INTERSTITIAL CONDENSATION, BREATHABILITY AND SOLID WALL INSULATION

The Basic Principle

Typically we humans exhale about 1 litre of water every day. Coupled with cooking, bathing and cleaning a family generates surprisingly large amount of water vapour every day into the house, much more than could be transpired through a breathable wall.

The outer skin of the building should be air tight to meet regulations but should also be vapour permeable. This is to allow any moisture which gets into the wall structure to escape to the outside. Brick, blocks and concrete are permeable and moisture will always find its way in the wall structure. If the moisture cannot escape, its presence can damage the structure of the entire structure. This is why it can be very dangerous to use non-permeable external wall insulation.

Air carried moisture in it and the warmer it gets, the more water it can hold. This is why improving thermal insulation can increase the amount of moisture in the air and result in more condensation if ventilation is not also improved.

Condensation

Condensation happens when water vapour in the air meets a cold surface with a dew point at the same or higher than the temperature of the air. For dwellings, residential and public buildings, f_{RSI}, the condensation Risk Factor should always be worked out to be no less than 0.75. When this happens on an exposed surface it can result in dampness and mould growth and can be avoided by ensuring the U values of the walls are above the stop-gap recommendations given in building regulations.

When it occurs within the fabric of the building from the air permeating through the structure it can have much more serious consequences. This phenomenon is called interstitial condensation. One cause of this is when the outside temperature falls below the dew point of the warm, wet air. The water will condense before it gets to the outside thereby depositing water inside the structure of the wall. The obvious solution therefore is often to increase the external temperature of the outside of the wall by using insulation. Whilst External Wall Insulation (EWI) will certainly help by pushing the dew point out of the inside of the wall closer to the outer surface, if this insulation blocks the passage of water, it can make the problem even worse.

The Energy Saving Trust publish recommendations about how safely to install insulation including advice on Marmox products, which is one of their approved products.

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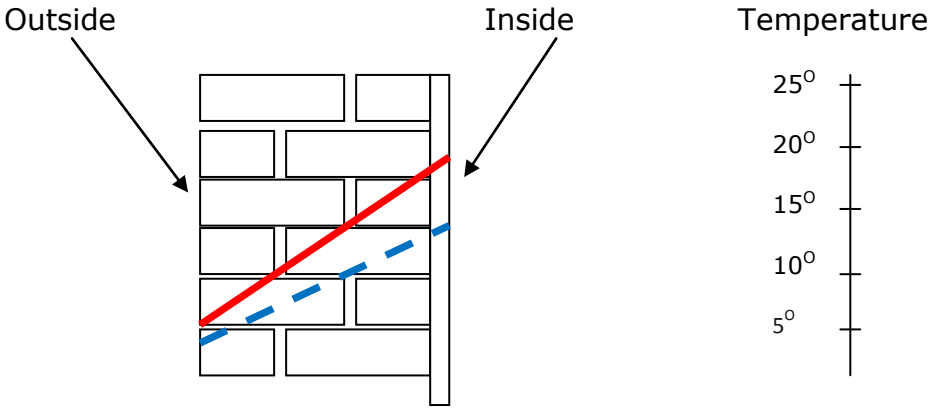
Interstitial Condensation

If moisture vapour builds up inside a wall and the temperature conditions are altered the vapour can turn to water, this is known as Interstitial Condensation. The warm air inside the house is able to carry more moisture than the cold air outside. It is also interesting to note that as insulation improves, the resulting warmer air will be able to carry even more moisture so better insulation can actually result in worse interstitial condensation.

The warmer air will have a higher vapour pressure and this air will always try to migrate to an area will lower vapour pressure; the outside. Usually the fabric of the external walls will allow moisture laden air to pass through it, and normally this does not cause any problems but if the outside surface temperature of the wall falls below the dew point of the migrating air, then damaging interstitial condensation will occur.

Solutions to Insulations and Problems for Condensation

The following diagram illustrates the typical solid wall construction that was common in the UK from the 17th century until the 1940s.



The red line shows the temperature gradient from the outside to the inside, the broken blue line is the dew-point line at which water vapour will condense to liquid water. These lines will always vary depending on the internal and external temperatures but the lines will not cross. If the red line (the actual temperature) touched the blue line, water would condense at that particular location in the wall. A problem with this diagram is that is shows that although there is no condensation, there is excessive heat loss through this wall (*typically the U value of an un-insulated solid brick wall is 2.1*). When people realize they are losing heat they would very often lower the temperature of the central heating or switch it off in some of the rooms. This can result in surface condensation on the inner walls because although the actual temperature is reduced (the solid red line), the dew-point temperature remains the same so the two lines meet at where the plasterboard is.

