Item No. 5

**CONTROLLING CONDENSATION IN DWELLINGS – 1 – VENTILATION**
**(For information only)**

**Purpose of item**

This is the second in a series of items on the subject of condensation within buildings. It discusses condensation within *dwellings* and by using case histories, will illustrate the relationship between *ventilation* and condensation.

The first, item No. 5 of bulletin No. 125 was largely a commentary on an article in the *Architects Journal* dated 3rd October 1979. The item was mainly concerned with the prediction of the risk of interstitial condensation and should be referred to when reading the present item.

**Conditions conducive to a reduction of the risk of condensation**

To eliminate *all* chance of condensation occurring within any part of a building including its fabric, the temperature of every part of that building must at all times be above the dew point temperature of the air in contact with it. The conditions required to maintain this ideal situation would require such fine balancing that they are seldom if ever achieved in dwellings.

If air conditioning is employed – or, as in the past, an ample supply of cheap fuel is available – the possibility of attaining these conditions is greatly increased.

**Controlling factors**

The dew point temperature of the air is a direct measure of the concentration of water vapour in it and is the temperature at which the water vapour in the air saturates it so that it can hold no more. If the temperature of such saturated air falls or if it comes into contact with anything at a lower temperature, some of the water vapour will condense.

The factors which control the concentration of water vapour in the air within a building are –

(i) The temperature of the air

(ii) The rate at which the moisture is being introduced into the air

(iii) The rate at which humid air in the building is diluted by being exchanged for drier external air, that is, the rate of *ventilation*.

The factors which control the temperature of the fabric of a building are –

(iv) The rate at which energy in the form of heat enters the part of the fabric in question

(v) The rate at which it loses heat.

**Control of the factors**

The five factors listed in the previous paragraph may be divided into two categories. Those which come under the control of the occupier and those that are controlled by the design of the building fabric. These categories cannot be mutually exclusive.

The occupier usually controls –

(a) The rate at which heat is fed into the building.

(b) The rate at which moisture is being introduced into the air by the normal occupational processes associated with living

(c) The rate at which humid air in the building is exchanged for drier air from outside the building.

The architect and his advisers have the responsibility of including sufficient thermal insulation in the fabric of the building and of ensuring that it is in the best possible place relative to the other components of the structure to reduce the risk of surface or interstitial condensation. The architect also has the responsibility of making provision for the building to be easily and conveniently ventilated, to enable the occupant to achieve a satisfactory rate of exchange of air.

Thus the architect can provide a dwelling which will be free of significant condensation *provided that* it is used within the limits of his design, in respect of heating and ventilation.

**The ventilation of bedrooms**

**The effect of ventilation on the dew point of the air in a bedroom**

The changes in the dew point of the air in a bedroom occupied by two sleeping adults, under differing conditions of ventilation are seen in fig 1. The four graphs show how the dew point temperature of the air changes over a period of four hours, under five conditions of ventilation – 0, ¼, ½, 1 and 2 air changes per hour.

It can be seen how even a small amount of ventilation will prevent the disastrous rise in the dewpoint which results from no ventilation at all.

In fact a room with no specific provision for ventilation may have an air change rate of as little as a quarter or a half, while an opening of 0.005 $m^2$, possibly formed by a window open to an extent of no more than a 5 mm gap, is sufficient to increase this rate to one or even two air changes an hour.

**Humidity and temperature conditions in a bedroom during the day**

The following table lists typical readings of temperature and humidity taken in bedrooms during visits made in the daytime. They were taken in three different houses where mould growth had been found to occur. It can be seen that they cover a range of temperatures which indicate an insufficient heat input in half the cases, but in all cases the relative humidities and dew point temperatures indicate that there is an unacceptably low level of ventilation.

| Air temperatures °C | Relative humidity % | Dewpoint temperature °C |
|---|---|---|
| 17 | 77 | 13 |
| 16 | 80 | 12.6 |
| 12 | 82 | 9 |
| 15 | 71 | 10 |
| 12 | 75 | 8 |
| 10 | 87 | 8 |

