THE IMPLEMENTATION AND EFFECTIVENESS OF AIR INFILTRATION STANDARDS IN BUILDINGS

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MEASURED AND BUILDING CODE VALUES OF AIR CHANGE RATES IN RESIDENTIAL BUILDINGS

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SYNOPSIS

Since 1970 measurements of air change rate have been carried out in about one thousand buildings by the Swedish Institute for Building Research (SIB). In this paper we present results from these measurements.

The studied buildings are of various design and have ventilation systems of different types, natural as well as mechanical. The buildings include single family houses, row houses, and multi family residential buildings, erected between 1900 and 1982.

The measurements have then been carried out using tracer gas (decay) techniques to determine the rate of air exchange. Other collected data include building geometry, building design, and meteorological conditions at the time of the measurement. The outdoor conditions have varied.

In the analysis the buildings have been divided into groups according to the year of construction, building design, and type of ventilation system. The measured rate of air change is compared to that required by the Code for each group of buildings.

In many cases measurements have been carried out before and after retrofits aiming at saving energy. For a lot of buildings pressurization measurements as well as tracer gas measurements have been done simultaneously. In these cases we have also estimated the airtightness of different building categories.

1. INTRODUCTION

In this paper we report results from an analysis of data on the rate of air change in residential buildings. The data have been collected by the field measurement unit of the Swedish Institute for Building Research (SIB) between 1974 and to 1983. These data have been collected for various research projects, having different purposes, like determination of the energy status of buildings, assessment of the indoor air quality in buildings, investigation of buildings with radon content in the air, diagnosis of building damages caused by moisture, etc.

The results given here are based on data from 600 buildings, representing one- and two storey detached homes, two storey row-houses, and multi storey apartment buildings, situated in different parts of Sweden. However, it should be noted that the collection of buildings does not constitute a true statistical sample from the Swedish building stock. Buildings from Mideastern and Northern Sweden are overrepresented.

During the measurements climate variables like the indoor and outdoor air temperature, the wind speed and direction at the building site, etc., have been recorded. The measurements have been rather equally distributed throughout the heating season.

The rate of air change has been determined, in accordance with common Swedish practice, by measurement of the decay of tracer gas (N_2O) concentration in the air[1], from an initial concentration of 30- 100 ppm. Fans have been placed in every room of the house, or the apartment, to ensure mixing of the air.

The measured air change rate can be compared to that required by the Swedish Building Code. For many years this Code has prescribed a minimal ventilation rate of 0.5 ACH (air changes per hour) for hygienic resons. In practice this limit has also become an upper limit, which should not be exceeded in new buildings and in retrofitted old buildings in order to save energy.

2. RESULTS

Some preliminary results of the analysis of the data considered here, including a determination of the effective leakage area of buildings, have already been presented[2].

In Fig. 1- 4 we present the measured rate of air change for flats in multi- family residential buildings, detached houses, and row-houses equipped with an exhaust air ventilation system or with a natural ventilation system.

For apartments with an exhaust air system, the average air change rate is not too far from 0.5 ACH, but the scatter around this average is 30 or 40 % (Fig. 1 and 2).

For apartments with a natural ventilation system, the rate of air change seldom exceeds 0.5 ACH, for new detached houses and row-houses it is in most cases substantially lower than 0.5 ACH. The scatter around the average value is between 40 and 50 % (see Fig. 3).

For detached houses and row- houses there is a difference between houses built before and after 1970, the average rate of air exchange being 0.33 and 0.23 ACH, respectively (see Fig. 4). This reflects the fact that buildings were made more airtight after the energy crisis, but only seldom measures were taken to counteract the resulting decrease of the air change rate. This was the case also for houses equipped with an exhaust air system. When this effect was noted, it became more common to supply houses with inlets.

Half the sample of detached houses and row- houses erected before 1970 is from Mideastern and Northern Sweden, which means that this building category is overrepresented in the sample. Another investigation[3] indicates an average value closer to 0.5 ACH than

the value of 0.33 ACH found in this investigation. This may reflect different local building traditions for older buildings.