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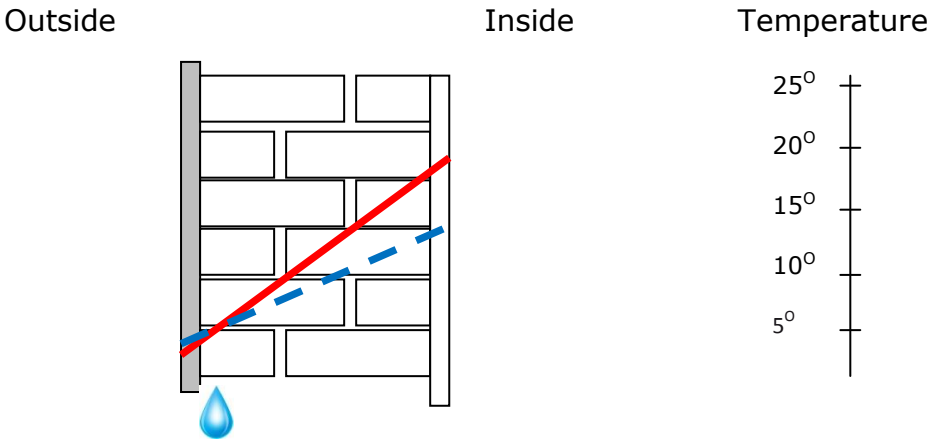
EWI or IWI?

Two insulation solutions have been devised to reduce the heat loss in solid brick houses but if not carried out with considering the consequences they can each be both counterproductive and dangerous.

External Treatment

Typically, the walls of pre-war houses are coated with a hard impermeable render. These renders were traditionally applied to waterproof the walls and because dry walls provide much better insulation than wet walls, in theory reduce the heat loss of the house.

Unfortunately, the impervious render prevents evaporation of moisture from within the porous wall, maintaining the relative humidity, and thus the dew point, at an artificially high level across the wall. It is very easy for the low temperature at the outer face of the wall to come into contact with this elevated dew point and cause condensation. To make things worse, a wall saturated with water will be a much worse thermal insulator.



The other external treatment is to apply an external layer of insulation. Again, it has been common to use an impermeable material. This, like the hard render coating will trap moisture within the brickwork and raise the dew-point temperature (the dotted blue line). When the two lines meet, water will condense.

Many insulation materials are not waterproof and if they become saturated with water they become ineffective and the walls then becomes not only damp but cold and damp.

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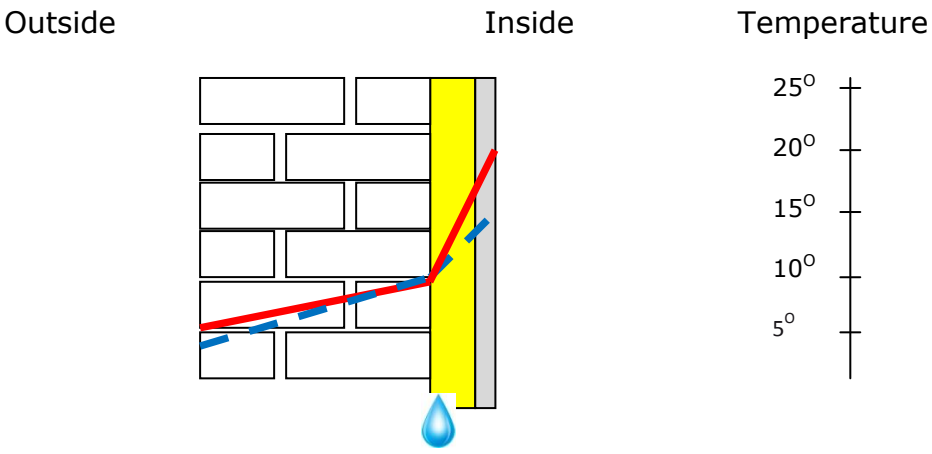
Breathable External Wall Insulation

There are several types of breathable external wall insulation board available such as HERAKLITH PANELS, which are waterproof, cement-bound Wood-Wool boards. These provide good thermal insulation and at the same time allow moisture vapour from the house to safely evaporate into the outside air. Woodwool boards would generally be coated with a lime render which itself is breathable so unlike cement type renders, it does not block the egress of water from the structure.

Internal Treatment Wall Insulation

A very common treatment to solid external walls is to line them internally with insulation and plasterboard. This treatment is not without its drawbacks. The insulation, by restricting heat loss through the fabric, reduces the temperature of the brickwork sufficiently to depress the temperature gradient down to meet the dew-point a few centimetres in from its inner face. Condensation at this point is particularly insidious as it is hidden from view until the dampness and mould has spread ruining the insulation and destroying the plaster. In addition, just as with brickwork and plaster, wet insulation provides no insulation at all.



