Data Logging Service - Condensation & Mould

J Browne Surveys offer a data logging service for condensation and mould problems in Kent.

Data logging is used to monitor the internal environment of a property. Our data logging equipment automatically logs the relative humidity, dew point and temperature at various intervals.

Using data logging equipment to measure humidity and temperature regularly inside and outside properties over a set period of time can help build a picture of why condensation and mould is occurring and determine the contribution to the internal environment that is being made by the occupier.

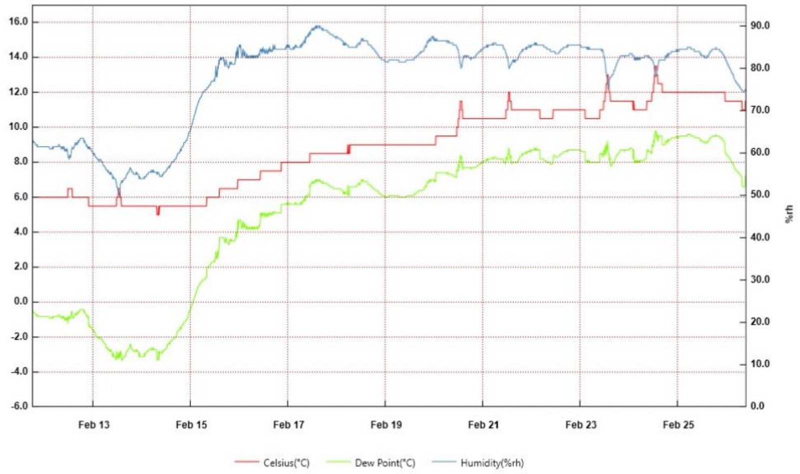
Modern living produces a lot of moist air and this usually comes from cooking, bathing, washing and drying clothes, apparently up to 17 litres of water can be produced daily in some homes. This is a fairly large amount and usually it is just floating around in the air waiting to vented to the outside or if the conditions are right, to condense on walls, windows and other surfaces. In certain areas such as bathrooms and kitchens the moist, warm air can spread to cooler parts of the house to condense on cold surfaces.

As a result of increasing air-tightness, increases in internal humidity can occur. This can lead to damp problems, and mould growth, with associated health problems for the occupants. The problem can be particularly associated with un-treated thermal bridges within dwellings.

Moisture trapped or present in the walls can increase the risk of early decay and deterioration of structural elements, increased risk of saturated buildings, moisture ingress, interstitial condensation and the build-up of toxic mould on the wall surface internally.

It is important that no improvement or intervention restricts the passage of the moisture either to the internal or external surface, without very careful consideration and design, and the possibility of unintended consequences is considered fully.

Our logging equipment is normally installed within a property for at least 4 weeks to gain valuable data. At the end of the logging period, the equipment is removed and the data is uploaded to a computer.



Once we have gathered all the data, we are then able to evaluate it and produce a professional report (with data shown in graph format). The report will explain what the data shows is happening and any recommendations.

Condensation

Condensation happens when molecules in a gas cool down. As the molecules lose heat, they lose energy and slow down. They move closer to other gas molecules. Finally, these molecules collect together to form a liquid when they reach Dew Point.

It is estimated that 15% of homes in England and Wales are affected to some degree by condensation. With building regulations demanding increasing levels of airtightness, condensation is an issue that needs consideration. Buildings can suffer from two types of condensation – surface and Interstitial.

Surface Condensation

Surface condensation is more obvious to building occupants as it forms on interior surfaces that are significantly colder than the room temperature. Typically, this will build up first on wall areas that are hidden behind large pieces of furniture, such as wardrobes or mirrors, where air circulation is reduced.

The air pressure differential causes humidified air to flow across cold surfaces resulting in moisture deposition.

When undertaking a Data Logging Survey, it's very important to take a record of the temperature of the wall surface to determine if this equals or drops below the Dew Point of the moisture carrying air. If it does, then the moisture will condense on the surface of the wall and will lead to 'Condensation Damp'.

You should note that this is a simplified explanation as there are many other factors involved. The ability of the internal moist air to diffuse through the walls to reach equilibrium with the external air is a factor as is the Differential Vapour Pressure (the difference between the moisture content of the external air and the internal air).

If solid walls have been previously treated for 'Rising Damp' the usual practice would be to apply a dense sand and cement render coat to the walls (which include a waterproofing admix). This coating traps moisture in the walls which reduces its temperature and lowers its insulation properties. In fact, this treatment can increase the risk of condensation damp by lowering the temperature of the wall surface.

