PERIODICA POLYTECHNICA SER. CIV. ENG. VOL. 47, NO. 1, PP. 137–140 (2003)

THE IMPORTANCE OF NATURAL VENTILATION FOR THE CLIMATE OF DWELLING HOUSES

Timea DÉNES

Department of Building Construction
Budapest University of Technology and Economics
H-1521 Budapest, POB. 91. Hungary

Received: December 20, 2002

Abstract

Natural ventilation is constantly present in buildings but it is difficult to measure. Prefabricated buildings play an important part in the study of natural ventilation, as they constitute approximately 15% of Hungary's total stock of buildings. Consequently, if we can find a solution for their economical operation, for instance by controlling the heat lost through natural ventilation, we will take an important step towards substantial savings for the national economy as well. We can do more than apply new materials and use modern technology. We have to study the effect of the limitation of filtration, and the probability of the appearance of moulding. (The train of thought outlined in the article is part of my future PhD. thesis being prepared with the help of Dr. Széll, Mária, my supervisor at the department.)

Keywords: natural ventilation, prefabricated building, filtration, moulding.

1. The Climate of Dwelling-Houses and the Role of Natural Ventilation

The microclimate [1] of the internal space is the result of a complex interaction of a set of variables, which influence the metabolism and the thermal processes of living organisms and of inorganic objects. The phenomena of the external and the internal space that affect the microclimate are solar radiation, wind, humidity, precipitation, air pollution, static electricity, etc. Several subjective characteristics may be created as a combination of the variables listed above, for example climatic comfort. The sense of heat is directly influenced by temperature, humidity and airflow. Airflow in closed spaces is created by natural ventilation, parts of which are called infiltration and exfiltration. Airflow may also be a result of diffusion, which happens through the pores of the building materials. It is important to know the required and the sufficient intensity of natural ventilation and its effect on the thermal balance of internal space. We also need to know the kinds of pollutants created in the space and their quantity to calculate the minimum volume of fresh air required [1]. The appropriate quality of air is a basic requirement of a healthy building, it is of decisive importance with regard to the inhabitants' health and their capacity for work.

Vitiated air contains a lower concentration of negative ions in the closed space, the level of CO_2 and other pollutants rises and pathogens are swarming. The cheapest – and most obvious – way of procuring fresh air is to let natural ventilation become realised.

The demand for fresh air depends on the function of the building/room. Let us take for example a classroom for 30 people with a floor-area of 54 m^2 (6 m by 9 m) and a volume of 150 m^3. The demand for fresh air is >35 m^3/h person. For 30 persons that makes 30 times 35 = 1050 m^3/h. That value divided by the volume of the classroom tells us the required hourly air exchange rate: 1050 m^3/h/ 150 m^3 = 7 times per hour [2]. In the case of a flat – taking its functional use into consideration– that value would be 3 times per hour.

Research programmes studied the effect of smoking as an activity causing pollution of the indoor air. They determined the amount of fresh air per capita that has to be provided as a function of the proportion of the smokers in the closed space (*Table 1*) [3].

Table 1. The demand for ventilation for different proportions of smokers, provided that they are the only polluters [3].

Category	Prescribed air exchange rates, m^3/h person if the proportion of smokers is			
	0%	20%	40%	100%
A	36	72	108	216
B	25.2	50.4	75.6	151.2
C	14.4	28.8	43.2	86.4

It is visible in the chart that the demand for air exchange in closed spaces depends on the use of the room, it is quite high and the presence of smokers causes it to increase significantly.

In connection with ventilation the limit value (in m^3/h) must be known that may be prescribed for the air exchange. It is advisable to characterise the required or the already existing air exchange using the appropriate units of measurement: the ventilated air has to be described by its temperature and velocity, vapour concentration has to be provided for the internal space. Thus air exchange may be controlled in an 'integrated' way. We also have to keep it in mind that the velocity of air movement is not to be judged by temporary maximum values but rather the average value typical of a long period [1].

As for the humidity of air we have to pay special attention to the study of its average and extreme values, the air flow generated by vapour pressure and differential pressure and the issue of the dew point and condensation on the surface, especially with regard to the corrosive effect they have on structures, and the required level of air exchange and ventilation.

The effect of air conditions in the internal space on our sense of comfort may be expressed in terms of the air exchange rate required (see *Table 2*) [3].

