VENTILATION STRATEGIES AND MEASUREMENT TECHNIQUES

6th AIC Conference, September 16-19 1985, Netherlands

PAPER 21

BASIC MATERIAL FOR THE INSTRUCTION OF OCCUPANTS OF HOMES. HOW, WHEN AND WHERE TO USE YOUR WINDOWS.

W.F. de Gids

TNO Division of Technology for Society
Department of Indoor Environment
PO 214
Delft
Netherlands

1. INTRODUCTION

Because from energy considerations houses must be built better air tight and problems of air pollution in homes occur more and more it is desirable to examine how occupants must be advised about the use of ventilating provisions. Building more air tight means namely that more than before opening of ventilating windows or gratings consciously will be necessary for supplementing the background ventilation through the cracks and chinks to a certain desired level.
This publication must be seen as a first endeavour to come from the existing situation of the use of windows and the occupants' ideas to the desired situation weighing on the one hand the energy aspect and on the other hand a right indoor environment.

2. PROCEDURE

On the basis of literature data [1], [2] on the behaviour of occupants relating to the use of ventilating provisions establishing how and why occupants ventilate it can be examined whether this is necessary or desirable.
Therefore, for this investigation, air tightness measurements have been carried out in ten typically Dutch dwelling complexes [3]. In each complex four homes were measured.
With the aid of the IMG calculation model for ventilation a calculation study has been carried out into the ventilation to be expected of these dwelling [4].
From these data basic material has been developed which can be used by public relation officers for special information of the group aimed at (e.g. occupants, housing association).

3. THE USE OF THE VENTILATING PROVISIONS

Table 1 summarizes the results of an inquiry among 1500 occupants of homes [1].
Table 1: Use of ventilating provisions

1500 homes Source: NWR Netherlands Housing Council

%

		Flap windows or ventilating slide in living room always	sometimes	never
Pivoting windows in the home	some hours per day	17	11	13
	1 hour a day and/or some hours per week	12	12	12
	sometimes a week one hour	7	7	9

This table shows the use of the ventilating provisions, namely the windows, in 1500 homes. The data were obtained through an inquiry.
The use of flap windows or a ventilating slide (above) and pivoting windows (left) is given. The flap windows can be opened always, somethimes or never, the pivoting windows some hours a day, one hour a day and/or some hours a week or some times a week one hour.
Three groups can be discerned.
Above to the left there are about 40% of the people ventilating rather much; in the middle there is a group of people ventilating to an average, about 30%; they will never use a flap window and sometimes a ventilating slide, but they will use the windows several times a week.
Below to the right are the people, also about 30%, who ventilate only (very) little. If these people live in air tight homes the problems are obvious.

A study which is directed more at the specific use of ventilating provisions in 610 homes [2] gives results over the question which window how long will be used and why.

Table 2 summarizes the use of the flap windows (vent lights).
Table 2 Use of ventilating provisions in 610 homes
Source Netherlands housing council

	Flap window	24 h	12 h	<12 h	one hour	shorter	not
530	living room	3	5	8	31	17	36
473	kitchen	12	20	13	30	13	12
455	bedroom	29	30	8	15	8	10
287	bathroom	24	24	9	24	9	11

In the living room the flap windows are used little: 36% do not use them at all, 31% use them an hour and 17% use them a shorter time. 8% use them shorter than 12 hours and 8% longer. The kitchen gives a dispersed picture.
The conclusion is that the flap windows are used rather frequently, though it is unknown wheter this is always at the right moments.
The bedroom flap windows are generally open for a long time and in some cases they are open for some hours. The same applies to the bathroom. So the flap windows are used rather much.

The use of the ventilating slides is summarized in Table 3.

Table 3: Use of ventilating slides in 610 homes

Ventilating slide	24 h	12 h	<12 h	one hour	shorter	not
114 living room	26	5	4	9	5	50
120 kitchen	62	8	2	9	2	17
79 bedroom	59	8	-	3	-	30
110 bathroom	73	3	1	6	2	15

The ventilating slide is found in about 100 homes in the living room. In 50% of the cases it is not used in view of possible complaints about draught, but yet in 26% it is open 24 hours a day. This may be related to the situation on the seaside in respect of the most frequent wind direction, so that complaints about draught will not occur so soon as a result of entering air. In many cases the slide in the kitchen is always open. This applies also to the bedroom and the bathroom.

