AIRTIGHTNESS IN BUILDINGS

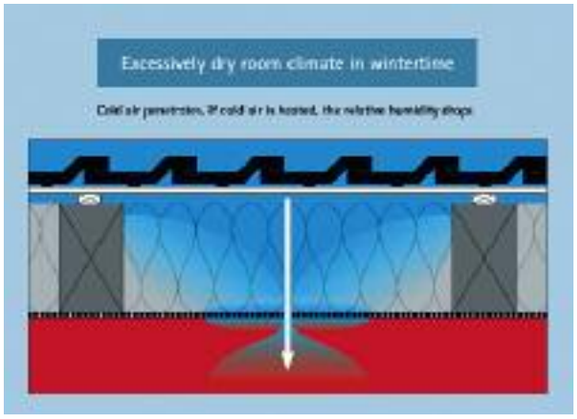
Part Two

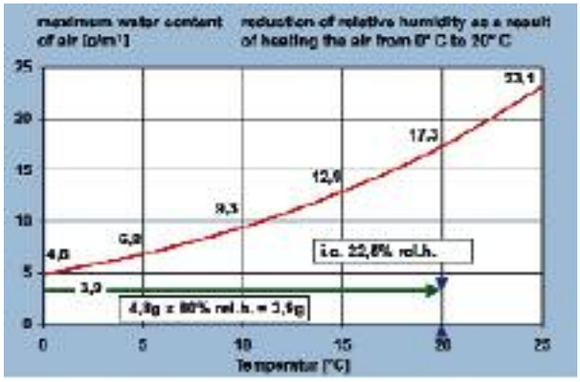
by Lothar Moll

Part Two of our series on 'Airtightness in Buildings' examines how airtightness can be successfully achieved in buildings. At the outset of this article, author Lothar Moll examines the different room climates during winter and summertime.

Airtightness – Room Climate in Wintertime

An excessively dry room climate in the wintertime occurs as the result of poor airtightness. Cold air is able to absorb less moisture than warm air. If cool air penetrates through gaps into the structure of the building, it heats up. At the same time, the relative humidity drops.

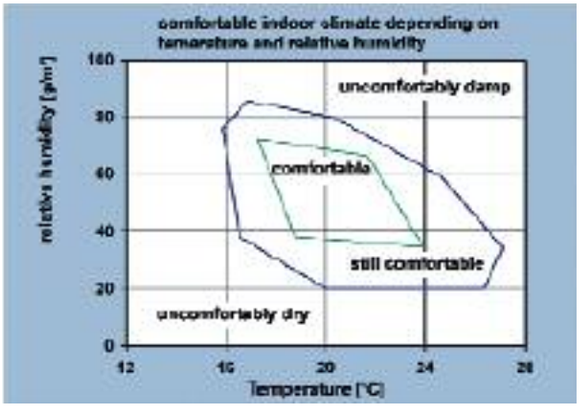




In figures: air at a temperature of 0°C is able to absorb a maximum of 4.8 g of water per m³ of air. Air at a temperature of +20°C, by contrast, is able to absorb 17.3 g/m³. At 80 % relative humidity, the water content at 0°C is still 3.84g/m³. If air is heated from 0 °C and 80 % relative humidity to +20°C, it has a relative humidity of only 22.2 % (3.84 g/m³ is 22.2 % of 17.3 g/m³).

The more cold air that penetrates through gaps into the living space, the drier the room air becomes. In practice, the relative humidity drops in this way to under 30 %. In such cases, it does not help much to humidify the room air. It is replaced constantly by dry outside air. The problem of dry room air disappears immediately when outside temperatures rise again.

Excessively dry room air not only reduces comfort but must also be considered from the point of view of health aspects. Viruses and bacteria multiply far faster in a dry room climate than in a damp room climate. This is known to lead to more frequent colds. Room air that is too dry also impedes oxygen absorption and vesicular breathing and leads to physical stress, fatigue and poor fitness. The climate should be in the comfort zone in order to achieve maximum effectiveness at the workplace:



Source: Sedlbauer, Breuer, Kaufmann,
Institute for Building Physics, Holzkirchen, Germany

Airtightness – Room Climate in Summertime

The two structural-physics characteristic parameters of phase shift and amplitude damping are crucial to summertime heat protection of a component or prefabricated compound unit. The phase shift describes how many hours heat needs to penetrate from the outside to the inside of the building. Values exceeding 10 hours are considered comfortable. The amplitude damping expresses to what extent the temperature inside the building heats up by comparison with the outside.