We have also investigated the scatter of the air change rate between apartments in the same building, relative to the average air change rate for that building, for some buildings equipped with an exhaust air ventilation system. In Fig. 5 we give the results from three buildings, where the rate of air change has been measured in about twenty apartments in each building. The scatter around the average is about 20 %. Taking into account a measurement error of about 10 %, the real scatter should then be about 15 %.

REFERENCES

1 FRACASTORO, G. V. and LYBERG, M. D.:
Guiding Principles Concerning Design of Experiments, Instrumentation and Measuring Techniques, ch. III e. International Energy Agency (IEA) Task III Document. The Swedish Council for Building Research, Document D11:1983

2 BOMAN, C-A and LYBERG, M. D.
Contr. to the ASTM Symp. on Measured Air Leakage Performance of Buildings, Philadelphia, PA, April 2-3 1984

3 HAMMARSTEN, S. and PETTERSSON, B.
Undersökning av hur statligt stödda energisparåtgärder utförts. The Swedish Institute for Building Research Report M80·18, 1980

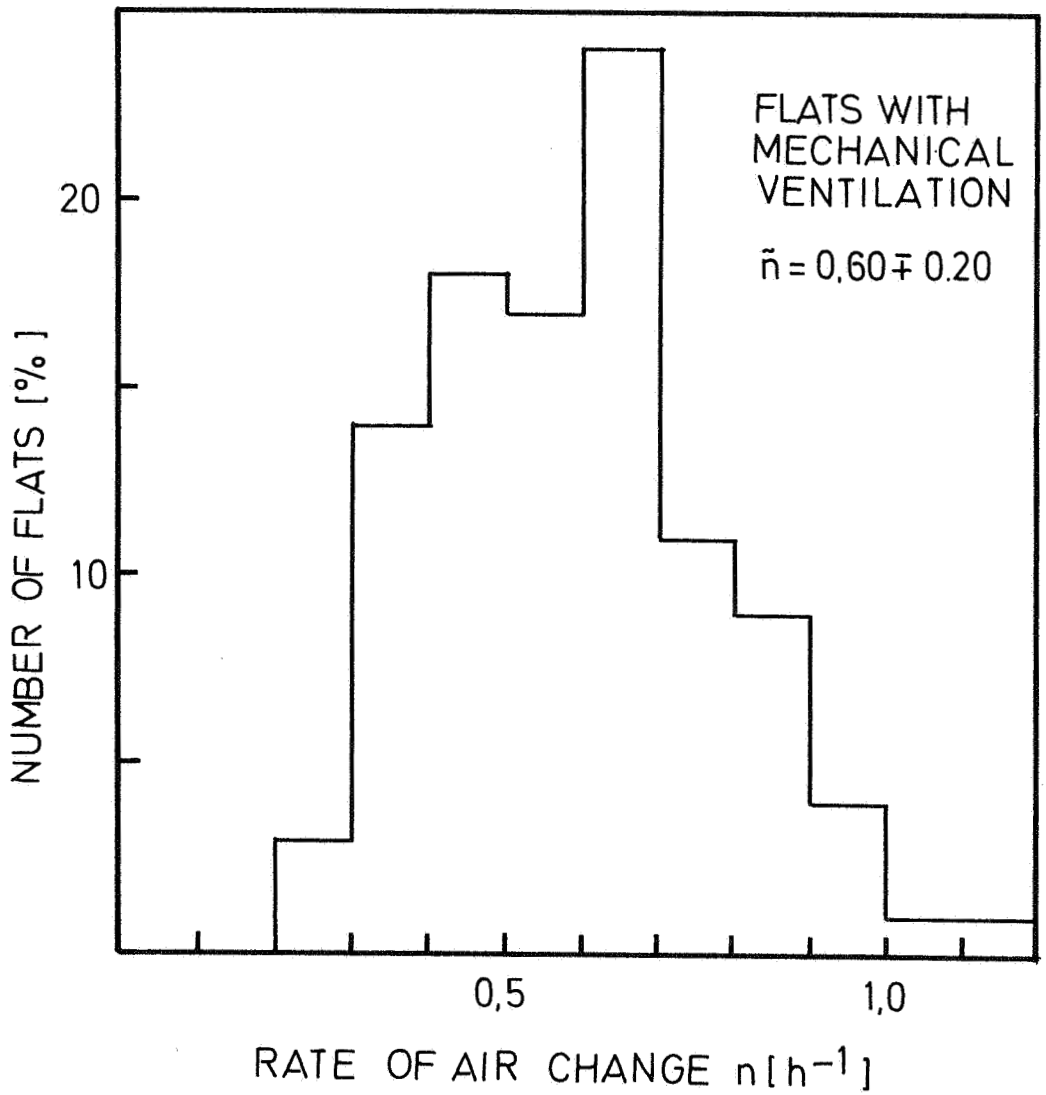

Fig 1 The distribution function of the rate of air changes, n, for flats in 3-8 storey multi-family residential buildings with an exhaust air ventilation system

