AIR EXCHANGE IN ROOMS WITH TIGHT WINDOW JOINERY

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ABSTRACT

The paper presented the results of investigations on air exchange in detached houses and blocks of flats in which tight joinery was put in, of the air infiltration coefficient a = 0.5 - 0.7m^3/(m·h·daPa$^{0.7}$). The buildings were ventilated naturally (by means of gravitation). The investigations were carried out at mean outside temperature t_e = 0°C. The SF_6 marker gas method was used, combined with chromatographic analysis.

The results proved that in the rooms where ventilation uptake channels were not installed, i.e. in spare rooms and bedrooms, the mean air exchange was twice lower than the minimum assumed for the sake of hygienic standards which equaled to n = 0.5 h^{-1}. The difference between the minimum and the mean value obtained in the investigations, determined the air amount to be provided into the rooms, e.g. by inflow ventilators or inflow ventilation system.

INTRODUCTION

Modern quality windows are characterized by their high tightness. It accounts for good thermal and acoustic insulating power. The necessary air exchange is carried out by means of periodic ventilation, partition and the door joinery untightness. Although ventilation provides inflow of fresh air, yet it comes only periodically and does not guarantee the continuous minimum exchange at the level 0.5 h^{-1} (1). The door joinery participation in the overall ventilation, however, amounts up to only 30% and is done mainly with used or polluted air (2).

The search for modern air inflow solutions becomes therefore a must alongside looking for more and more tight joinery. The air inflow devices can be mistakenly regarded, especially by window producers, as deteriorating the joinery quality. It should be emphasized that being components of modern building partition technology they improve the inner microclimate but they do not affect the quality of windows installed in the partition.

In order to determine the actual value of air exchange in rooms with modern joinery which, among others, is indispensable to air inflow design, a few apartment building window types were examined. The results obtained can provide a basis on which the minimum efficiency and proper characteristics of the air inflow design can be determined.

METHODS

Investigations were carried out in three - storeyed buildings (two full storeys and a converted loft) with natural gravitation. Plastic windows were fixed, they had double rubber seal of closed profile. All windows were fixed according to producer's guide lines (with genuine metal catches) and packed with polyurethane foam. The experiment stand was located, in all cases, on the second storey, in rooms which did not have exhausters. The room doors and the front door were all closed.

Inner conditions were modeled by inner temperature $t_i = 20^0C$ ($\pm 2^0$) and permissible air flow velocity $v_{max} = 0.1$ m/s. Weather conditions were affected by outside temperature $t_e = 0^0C$ ($\pm 6^0$) and wind velocity $v_e = 0 - 2.5$ m/s. The window coefficient was $a = 0.5 - 0.8\ m^3/(m \cdot h \cdot daPa^{0.7})$:
1 - $a_1 = 0.5\ m^3/(m \cdot h \cdot daPa^{0.7})$,
2 - $a_2 = 0.6\ m^3/(m \cdot h \cdot daPa^{0.7})$,
3 - $a_3 = 0.65\ m^3/(m \cdot h \cdot daPa^{0.7})$,
4 - $a_4 = 0.8\ m^3/(m \cdot h \cdot daPa^{0.7})$,
whereas that of the front door $a_d = 3.5\ m^3/(m \cdot h \cdot daPa^{0.7})$.

The air exchange measurements were taken by means of the electronegative marker method (2). SF_6 (tracer gas) concentration analysis was made with AF - 1 chromatography and air exchange was determined through the concentration change of the exponential form discrete function (2). For each profile type 6 series, consisting of 5 measurements each, were taken which made 120 readings altogether.

