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Trickle ventilators in offices

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information paper

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Trickle ventilators are identied in Approved Document F as a means of providing natural background ventilation in ofce buildings. Research at BRE determined their optimum open areas, and their effectiveness was assessed by airow modelling, laboratory tests and eld measurements in occupied ofces. Purpose-designed trickle ventilators, sized according to these criteria and incorporated in the overall ventilation strategy of an ofce building, can provide the required background ventilation during the heating season without compromising thermal comfort.

Natural ventilation and low energy ventilation within office buildings has increasingly come to the attention of designers and specifiers, driven primarily by two factors:
- the commitment to reduce carbon dioxide and CFC emissions as part of the Rio Agreement;
- the occupants' preference for naturally ventilated buildings[2].

It is estimated that:
- there are over 1.6 million non-domestic buildings in the UK;
- annual growth of new buildings is estimated at 2.5% of total stock and major refurbishment is 7.5 %;
- of the £900 million spent on energy, savings of £280 million are possible through cost-effective improvements to design and management of buildings and their services.

When used as part of an integrated approach to providing background ventilation, trickle ventilators can meet the requirements of the Approved Document and can assist in providing good indoor air quality for occupants.

Size of opening

Approved Document (AD Part F1) [1] of the Building Regulations for England and Wales gives the following size of openings to provide sufcient background ventilation in occupiable rooms (ofces):

Floor area	Opening area
up to 10 m^2	4000 mm^2
greater than 10 m^2	400 mm^2 per m^2 of oor area

Figure 1 Interior of an ofce showing trickle ventilators installed in the window frames

What is a trickle ventilator?

In its simplest form a trickle ventilator is just a slot or row of holes cut into the window frame usually above the glass and protected by a formed plastics cover. More sophisticated designs incorporate automatic control to provide constant and/or controllable air flow independent of external conditions of wind and temperature. It is a purpose-built means of bringing ventilation air into a room. Figure 1 shows an office with trickle ventilators installed in the window frames.

Trickle ventilators were developed initially for the domestic market to provide background ventilation for habitable rooms. However, they can be used in non-domestic buildings as part of a natural ventilation or hybrid ventilation strategy. The refurbishment of a building represents a good opportunity for the inclusion of trickle ventilators.

Why install a trickle ventilator?

Current concerns about indoor air quality, energy conservation and the environment have led to the concept of *Build tight - ventilate right*[3] being considered as the basis of good design for ventilation. In essence, this concept requires that the building envelope be air tight: ventilation will then be provided in a controlled way. For naturally ventilated buildings, an airtight envelope means that adequate, controlled background ventilation must be provided for the occupants.

A total ventilation opening of not less than 400 mm^2 per m^2 of floor area is recommended[1] for occupiable spaces with floor areas of 10 m^2 or greater to meet the requirement for background ventilation. One way of providing sufficient background ventilation in an office space is via trickle ventilators; Figure 2 shows a number of different designs.

Controlling air ow with trickle ventilators

The rate of air flow into a space via trickle ventilators is dependent to a great extent on external conditions. Basically, trickle ventilators provide background ventilation; higher rates of ventilation should be provided by other means, such as windows. To provide minimum ventilation, trickle ventilators may be oversized for the more common external conditions but this could lead to draughts under some circumstances and to wasted energy in heating the incoming air.

There is evidence[4] to suggest that occupants within an office will use trickle ventilators to control their environment, provided that they are familiar with their operation. But there are many situations where occupants are not familiar with trickle ventilators, or are not aware of their existence. The ventilators are just not used but are left however they were originally set. Some means of controlling incoming air is desirable to use the ventilators properly.