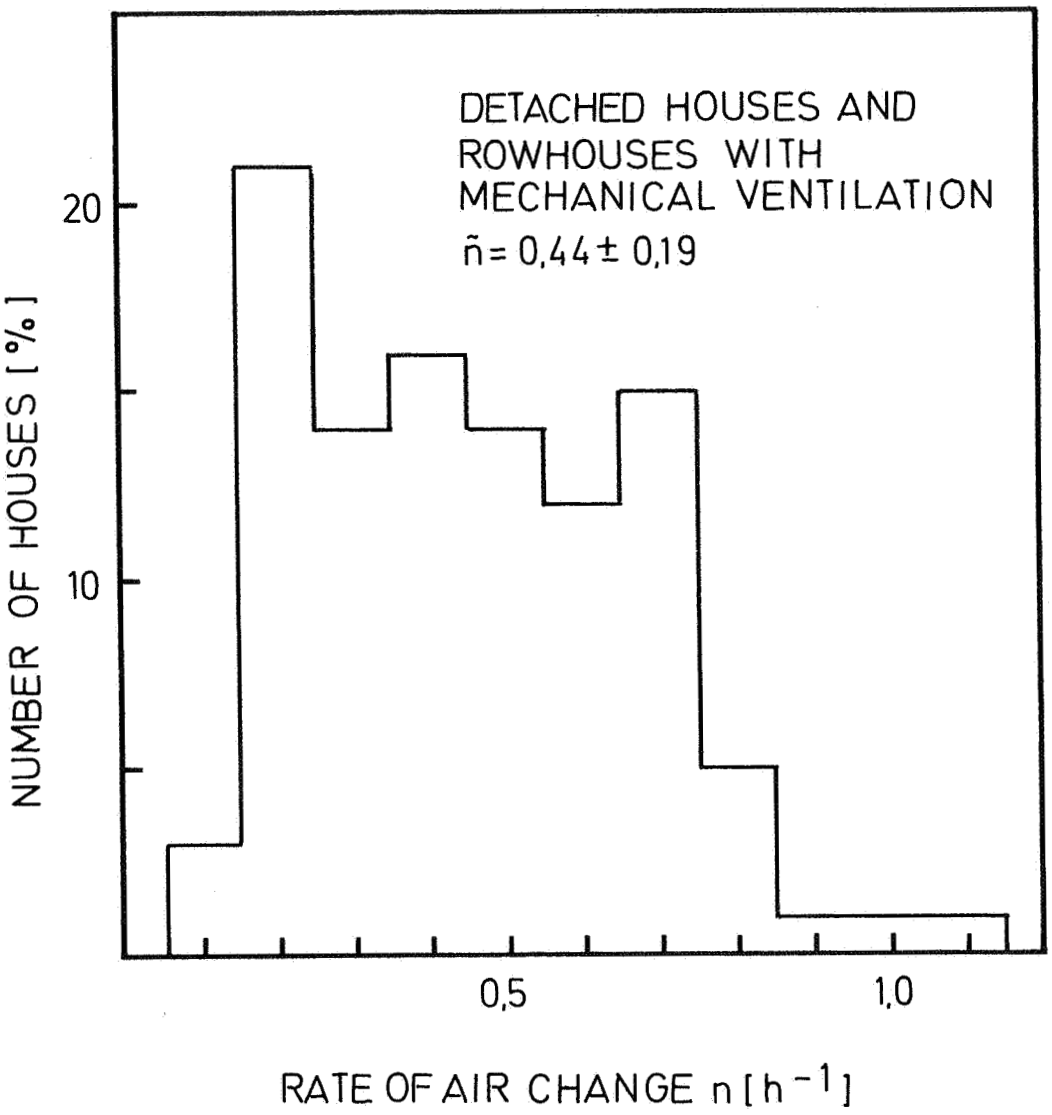

Fig 2 The distribution function of the rate of air changes, n, for one and two storey detached houses and row-houses with an exhaust air ventilation system