Both characteristic parameters are based on a stationary state, for example they are based on the fact that there is no air movement in the building structure. The heat flow is able to heat the next pore only when the pore in front has been heated. Air movement in thermal insulation as the result of leaks in the building envelope leads to far faster heat transport since the heat is then transferred by convection (air flow).

The findings in relation to the effect of airtightness were incorporated in mandatory legislation in Germany in 1995

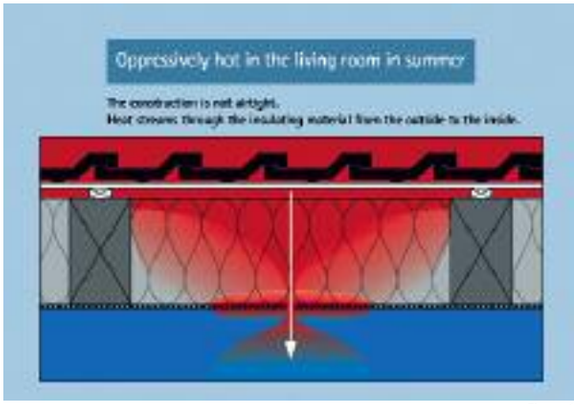


Figure 1

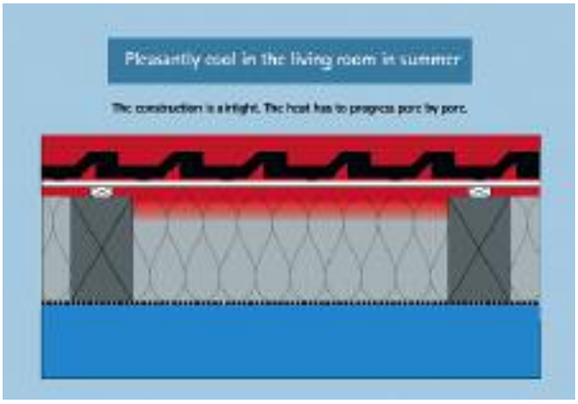


Figure 2

(6 years after the publication of the measurement study by the Institut of Building Physics (with the 3rd German Thermal Insulation Ordinance) in relation to airtightness and led to the preliminary Standard DIN 4108-7. The German Building Code for energy performance (EnEV) and DIN 4108-7 followed in the years 2000 and 2002.

While Standards have an advisory character and define minimum requirements, ordinances and regulations are binding by law. If the minimum requirements in respect of airtightness are not achieved, repairs will be necessary. These are generally extremely expensive. Renovation costs exceeding €50,000 are not a rarity.

Implementing Effective Airtightness

Overlaps of vapour barriers/vapour checks must be sealed with adhesive tape in order to achieve effective airtightness. Junctions to adjoining building elements can be reliably and permanently sealed with airtightness adhesives.

Adhesive Tapes for Overlaps of Vapour Barriers

Adhesive tapes for airtightness must feature

- a high initial adhesive force at normal temperatures
- a high initial adhesive force at cold temperatures
- a very high final adhesive force
- a high peeling resistance (AFERA 5001)
- a high shearing resistance
- a high thermal resistance
- an adequate moisture resistance and
- a durability exceeding 30 years.

The initial application force is crucial to attain an effective adhesion. If an adhesive tape was simply applied loosely, this would not result in a firm seal. A high initial adhesive force is important so that the adhesive tapes maintain contact after application. A high initial adhesive force at low temperatures is necessary since the airtightness installation is usually carried out when the heating system is not operational.

A very high final adhesive force is required so as to ensure that the sealed junctions are secure even if stresses and strains act

on the bonded joint. In this case, the base surface is particularly important. Base surfaces are subdivided into two substrate categories in accordance with FLiB: PE film and timber. PE films should have a surface tension of more than 40 mN/m. But PE films with a surface tension of only 30 mN/m must still be able to be bonded reliably. Timber should be smooth, i.e. planed or sanded. An adhesive tape cannot adhere well to rough timber.

Besides peeling adhesion at 180° (the typical adhesive tape parameter) and peeling adhesion at 90°, it is above all a high shearing strength that is required. This expresses how well the adhesive tape 'welds' to the base surface.

A high thermal resistance ensures that the adhesive tape functions are reliable even if subjected to high temperatures. This may be the case in the construction time or at windows in the roof area.