The ideal situation is to have a 'breathable' wall in solid walls and not to allow sand and cement to be used (cavity walls will differ). If the moisture content in the wall keeps increasing (even slowly) without drying, then problems will arise sooner or later. Allow the moisture to diffuse through the wall. (Diffusion: The net movement of water molecules from high concentration to low concentration).

For every 1% moisture content in the walls the insulation performance of the wall will reduce by 5%.

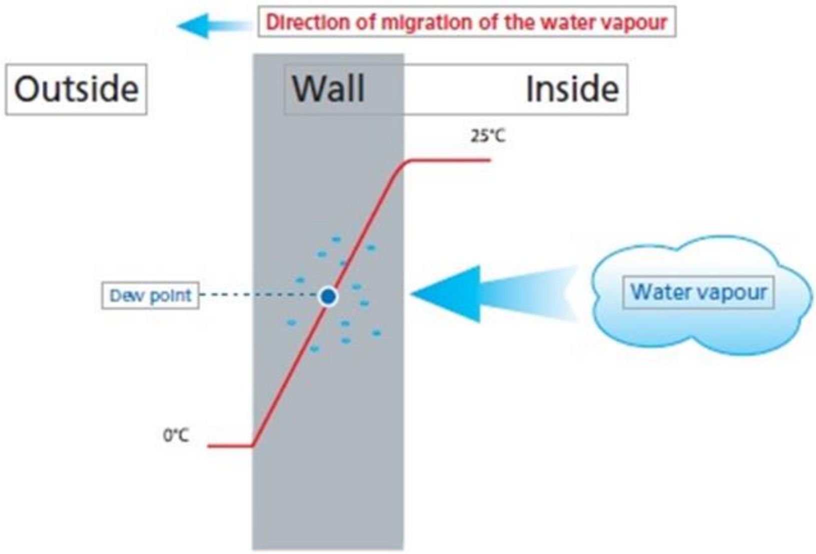
In addition, moisture trapped in solid walls by impervious external wall coatings can result in moisture migration to the inner surfaces of the building, resulting in mould and premature decay of finishes and fittings

Don't seal it in as it prevents evaporation.

Interstitial Condensation

Interstitial condensation occurs where warm, moisture-laden air from the interior diffuses into a vapour-permeable material such as a porous brick wall. The pressure differential between inside and outside air means that the moist air will diffuse through the wall where the vapour pressure is lower.

Let’s say the outside surface of the wall is at 0°C so at some point in the thickness of the wall, the temperature gradient will reach dew point and interstitial condensation will form.



In masonry, there is a good chance that the condensed water will dry out fairly rapidly in warm weather. However, if a non-permeable coating is applied to the external surface of a solid wall this will hamper or prevent the moisture from evaporating from the wall.

Solid walls should be allowed to ‘breath’. In addition, if a non-permeable insulation board is applied internally then the wall will not be able to take up heat from the room and the dew point will move inwards. This creates a risk of Interstitial condensation forming close to the inner face of the wall structure.

Moisture will accumulate and the wall will be prevented from drying out by both the impervious external coating and the non-permeable insulation board internally. The application of internal wall insulation can mean that an external wall is no longer dried by heating the interior of the dwelling. As a result, moisture is not driven out of the walls, which can cause structural damage and the failure and decoupling of the internal finishes (including the internal insulation itself). One mechanism for damage is ‘frost damage’ to the brick as the water in the wall freezes. It is important to understand the physics of how solid walls perform and deal with moisture transference based on their levels of humidity.

Adding insulation to a wall might provide a warmer room surface, but as noted above, the formation of interstitial condensation could have more insidious side effects. By way of example, a rendered brick cavity wall was insulated with blown cellulose fibre. The home owner started to identify damp patches internally and over the space of two winters the external rendering started to deteriorate noticeably. The insulation was restricting air circulation in the cavity while the outer leaf was now remote from the warm interior, lowering its temperature and permitting condensation to form behind the render. This was then freezing and causing the render to delaminate.

Capillary Condensation

Capillary suction, or Sorptivity, is the transport of liquids in porous solids due to surface tension acting in capillaries. It is a function of the viscosity, density and surface tension of the liquid, and the pore structure (radius, tortuosity and continuity of capillaries) of the solid.

Capillary condensation is the "process by which multilayer adsorption from the vapor phase into porous medium proceeds to the point at which pore spaces become filled with condensed liquid from the vapor phase".

