THE NEED FOR HUMIDITY CRITERIA

When building professionals and building owners ask the question “what humidity should I maintain in my building?” they usually do not get a satisfactory answer. The reason for this is that the question is difficult to answer. The “right” answer very much depends on what is in the building (artifacts, people, plants), the priorities of the building owner or occupants, and the building construction details, especially details regarding the thermal integrity of the building envelope. It is important to maintain humidity conditions that meet the needs of the people and things inside the building without destroying the building itself. Humidity and moisture can especially become an issue when there is a change in building use or occupancy. Changes in ventilation, indoor RH, moisture release, or building air pressures can create moisture problems in a building where there were none before. Perhaps it is possible to provide better guidance to building owners and occupants in making decisions about humidity and building use.

Building researchers and consultants also have long had a need for criteria to determine if a building or building component will be operating satisfactorily. Better tools for calculating moisture contents of building design and materials in service are beginning to become available (e.g. the MOIST computer model), but no agreed-upon criteria exist as yet to evaluate the results obtained with those tools. For many years avoidance of surface condensation and various saturation moisture content criteria were used. These criteria were aimed at prevention of decay and structural damage to building materials. For instance, some have used a wood moisture content of 20% or higher as a criterion for moisture problems, while others have used fiber saturation (around 30% MC for solid wood). More recently mold and mildew growth has been recognized as a basis for performance criteria, resulting in criteria for surface relative humidity. A consensus on the “best” criteria would be of use to many building professionals.

HUMIDITY CRITERIA FOR HUMAN HEALTH AND COMFORT

ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy is perhaps the most widely known standard for indoor humidity in the United States. This standard defines one temperature comfort zone for winter and one for summer. In the 1981 version of Standard 55 the comfort humidity range was defined in terms of dew point temperature, and ranged from 35°F (1.7°C) and 62°F (16.7°C). This translates into approximate RH ranges of 25% to 80% in winter and 20% to 70% in summer, depending on temperature. Although ASHRAE 55-1981 professes to be based on considerations of respiratory health, mold growth, and other moisture related phenomena, the 1981 version appears to be primarily a human comfort standard. It appears from the 1981 version that people are not particularly sensitive to relative humidity and are comfortable in a wide range of RH conditions. However, the 1992 version of ASHRAE Standard 55 contains a drastically reduced upper RH limit of 60% RH, winter and summer, which coincides with the upper RH limit recommended by Sterling et al. (1985). This lower upper limit apparently reflects a concern for mold and mildew growth and health, not comfort. The Canada Department of National Health and Welfare (1987) recommends RH ranges of 30% to 80% in summer and 30% to 55% in winter, based on comfort and health considerations. Apparently, the winter maximum of 55% is based on the danger of condensation or mold growth. Neither the ASHRAE
RH criteria for human comfort are not very restrictive. None of the above criteria sufficiently recognize the importance of microclimates and the building envelope. These criteria are all in force simultaneously, and to deal with health issues in terms of surface RH and temperature criteria. Exceptions may be special requirements for occupants with extreme sensitivities or allergies. This would indicate that comfort criteria for “middle of the room” RH should be according to the "old" ASHRAE Standard 55.

**HUMIDITY CRITERIA AT BUILDING SURFACES**

As David Miller states in his concluding remarks in these proceedings: there is a consensus that fungi should not be allowed to grow in buildings. He also points out that favorable conditions for mold growth vary with mold species and substrate. However, building professionals need a simple standard or criterion by which to judge the likelihood for mold growth in new construction or retrofits, as was clear from comments from the audience during the symposium. Recognizing the complexity of the issue but responding to this need, the International Energy Agency Annex XIV proposed a simple performance criterion for building surfaces: the monthly average water activity of a material surface should not exceed 0.8 (see the paper by Hens in these proceedings). Water activity is the ratio of water vapor pressure in the substrate and that of pure water at the same temperature and pressure. For practical purposes monthly average water activity may be equated to monthly average RH at the surface of the material. Thus average monthly RH at the surface should remain below 80%. Only for non-porous materials which are regularly cleaned (glass, metals, glazed tiles, etc), avoiding prolonged surface condensation should be made the criterion.

The authors believe that a maximum 80% monthly average surface relative humidity is a useful criterion for building professionals. In addition to relative humidity a simultaneous temperature criterion should be defined. This becomes especially critical when assessing the potential for mold growth in unheated spaces or building envelope cavities. Although various molds can grow at a wide variety of temperatures there seems to be agreement in the literature that molds generally will grow at temperatures between 32°F and about 104°F (0°C and 40°C). Mold may survive but will not grow at temperatures below 32°F, and mold will generally not survive prolonged exposure to temperatures above 104°F (Hunter and Sanders 1991). It seems therefore appropriate to use a temperature criterion of 32°F to 106°F concurrent with the RH criterion.

**OTHER CRITERIA**

Special humidity requirements may override or be imposed in addition to the above requirements for human comfort or health. Examples are special environmental requirements in museums, libraries, and swimming pools. These criteria may contain not only humidity levels, but also criteria for rate of change in humidity. At this time we will confine ourselves to mentioning the need to consider any such special requirements.

Concerns for degradation or dimensional stability of building materials may also supersede the other criteria for humidity. Concerns for dimensional stability of wood building products during cold weather, when temperatures are too low for growth of mold or decay organisms, is one example. James Connolly, in his article elsewhere in these proceedings, cites cyclic condensation deteriorating paint finishes as another example. He also includes a list of suggested maximum moisture contents for a variety of materials under different conditions. This list is a very useful tool but obviously needs further discussion and expansion.

**RECOMMENDATIONS**

On the basis of previously reported data as well as information presented at this symposium we put forward a set of interim performance criteria for humidity inside the building as well as the building envelope. These criteria are all in force simultaneously, but one or two may govern at any given time, location, or building design. We realize that these recommendations are not based on consensus, and on incomplete information in some areas.

a. Occupied zones: Relative humidity in the center of the occupied zone should be maintained between 25% and 80% in winter and
b. Interior surfaces and building cavities: Monthly mean RH less than 80% at all interior building surfaces, including building envelope cavities, if concurrent monthly mean temperature at same surfaces between 0°C (32°F) and 40°C (104°F). 
basis: IEA Annex 14, with addition of temperature specification and expanded surface definition.

c. Special requirements for specific building uses, dust mite control, and specific materials may have to be considered in addition to the above.

In addition we recommend the following:

1. Building owners and the building design community need better and more education on the basic principles of building physics and moisture in buildings in particular.

2. We need to better understand how and under what conditions mold growth in building cavities can affect indoor air quality.

REFERENCES


