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Humidity: the forgotten factor?

The CIBSE recommends a minimum level of 40% relative humidity for air conditioned buildings, but evidence suggests this figure is often much lower. Why do so many designers ignore such a basic requirement? *Tom McDonnell* presents a specifiers' guide.

How much importance do designers attach to the correct use of humidification, and what are the consequences of inadequate relative humidity (rh) levels? Even when humidification has been incorporated, what are the design pitfalls that will trap the unwary?

If, as evidence suggests, humidification is either consciously omitted or inadequately controlled[1], then the comfort, performance and health of building occupants can be adversely affected.

Bearing in mind that office workers represent about two thirds of the UK workforce, the potential for disruption is inestimable.

Ironically, the welfare of research animals and the protection of inanimate objects – works of art and computers, etc – is usually achieved through well maintained air conditioning and controlled rh levels.

Another apparent paradox is that even diligent designers, who usually pay close attention to effective air distribution and correct air temperatures for both heating and cooling cycles, display a *laissez faire* attitude to humidity control.

The CIBSE *Guide* is unambiguous in recommending a minimum level of 40% rh[2], a standard ignored in many new buildings[3]. Therefore, the consequences of not providing a constant and correct degree of humidification perhaps need to be restated.

What are the problems?

Raising the air dry bulb temperature always causes humidity reduction. During the winter season, where fresh air temperatures may be raised from 0°C to 22°C, the rh of the air will probably fall from 100% to around 25%.

If this is not countered, the low rh will have a detrimental effect on building occupants. One example concerns the nose and nasal passages. These represent one of the body's first lines of defence against harmful substances. A mucus lining of the air passages traps dust and other particles, and warms and moisturises the air before it passes to the lungs.

Breathing excessively dry air – ie air below 35% rh – for long periods dries out the mucus lining, reducing its ability to filter out airborne particles. People take in greater quantities of harmful substances into their lungs than they ever would do by the mouth or through the skin[4].

The situation is further compounded by the time delay effect that the absence of humidity has on the human body. For example, the sensory organs are very receptive to ambient temperatures. We can all tell immediately if we feel too hot or too cold. But this is not the case with humidity, where it may take the occupants many hours to realise they are feeling the effects of low humidity levels – by which time the damage has been done.

Individuals may not be aware of low rh levels, and will be unable to identify that it is causing discomfort or illness symptoms. This hidden effect makes humidification problems so difficult to isolate, and poses a problem for the more enlightened engineer attempting to brief his client on potential hazards.

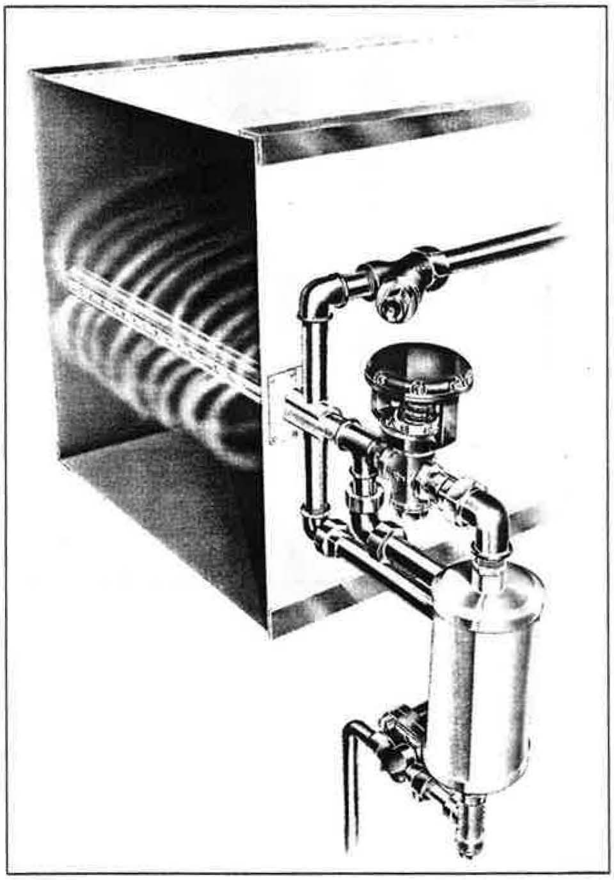
Installation errors

Even in installations where humidifiers have been incorporated into the building services, elementary errors in plant selection and design can still contribute to an unsatisfactory service.