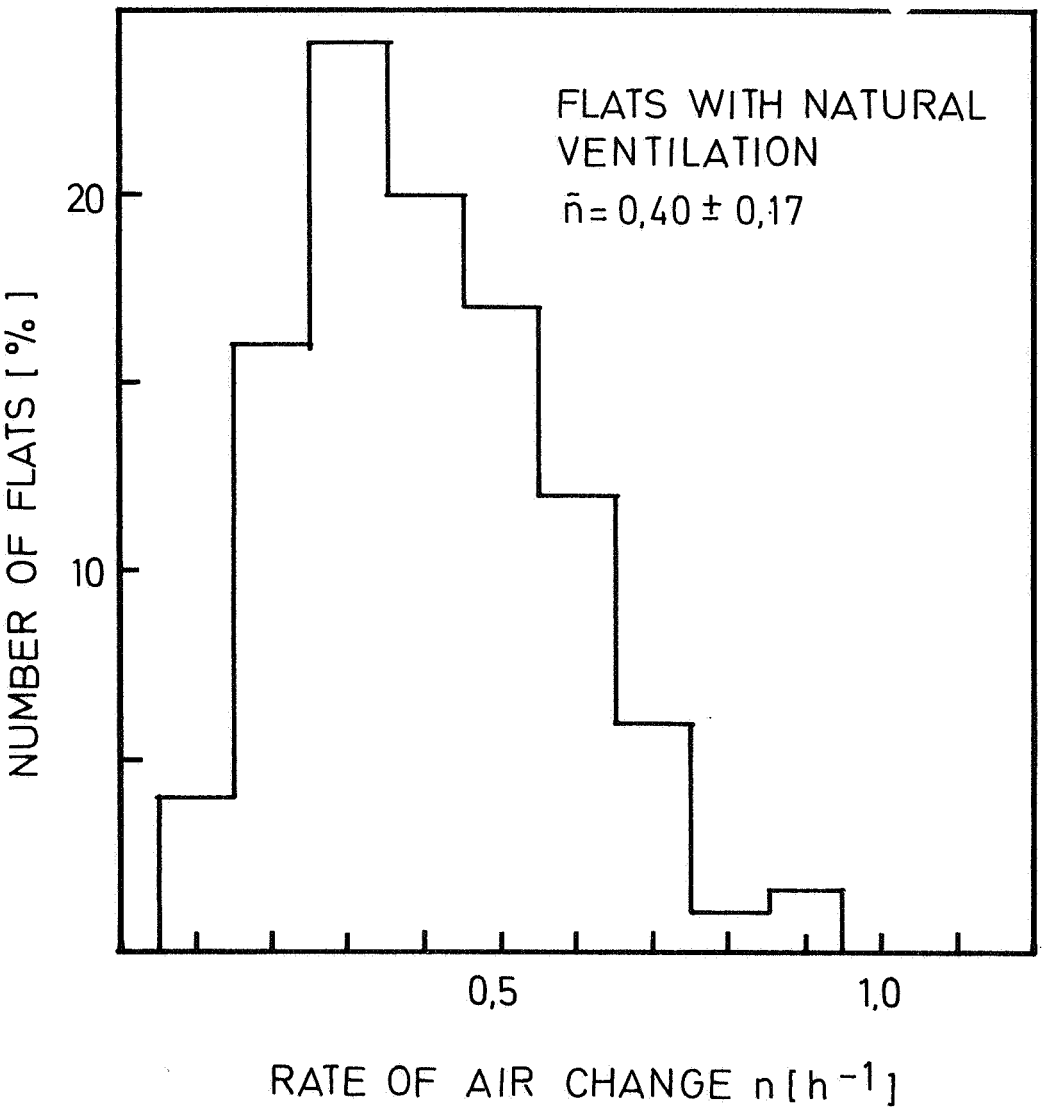

Fig 3 The distribution function of the rate of air change, n, for flats in 3-storey multi-family residential buildings with a natural ventilation system

