# OPTIMUM VENTILATION AND AIR FLOW CONTROL IN BUILDINGS

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(Title)

## AIOLOS : CREATION OF AN EDUCATIONAL STRUCTURE ON THE USE OF PASSIVE COOLING VENTILATION TECHNIQUES FOR BUILDINGS


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## ABSTRACT

AIOLOS is a project partly financed by the European Commission, DG XVII for Energy, within the frame of the ALTENER programme. The purpose of the project is the creation and dissemination of educational material on the use of passive ventilation cooling systems and techniques as applied in buildings. All information will be coupled with the problems of passive solar heating, daylighting and visual comfort. The project is oriented to South European but also North European countries with moderate climate presenting cooling problems. Existing information and knowledge together with recent European research results will be compiled into an educational package. The package will include brochures of case studies, slides, didactic software, technical manuals, guidelines and a handbook with basic and up-to-date knowledge acquired by recent research projects in the field. The aim of the project is to provide building professionals with all necessary knowledge and tools on the efficient use of passive ventilation in buildings. All material will be in a flexible form so that it can be updated on a regular basis. Dissemination will be achieved by seminars attended by building professionals. The overall duration of the project is 18 months.

## 1. INTRODUCTION

Recent research activities have shown that application of passive cooling techniques in Europe can significantly reduce the energy consumption for cooling purposes. Research in the field of building related topics has lately made such rapid progress that it has been difficult to pass new technological achievements to professionals. Lack of knowledge transfer in the field of passive cooling technologies has created confusion regarding their

application, which is the main reason for non appropriate use of passive elements and techniques in buildings.

Evaluation of existing educational activities regarding the integration of passive cooling techniques in building design has shown that the related topics are rarely treated as an entity involving all building professionals. Appropriate education of all professionals involved in the field of building design could lead to energy conscious building design.

AIOLOS is a project partly financed by the European Commission, DG XVII for Energy, within the frame of the ALTENER programme. The project, having an overall duration of 18 months, is currently in progress and it is due to expire in May 1997. The University of Athens acts as a coordinator, with the participation of six European Research Institutions:

- CONPHOEBUS (Italy)
- LASH/ENTPE (France)
- University of La Rochelle (France)
- BBRI
- University of Porto (Portugal)
- University of Seville (Spain)

The general aim of the AIOLOS project is to create educational material on the efficient use of natural ventilation for buildings. All material should have a complete, flexible, modular and transferable educational structure, which should have the following specific targets:

- To evaluate and translate all existing information as well as the knowledge acquired within the frame of the European research on passive ventilation of buildings into a complete educational package dealing with the efficient use if passive ventilation for buildings.
- To create the necessary educational infrastructure that can be transferred to all educational activities and can be used by all professionals involved in the field of buildings.
- To provide building professionals with all necessary knowledge, tools and information on the efficient use of passive ventilation in buildings in order to decrease the energy consumption for cooling purposes, increase the indoor thermal comfort levels and improve indoor air quality.

Based on these targets, the work of AIOLOS project will result in the following deliverables:

- a handbook on Natural ventilation
- a series of case studies on naturally ventilated buildings
- a tool for the evaluation of the performance of natural ventilation as well as the thermal performance of buildings where it is applied as a cooling technique

This paper presents a description of the contents of the handbook, a presentation of the didactic software and an analysis of the case studies that have been carried out within the framework of the AIOLOS project.

## 2. A HANDBOOK ON NATURAL VENTILATION

In order to fill an existing gap in the current bibliography concerning the topic of natural ventilation, a handbook has been under development within the frame of the AIOLOS project. The handbook is addressed to architects, engineers, technicians and, in general, scientists involved in the field of building physics. Its contents cover a wide range of issues related to the subject, including fundamental as well as state of the art information. Practical methods to integrate natural ventilation in urban, suburban and rural environment are discussed together with coupling procedures with conventional systems, thermal comfort notions and indoor air quality aspects. Evaluation methods for the efficiency of natural ventilation and examples of successful design are presented. The book is structured in six chapters.

The first chapter is introductory, presenting passive cooling as an alternative concept to deal with energy and environmental problems caused by the excessive use of air conditioning systems. Natural ventilation is introduced as a passive cooling strategy.

In the second chapter, the basic principles of natural ventilation are described. The interaction of the wind with built environment is presented in a section on air flow in urban environment. Existing methods for wind data transfer from standard meteo stations to specific locations and heights are presented. The impact of various parameters, physical and geometrical on the ventilation efficiency is discussed. Specifically, the impact of climatic/microclimatic parameters on the promotion of natural ventilation is analyzed and the combined effect of the wind and buoyancy as driving mechanisms is presented. Finally, the contribution of natural ventilation to the improvement of the indoor climate, from the aspect of thermal comfort and air quality is discussed.

