OCCUPANT INTERACTION WITH VENTILATION SYSTEMS

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THE ROLE OF TRICKLE VENTILATORS IN DOMESTIC VENTILATION DESIGN

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SYNOPSIS

This paper discusses the use of trickle ventilators in the design for natural ventilation in dwellings. The discussion is based around the results of a field monitoring experiment where 17 out of 32 houses were fitted with trickle ventilators as a remedial measure to improve the distribution of ventilation and to reduce the occurrence of condensation. Reductions in condensation, effects on energy use, window opening and occupants views are considered. The paper concludes that trickle ventilators are a successful component part in the design of natural ventilation systems in dwellings.

1. INTRODUCTION

This paper discusses the use of trickle ventilators in the design for natural ventilation in dwellings.

Over the past decade in the U.K., in order conserve energy, the standard of domestic construction has become much 'tighter' in terms of reduced air infiltration. This has been achieved by the use of high performance components, better constructional detailing, and general draught sealing. It is now generally accepted that in modern 'low-energy' dwellings there is a need to design for ventilation to ensure occupants well being and to reduce condensation risks. Traditionally, in the U.K. domestic ventilation is predominantly natural, relying on air infiltrating through open areas (fortuitous and purpose made) in the fabric. Now the fortuitous openings are being reduced by tighter design and the traditional purpose made openings, ie. windows, are usually insensitive to the fine control needed for winter time ventilation.

Trickle ventilators are a component part of natural ventilation design in well sealed houses, offering an openable area sufficient for winter ventilation, that does not incur a significant energy penalty. There are three main designs for predominantly natural ventilation, involving the use of trickle ventilators, namely :

(i) Natural in/Natural out : using trickle ventilators as both the source of air inlet and outlet.

(ii) Natural in/Mechanical out : an extension of (i) with additional air outlet using mechanical extract.

(iii) Natural in/Natural out : using trickle ventilators as the source of air inlet with additional air outlet paths using stack ventilation ducts in the bathroom and kitchen (REF 1).

This paper discusses the first of the above schemes, which is currently the most common in operation in the U.K. The discussion is mainly based on the results of a monitoring experiment on a sample 32 houses of which 17 had trickle ventilators installed. Some initial results were presented in an earlier publication (REF 2) along with detailed ventilation measurements carried out on the houses. This paper presents a more detailed analysis of the trickle ventilators experiment, which was funded as a Department of Energy (BRECSU) Demonstration Project (REF's 3,4).