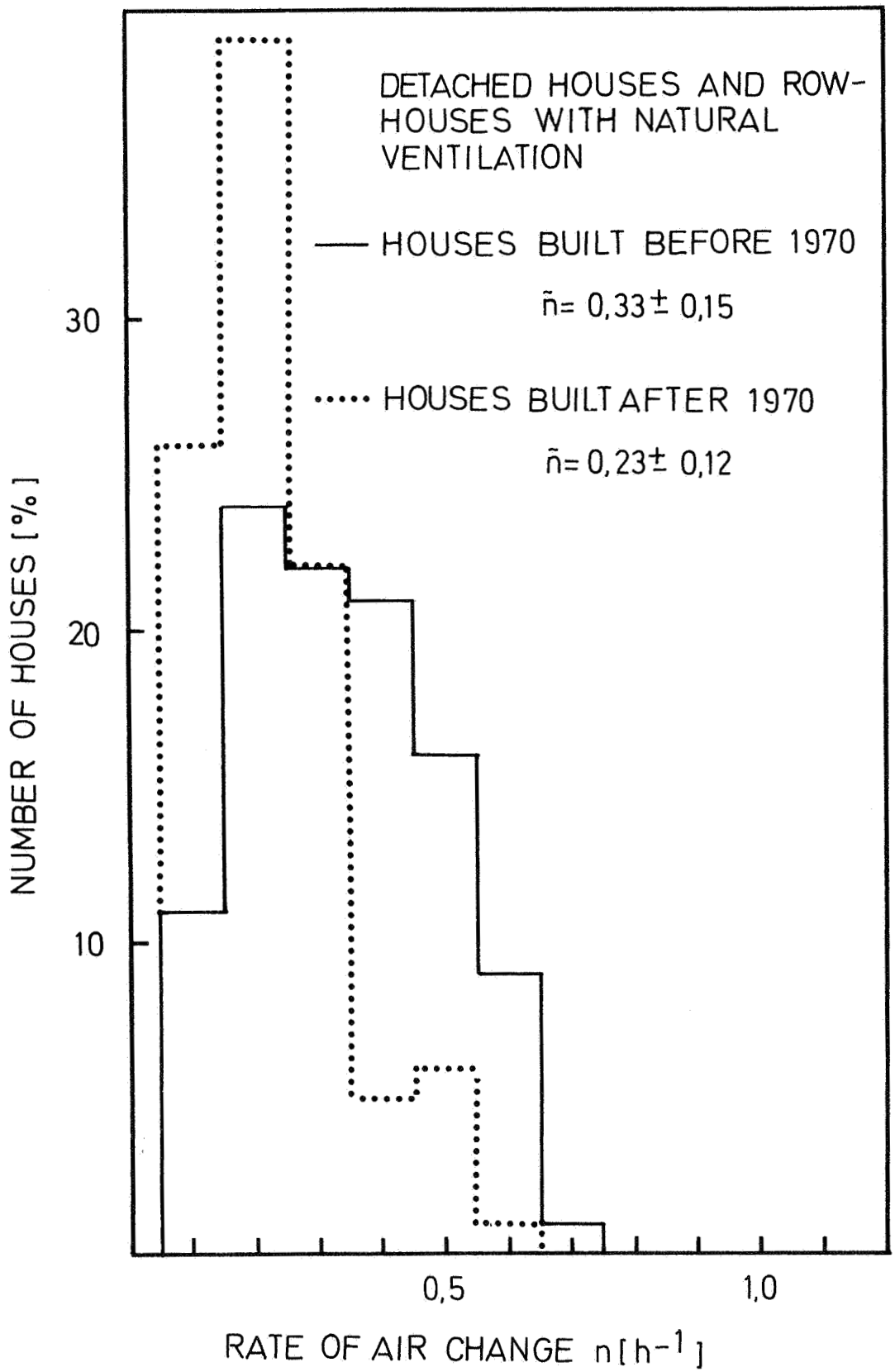

Fig 4 The distribution function of the rate of air change, n, for 1- and 2-storey detached houses and row-houses with a natural ventilation system. The houses have been divided into two groups according to the year of construction