The third chapter presents all the methodologies that have been developed so far for the air flow prediction. Principles on various levels of modeling are presented: empirical models and computational models. Special focus is given on the possibilities and ranges of application for each modeling level. Empirical methods and simplified models are presented together with the limits of their applicability. Computational models include network, zonal and CFD modeling.

The fourth chapter is on diagnostic techniques. Tracer gas and PFT techniques for the air flow rate measurement are presented. Advantages and disadvantages of each technique are discussed. Temperature measurements as a means to characterize indoor thermal comfort conditions are also presented.

Chapter five is on critical barriers involving all parameters that may prohibit the use of natural ventilation. These are related to daylighting, shading, acoustics, fire regulations,

building type, safety, regulations and outdoor pollution. The interaction of natural ventilation with each of these parameters is discussed.

Chapter six presents techniques and solutions from practice for a successful incorporation of natural ventilation principles in the design stage. Examples of successful designs are given.

## 3. THE AIOLOS DIDACTIC SOFTWARE

The aim of this tool is to help the user understand the possibilities of natural ventilation as well as the impact of its use on the thermal behavior of a building.

In order to satisfy the first aim, a multizone air flow network model has been supplied with the facility of sensitivity analysis which gives the user the possibility to study the impact of various parameters on ventilation. These parameters include building (indoor air temperature, opening dimensions) as well as climatic parameters (wind speed and direction, outdoor air temperature). The user is able to specify a variation range for his parameter of interest and the program performs successive simulations keeping the rest of the input data constant. Results are given both in analytical and in graphical form.

Another important educational feature of this tool is the "reverse process". This feature gives the user the possibility to define a desired target under specific climatic conditions and run a simulation to calculate the parameters that will ensure that the target will be fulfilled. For example, the user might want to know for a specific case he is studying, what would be the most appropriate opening size (parameter) in order to achieve a specific number of air changes per hour (target) in a studied zone. To achieve this, the program selects the most appropriate values for the specified parameters among a very high number of simulation results.

In order to satisfy the second aim, the overall performance of a building will be assessed by thermal models which will be linked to the airflow model.

## 4. CASE STUDIES WITHIN AIOLOS

In order to study different aspects of natural ventilation a number of case studies will be carried out in different climates, using a variety of naturally ventilated building types. The aim of this activity is to demonstrate the natural ventilation efficiency and the impact of various design parameters (climatological and architectural) on it. For this purpose, the following buildings will be investigated.

- An office building in Athens (Greece)
- A single family residence in Porto (Portugal)
- A studio apartment in La Rochelle (France)
- A family apartment in (Italy)
- A school building in Lyon (France)

- A single family dwelling (Belgium)

This collection of buildings covers a wide range of climatic conditions and a variety of building uses. Indoor air temperature and ventilation measurements will be available for each of them in order to demonstrate their thermal behavior and the impact of natural ventilation on it. Experimental data will be used in order to perform simulations using the AIOLOS software tool. Sensitivity analysis will be carried out in order to demonstrate the efficiency of various natural ventilation configurations and techniques on the overall thermal performance of the building. A thorough description of the building characteristics together with the results from the measurement and simulation campaigns for each case study will be given in the form of brochures. The educational material developed within AIOLOS will also comprise a series of slides based on the case studies.

## 5. AIOLOS DISSEMINATION ACTIVITIES

Dissemination activities within the framework of AIOLOS programme involve the organization of two seminars: the first is scheduled to be held in Lyon on the 21-22 of November 1996 and the second one in Athens at the end of the programme. The seminars will be addressed to engineers, architects, designers and scientists involved in the field of building physics and will include a variety of lectures and workshops on the following topics: air flow and thermal processes in buildings, air flow modeling, coupling of air flow and thermal models, critical barriers and practical solutions for natural ventilation as well as presentation of case studies in naturally ventilated buildings.

## 6. CONCLUSIONS

AIOLOS is an ALTENER project on the creation of an educational structure on the use of passive cooling ventilation techniques for buildings. Within the framework of the project an educational package will be developed consisting of a handbook on natural ventilation, a number of brochures and slides from existing naturally ventilated buildings and a computational tool for educational purposes. Dissemination activities involve the organization of two seminars on the subject of natural ventilation. The project has an overall duration of 18 months and is currently in progress.

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