Table 4: The use of pivoting windows

Pivoting window ajar	24 h	12 h	<12 h	one hour	shorter	not
528 living room	-	-	2	12	21	65
580 bedroom	12	19	16	25	12	16

In the living room nobody uses these windows very long. A reasonable percentage 'airs' one hour and 65% does not use a pivoting window at all. In the bedroom all kinds of use occur.
The right users are found here among people who use the window one hour or shorter.

Table 5: The use of mechanical ventilating provisions

Mechanical ventilation 210 kitchen	24 h	12 h	<12 h	one hour	shorter	not
	-	1	8	64	23	4

In 210 homes of the 610 there was such a provision, but it was not clear wheter this was a mechanical system (a central provision) or an exhaust hood (a decentralized provision).
64% of the people uses it one hour, 23% still shorter. It must be observed that, if it concern specifically the kitchen ventilation with a device, it does not seem so unreasonable. Turning on the ventilation for twelve hours seems a little long.

4. WHY ARE VENTILATING PROVISIONS USED

Table 6: Why do people ventilate?

Considerations	% thinking of it		
	strongly	a little	total
Energy	52	25	= 77
Health	52	25	= 77
Fresh air	70	21	= 91
No draught	71	19	= 90

The reasons energy and health have the same score, 52% thinks of it strongly and 25% a little. The others do not think of it or do not answer.
Fresh air and avoiding draught score higher. Obviously people have the idea that they must ventilate to keep the home fresh.

5. RESULTS OF THE AIR TIGHTNESS MEASUREMENTS AND CALCULATION STUDY

The results of the air tightness measurements are divided into one-family homes and flat dwelling as follows.

5.1 One-family houses

Number of homes examined: 19, divided over 5 locations.
Air passage measured:
C_{av} = 122 dm^3/s at 1 Pa; A_{net} = 915 cm^2; n_{av} = 67
Dispersion:
lowest value C_{min} = 74 dm^3/s at 1 Pa
highest value C_{max} = 194 dm^3/s at 1 Pa
standard devation σ_{n-1} = 36 dm^3/s at 1 Pa
standard deviation in $n\sigma$ = 0,16
Distribution over the skin of the home:
- fronts 3-20%; ducts 20-35%; other (roof, floor etc.) 25-70%.

5.2 Flat dwellings

Number of homes examined: 20, divided over 5 locations.
Air passage measured:
C_{av} = 23 dm^3/s at 1 Pa; A_{net} = 169 cm^2; n_{av} = 1.58
Dispersion:
lowest value C_{min} = 3 dm^3/s at 1 Pa; highest value C_{max} = 50 dm^3/s at 1 Pa;
standard deviation σ_{n-1} = 11.5 dm^3 at 1 Pa; standard deviation in $n\sigma$ = 0.17
It should be observed that the minimum value was measured in a flat with mechanical ventilation, with the mechanical ventilation sealed. So the air leakage measured is the front + possible rest, such as in flats mainly the meter box.
Distribution:
- fronts 13-60%; ducts 30-70%; other <7%.

5.3 Results of the calculation study

Table 7 summarizes the results of the calculation study [4].

Table 7: Review of the total ventilation (calculated) at an outdoor temperature of 5°C and an average shelter, indoor temperature 18°C, volume flow in dm^3/s (q_v); all windows and doors closed.

home	wind velocity m/s	air tight q_v dm^3/s	normal q_v dm^3/s
one family home	2	16-34	55-78
	5	30-42	80-100
	10	55-70	120-162
flat dwelling	2	5-12	20-33
	5	9-16	28-40
	10	20-26	49-70

The dispersion per column is caused by:
- ventilating system - natural
  - mechanical exhaust
- characteristics of the home (architectural)
- effect of wind directions, e.g. wind on fore front or back front
- temperature influences.

6. WHAT VENTILATION LEVELS ARE DESIRED

What would people desire for ventilation dependent on use and occupation of the home?

Figure 1: What is desired for a family of four persons? living room; bedroom (2 persons); time; dm^3/s.