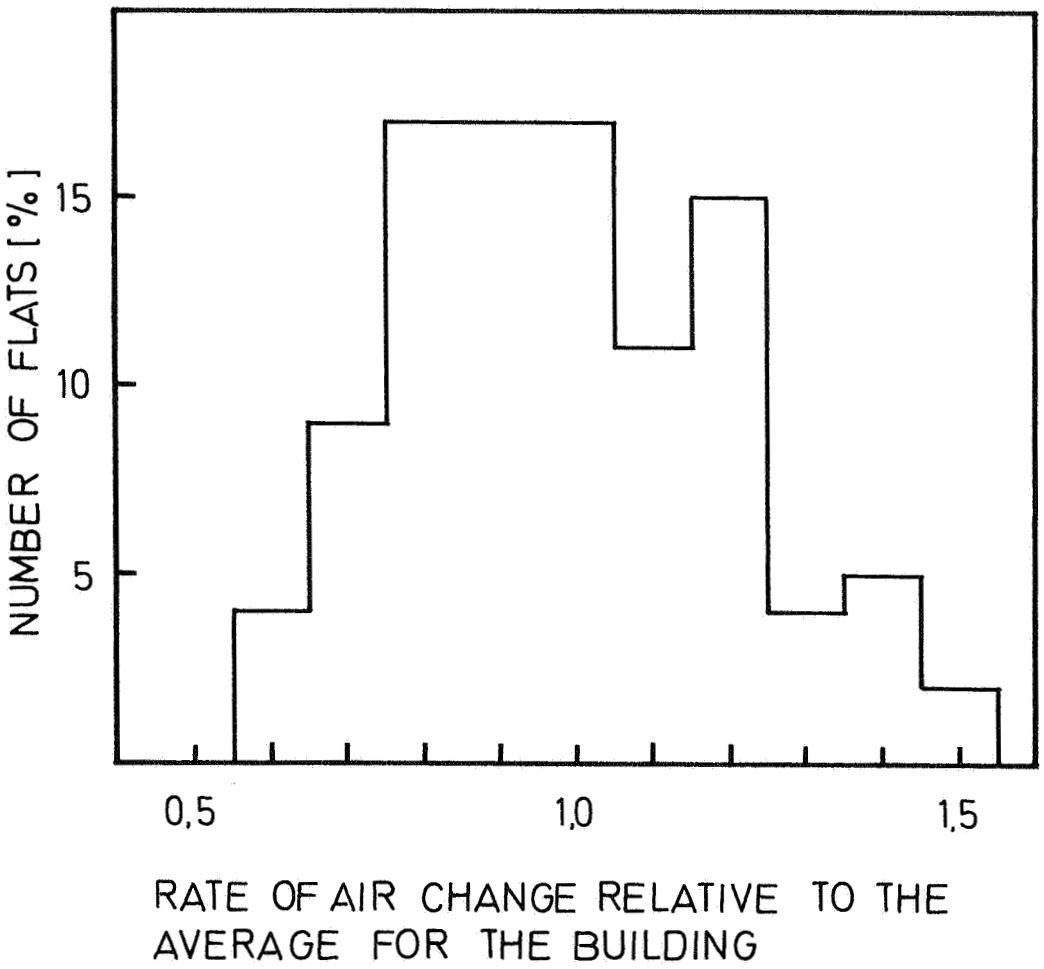

Fig 5 The distribution of the rate of air change for apartments in the same building for buildings with an exhaust air ventilation system (average value = 1.0). Data from 3 apartment buildings. The scatter is 22 %