Condensation can take place in narrow capillaries at pressures which are lower than the normal saturation vapor pressure. A capillary does not necessarily have to be a tubular, closed shape, but can be any confined space with respect to its surroundings.

The condensation occurs at a lower relative humidity depending upon the size and the geometry of the pore. The smaller the pores, the lower the vapour pressure at which the condensation will take place. The Porosity and Permeability of the wall structure also has a part to play.

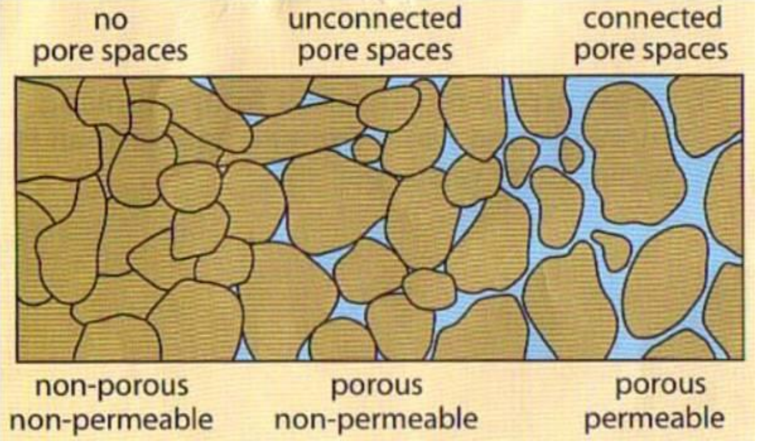
Water always moves from a higher water potential to a lower water potential. Water potential quantifies the tendency of water to move from one area to another due to osmosis, gravity, mechanical pressure and matrix effects such as capillary action (which is caused by surface tension).

Porosity refers to the empty spaces within a given material i.e the amount of pores. The porosity of the wall is a measure of the ability of the wall structure to hold fluid within its pore space.

Permeability on the other hand is a measure of the ease with which a fluid can move through a porous wall (or anything else). It refers to how connected the pore spaces are to one another.

A wall may be extremely porous, but if the pores are not connected to one another, it will have no permeability.

Likewise, a wall may have just tiny pore openings indicating low porosity but if they are well connected, the wall becomes highly permeable despite its low porosity.



Thus, the vapour condenses as a liquid and gradually fills up the pores. The vapour pressure, at which the capillary condensation occurs, is related to the size of the pore, the surface tension, the temperature and the molecular volume.

Capillary Condensation is dependent on Pore Geometry and Curvature of the meniscus.

Hygroscopic contamination

By way of completeness (as it does relate to high humidity), mention is made of hygroscopic contamination (or Salt Damp). The moisture present isn't the result of groundwater or penetrating damp, but from moisture within the air which is attracted to the surface of the wall due to salt contamination. Hygroscopic salt contamination is very common on chimney breasts and as a result of rising dampness and water ingress. The intensity of the damp patches varies according to the humidity on any given day.

When first seen, the damp patches can be mistaken for condensation that has soaked into the decorations. Unlike condensation though, no droplets will ever be seen glistening on the surface, and it will never (or very rarely) dry as the humidity in the UK is not normally low enough for long enough, to dry out the salts.

Ground water and other penetrating dampness introduces Chlorides and Nitrates (salts) into the building fibre. As the water evaporates these salts are left in the building and over many years become concentrated on the wall surface. These salts can also be introduced through the combustion of fossil fuels.

During periods of high humidity (such as the winter months, or periods of prolonged rain), moisture vapour (condensation) is attracted to the salts, causing them to become soluble and therefore damp.

A special category of salt movement is presented by salts that are so strongly hygroscopic, they dissolve in the moisture they absorb from their surroundings. By drawing in enough moisture to form their own 'pools of water', they can migrate through the pores of an air-dry wall in the same way as if the wall was extremely damp.

Cavity Drain Membranes are often used to deal with this problem.

Temperature

The World Health Organization made recommendations in a 1991 guidebook called 'Indoor Environment: Health Aspects of Air Quality, Thermal Environment, Light and Noise'. In this they state that the desired internal air temperatures should be between 18°C – 24°C for healthy adults. This would be increased to 20°C for vulnerable groups like the disabled, elderly and babies.

They go on to write that temperatures below 16°C with high relative humidity (RH) can impose certain health risks from respiratory and arthritic diseases as well as reactions from the likes of moulds, dust mites and allergens from pets.