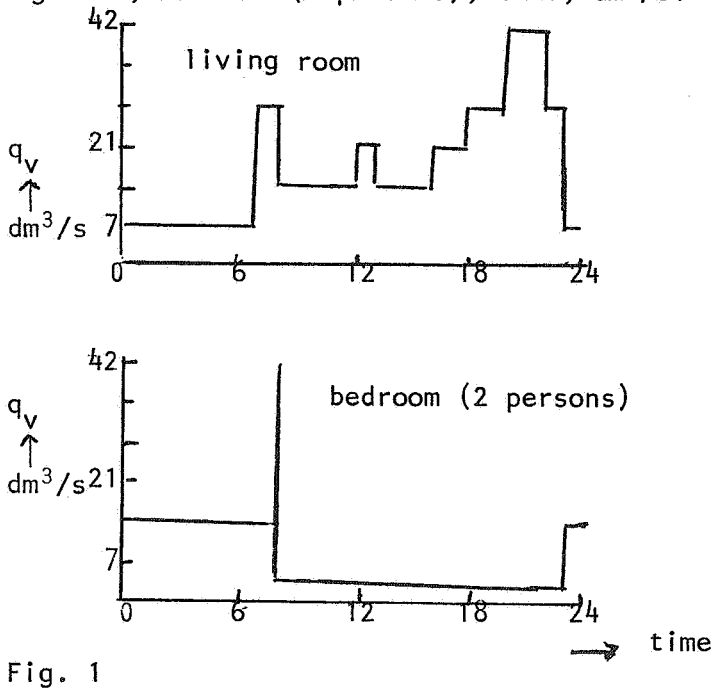

Fig. 1

The time is plotted horizontally, the volume flow vertically. For a family of four persons, with all people in one room, the amount which must be ventilated is 4 x 7 = 28 dm^3/s. In the morning the family has breakfast in the living room and then this amount is needed. It is not necessary to go lower than 7, because in the living room there will be always someone present. During the day with one child at home a level of 14 is necessary. If there is still another child at home from school 21 dm^3/s, and at the end of the workday if there are four persons 28 dm^3/s is desired and in the evening with two visitors 6 x 7 = 42 dm^3/s. At night 7 suffices. This pattern can be considered desired optimum pattern. The occupant should reckon with this, though a difficulty is added to it as will be obvious in a moment. Take a look at the volume flow and the time during the day of one bedroom for two persons (lower figure), this must be vented by 14 dm^3/s or 50 m^3/h. In the morning the wife makes the beds and wishes that the dust raised dilures and disappears with air. So, she open a pivoting window for a very short time, 20 minutes is quite sufficient, and causes then a high peak of 42 dm^3/s, or higher.
After that, if there are no persons left, the level may be low, but a minimum level is desired.

Consider a similar approach for the kitchen and the bathroom, the most important two wet rooms, then we see for the kitchen the following picture (figure 2).
Figure 2: Kitchen. Bathroom. time.

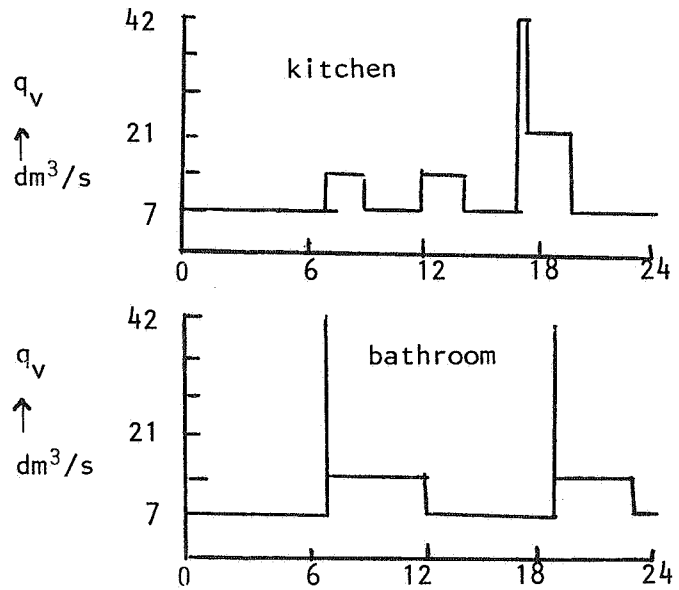

Fig. 2

It is assumed that there is always one person present. The requirement for the kitchen is that is must be possible to attain 21 dm^3/s or 75 m^3/h. Normally this is necessary for cooking, so in the evening for 1 or 2 hours and further over the part which produces humidity. In the morning when preparing breakfast and in the afternoon when preparing dinner a little more is needed than during the rest of the day. Really, during cooking, one would like to have a high peak to ventilate vapour and cooking smells. For this the temporarily higher value is needed. Using a high reading on an exhaust hood without an engine is a reasonable possibility to put a peak on it.
For a good use of windows and other ventilating provisions, dependent on the type of home, the degree of shelter and the wind velocity one can use the data from Table 8.

Table 8: Basic ventilation for three persons.
Which type of windows open? How far?
What chinks sealed?

