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how to avoid mould problems

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Moisture conditions in buildings – how to avoid mould problems

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Abstract

Growth of mould requires the presence of moisture at a certain high level. In a heated indoor environment such moisture levels occur only if there is a reason for the moisture supply. Such moisture can come from the use of the building, because of malfunctioning constructions, or it can be the result of insufficient ventilation. The article will give an overview of these reasons, and thereby also give hints to how problems can be avoided.

1. Introduction

Because of the cold weather, the outdoor air in Greenland contains very little humidity. When outdoor air is heated as it enters the buildings, it comes to a very low relative humidity – far below the levels at which mould could thrive. Thus, when moisture problems do occur, it is because of one of the following reasons:

1. High indoor moisture release due to occupant activity.
2. Insufficient ventilation
3. Construction failure

The first two causes often work in combination to cause too high relative humidity.

2. Water vapour content in air

There is always some humidity in indoor and outdoor air. How much humidity is possible is described by the water vapour diagram (Figure 1). The diagram tells that at a certain temperature, the air can contain only a certain maximum amount of water vapour, e.g. at -5°C that maximum amount is 3.2 g/m^3. This is the saturation value for the humidity by volume, v_s. For every 10°C warmer the air, it can hold approximately twice as much water vapour (this obeys Arrhenius' law).

The ratio between how much is the humidity by volume, v, and the saturation value at the actual temperature, is called the relative humidity, RH, and is usually indicated in %. Outdoor humidity is often in the 80-90% range. Figure 1 shows that a typical value for the humidity by volume at -5°C would be around 2.6 g/m^3.

When that air comes into a heated building, it still contains around 2.6 g/m^3, but now at a considerably higher temperature, e.g. 21.5 °C, where the saturation value for humidity by volume is 18.9 g/m^3. The relative humidity is now just 2.6/18.9·100% = 14%. Mould growth will not occur at such low humidity, but rather requires somewhere between 65% and 95% RH (Andersen, 2012).

2.1 Indoor moisture release

However, due to occupant activity in the indoor environment, some moisture releasing processes add humidity to the indoor air. Koch et al. (1986) investigated how much would be a typical release of moisture in the home of a normal Danish family (with two adults and two children). It can vary significantly from family to family, but 10 kg/day is a good number for reference. Main contributors are transpiration from the human bodies, laundering and drying, bathing, cooking, etc.

2.2 Ventilation and its sufficiency

In a household with a volume 250 m^3 of air indoors, which is being exchanged every two hours (on average), the 10 kg/day should be distributed over 3000 m^3 of air. The humidity by volume of the air would then increase by 3.3 g/m^3, and the indoor humidity would come to 5.9 g/m^3. RH would be 31% - still not a problem.

However if a family feels it is too cold to ventilate the air so it is renewed every two hours (the recommendable air exchange rate), and therefore prevents the supply of fresh air so it becomes only half of what it should be (an air exchange every four hours), then the moisture excess becomes 6.6 g/m^3, and the indoor humidity by volume becomes 9.2 g/m^3, and the relative humidity increases to 48%. This is illustrated by the highest right-hand spot in the water vapour diagram, Figure 1. This humidity also is not problematic per se.

However, if that indoor air comes in contact with cold building elements, e.g. in a corner, behind furniture, or near the frame of a window, then its relative humidity would increase. If the temperature comes down to 10°C, then the air can no longer hold more than the 9.2 g/m^3, and relative humidity becomes 100%. Condensation, or dew, will now begin to form on the cold surfaces, particularly if the air is cooled even further. 10°C is the dew point of the air with that humidity.

