The estimated exhausted airflow came to 68% of the decay test estimate. Neglecting the air exchange through the door and considering the basically spatial homogeneous gas concentrations in the two tests reported the observed discrepancy between the estimated exhausted airflow rates might have been caused by an inadequate technique in estimating the occupant $CO_2$ generation rate. Previously it has been reported[4] that for a specific activity it will usually be possible to predict an individual's $CO_2$ production within 10%, and so in the present study a more detailed observation of the occupancy and the activity might have reduced the reported error of the outlined simple analytical model.

## Conclusion

A control program on the $CO_2$ concentration in a well mixed room may by an appropriate sampling strategy also supply information on the exhausted flowrate. The outlined analytical model is simple but it is emphasized, however, that an accurate estimate of the $CO_2$ generation rate is needed.

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# Ventilation Research in Hungary


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## Introduction

Ventilation research in Hungary dates back to the early 1960's, when the mass production of multi-storey tower blocks began. At that time the main aim of most research activity was to develop suitable ventilation strategies for this type of building. Two solutions were developed and have been in use since that time.

For buildings with up to four storeys, natural ventilation, with built in collecting ducts for the exhaust air, is utilised. For buildings with more than four storeys mechanical extract ventilation with collecting ducts equipped with roof mounted fans is used. The fresh air supply is provided by infiltration through cracks around the windows. The other large section of Hungarian building stock, family and detached houses, do not possess active ventilation systems. However, the multi-storey buildings have always posed more problems with regard to ventilation than the detached houses.

After the oil crisis in the seventies the main aims of ventilation research changed. Many energy saving measures had been taken by the authorities, among them the reduction of infiltration heat losses. The Ministry of Building and Urban Development ordered the production and installation of better quality airtight windows, and the draughtproofing of existing window assemblies. Since about 1980 the wide use of these window structures has led to a variety of difficulties with indoor air quality, and recent ventilation research in Hungary has been aimed at providing solutions to these problems.

## Ventilation problems

When airtight windows are installed the fresh air change rate, whether provided by natural or mechanical means, is reduced. The practical consquences of this are:

- High concentrations of indoor contamination and odour, and in the worst cases insufficient fresh air for human needs.

- High indoor relative humidity and condensation.

- Mould growth (this occurs only in certain cases and depends upon the prevailing conditions).

The latter phenomenon, which is more significant than the first two, caused many problems and in some cases led to lawsuits between builders and owner-inhabitants. Some of these problems can be attributed to inadequate ventilation practice. Factors specific to this area are:

- There are no suitable 'low cost' ventilation systems or solutions to the changed circumstances.

- Coherent and uniform codes of practice and regulations are required by those involved in design and installation activity.

- Special regard must be made to the reconstruction and restoration of old buildings.

- Suitable technical solutions must be provided for the existing problems mentioned above.

- There is a lack of measurement methods for quantifying the leakage and air change rate of existing buldings.

## Research Projects Launched

In order to develop solutions for existing ventilation problems several research projects have been launched.

### Development of Regulations

This work has started with the revision of existing codes and the preparation of modifications. New calculation methods have been devised for use at the design stage, and these separate out the heat losses due to conduction and infiltration (1).

These new methods have created the demand for more detailed input information such as meteorological data and wind pressure coefficients. A separate project has been launched to establish a wind pressure data bank based on wind tunnel experiments examining dwellings and industrial buildings. The greater part of this work has already been performed and the data processing for IBM – compatible computers is now in progress (2). Figure 1 shows an instrumented model placed in the wind tunnel.