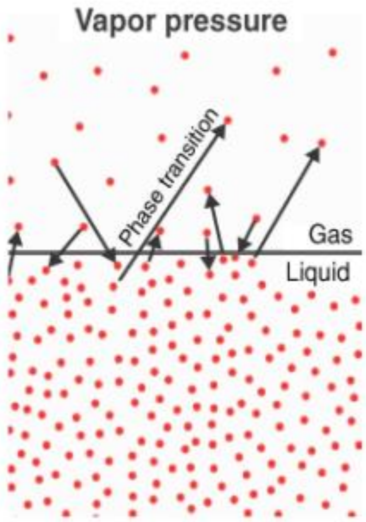
Temperatures below 12°C can become more of a health risk particularly to vulnerable groups. Below this temperature cardiovascular changes can be detected, especially in the elderly. At 6°C there is a risk of fatal hypothermia which would be more prevalent in elderly people who are immobile.

Temperature also has a big part to play in condensation. Temperature is the sole factor that affects vapour pressure. The vapour pressure of a liquid is independent of the volume of liquid. Vapor pressure is opposite in direction from atmospheric pressure. Vapor pressure is the pressure exerted by a liquid back on the atmosphere.

Temperature has an exponential connection with vapour pressure, which means that as the temperature rises, the vapour pressure rises as well.

An example is water's vapor pressure, which happens to be relatively low because of the hydrogen bonding between the water molecules. No matter what volume the water is, the vapor pressure of the water is the same as long as the temperature is not changed.

For vapour pressure to exist, the vapour (gas phase) MUST be in physical contact with the liquid (or solid) it came from. You CAN'T have vapour pressure without the two phases being present and in contact. The higher the vapor pressure, the faster the rate of condensation.



Relative Humidity (RH)

Relative humidity (RH) is the amount of moisture in the air compared to what the air can "hold" at that temperature. There is always moisture or water vapour in the air and normally we don't see it and often it does not cause a problem, but it is there even in the air that we breathe out. Air has the capacity to hold a certain amount of water vapour and this depends on a few different variables such as the room temperature and the temperature of the surrounding walls and other surfaces.

The amount of moisture in the air is usually expressed as the Relative Humidity (RH) which is the measure of how much moisture is contained in the air at a given temperature, and expressed as a ratio between the amount of moisture contained in the air and the maximum amount of moisture the air could hold if that temperature remained unchanged.

Generally speaking, the relative humidity (RH) in a room will be about 10% lower than the RH close to the surface of an outside wall. So, at 74% RH in the room, we can expect 84% on the external wall. If conditions are left like this for more than a few days, mould growth is inevitable – long before condensation actually occurs. Once mould spores are established, they can continue to grow at RH levels below 80%.

The amount of moisture that air is capable of holding will alter with the temperature. The warmer the air is the more moisture it can retain. Therefore, the Relative Humidity changes not only by the amount of moisture, but also the temperature. The internal environment is a constantly changing phenomenon, with the air temperature and humidity in flux for much of the time. This means that one-off readings can be used only as a guide. Longer term monitoring can help, using data loggers. Logging the temperature, humidity and dew point over time will allow the information to be analysed. Is the temperature falling, thereby reducing the amount of water vapour the air can hold, or is the temperature constant but the amount of water vapour in the air increasing?

Consider this extract from a Damp Report …" I measured the RH in the lounge of the house and found it to be 65%, however, the RH in the cellar was over 85%, demonstrating that the cellar was damp".

It is correct that 85% is a higher RH than 65%, but it is totally wrong to affirm that this shows the cellar was damp, in comparison to the lounge. This is because of the 'Relative' in relative humidity. It is relative to temperature. This is crucial because the ability of air to retain water vapour is dependent on the temperature of the air. Thus, warm air can retain more water vapour than cold air and cold air less so. So, in the case the surveyor quoted above, it could easily be the case that the cellar was a little cooler than the lounge, but it may have had the same amount of water vapour in it. In this case the higher RH would merely demonstrate that the cellar was colder, or the lounge was warmer if you like. So, with the same amount of water vapour present in both spaces – the RH could vary. Had the surveyor measured air temperature and calculated the Vapour Pressure, he could have demonstrated the real difference in the amount of vapour in the air.