Even if the indoor air is cooled to another temperature not as cold as 10°C, the relative humidity will increase. For instance at 14°C it reaches 75% RH. That may be a sufficiently high humidity that mould could

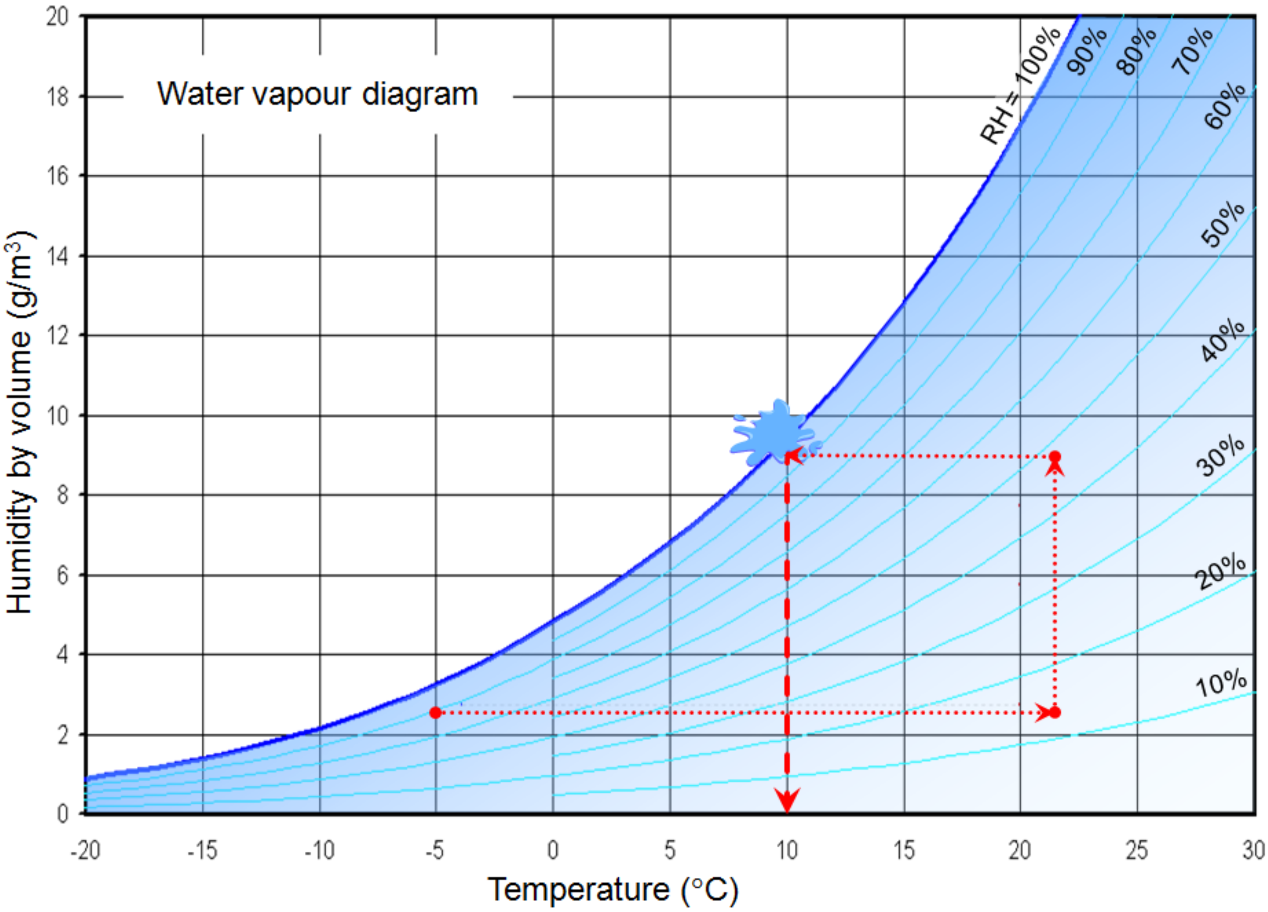

Figure 1: Water vapour diagram showing the state of moisture in air as it enters into a building from the outdoors (at -5°C), is heated to 21.5°C and then humidified by indoor activity. The figure then shows how condensation or high relative humidity may occur when the indoor air gets in contact with cold construction parts (at 10°C).

grow.

In order to avoid such a critical situation, either the moisture release should be minimized, or the ventilation rate should be kept sufficiently high. In addition, it should be avoided that cold surfaces exist, e.g. by using well insulated structures, and by avoiding cold bridges.

