Humidification - friend or foe?

The required humidity in office spaces and the question whether or not humidification is necessary, have been controversial issues for years. On the one hand, it is generally taken that the relative humidity should not be too low in the winter, for instance 30% R.H at the lowest. On the other hand, however, there has been a lot of resistance to the way HVAC technology has tried to realise this objective. As a result of maintenance problems, corrosion, costs and particularly the often poor hygienic conditions, humidification systems have become less popular. Re-orientation as to whether air humidification is desired or required and an analysis of the possibilities modern HVAC technology can offer are urgently called for.

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Starting point for the investigation will be 'human health'. It goes without saying that this aspect takes first priority over aspects such as 'thermal comfort'.
According to many researchers [1], the risk of infection of the airways increases with a low air humidity, due to drying out of nose and glottal larynx mucous membrane, thus losing their function as dust filter partly or entirely. The lower limit mostly mentioned in this context is 40 % RH. Personal tendency and smoking habits affect this limit as well.

Humidity and indoor dust

With a low R.H., dust is spread easily in an office space. Since dust functions as carrier of viruses, the risk of viral infections basically increases with a low R.H.
However, increasing R.H. to limit the risk of viral infection might have a contrary effect, since a higher R.H. increases the chances of survival of viruses and bacteria, thus leading to potentially more of these organisms in the air. An effective *dustfighting* through optimal filtering of the ventilation air, thorough cleaning, avoiding dust sources in the room and possibly the use of ionizers can reduce this risk effectively.
For vacuum cleaning a central vacuum cleaning system is absolutely favourite. Some manufacturers supply vacuum cleaners provided with highly efficient filters, which can be used as next best.

Many people, including the writer of this article, would, under normal circumstances, not or hardly be affected by dry air. In dusty rooms one might be more affected by it than in rooms with clean air. Long stays in an extremely dry environment, for example during a long flight, is not very pleasant and certainly not healthy. A sneezing passenger, for example, might infect quite a number other passengers. In addition to the dry atmosphere, the dense crowd plays a part, spreading human dust (skin scales, clothing), viruses and bacteria in the small living space.

The question thus arises as to whether the humidification policy should be adjusted to a large group of people who are not bothered by dry atmosphere or to the smaller group who is indeed sensitive to humidity. Or should other factors be considered?

Humidity and the sick-building syndrome

The notion of Sick Building Syndrome (SBS) is used to refer to a recurring pattern of complaints which is particularly associated with modern office buildings often equipped with HVAC installations.
There are various SBS definitions, which are all characterised by the fact that they deal with a problem involving a considerable number of complaints voiced by people working in buildings, without being able to pinpoint the exact cause of those complaints. Recurrent SBS complaints often include complaints about the nose (stuffed up, itching, runny nose), the eyes (itching, irritating eyes, tears), mucous membrane (dry throat, stuffed-up nose), skin (dry skin, rash, itching skin), listlessness, headaches and asthma-like symptoms.
It is striking, however, that many people experiencing the above-mentioned complaints, blame the dry air inside. Humans, however,

do not have a sense that directly recognises humidity, and, as far as we know, SBS research has never established a clear relation between complaints about dry atmosphere and the actual air humidity. More than once, for that matter, the contrary proved to be true!

Based on extensive research, David P. Wyon, a prominent Swedish physiologist, has established that it is not as much as the air humidity itself that causes people to complain about dry air, but rather the temperatures which are too high. Lowering the air temperature by 2 °C from 23-24 °C to 21-22 °C will have a more positive effect on the number of complaints than increasing the relative humidity from 20% to 40% R.H. will [2]. Other researchers, mainly from Scandinavia, share this conclusion [3,4].
In hospitals, nursing homes and homes for the elderly a temperature of 23°- 24° C is required and humidification is desirable for that reason. Added to this the health condition of the residents makes humidification even more necessary. However, the staff generally will not appreciate this.
In offices a maximum room temperature of 20°-21° C is recommended in the heating season, thus lessening the need of humidification.
The questions therefore remains whether air humidification should be used when fighting the Sick Building Syndrome. There are just as many in favour of this argument as there are against it [5,6].
It seems, however, that the supporters have been guided by the positive effects of air humidification on health; while the opponents focus more on the possible risks involved in humidification. This, however, can by no means be regarded as a very accurate consideration of the pros and cons.
A shaky bicycle can be dangerous but cycling itself, on the contrary, is very healthy!