2. DESCRIPTION

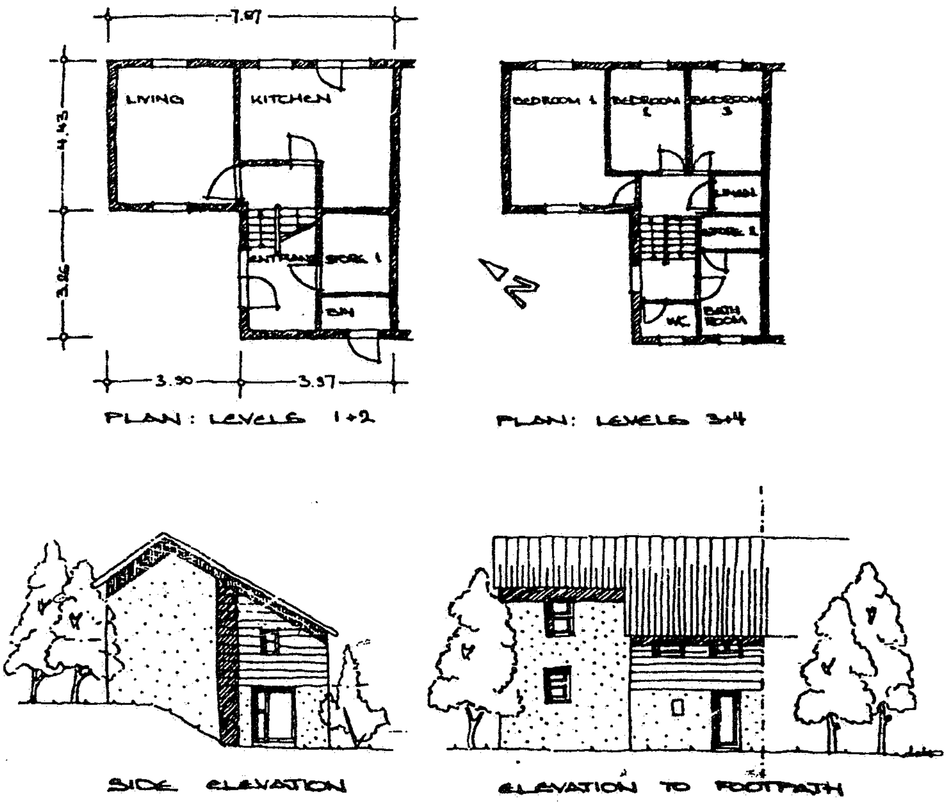


FIGURE 1. HOUSE PLANS AND ELEVATIONS

The houses were all three bedroom terraced houses (Fig 1), situated on a southwest facing hillside in Abertridwr, South Wales. Trickle ventilators were installed in the window frames of 17 houses out of the sample of 32 houses. The houses had previously been the subject of a 'better insulated houses' project (REF 5) and as such approximately half of the houses in each group (ie. those with and those without ventilators) had insulation standards in excess of what was then recommended by the UK Building Regulations. Holes were drilled in the window frames providing an open area of 350 sqmm (for a 'standard' ventilator) with the ventilator in the fully open position. Physical and social monitoring was carried out over approximately a 20 month period, beginning 6 months prior to the installation of the ventilators. The physical monitoring included the continuous measurement of energy use, internal air temperatures and external conditions, (REF 3) as well as ventilation and air leakage experiments (REF 2). The social monitoring included surveys of condensation occurrence, window opening, and occupants use and reaction.

Prior to the installation of the trickle ventilators, ventilation measurements carried out on the Abertridwr site showed that, although the whole house average air infiltration rates were reasonably satisfactory at 0.5 ac/hour, the individual room rates were in many cases extremely low and there were a number of serious cases of condensation and mould growth. Preliminary measurements in two houses which had trickle vents installed showed an improvement to the distribution of ventilation in the rooms together with a marked reduction in condensation mould growth (REF 3).

3. RESULTS

3.1 Reduced Condensation

For the occupants condensation becomes a problem when it manifests itself in mould or damp patches. It was therefore these visible signs that were considered when assessing the problem of condensation. The seriousness of mould growth was assessed according to its extent, being categorized as non-existent (none), present in the window recess (some), or present underneath windows and in other areas (severe). Three surveys were carried out, in the April 81, prior to the installation (the following January), in April 82 and in April 83. The results of the surveys are summarised in Table 1.

TABLE 1. CHANGES IN OCCURRENCE OF MOULD GROWTH

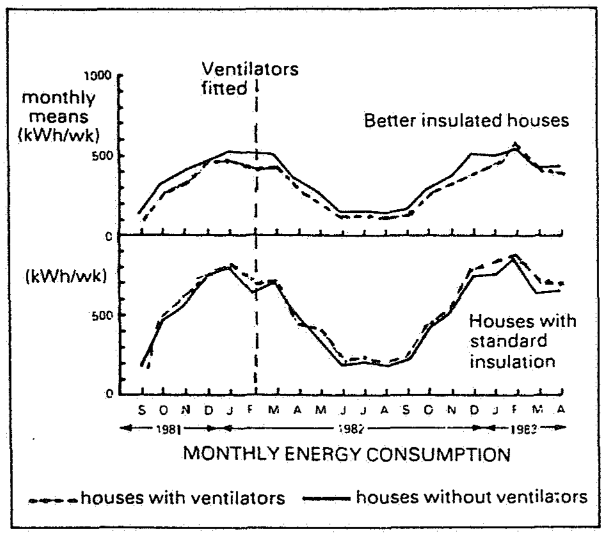
	Houses with ventilators (17)			Houses without ventilators (15)		
	severe	some	none	severe	some	none
Before April 82	6	2	9	/	7	8
April 82	2	6	9	2	8	5
April 82	1	7	9	4	7	4

Between April 81 and April 82, four houses with ventilators showed an improvement in the reduction of mould growth, while at the same time three houses without ventilators showed an increase in mould growth. Overall (after April 83), of the houses with ventilators, one third had reduced mould growth during the experimental period, while those without ventilators, one third suffered increased mould growth. From this perspective, the ventilators can be said to reduce rather than cure the condensation problems.

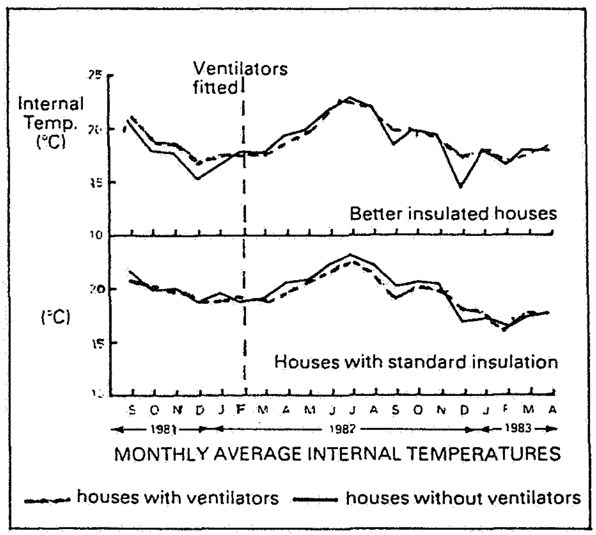
3.2 Energy Use

In order to analyse the energy performance, the houses were divided into four groups, namely :