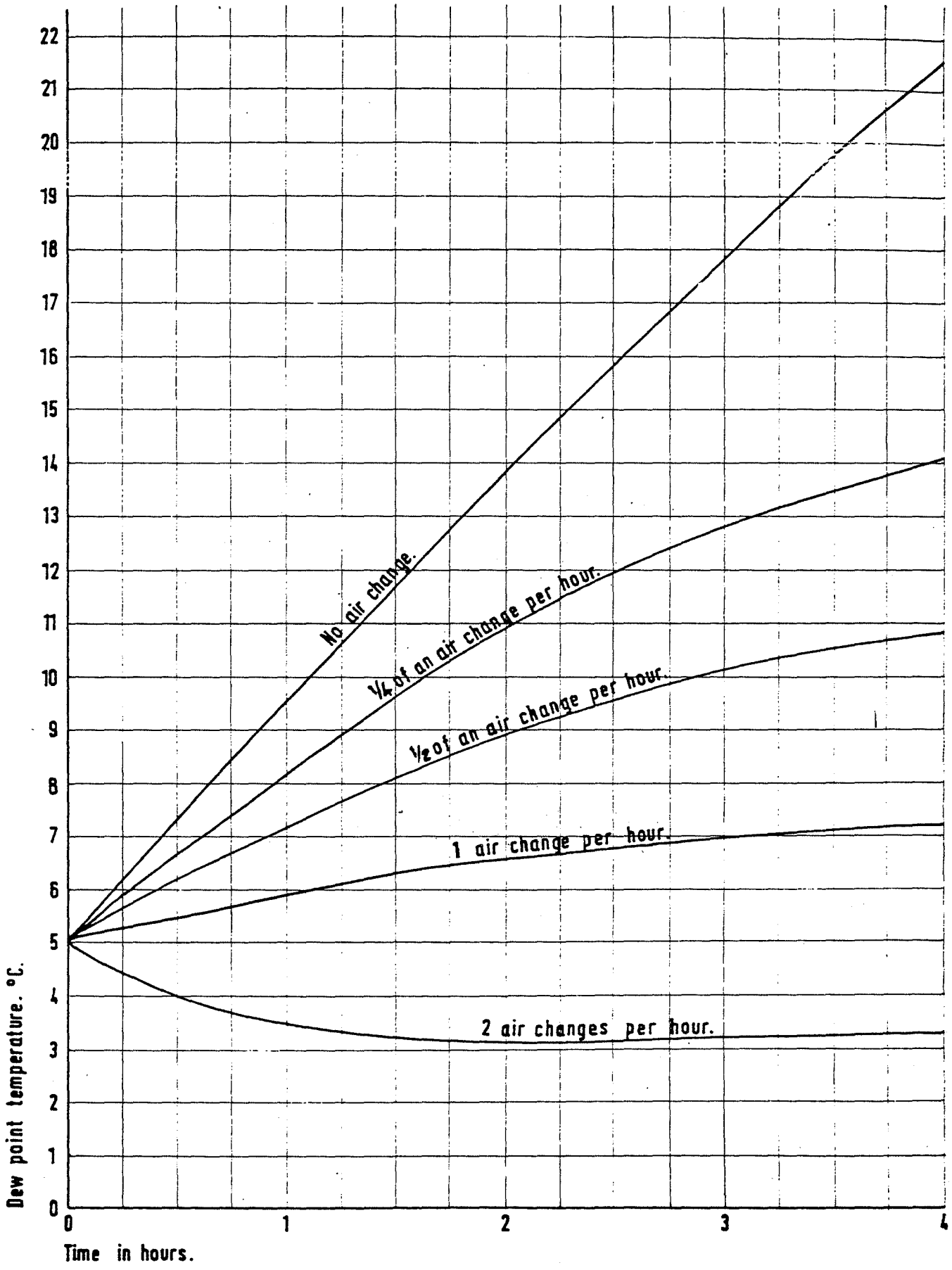
The temperature of the wall surfaces in these rooms were, at the time of the investigations, slightly above the dew point temperatures but it is clear from fig. 1 that this situation would be reversed soon after the occupants went to bed, with a resultant accumulation of condensation on the walls.

The pressure of water vapour in a poorly heated bedroom will often be lower than that in the warmer parts of the house. This pressure difference will drive water vapour from the warmer rooms to the colder and this is one of the reasons why condensation problems are so often found in bedrooms and why the ventilation of bedrooms can be so effective in combating condensation.

**Mould growth on a bedroom ceiling**

A striking example of the effect of ventilation was seen in an end of terrace house of virtually traditional construction.