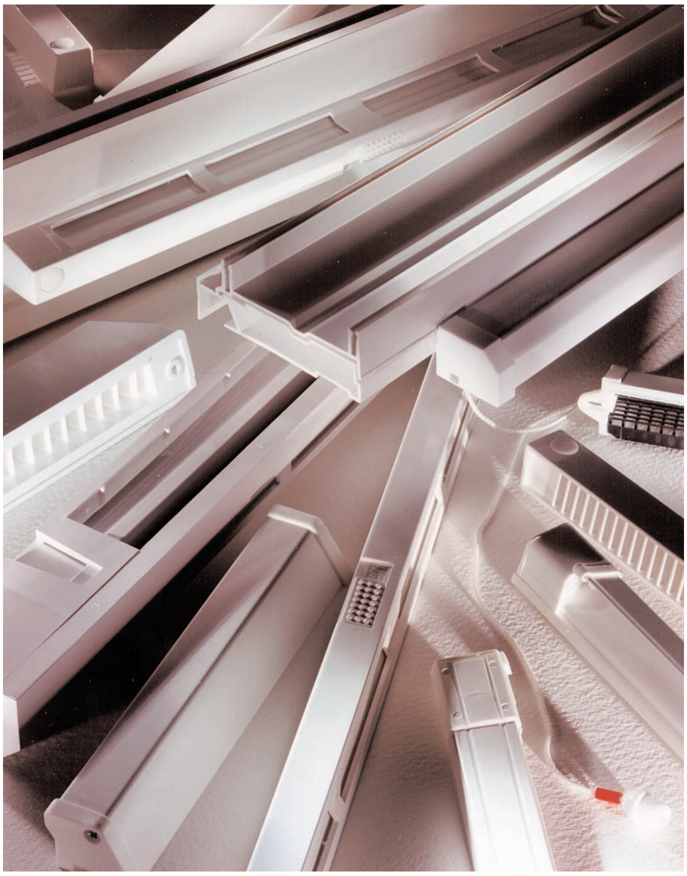

Figure 2 Different designs of trickle ventilator

Courtesy of Willan Building Services Ltd

Existing means of controlling the operation of trickle ventilators include:

- *Basic* The basic trickle ventilator is simply a series of holes or slots in a window frame covered with a formed, plastics cover to give protection from the weather. It is fixed and allows no control. Proper selection and positioning of this type is necessary for effective use.
- *Hit and miss* This type of ventilator has some means of being closed: usually a slide moves over the openings. This type is either open or closed and relies upon the occupant to operate it. For effective use, it is important that occupants are fully aware of the ventilators and their operation.
- *Humidity* Mainly used in dwellings, its scope for use in offices is limited because moisture is not a dominant pollutant. This type is of value in environments that are especially prone to dampness, eg bathrooms and kitchens, where extra ventilation is needed at certain times.
- P*ressure* This is generally used in offices. There are several designs which operate under different conditions, for example inside/outside pressure difference.
- P*ollutant* *(CO_2/CO/Smoke)* This has been used in schools, theatres, shopping malls etc. and occasionally in dwellings. Its use in offices is debatable because the only dominant pollutant is CO_2 and considerable drift has been reported. It may be useful where there is an intermittent external pollutant which must be prevented from entering.

Assessing their effectiveness

Work at BRE assessed the effectiveness of trickle ventilators in providing adequate controlled background ventilation in offices during the winter months. It involved computer modelling, laboratory measurements and field studies in occupied offices.

Computer modelling

A preliminary study[5] used BREEZE[6], the multi-zone air flow prediction software; this is a suite of programs developed at BRE to evaluate ventilation rates and inter-zonal airflows in multi-storey, multi-celled buildings. The objective was to determine whether trickle ventilators could provide the required background ventilation in offices during the heating season.

The building modelled was the BRE Low Energy Office[7] - see Figure 3. This building is similar in size and form to many naturally ventilated office blocks found in the UK. An added advantage was that extensive model and full-scale data were already available for input into the model and for validating the prediction. Through a weather and occupancy patterns parametric analysis, modelling confirmed that the openable size requirements specified in the Building Regulations can provide the required background ventilation - see Figure 4.

