is the word for future developments. It is no longer possible to think separately of infiltration or ventilation, neither is it possible to separate the ventilation system from the buildings. The interaction between urban environment, site, building and all kind of systems (heating, ventilation, lighting and even plumbing) in relation to the inhabitants with their different attitudes will challenge us to minimize the energy consumption due to ventilation and infiltration and so to find the right solution for a sustainable future.

9. AIVC TODAY

Today AIVC is the premier organization for in-

formation related to ventilation. This statement comes from the highest authority in today's web-connected world—Google. Most of the time if one types in the word "ventilation" on Google, the AIVC is the top entry out of over 3 million references. This recognition is a reflection of the value the AIVC has provided through the previous 25 years.

Traditionally, the primary technical output of the AIVC was its series of detailed reports on various aspects of the field. These relatively long documents were intended for specialists and experts and provided leading edge research information. The Tech Note series combined with the similar annotated bibliography, handbook and guide series, accounted for about 3 technical publications per year.

Over the course of AIVC's 25 years, the field has matured substantially and the core research information is generated by a wide variety of groups throughout the world. Accordingly, the emphasis of the AIVC has been maturing as well. The AIVC is focusing less on the specialist researcher and more on the broader benefits of international collaboration and the dissemination of information to policy-makers and other non-specialists.

Approximately 2 years ago the AIVC added a new document series to its library, the Ventilation Information Paper (VIP). VIPs are intended to address a specific topic in the field for the non-specialist. They are intended to be 5-10 pages including examples, pictures and other aids to help give the reader an appreciation of that area without having to go into too much detail. VIPs generally have links and references to more detailed information for those who wish to follow up.

The AIVC's target is to generate roughly 6 VIPs a year. In the first 20 months of VIP production ten VIPs have been published:

- VIP 1: Air tightness of ventilation ducts (6/03).
- VIP 2: Indoor air pollution – part 1 (12/03).
- VIP 3: Natural ventilation in urban areas (3/04).
- VIP 4: Night ventilation strategies (3/04).
- VIP 5: Displacement ventilation (6/04).
- VIP 6: Heat recovery (6/04).
- VIP 7: Indoor air pollution – part 2 (9/04).
- VIP 8: Air tightness of buildings (12/04).
- VIP 9: Energy performance regulations (12/04).
- VIP 10: Sheltering (3/05).

Many more VIPs are in various stages of preparation.

Although more emphasis has been given to focused products such as VIPs, the more academic side of the AIVC has not been abandoned. The AIVC recently completed the "State of the Art Review of Ventilation" as a book as well as a couple of new Tech Notes.

10. CONCLUSION

Traditionally ventilation and infiltration account from one-third to one half of the space conditioning load of buildings in developed countries. As the minimum ventilation requirements are followed as building envelopes improve this fraction is more likely to increase rather than decrease. Ventilation requirements could become a dominant energy driver in a variety of climates. International efforts such as the AIVC facilitate a cooperative solution to providing sustainable solutions to these shared problems. Even more can be achieved as others join the effort.