Humidity and thermal comfort

There is no considerable influence of the air humidity on thermal comfort. ISO 7730 [7] states the following in Annex D (informative): *"It is recommended that the relative humidity be kept between 30% and 70%. The limits are set to decrease the risk of unpleasantly wet or dry skin, eye irritation, static electricity, microbial growth and respiratory diseases"*.

Figure 1 shows the influence of R.H. and air temperature on the thermal comfort. The diagram is constructed on the basis of the PMV formula in ISO-7730, and the following conditions:

- *metabolism : 1,4 met*
- *clothing value : 1,0 clo*
- *rel. air velocity : Var: 0,1 - 0,15 and 0,2 m/s*
- *PMV : 0*

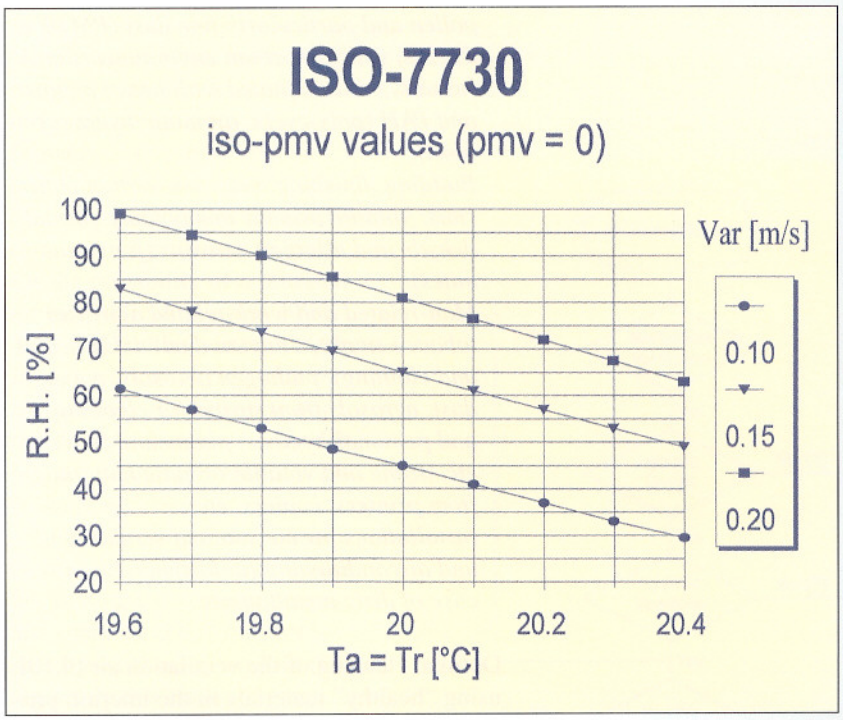

Figure 1. Influence of R.H. and Air Temperature on the Thermal Comfort

Lowering the R.H. from 45% to 30% could be compensated with Var = 0.1 m/s by an increase of the air temperature from 20 °C to 20.4 °C at PMV = 0 constant and mean radiant temperature is equal to air temperature. This holds for a uniform thermal environment, yet is not always the case in practice; reality is often much more complicated.
This may be illustrated by the influence of air humidity on thermal comfort when people move between different humidity zones in a building. This is caused by absorption and evaporation of humidity in and out of clothing. For example, it is difficult to ensure thermal comfort for someone moving from a humidified space to a non-humidified meeting room or canteen. Body moisture in the clothing evaporates and causes thermal discomfort.

Humidity and indoor air quality

If the air is polluted by irritating and/or harmful substances, extra attention should be paid to a proper level of air humidity. Thus, mucous membranes in the airways

will stay in better shape and will be more resistant to air pollution. The same goes for the eyes and the skin.
The most widespread sources of air pollution in the indoor environment include [8]:

- *The outside air: irritating gasses, such as ozone, nitrogen oxides, sulphur dioxide, volatile organic materials, "black smoke", pollen and particularly fine dust (PM10 - PM2,5) which in urban environments is (usually) contaminated with heavy metals and PAH (poly-cyclic aromatic hydrocarbons).*
- *Building, finishing and construction materials: volatile organic compounds, formaldehyde and allergen aerosols (fungi and mites).*
- *Man-related and work-related activities: tobacco smoke, "human dust" (skin scales and clothing), pathogen aerosols, paper dust, aerosols from sprays for cleaning and personal hygiene, plants and flowers, etc. ozone and volatile organic materials from printers, copiers, etc.*
- *Installations for mechanical ventilation and airconditioning (unfortunately) in case of dirty installations.*