Figure 3 BRE low-energy ofce used in modelling exercise

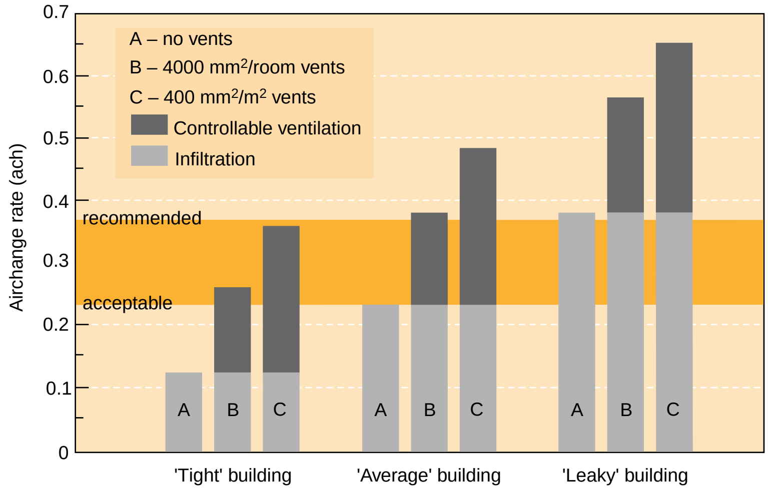

Figure 4 Effect of ventilators and envelope tightness

Laboratory tests

To support the findings of the computer modelling, laboratory tests were carried out in winter in two identical adjacent deep-plan rooms at BRE[8]. Trickle ventilators were installed in one of the rooms; the other room was used as a control. The main aim was to determine if trickle ventilators, sized according to the guidance, would provide sufficient fresh air. Measurements showed this to be the case, but that it is wind dependent.

To simulate an occupied office, CO_2 was released into both rooms at a rate representative of the metabolic CO_2 release rate of people. Occupant density was varied between the recommended minimum of 8 m^2 of floor area per person, and the average occupancy allowance in the UK and Europe, which is 14 m^2[9]. Placing heat sources of 100 W at appropriate locations simulated heat gains.

Figure 5 shows the difference between CO_2 level in the two rooms for a typical working day. The tests confirmed that sufficient fresh air can be provided by trickle ventilators to reduce CO_2 levels to about 1000 ppm for average weather conditions in an office with an occupancy density of 8 m^2. This level of metabolic CO_2 can be used as a surrogate indicator of a fresh air flow rate of 5 ls^{-1} per person[3]. Larger ventilators would be required for higher levels of occupancy.

Trickle ventilators with an openable area of at least 400 mm^2 per m^2 of floor area can provide adequate fresh air in winter in a suburban office with a maximum occupant density of about 8 m^2 floor area per person[7]. For the trickle ventilators to perform effectively, internal doors should be fitted with transfer grilles or should be kept open. Draughts did not generally appear to be a problem either sitting, at head height, or at ankle height at distances of up to 2 m from the

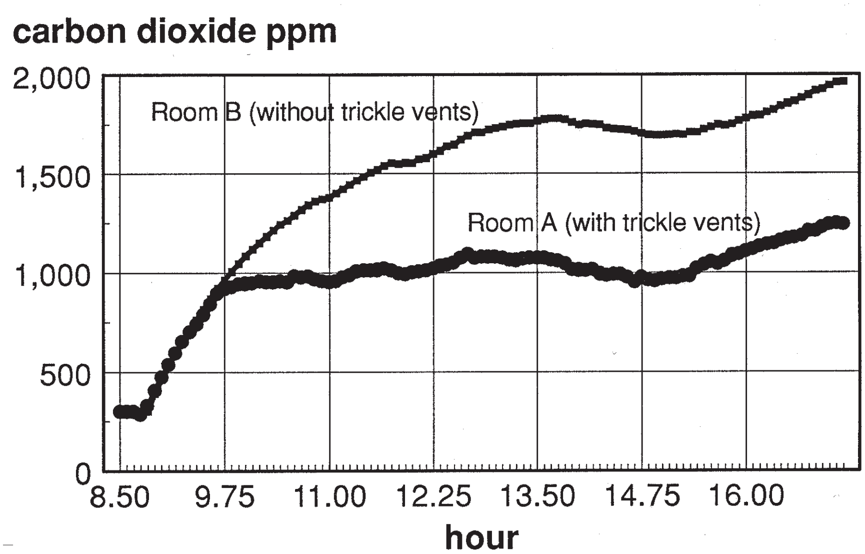

Figure 5 Typical experimental results. This shows the CO_2 concentration during a working day in two adjacent experimental rooms occupied by three people under typical external conditions. Room A is tted with a trickle ventilator.