A complaint had been received of extensive mould growth on the ceiling of a bedroom. The investigating officers found, in addition to the mould growth, that the plasterboard had become so sodden with condensation as to require complete replacement of the ceiling. It was noted that the window was closed. They then inspected the roof space and found that the glass fibre insulation had been omitted from above the ceiling of both back bedrooms the other one of which was adjacent to the flank wall of the terrace.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2
1
0
Dew point temperature. °C.
0
1
2
3
4
Time in hours.
No air change.
¼ of an air change per hour.
½ of an air change per hour.
1 air change per hour.
2 air changes per hour.

Figure. 1.

The investigating officers then inspected the other bedroom, expecting to find a similar condition but, instead, found that there was no sign of mould in the room. The window which has a vertically sliding sash, was open to provide a gap of about 5 mm. On discussing the matter with the occupier, the officers were informed that the mould infected room was that of her son, who could not be persuaded to open the window, while the other room was that of her daughter, who always kept the window slightly open.

**Ventilation and economy**

When one advises an occupier of a dwelling affected by condensation to increase the amount of ventilation, he often replies that he cannot afford to open the windows and lose heat from the house. It has however been the experience of the writer, that in many instances the occupants of one of a pair of virtually identical dwellings have complained of chronic mould growth and high heating bills and have limited the ventilation to the absolute minimum while the occupants of the other maintain a few windows open to a very small extent and in consequence do not suffer from condensation, enjoy a fresh atmosphere and pay no more and, in many cases, less for their fuel than those who eschew ventilation. The reason for this may be that those who reduce ventilation to a minimum may increase their heat input to the house in an attempt to counteract the discomfort resulting from high concentrations of water vapour, carbon dioxide and odours.

**Changes in circumstances leading to an increase in the risk of condensation**

**A change from an old house to a new one**

Several cases have been encountered where tenants have moved from dwellings having suspended timber floors and open fireplaces to a house having concrete floors and no flues, or where the building itself has been dernised and timber floors replaced with concrete, fireplaces blocked and windows and doors draught-proofed.

In either case the occupants are accustomed to a building which is subject to a great deal of adventitious ventilation and do not readily develop the habit of ventilating their dwelling, with the result that they find themselves suffering from the effects of increased humidity. Condensation forms on the floor, windows and walls and mould-growth soon develops.

**A change in the method of heating**

It is very noticeable that as open coal fires have given way to the more convenient gas and electric fires and as, in many cases, fireplaces have been removed and their flues taken out of effective use, so the incidence of condensation and mould-growth has increased.

**Conclusions**

The increase in the occurrence of problems of condensation and mould growth over the last two or three years is largely due to economic and social reasons.

We are rapidly coming to the end of a fuel glut, the like of which we will not see again, and the consequent rise in fuel prices has resulted in a reduction in the consumption of fuel for heating and a tendency to reduce ventilation order to limit heat losses.

In many families today both husband and wife go out to work and the total heat input to the fabric of the dwelling is much less than when one member of the household remains in all day and heating is continuous, albeit at a lower rate.

The use of unflued propane gas and oil heaters – which have the advantage that payment for the fuel is made in small amounts at the time of purchase – has led to an enormous increase in the amount of water vapour generated in many dwellings.

Many modern houses have been built without flues. Doors and windows are made to closer tolerances. There has been a tendency to construct floors of concrete instead of timber. Houses are thus constructed to be more air-tight and the installation of additional draught-proofing reduces adventitious ventilation still further.

Occupants must compensate for this reduction in ventilation by making full use of all equipment provided and especially by leaving bedroom windows open to the extent of a few millimetres at night. Alternatively, where, as is often the case, occupants take active steps to eliminate any ventilation, it may be necessary to consider the installation of a concealed system designed to provide a reasonable amount of tamper-proof, draught-free, permanent ventilation. However, the achievement of all these properties in any system presents a considerable design problem.

**Enquiries**

Any members of staff requiring further information or advice on the topic of ventilation in relation to condensation, should contact one of the following –

J C D Twiston-Davies of Materials Information Group, Ext 8205
I R Bealby of Scientific Branch, Ext, 4637
A R Thomas of Housing Department, Ext 4886.

**Previous bulletin reference**

Bulletin No. 125 (2nd Series) dated December 1979, item 5 – *Prediction of the condensation risk*.

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