Optimal cleaning of the ventilation air [9,10], using "healthy" materials in the interior, preventing pollution by man-related and work-related activities, a good design and regular cleaning of interior and installations [11], and finally, adequate ventilation can provide the indoor environment with a great deal of protection. A building that has already been optimised as far as these aspects are concerned from the design stage up to and including its actual use, and which is operated on the basis of these aspects, would, in principle, not require air humidification. However, allowing for a certain 'error tolerance' would most certainly be advisable, especially considering the ever increasing, most vulnerable group of people, i.e. those with airway disorders (CNSLD patients, allergies). In addition to this, it is also advisable to protect employees in laboratories, etc. against odd substances in the air by means of air humidification.
Figure 2, taken from a very interesting article written by E.M. Sterling et all [12] shows an optimum R.H. of 40 - 60 %. In non-ideal real-life buildings the RH should therefore be kept at a minimum of 40 %. During very low outside temperatures a reduction down to 30% is acceptable for energy saving and building physical reasons.

Humidity and static electricity

With a low air humidity and wrong carpets, static charging and discharging may occur, which may in turn result in computer errors when touching computers. An air humidity from 40% to 50% is one of the solutions to

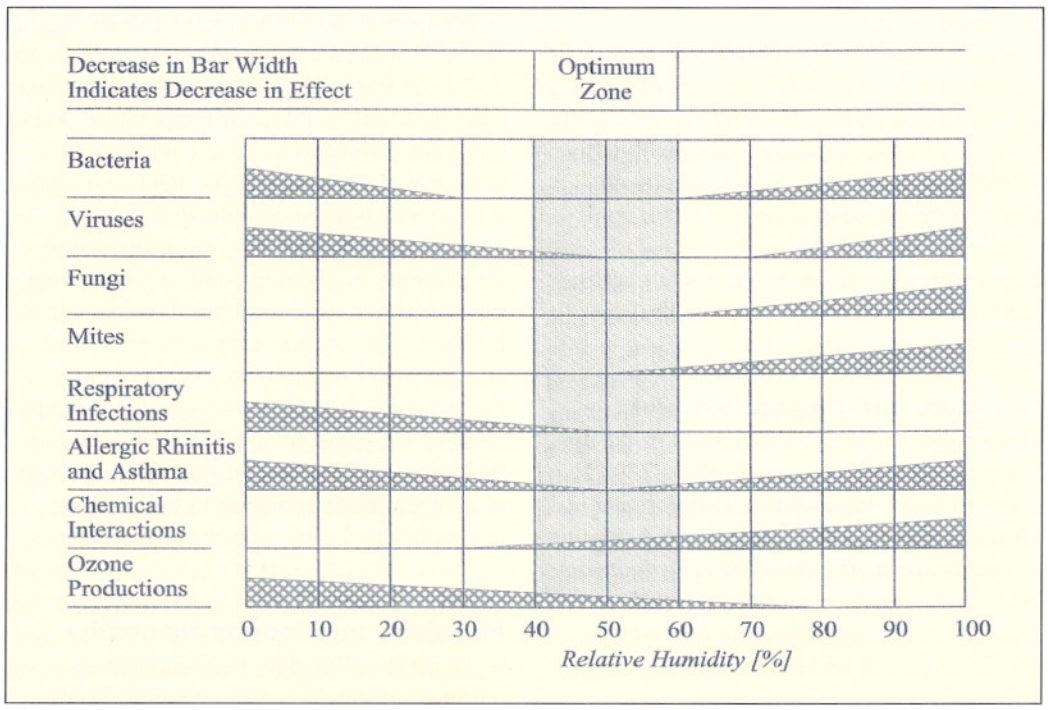

Figure 2. Optimum R.H. ranges for health

this problem. The higher level of humidity will, especially with hygroscopic materials such as wool, facilitate discharging electricity. However, opting for an anti-static carpet, or applying an electric conducting coating if the wrong carpet is already placed, would be a fundamentally better solution. This is emphasised by the fact that the above-mentioned minimum R.H. of 40% does not entirely prevent problems concerning static electricity.