Type of home	Situation	Age	Air tightness	Calm/quiet 2 m/s	Normal 5 m/s	Strong wind/Storm 10 m/s
One-family home	normal	older than 1950	leaky	no windows open, chinks of front/roof floor to be sealed from energy considerations		
	shelter	1950 1975/1980	normal	no windows open, chinks of roof/floor to be sealed from energy consideratio		
		from 1975/1980	tight	1 flap window open or 3 ajar	nothing open	nothing open
	very tight shelter	older than '50	leaky	see normal shelter		
		1950-1975/80	normal		see normal shelter	
		from 1975/80	tight	1 flap window open or 3 ajar		nothing op
Flat dwelling	normal shelter	older than '50	leaky		nothing open	
		1950-1975/80	normal	1 flap window ajar	nothing open	
		from 1975/80	tight	1 flap window open or 3ajar		1flap wind ajar
	very tight shelter	older than '50	leaky	1 flap window ajar	nothing open	
		1950-1975/80	normal	1 flap window ajar	1 flap window ajar nothing open	
		from 1975/80	tight		see normal shelter	

Let us now consider the bathroom: the requirement for a bath room in the Dutch Standard NEN 1087 is 14 dm^3/s. There are moments when one should like to exceed this level, e.g. if the bathroom is entirely filled with vapour. Generally, a minimum level is required, surely for evaporating humidity from the building construction, over a longer time. In general one should not go below 7 dm^3/s. Perhaps the 14 dm^3/s line should be continued with a few temporary peaks. It is essential that the occupants are not instructed to use the ventilating provisions of the bathroom only during bathing or washing, but especially a long time afterwards.
Some hours after the use of the bathroom switch the ventilating provisions at a high reading and afterwards at a low reading, but do not swithch them off, that is absolutely necessary for wet rooms.

7. WHAT IS NECESSARY TO ATTAINS THE FOREGOING?

At any case two matters are necessary: good provisions and a good use of these provisions. Mostly there is something wrong with both. The requirements for good provisions in the Netherlands can be improved and in the revision of NEN 1087 we shall strive for improvement of the controllability and the adjustability.
In the first place a good design and a good dimensioning are important.
The window must be large enough; the ventilating installation must be well-designed/dimensioned, such that the flow is sufficiently strong. Exhaust at a rate of 100 m^3/h for a home the toilet of which is ventilated naturally, is below the standard, actually.
Firstly, the toilet may not be ventilated only naturally, but the total air flow, the nominal flow of the ventilator of 100 m^3/h, is also too low. Therefore, a good design and dimensioning are important, in the first place.

Often, there is a lack of good forms of controlability. The standard is very simple, perhaps too simple: the volume flows must be adjustable.
The controlablility can be improved to a great extent in the ventilating industry in general. Also good adjustability is necessary, for the ventilating installation can be grovided with a good control device, but if this is disturbed by a minor cause, e.g. the wind presure, it is of no use.

The ventilating provisions must be well within reach. Often one knows how to open flap windows, but does not know how to close them, for then they are out of reach.

They must be easy to handle, not complicated. If the window must be handled by pulling a cord one must know then if the window is open or closed.

They may cause no inconvenience by draught and no noise annoyance. As concerns this last item the mechanical installations often are designed wrong.

8. CONCLUSION

The right use of ventilating provisions at any rate requires good instructions, better than has been the case till now, that will be clear. The instruction must take account of the building type of the home, one-family house or flat. Also other things such as open staircase and open kitchen will affect the ventilation.
Further the degree of air tightness, the weather conditions, the occupation and the activities. They must form the centre in the instruction and it can be imagined that if such a whimsical pattern is added it is no easy task for the instruction. But I think it a challenge which surely can lead to reasonable results, if there is sufficient knowledge of all these matters. How do people ventilate at the moment, why do they close or open windows and at what moments in a given type of building and air tightness? Where must people open windows then under what weather conditions? And they must be urged that it very much depends on the occupation and the activities. Systems which independent of the occupation and activity are always on the nominal power are not at all ideal. They are not well controllable namely and perhaps do not meet one starting point of the Dutch standard.
Finally, a good attitude of the occupants is required. If this lacks it is impossible to attain a good operation with this kind of systems, wheter they are mechanical or natural.

Literature:

[1] Beek, F.M. van
Experience and use of windows in homes
NWR, Almere 1981

[2] Wees, E. van
Study of the ventilation behaviour of occupants
NWR, Almere 1983

[3] Gids, W.F. de
Air tightness measurements in one-family homes and flats
IMG-TNO, Delft 1985

[4] Gids, W.F. de
Calculation study into the ventilation of dwelling
IMG-TNO, Delft 1985