The moisture resistance is important, above all, during the construction phase. After plastering and screed work is complete, there is a great deal of moisture in the building. Adhesive tapes must also adhere reliably under these conditions. (See figures 3 and 4).

Durability is one of the fundamental characteristics of the adhesive sealing tape. Statistically, buildings last for at least 30 years before they are converted, renovated or modernised. These cycles may, however, also be far longer. Aging components, such as resins, should consequently be avoided at the junctions and connections to building elements. Simple adhesive tapes such as those used to tape up parcels become brittle, even after only a few years. Were they used in the construction sector; they would not ensure sustained airtightness and would simply drop off.

Vapour Barriers and Vapour Checks

The junctions to adjoining structural components are made with airtightness adhesive glues. It is important that the vapour barrier/vapour check be joined with a loop so as to compensate for movements structural components harmlessly. Sealing adhesives glues are required to comply with the same durability requirements as adhesive tapes. (See figure 5).

Figure 3

Figure 4

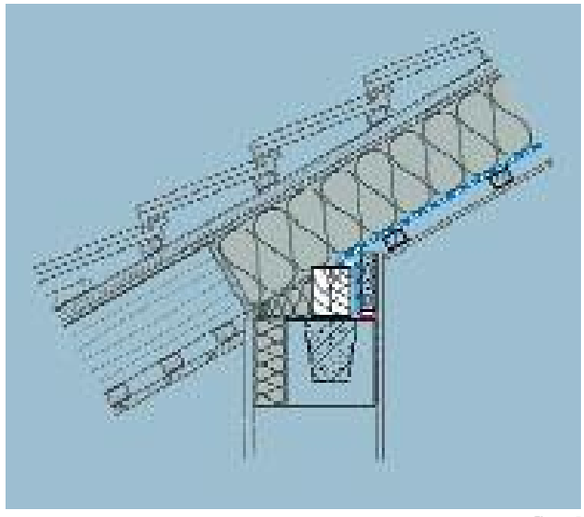


Figure 5

Prevention of Structural Damage

Right through into the 1990s, it was the general belief that moisture barriers with a high diffusion resistance offered optimum protection against structural damage. Today, we know that films and sheets with an intelligent moisture management system are the optimum means of avoiding structural damage reliably and permanently. These intelligent vapour checks and air-sealing membranes have a diffusion resistance that varies dependent on humidity and are able to change their molecular structure. This means that they are diffusion-tight and protect the structure reliably against moisture penetration in the wintertime but they are open to diffusion and allow maximum drying out in the summertime. (See figure 6).

Solutions for Energy Saving, Enhancing Comfort and Cutting Costs

The construction sector is the sector with the highest resource demand worldwide. In our national economies, we consume the largest quantities of primary energy to produce buildings – and the same applies to the quantity of energy used for building occupancy.

If we manage to implement intelligent solutions for buildings and if we manage to get to grips consciously with building designs and their structural physics aspects, we will be able to save energy to an extent not possible in any other sector of our society and consequently reduce CO_2 emissions and the costs of building maintenance – and all with optimum comfort in the home and at work.

Insulation is only effective regarding energy saving, CO_2 emission, freedom from structural damage and living comfort when the building envelope is airtight. Airtightness is thus the decisive factor. This can be achieved by sticking overlaps of the vapour barrier/vapour check with adhesive tapes and by connecting the vapour barriers/vapour checks to adjacent building components with airtightness adhesive glues. Airtightness requires simple provisions and the results are enormous.

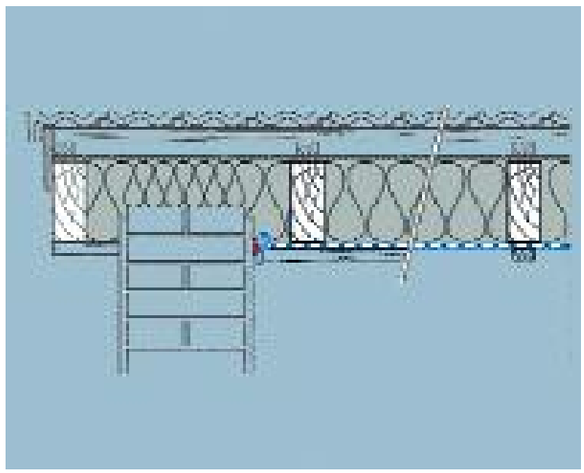


Figure 6

Lothar Moll, pro clima Germany. Ecological Building Systems are the sole distributors of pro clima in Ireland and the UK.