Absolute Humidity

Another way to assess the amount of water present in air is to measure the Absolute Humidity of the air. Absolute humidity (expressed as grams of water vapor per cubic meter volume of air) is a measure of the actual amount of water vapor (moisture) in the air, regardless of the air's temperature. The higher the amount of water vapor, the higher the absolute humidity.

SPECIFIC HUMIDITY refers to the weight (amount) of water vapor contained in a unit weight (amount) of air (expressed as grams of water vapor per kilogram of air). Absolute and specific humidity are quite similar in concept.

In saturated air the density (or amount) of vapour at 0 °C is 4.85gm/m3 and 17.3gm/m3 at 20 °C. However, simply warming air does not mean that the vapour pressure will automatically change; it will remain the same unless further moisture is added.

Vapour Pressure

Vapour Pressure (VP) is a direct measure of the amount of water vapour in the air. As more water molecules evaporate and enter the air as a gas, they do exert pressure. Remember that the environment isn't a 'closed system' like say, the gas over a liquid inside a cylinder, so when Vapour pressure is stated, it is not by measurement, but by calculation. However, it helps to think of it as 'pressure' because it is energy, which causes water molecules to escape their liquid state and enter the air as a gas.

These water molecules will travel freely in the air for as long as energy levels allow, before eventually being re-absorbed into a liquid state. As VP rises let's say in the kitchen, it spreads out and VP rises in other rooms too and so on. Unlike RH, vapour pressure is an 'amount'. For example, 1kPa (kilopascal) is more than 0.5kPa because the former sample had more water vapour in it – regardless of the temperature of the air.

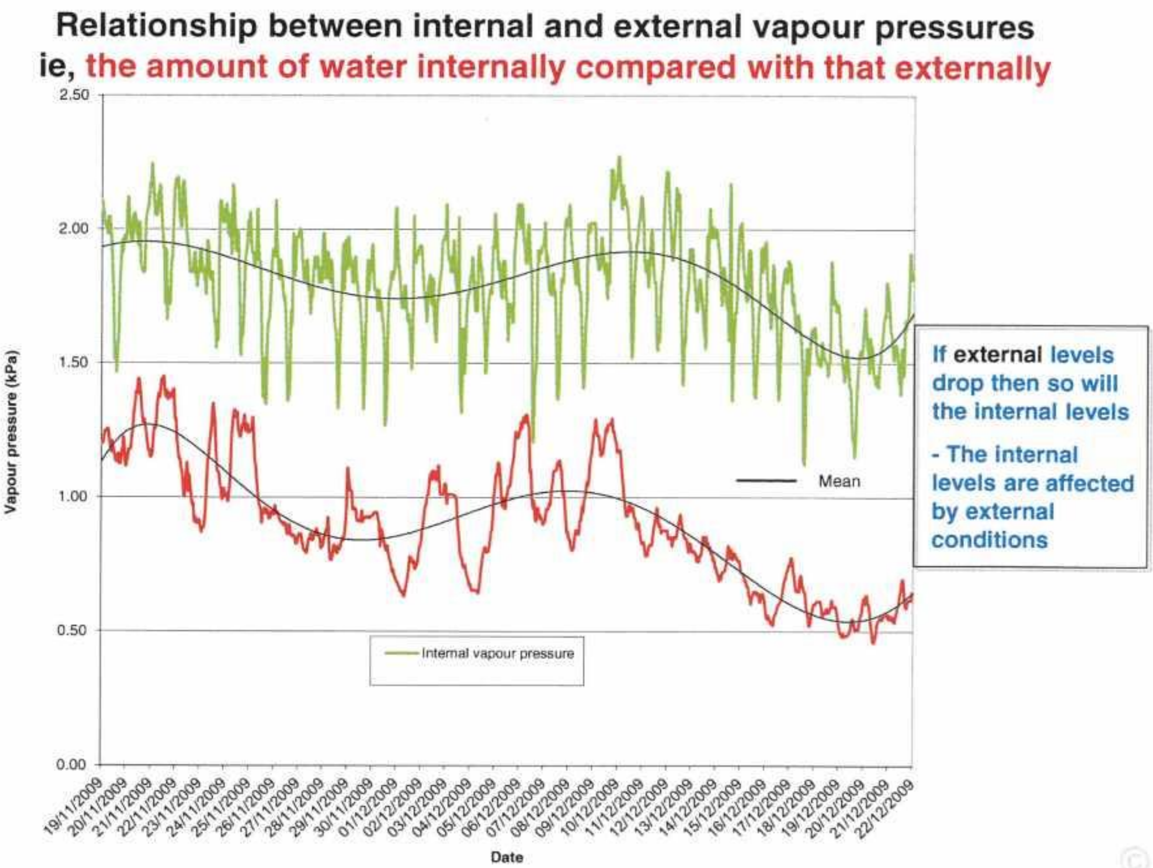
Differential Vapour Pressure (DVP)