One solution to protect the insulation is to include a VAPOUR BARRIER behind the insulated plasterboard which is generally a single continuous sheet of polythene. This also poses problems since if the barrier become broken, ripped or acquires just the smallest puncture marks, water will accumulate there and there will be a bloom of localised damage.

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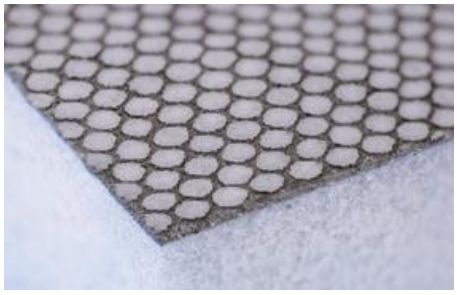
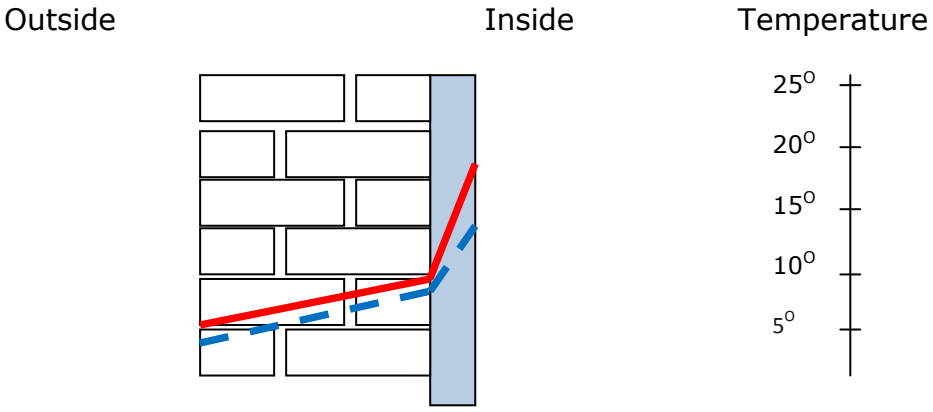
Using Marmox Insulation Board as Dry Lining



Dry-lining insulation with Marmox Multiboard simplifies this operation because it is both an insulation board and because it is waterproof, it acts as a vapour control barrier. Because Marmox is a moisture barrier, the water vapour inside the house cannot get into the wall to start with so there is therefore a lower vapour pressure so less moisture to condense.

The only possibility of interstitial condensation here is from external water or moisture brought up from the ground. Even if this were to happen, because Marmox Multiboard is waterproof it will not be affected by the presence of water. Unlike many other insulation materials, being composed mainly of extruded polystyrene, Multiboard is ideal for wet conditions and the U value of the insulation will not be affected whatsoever.

The other benefit is that whereas with insulated plasterboards there are three layers with just one component being the active insulating material: vapour barrier, insulation material and plasterboard, using Marmox there is just one, the Marmox Multiboard itself.



Even with Marmox however care must be taken to ensure all the gaps, joints and edges are sealed with a waterproofing sealant (such as Marmox waterproofing sealant) or localised ingress of moisture could ensue and damage the brickwork behind the Marmox.

In Timber Framed, Concrete or Cavity Walls

Although timber frames are treated, timber will always be vulnerable to rot which could lead to structural failure. Correct design should ensure that the timber is kept dry and warm and that the vapour barrier and insulation are positioned correctly.

It must always be remembered that by insulating a wall internally the dew point is moved outwards; away from the surface. In a solid masonry wall that isn't really a problem, but in either a wooden or cavity wall or in a concrete wall the dew point could be moved to a position where condensation occurs hidden within the structure of the wall. If that point coincides with the position of the steel reinforcement, wall ties or even timber joints then the consequences could be extremely serious so computer simulations for all types of internal and external wall insulation should be carried out by an expert surveyor especially when considering internal wall insulation with timber framed structures.

U Values

On a 215mm solid brick wall with no external insulation and a 15mm cement render you would have the following U values with Marmox Multiboard

- Without doing anything to the wall, the U value = 2.1Watts
- 10mm Marmox = 1.3Watts
- 20mm Marmox = 0.9 Watts
- 30mm Marmox = 0.7 Watts
- 50mm Marmox = 0.5 Watts

Marmox UK can calculate the U value, and Condensation Risk Factor specific to your design if you contact them.

In Summary

- Reduce the amount of moisture going into the walls from the inside
- Allow any moisture to escape by not using an impermeable covering
- Keep the wall's internal temperature above that of e dew point