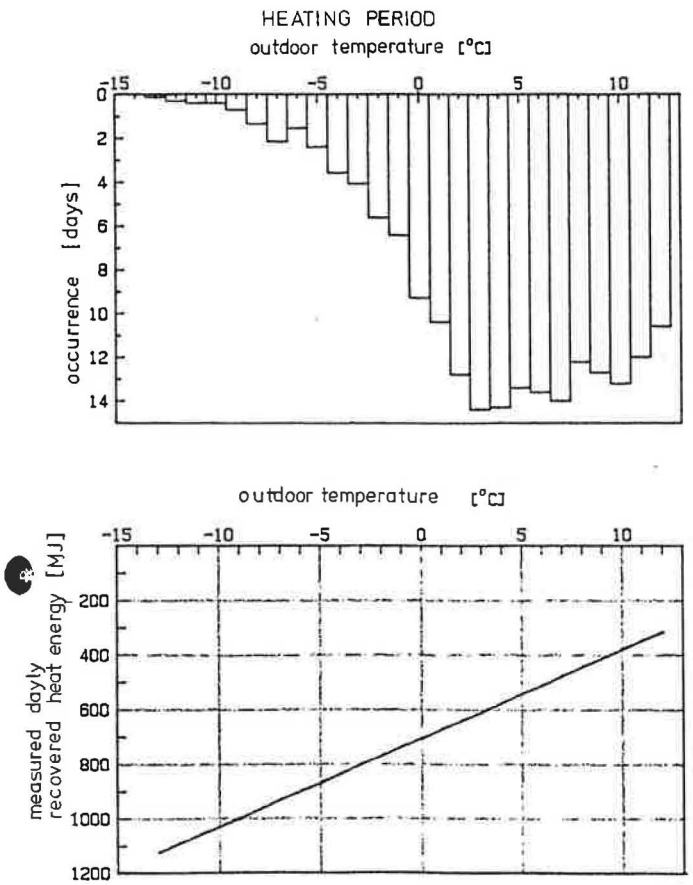


*Figure 1: A model of a Row of Blockbuildings in the Pressure Test Wind Tunnel*

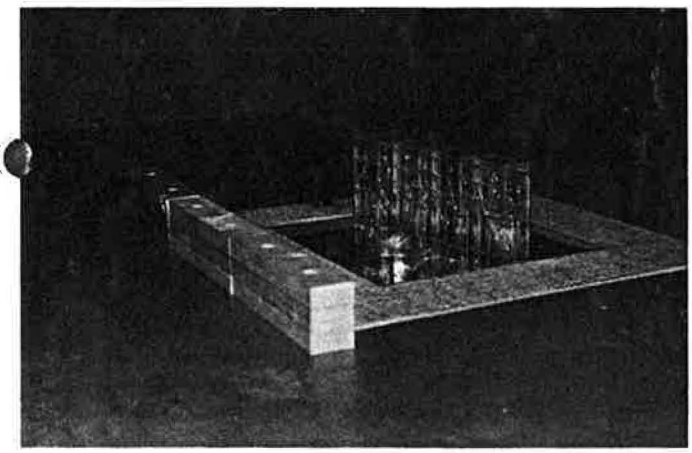

*Figure 2: Evaluation of Energy Saving Potential of Balanced Ventilation System with Heat Recovery*

**Development of Ventilation Systems**

To eliminate the consequences of insufficient ventilation in dwellings both short and long term solutions were proposed. In the short term, supplementary fresh air inlet devices were designed and installed under existing windows (3). These allowed the ingress and distribution of fresh air while providing protection against outside noise, dust, insects and unwanted wind effects. Laboratory and site measurements have been performed and on the basis of successful results the production of these devices has begun.

The long term solution rests with a newly designed balanced ventilation system. This has been evaluated by a one year monitoring project in a newly occupied 11 storey building(4). The system is equipped with a heat recovery battery and has proved to be energy efficient, also no complaints from the user-inhabitants were encountered.

Figure 2 shows the occurrence of outdoor temperature during the heating season in Hungary and the measured daily heat energy recovered by the ventilation system.

The predicted amount of regainable energy during a heating season is given by:

| | |
|---|---|
| Summation of recovered heat energy weighted with relative occurance of outdoor temperature: | 106.8 (GJ) |
| Summation of surplus energy consumed: | 17.8 (GJ) |
| Regainable energy during a heating season: | 89.0 (GJ) |

**Measurement Techniques**

A recently started project intends to establish a pressurization rig and equipment for measuring tracer gas concentrations.

The main parts of the system are ready. For leakage determination an axial fan with thiristor control and equipment for pressure and velocity measurement are used. For the tracer gas technique the basic apparatus to be used is an URAS 7N Infrared gas analyser prepared for N20 tracer. It is intended to develop a constant concentration method which will be applied to multicell measurements of the fresh air change rate in each cell.

## Conclusions

Ventilation problems in Hungary have promoted extensive research and development in several fields. The focus of the research is directed towards ventilation of dwellings where low air change rates have led to indoor air quality problems. Consequently technical solutions must be developed and implemented. These have to meet the requirements of energy saving, user demands and investment and operational cost.

While this report deals with domestic buildings, several ventilation research projects examining industrial or farm buildings have been investigated. During this research and development activity it is felt that cooperation with other reseachers working in these areas would be of mutual benefit.

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