Figure 6 Monitoring equipment mounted on a mast and in place in an ofce

ventilator. However, air speeds at ankle height were high enough sometimes to cause discomfort; appropriate design could correct this problem; for example, directing the incoming air upwards would prevent the air from reaching floor level before it had mixed with the warmer air inside.

Field studies in two occupied ofces

After laboratory studies, a field study was carried out in two occupied offices in a building at BRE[10]. The offices were fitted with trickle ventilators and measurements were carried out over a two-week period in each office; the trickle ventilators were kept closed during the first week and open during the second.One office was situated on the first floor of a four-storey building; its floor area is 12.5 m^2. The other office is in a single-storey building and had a floor area of 16 m^2. Trickle ventilators were sized using the same criteria as for the modelling exercise. Monitoring equipment was mounted on a stand - see Figure 6 - to measure air speed, CO_2 concentration, and relative humidity and air temperature. Door opening was recorded by triggering a datalogger by a microswitch attached to the door frame. The occupants were given a log sheet on which to record window and venetian blind use.

Carbon dioxide levels recorded in both offices confirmed the laboratory study findings that levels did not exceed 1000 ppm when a ventilator was correctly sized for the occupancy of the office. With the ventilators closed, the CO_2 level was higher and reached a similar level to that in the corridors.

Figure 7 External views of the two multi-storey ofce buildings showing detail of trickle ventilator installation.

Full-scale eld studies

A second field study was carried out in two multi-storey office blocks during the heating season[4]. Both buildings are in a town. Four storeys high, they are used mainly for clerical and administrative work - see Figure 7. When they were refurbished recently, trickle ventilators were installed which could be opened or shut manually by the occupants.

One of the offices is located on the first floor of the building; it is a large, open-plan space with a floor area of 250 m^2 and is occupied by about 15 people.

In the other building, the open-plan office is on the second floor; it has a floor area of 86 m^2 and is occupied intermittently by up to five people.

Both offices were in general use Monday to Friday and closed over the weekend. The monitoring procedure was similar to that used in the first field study except that door opening was not monitored. In both offices, the occupants recorded their use of windows, venetian blinds and ventilators; towards the end of the monitoring period, each was given a questionnaire about the office environment.

The same measuring station that was used in the study in two offices at BRE was set up in the office being monitored. In both offices, confidential work was carried out so the doors were kept closed. Ventilation was measured using the perfluorocarbon technique (PFT) developed at BRE – see IP 13/95; this gives the time averaged ventilation rate over the monitoring period in both offices. A temperature sensor was placed outside the building to obtain local external temperature. Weather data was obtained from the nearest meteorological office site - see Figure 8.

The findings of these studies can be summarised as follows:

- For offices up to 10 m^2 floor area, trickle ventilators of 4000 mm^2 open area can provide adequate background fresh air and maintain good indoor air quality in winter. In larger offices, trickle ventilators need an open area of 400 mm^2 per m^2 of floor area.
- People will use trickle ventilators to control their environment, provided they are familiar with their operation.
- There should be no cold draughts if trickle ventilators are properly positioned and designed.