Table 2. The condition (and characteristic) of the sense of comfort (air temp. +20˚C).[3] The required rate of ventilation is listed with regard to the standard of comfort.

Air space per person: m^3/person	Evaluation demand for air exchange: m^3/h person		
	very favourable	favourable	acceptable
6	55	42	29
10	45	32	19
14	35	22	9

It is visible in the chart that the increasing specific air space leads to the decrease of the prescribed rate of air exchange, which has a favourable effect on energy consumption.

2. Characterisation of Prefabricated Concrete Buildings

The required rate of air exchange is different in the various rooms of pre-fabricated concrete buildings depending on the prospective vapour load. Such values are summarised in *Table 3* [4].

Table 3. Prospective vapour load and demand for air exchange in certain rooms of pre-fabricated buildings.[4]

Room function	Room volume m^3	Temperature ˚C	Vapour load g/h	Specific airflow (ventilation) m^3/h	Required hourly air exchange rate
Living room	40...80	20	100...300	25...70	0.3...1.8
Bathroom in use	20...30	24	700...2600	135...500	4,5...15
Kitchen in use	20...40	20	600...1500	150...300	3.8...18

Required air exchange rates range between 0.3 and 18 times per hour in the rooms discussed above, which casts some light on the problems the task of ventilation poses.

It is a fact that the appearance of condensation may be prevented on the surface of structures with ‘heat bridges’ in prefabricated buildings by keeping relative humidity at the appropriate level. That can be achieved by ventilation, continuous air exchange in the rooms, or by a certain amount of overheating taking advantage of the fact that warmer air can hold a larger quantity of vapour than cold air [4].

There is a total of 605,000 of this type of buildings in Hungary, which seems to be sufficient justification for the thorough analysis of this issue. Passive ventilation is generated in these buildings according to the principle of the stack effect, in other words as a result of the differences in the temperature and pressure of the internal and external air, due to the height of the stack. The heat loss by filtration is higher in these kind of buildings than in other buildings, because high buildings standing mostly on their own attract a greater intensity of environmental effects, and that is certainly true of air movement (especially on the top floors).

The improper sealing of some panel junctions and the air permeability of doors and windows have a negative effect on the heat balance of the rooms. The most heat is lost by exfiltration through the perimeter walls built in the course of the finishing works as these structures are not sufficiently air-tight [2].

The great number of prefabricated buildings and the arising problems of building construction demand us to pay special attention to them with regard to the energy they consume. One way of decreasing energy consumption is installing more modern and economical doors and windows. Those structures are more air-tight and therefore reduce the undesired air exchange of the rooms. The increase in the humidity may lead to the 'activation of the heat-bridges' and may eventually cause moulding. Earlier frequent and intensive airing and overheating of rooms were advised as preventive methods, but that could only be regarded as a temporary solution as it caused excessive energy consumption. The original aim was exactly the reduction of energy consumption, thus the vicious circle is complete. A way out of this seeming dilemma is by ensuring that the effect of the installed structures on ventilation is regulated. Structures must not stop ventilation only reduce it, in other words air exchange must be kept within the proper range of intensity [1].

The prescribed rate of air exchange must be ensured to prevent moulding. That may be carried out for instance by the application of ventilation slits which may also be integrated in the window and permit the regulation of air exchange.

3. Conclusion

Solution of the problems shown above is possible through the complex renovation of buildings outdated from the point of view of energy consumption such as prefabricated buildings. Energy conscious renovation consists in the integrated application of architectural means and certain kinds of building constructions and sanitary installations. Advisable applications include: vestibules, glazed winter gardens, subsequently installed thermal insulations, modern heating systems, etc. In the course of the renovation we must endeavour to utilise renewable sources of energy. Solar radiation is to be used for heating and natural lighting of spaces, wind and buoyancy for natural ventilation.

References

[1] SZÉLL, M., Döntéstámogató módszer faanyagú homlokzati nyílászárók értéknövelő felújításához, kandidátusi értekezés, Budapest, 1990.
[2] SZÉLL, M., Ablakok kiegészítő szerkezetei, *Épületfenntartás*, 1992./3. (pp. 9–17.)
[3] ÁGOSTHÁZY-EÖRDÖGH, É., Az egészséges lakás, TEMPUS SJEP 09015-95 Budapest, 1995.
[4] BIRGHOFFER, P.–HIKISCH, L., A panelos lakóépületek felújítása, Műszaki Könyvkiadó, Budapest, 1994.