Humidity and the building

A high air humidity in the winter is bound to have certain risks for the construction of buildings. The risk of condensation on cold planes and in certain constructions increases, which may cause damage, as well as fungal growth. Many people are allergic to this. In general, it is recommended that humidity is kept as low as possible during winter.

Conclusions

- *Humidity and Health:*
  - R.H. preferably not under 40 %
- *Humidity and Indoor Dust:*
  - Dust fighting of paramount importance
  - Think of ionizers
  - Humidification only in case of unavoidable dust
- *Humidity and SBS:*
  - Keep maximum room temperature in winter at 21° C or below
  - Humidification at higher room temperatures
- *Humidity and Thermal Comfort:*
  - No humidification required
- *Humidity and Indoor Air Quality:*
  - No humidification required in case of a healthy indoor environment
  - In other cases and if mechanical ventilating systems are not designed and operated hygienically, humidification up to 40 %.
- *Humidity and Static Electricity:*
  - First choice is good carpeting
  - Humidification is second choice
- *Humidity and the Building:*
  - Humidification not desirable

These conclusions are pictured in the decision diagram humidification, fig. 3

Summary

Healthy people in a clean and healthy indoor environment will probably not need air humidification. This ideal situation can, of course, not be realised, but one could, dependent on the location, try to approach this situation. Persons sensitive to dry air may be helped by the use of individual ionisers and/or humidifiers.

Health, air quality, regular cleaning and company processes influencing this are, however, not constant factors.

In many cases, especially in buildings with mechanical ventilation equipment or airconditioning, it is preferred to allow for the possibility of a minimal air humidification up to 30% - 40% R.H. in the heating season. *It goes without saying, that the remedy may not be worse than the disease, in other words: the highest degree of hygiene is absolutely necessary.*

A thorough investigation has to be made to evaluate the various humidification systems on this and other aspects. Our profession has still some work to do regarding this issue.

References

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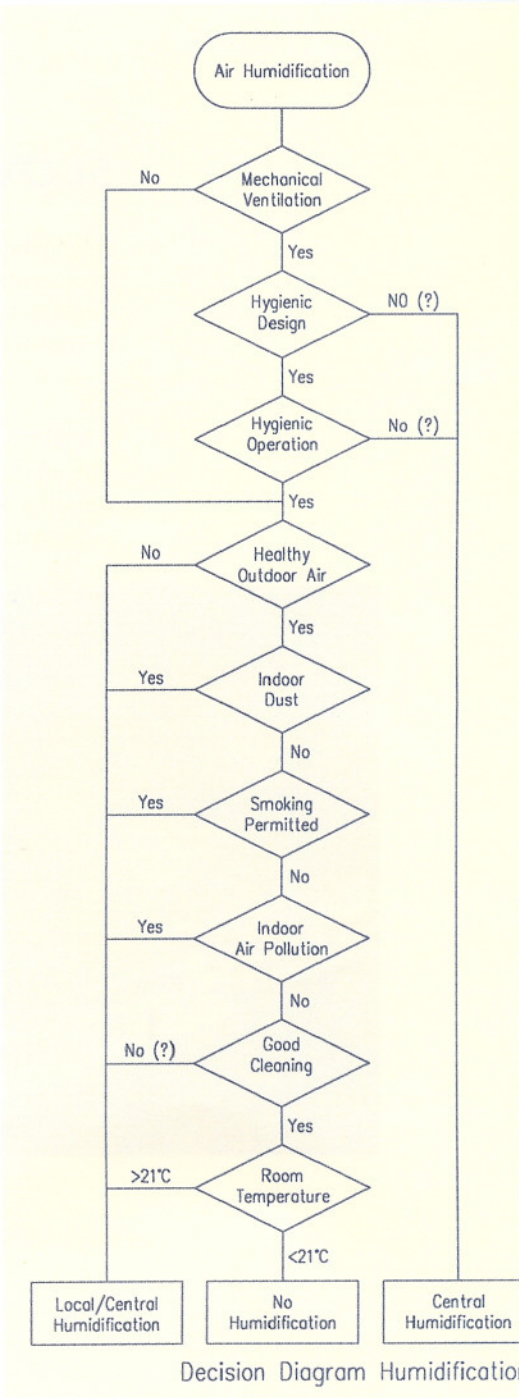

Figure 3. Decision Diagram Humidification