- Better insulated : with ventilators
- Better insulated : no ventilators
- Standard insulated : with ventilators
- Standard insulated : no ventilators



(a)



(b)

FIGURE 2. (a) MONTHLY ENERGY CONSUMPTION
(b) MONTHLY AVERAGE INTERNAL TEMPERATURES

The Energy Consumption for each group is given in Figure 2(a) for the period prior to, and after the installation. Figure 2(b) shows the average internal temperatures for the same period. There is no significant change in energy performance attributable to the installation of the trickle ventilators. This implies that there is no energy penalty. The ventilation measurements (REF) showed an increase of about 10 % from the trickle ventilators fully open which as a percentage of the total heat input would be about 2%. Therefore a significant rise in energy use was not expected.

3.3 Window Opening

The window opening surveys were grouped into 6 time periods. For each period the total number of windows open were divided by the number of surveys and the number of houses provides an average window opening score. The results are summarised in Table 2.

TABLE 2. MEASURED LEVELS OF WINDOW OPENING
(average number of open windows per house)

	WITH VENTS	WITHOUT VENTS	DIFFERENCE
Winter 81/82 (before vents fitted)	0.7	0.6	+0.1
Spring 82	0.7	1.1	-0.4
Summer 82	2.0	2.2	-0.2
Autumn 82	1.3	1.4	-0.1
Winter 82/83	0.3	0.5	-0.2
Spring 83	1.6	2.3	-0.7

The Table shows that the houses with ventilators open windows less frequently than those without, about threequarters of a window per house difference by Spring 83. The indication is that there is a period of time over which the occupants learn how to use the new ventilation system, using the trickle ventilators instead of opening windows. This learning process appears to take place over the first year of the measure.

3.4 Occupants Views

The response of the occupants to the ventilators was positively in favour of their use. Occupants were pleased to have the ventilators fitted, believed they helped with reducing condensation and found them a useful alternative to window opening. There were however two factors that attracted criticism, namely, (a) a belief that the ventilators caused draughts, and, (b) their perceived inability to quickly ventilate a room.

(a) Draughts :

Several occupants made reference to draughts from the ventilators during cold and windy weather. The comments from the occupants suggest that 'draughts' were noticed, not as a perception of cold air on the skin, but visually, because of a moving curtain or aurally, because of a ventilator rattling. These problems are rectified if a different ventilator were used, eg the Trimvent (TITON) which defects the air parallel to the plane of the window. It was not possible to use the Trimvent at Abertridwr as a retrofit measure because its fixing would have weakened the existing window frame.

(b) Speed of Reaction :

For occupants to use the ventilators they must believe them to be effective. Some of the interviews with the occupants indicated that the occupants initially expected the ventilators to perform in a similar way to window opening (ie. to clear the air in a room quickly). When this did not happen there was a feeling that the ventilators were of a limited practical value. However, over time, the interviews with the occupants indicated that families learn to use the ventilators by a process of experimentation which shows them what the ventilators can and cannot do, ie. there is a learning curve. Families develop a pattern of ventilation that includes both window opening and the use of ventilators, a pattern that can accomodate the changing requirements of summer and winter as well as the exceptional demands of particular times of day.

Therefore, regarding the above criticisms of the occupants, the first can be avoided by the design of the ventilator and the second disappears over time as the occupant develops new ventilating habits.

4. CONCLUSIONS

In general the use of trickle ventilators improve the internal environmental conditions without incurring a significant energy penalty, namely :

(a) They improve the distribution of ventilation within the internal spatial layout during the heating season, allowing the ventilation rates for individual rooms to be controlled closer to their pattern of occupancy than could be achieved by opening (or not opening) windows.

(b) They reduce the level of condensation mould growth.

The use of trickle ventilators provides a successful method for the control of winter ventilation in well-sealed, energy efficient dwellings. Firstly, producing a well-sealed house results in energy savings. Trickle ventilators then provide the ventilation control necessary to maintain satisfactory internal environmental conditions.

Also, it was found that window opening was reduced during the heating season, though not enough to result in identifiable energy savings.

The installation of the ventilators (to houses on an exposed site) created no difficulties with rain penetration and there was no evidence to suggest that the durability of the window frames had been impaired in any way.

There are now a number of solutions being suggested for ventilation design in modern 'low-energy' dwellings. One such solution is the trickle ventilator configuration discussed in this paper, which has probably been tested more than most others. In the UK, future energy efficient design is likely to be assessed against 'performance standards' which will be based around a finite number of approved solutions. There is therefore the need to select a limited number of available solutions for ventilation design and to thoroughly test each one over a range of operating conditions. A number of approved solutions can then be offered for use by the building industry. This will hopefully reduce the risk of failure in future ventilation design.

Trickle ventilators are now generally recognised as a component part of all the main design solutions for natural ventilation in dwellings.

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