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Development and validation of a new method for determining humidification and dehumidification needs

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ABSTRACT

The use of ventilation systems in buildings is increasing. In buildings such as libraries and museums, ventilation systems have been used to maintain optimal hygrothermal climatic conditions for important and extremely rare artefacts. Ventilation systems are now increasingly used for normal purposes in residential and commercial buildings. In cool temperate climates such as in Austria, winter exterior air is very dry. Because of dry outdoor air, when using a ventilation system in winter with constant air exchange, the relative humidity of indoor air is often under the comfort limit, requiring air humidification. In the summer, the same rooms must be dehumidified due to excess air humidity. Air humidification and dehumidification are processes that consume a large amount of electricity and humidification and dehumidification requirements should therefore, be minimized. Until now, the amount of necessary humidification or dehumidification has been undefined and could not be calculated easily. This paper presents a new simplified method for identifying the humidification and dehumidification needs taking into account the effective moisture capacity of a room. This model will be integrated into the Austrian energy certification program. The moisture capacity of a room was obtained in the course of the investigation presented in [1], using measurements from a number of different materials that were used as humidity buffers. For the moisture coupling of room to building components, an analytical solution was developed and presented in [2].

1. Introduction

Over the last decades, energy efficiencies in buildings have increased significantly. The building envelope has been optimized to effectively minimize the influences of transmission heat losses and thermal bridges. Buildings have low infiltration levels requiring mechanical ventilation to provide hygienic air exchange levels for inhabitants. Ventilation systems are often used to reduce winter ventilation heat losses, or to provide a precooled fresh air supply during the summer. External air may be either humidified or dehumidified as not only temperature, but also humidity are important to meet the predetermined indoor comfort conditions. Many researchers are working on this important topic. The use of renewable energy for humidification has also been developed. In Ref. [3], a humidification element necessary for the air conditioning system is shown which uses solar energy with a pan humidifier instead of electricity. A mathematical simulation of the solar humidifier was also presented based upon the weather data of a hot day in the region.

The amount of heat or moisture transport from the exhaust to the supply air depends on the efficiency of the heat and moisture exchanger. Usual dimensioning of heat and moisture exchangers is based upon the ability of the exchanger to transfer sufficient heat and moisture from the exhaust to the supply air for defined indoor and outdoor temperatures and humidity levels.

It is already known that humidification and dehumidification are much more difficult to adjust than pure heat recovery and moisture balancing requires more energy. Humidification is an essential energy consumer. Humidifying to 50% relative humidity instead of no humidification may increase the heat demand by more than 30% [4]. Large amounts of energy can be saved with a suitable reduction of the ventilation rate and appropriate set points of indoor conditions according to current standards and guidelines [5]. The formulas are given in [5] for the energy necessary for heating, cooling, humidification and dehumidification of outdoor air to the desired indoor conditions.

Not only are the indoor and outdoor air conditions dynamic, but different buildings have different moisture and heat storage capacities. Predefined conditions are often inaccurately estimated, resulting in incorrectly dimensioned ventilation systems. The existing

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