3. Construction failure

The Greenlandic climate is rather harsh with strong winds and with precipitation, possibly in the form of snow drift. It is essential that the envelopes (exterior constructions) of buildings in Greenland are made to sustain this load.

Much of the building tradition in Greenland is inherited from Danish building tradition. Many design principles are good, but they are not particularly suited for the exacerbation offered by the Greenlandic climate. Particularly, the snow loads around buildings which are typical in Greenland are rare, or at least significantly less, in Denmark, and thus Danish design rules may be insufficient to use in Greenland. As an example, the Danish Building Research Institute publishes a good guide book on moisture protection of buildings (Brandt et al., 2009, SBi Anvisning 224), but the guide book only mentions few and very general precautions to take against snow and snow drift. Thus, the guide book is not particularly suitable for Greenlandic construction. Better might be to use the similar Norwegian guidebook (Geving et al., 2002), where many details are obviously better suited for a windy climate with high loads of snow and frost.

Figure 2 show drawing from an old guidebook from the Danish Træbranchens Oplysningsråd (nowadays: Træinformation) about proper constructive moisture protection of building elements. The recommendations are generally good and should also inspire Greenlandic construction (Træbranchens Oplysningsråd, 1984).

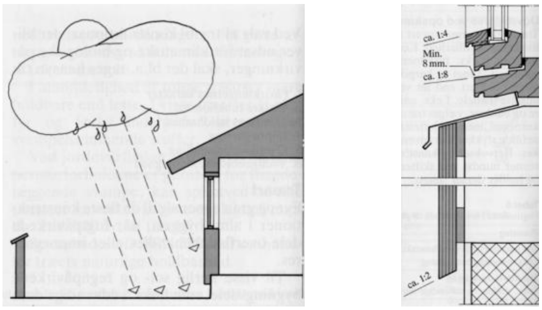

Figure 2: Important details on how to deflect and divert water from the building envelope.

Many precautions to prevent water ingress in building constructions are about simply constructing things right. It seems, unfortunately, that for many years there has been too little awareness among actors in the Greenlandic building industry to construct right. Numerous building details have simply not been carried out in a correct and sufficiently careful way. Well known details for shedding water and leading it safely away from sensible construction parts have not always been carried out like they should. This is particularly critical when the constructions are made of sensible materials like wood.

The pictures below show examples of constructions which have failed.

Figure 3: A lake of (frozen) water standing n the basement of a new building.

Figure 4: Wrong detailing of a flashing at a roof edge.

Figure 5: Poor fitting of the materials in a corner to each other. A leaky assembly.

Figure 6: Wetted construction material from leaky construction.

Figure 7: Sheathing membrane not attached correctly to the wooden members at the lower construction perimeter.

Figure 8: Window frame made without water deflecting details.

4. Recommendations

4.1 For the building user

- Make sure to minimize the indoor moisture load and make sure the ventilation is sufficient.
- Do not dry laundry indoors.
- Use a kitchen hood when cooking.
- Do not block ventilation openings, particularly not the exhaust fans from humid rooms.
- Don't place furniture close against an external wall or in a cold corner.
- Make sure to ventilate the dwelling a few times a day (5-10 minutes every time).

4.2 For the professional

Construct right.

- Use appropriate guidelines, and not only the Danish ones. You may also look to Norwegian guide books.
- Adopt a commissioning program to ensure that the building is designed and constructed according to good and intended principles.
- Make sure the ventilation is sufficient – also for rooms which are not occupied: Basements and attics. Ensure that the ventilation openings are not blocked by snow (or other objects), and make sure drifting is prevented from entering into the construction.
- Make sure to prevent that standing (melt) water from the construction base around and below buildings can cause problems.
- Make sure to avoid construction moisture. Construction materials should be dried and they should be protected from weather exposure on the construction site.
- Make sure to maintain the buildings properly. The Greenlandic climate is hard on the buildings, and many construction materials are vulnerable and need frequent maintenance.

5. Conclusions

The climatic situation in Greenland makes it very important that occupants of buildings as well as the professionals who construct and operate the buildings do their utmost to follow accepted recommendations. And such recommendations should be developed particularly for the climate and needs of building users in Greenland.

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