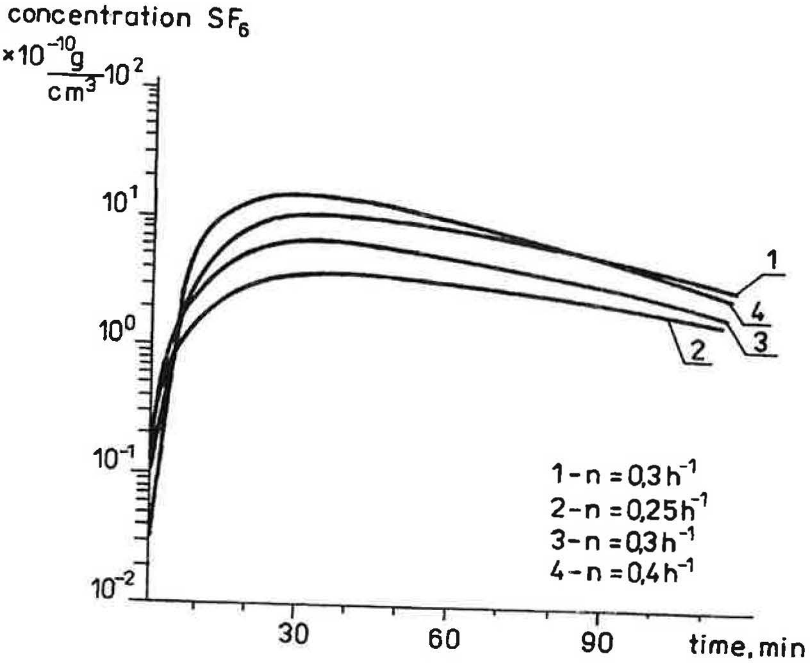

Figure 1 Air change rate in rooms with tight window joinery

RESULTS

Air exchange value

The investigations were carried out at the seal maximum holding down, which was set at an eccentric controller in the window furniture. Investigation results were presented in Fig. 1. The air exchange value is determined by a tangent to an experimental curve. In all cases the value is below 0.5 h^{-1}, the mean one being $n_s = 0.3\ h^{-1}$. It should be noticed that approximately 30% of it is due to inter - room flows through untight door joinery. The air exchange averaged value n_s seems interesting because of practical applications as it provides the basis to determine the numerical quantity by which air exchange should be supplemented by a downcast ventilator. Taking into account both external atmospheric conditions of the experiment and the value $n_{min} = 0.5\ h^{-1}$ thought to be the absolute minimum, the necessary complementary inflow should range $n_u = 0.25 - 0.35\ h^{-1}$.

While comparing the results obtained with downcast ventilator parameters (3) it ought to be stated that for the sake of conditions set down in the experiment, the optimum diameter of a controller fixed in the room will be $\phi = 40$ mm. For such a diameter it is possible to supplement the air exchange by the intended value n_u.

Air exchange at manual control

The possibility of manual control by an eccentric handwheel in the furniture envelope was used in the course of experiment. It was set for the minimum holding down which actually resulted in untightening the closed windows. Fig. 2 presented averaged air exchange values for untight windows.

Untightness did not provide desired results. The averaged air exchange ranged around the value $n_r = 0.8\ h^{-1}$. Taking into account the experiment conditions it should be expected that at slight decrease in outside temperature or at wind velocity increase, the value n_r will increase exceeding the maximum values.

Manual control, and similarly nonautomatic downcast ventilators, seems an impractical solution. It does not ensure continuity but it also creates a potential situation in which controllers once set at the maximum (at low temperature - for the heat loss protection) will remain at the same position until the end of the period when central heating is used.

The facts account for the necessity of keeping permanently the high tightness of quality windows. At the same time they specify clearly the air controller function. Air controllers are considered building components responsible for air exchange up to permissible values. As all partition elements, downcast ventilators have to satisfy the conditions of acoustic tightness as well as be adjustable to temperature and wind velocity changes, providing proper inner microclimate.

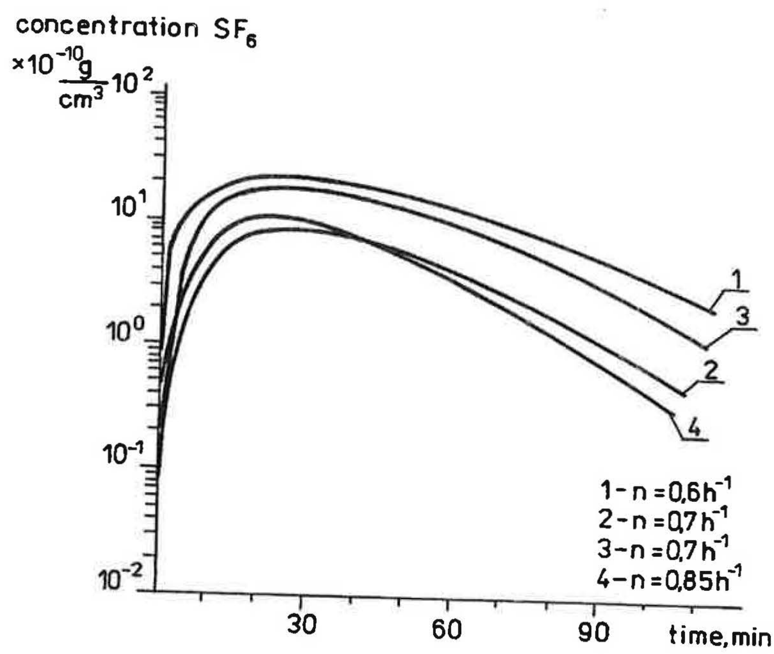

Figure 2 Air change rate at manual control

CONCLUSIONS

Modern windows of high insulating power offer tightness ensuring air exchange at the level $n_s = 0.3\ h^{-1}$.

For the sake of proper ventilation it is necessary to install automatic controllers being components of external partitions. They will guarantee adequate microclimatic conditions.

Downcast ventilator characteristics have to account for window tightness. With joinery of increased insulating power ventilator characteristics should assure complementary fresh air inflow at the value $n_u = 0.25 - 0.35\ h^{-1}$. In this way proper microclimatic conditions will remain stable without deteriorating the joinery quality.

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