The most common pitfalls can be classified into three categories, and these fundamentals still apply even where plant and controls are apparently in sound working order.

The three categories are: humidifier type, service and maintenance and design criteria.

Most authoritative guidance recommends that humidifiers should be of the steam injection type, either self-generative or direct injection from steam plant.



Steam injection humidifiers, designed for installation in ac ducts.

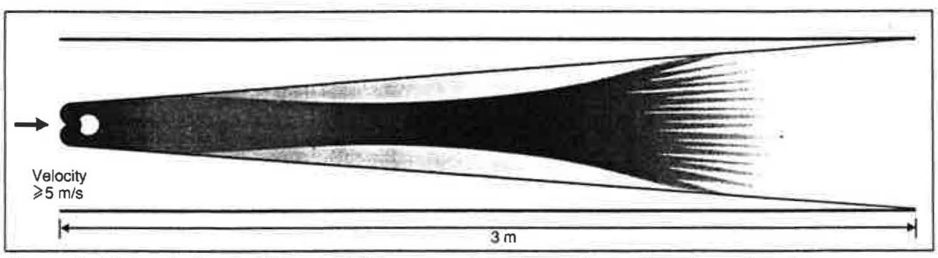


Figure 1: High velocity air will carry visible vapour downstream, increasing absorption distance.

Water systems below 65°C, relying on the adiabatic saturation principle, are considered unsuitable because they are a major supplier and disseminator of microbial contamination[5].

Experience indicates that maintenance of plant is generally neglected. Regular servicing should be carried out at least once a year in the interests of a trouble-free operation.

Water analysis with regard to self-generative humidifiers, or boiler feed water in the case of direct steam injection, should be analysed at the start of the system's design. Water having total dissolved solids outside the band of 200-500 micro siemens may need additional attention in terms of service.

Many manufacturers offer service contracts in connection with their own equipment, ensuring that humidifiers work at their optimum level.

Design criteria

In order for the steam vapour to be readily taken up by the airstream – ie visible vapour to have been absorbed within 0·5 m travel of the inlet manifold – then a number of important factors must be addressed. These are air velocity, manifold location and arrangement and system psychrometry.

Supply air will carry the visible vapour further down the duct before complete absorption is achieved (figure 1). High velocity air, (over 5 m/s) will carry visible vapour quickly downstream, increasing the absorption distance beyond that required by lower velocity air.

Multi-manifolds will help by presenting the steam to the air over the full cross-sectional area, thus improving absorption.

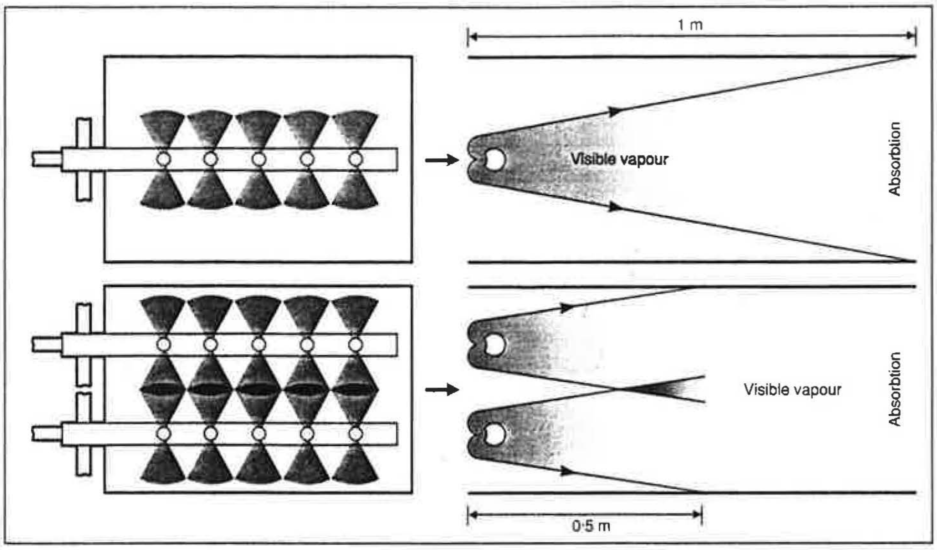


Figure 2: Two different ways of arranging humidification manifolds in ductwork.