The thing to understand about differential vapour pressures, is that they will seek to equalise. External vapour pressure fluctuates and tends to drag the internal VP with it. This is why taking a corresponding external measurement is crucial whenever a surveyor refers to the internal conditions. Subtracting the external vapour pressure from the internal will provide a vapour pressure differential. The extent of the differential between the internal and external measurements is an essential component of the investigation. It will give guidance on the balance between moisture production in a building and the ventilation regime.

The warm internal air which contains water molecules tries to equalise with the lower external vapour pressure. For example, let's say you have warm air being generated inside your property on a day where there is heavy snowfall outside. That warm air is going to be laden with moisture (from washing, breathing, cooking etc), and thanks to the difference in pressure between the inside and outside of your property that moist warm air is going to be drawn outside through the wall, any cracks and openings etc.

As we know, the pressure is the amount of moisture in the air so when there is a difference between the external VP and the internal VP we get a differential vapour pressure. This difference in vapour pressure is measured in kPa(kilopascal). When we know the difference then we can calculate the specific amount of moisture in the air.

The rate of diffusion through the wall will depend on its vapour resistance and the vapour pressure differential.



Avoiding damaging condensation - BS 5250:2011+A1:2016

The first and most important step is to avoid generating moisture within the building as far as possible and to limit the spread of warm moist air from one room to another. Any activity involving the use of water in a heated building has the potential to increase the risk of condensation as warmed air absorbs moisture from any source, be it industrial process, bathing, cooking, growing house-plants or washing clothes. The spread of warm moist air from areas such as bathrooms, kitchens, toilets and laundries can be limited by keeping doors closed and by opening windows or using extract fans to remove excess moisture as close to source as possible.
Laundry should never be hung to dry in unheated or unventilated rooms; if outdoor drying is not available laundry should be dried in a well ventilated room or in a ventilated drying cabinet or in a condensing tumble dryer [or one which is vented direct to the outside]

The most efficient and cost-effective way to remove excess moisture is by natural ventilation. This relies upon the bouyancy of warm internal air and the provision of carefully sited vents which encourage a steady flow of air through the building. Alternatively, excess moisture may be removed and condensation minimized by mechanical extraction, such as using an electrical fan controlled by a humidistat.
Having first reduced the amount of moisture in the air as much as possible, energy used to heat the building during cold weather is best applied to heat all internal spaces throughout the day. The risk of condensation is reduced by maintaining a steady, even temperature rather than allowing wide temperature variations in different rooms and/or at different times. Heating by means of flueless room heaters which use paraffin or bottled gas are not recommended as they greatly increase the amount of moisture in the air. Furniture, especially large items such as wardrobes, should not be placed hard against an external wall, and air should be able to circulate around all furniture.
NOTE *If some rooms are unheated then water vapour which moves from other rooms can accumulate to the point where it will cause condensation.*

As an authoritative voice within the industry BS5250 states the following:

Monitoring temperatures and humidities : 'Data loggers should be placed against an internal wall between one metre and two metres above the floor. They should not be exposed to direct sun or heat from heating appliances, or other equipment such as a television. In many cases they may be placed on an appropriate item of furniture, but this is not always possible (some living rooms, for example have only a suite and television). It may be possible to fix the loggers to the wall with a picture hook, or with a suitable non-damaging adhesive.

At the end of the monitoring period, the recorded data may be downloaded from the loggers to a PC or laptop, using the software provided with the logger, and then transferred to a spreadsheet for analysis. The recorded temperatures and relative humidities may then be used to calculate the vapour pressure, an index of the amount of water vapour in the air using the equations in Annex C. The simplest summary of the data collected is the overall means of the temperature and humidity in each room, however more information about the performance of the house may be gained from calculating daily means and the difference between the daily maximum and minimum temperature.'

'In order to avoid surface condensation, the appropriate relationship between internal vapour pressure and the temperature of internal surfaces has to be achieved. In buildings with high internal humidity all surfaces have to be kept at a higher temperature than those in buildings with low internal humidity; they therefore require a higher level of insulation or greater use of energy, be it for heating or for the removal of excess moisture.'