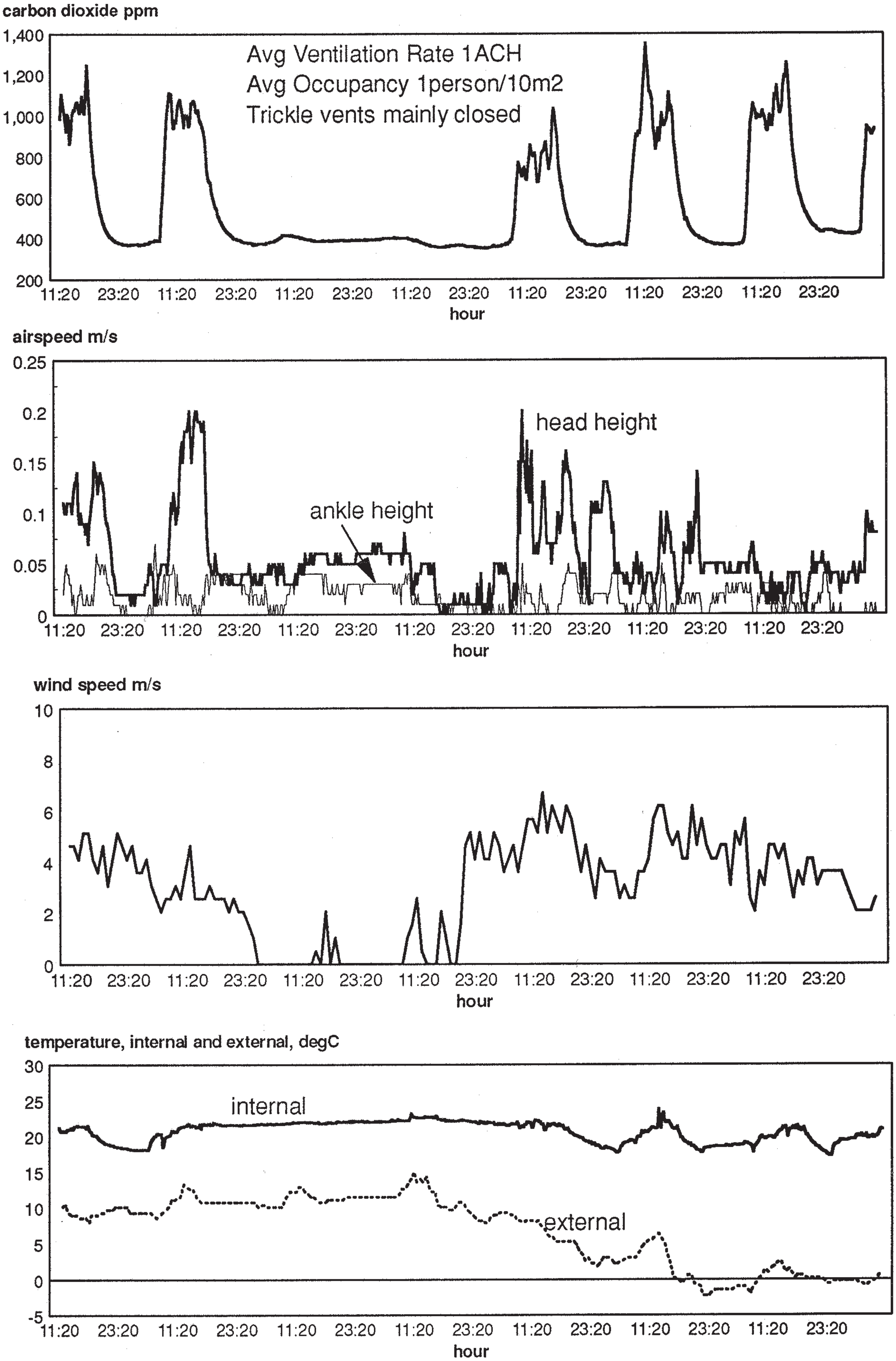

Figure 8 Graph showing typical results from one weeks monitoring in one of the ofce buildings

Conclusions

A series of studies carried out at BRE has led to the evaluation of the effectiveness of trickle ventilators at providing background ventilation. From these studies, guidance has been developed on the size of openings; they also confirmed that properly sized trickle ventilators will provide adequate background ventilation and that occupants will use them.

The studies led to the development of the guidance on size of openings (see box on page 1) which has been incorporated into Approved Document (AD Part F1)[1] of the Building Regulations for England and Wales.

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