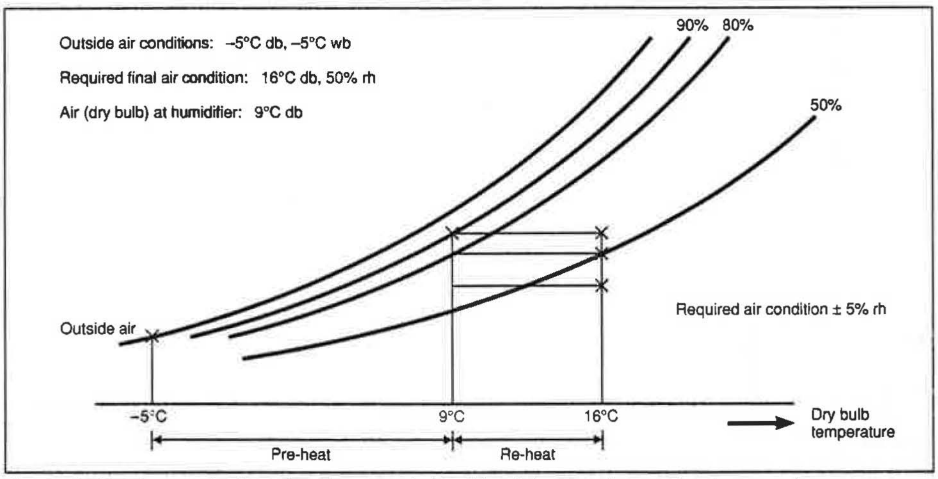


Figure 3: Psychrometric chart showing the relationship of rh to pre-heat and re-heat requirements.

Manifold length is normally tailored to extend to full duct width, and the number of manifolds required will obviously increase with duct depth to avoid air by-pass.

Ideally, humidifier manifolds should be located external to ahus, ie in the downstream supply ductwork. This reduces cost because ductwork is smaller and therefore cheaper, and required clearances up and downstream of manifolds are easier to incorporate.

Low air temperatures present a rather more difficult problem, and such a situation can arise where pre-heaters and re-heaters are used, with the humidifier located between the coils.

Figure 3 is an extract from a psychrometric chart that illustrates this problem. Assuming a realistic specification, allowing ±5% rh, it can be seen that the rh after the humidifier could rise to 90%. This may allow wetting-out to occur on obstacles such as turning vanes and fans positioned within 1 m distance downstream of the humidifier, and even on the duct walls.

This undesirable condition will exist until the air is reheated, thus reducing the rh. The problem can be resolved by omitting the reheat coil and transferring the total load to a single coil. Where the reheat coil cannot be omitted, more load should be apportioned to the preheat coil, raising its 'off' temperature and moving the air at this point in the system away from the saturation curve.

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References

[1] "Sick buildings can be just unfit", *Building Services*, April 1988.
[2] CIBSE *Guide A1*, "Environmental criteria for design", CIBSE, 1978.
[3] "The office environment survey: a study of building sickness", Building Use Studies, 1987.
[4] Mackarness R, "Chemical allergies", 1990.
[5] "Indoor air quality - biological contaminants", WHO, 1988.

To provide guidance on a range of humidifiers, the BSRIA Microclimate Centre is carrying out a survey of different buildings incorporating active and passive humidification systems. These include atomising nozzles, wetted cell, electrode boiler, ultrasonic, water fountain and plant humidification methods.

The study is jointly funded by several sponsors including the DoE, the Department of Health, Arup Research and Development and Eaton Williams, and is scheduled for completion by July 1993. The results will be compiled into a BSRIA report and Application Guide/Technical Note.

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