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A PC-tool to calculate the Moisture Buffer Value

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Abstract

Hygroscopic building materials have the ability to moderate the relative humidity variation without the need for active systems. The moisture buffer phenomenon can be assessed by way of the Moisture Buffer Value (MBV). Some authors have pointed out that the MBV is sensitive to several parameters, however, there is no model that involves all them.
The aim of the developed PC-tool is to take into account all these variables to calculate the MBV of hygroscopic building materials. The material hygroscopic properties will be needed to solve the moisture storage and transport inside the porous materials and consequently to predict its MBV.

Keywords: Moisture Buffer Value; Moisture buffering; PC-tool; Hygroscopic building materials; Humidity.

1. Introduction

Related literature shows that indoor humidity has a significant effect on a variety of requirements: occupant comfort and health [1,2], indoor air quality [3], building durability [4] and energy consumption [5]. Besides, to satisfy the requirements of European Directives of Energy Efficiency [6], it is necessary to reduce both the energy consumption and the greenhouse gas emissions associated with the use of HVAC systems. As a consequence, the development of strategies based on passive systems to reduce the dependency of active systems in order to control the indoor humidity level has a research interest.

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Hygroscopic inner coating materials and furnishing materials have the ability to naturally moderate the peaks of indoor relative humidity through their moisture capacity. This ability is called Moisture Buffering. To quantify this buffering ability it can be used the Moisture Buffer Value (MBV) proposed by Nordtest protocol [7]. This property quantifies the amount of moisture that a material can storage and release when the material is subjected to cyclic variations of the surrounding relative humidity.

Several authors [5,8-11] have pointed out that some hygroscopic building materials can affect the indoor air quality and the energy consumption of buildings by transferring, storing and releasing moisture. Predicting the moisture behavior of building materials and their buffering capacity can help to design and build buildings that maintain adequate indoor moisture levels in an efficient and sustainable way.

In this work we present a tool to simulate and predict the MBV of building materials considering all the parameters that have an impact on the phenomenon.

Nomenclature

A	exposed area, [m^2]
MBV_{ideal}	ideal Moisture Buffer Value, [$kg/(m^2 \cdot \%RH)$]
$MBV_{practical}$	practical Moisture Buffer Value, [$kg/(m^2 \cdot \%RH)$]
p_{sat}	saturation vapour pressure, [Pa]
b_m	moisture effusivity, [$kg/(m^2 \cdot Pa \cdot s^{1/2})$]
t_p	time period, [$s^{1/2}$]
w	moisture content, [kg/m^3]
m_{max}	maximum moisture mass, [kg]
m_{min}	minimum moisture mass, [kg]
δ	water vapour permeability, [$kg/(m \cdot s \cdot Pa)$]
φ	relative humidity, [°/1]
μ	water vapour resistance factor, [-]

2. Methodology

As has already been said, Nordtest protocol [7] defines the Moisture Buffer Value property. The protocol differentiates various definitions of the MBV depending on the factors that take part in the phenomenon of moisture buffering. The definition scheme is divided into three levels: material level, system level, and room level.

The material level is obtained from material properties without taking into account the influence of the surrounding climate. This definition is based on material properties which are determined under steady-state and equilibrium conditions.

The system level should be seen as a parameter that can describe the behavior of different components, such as interior surfaces with a surface coating. At this level, an experimental method proposed by Nordtest protocol [7] can be used so as to obtain the MBV. The time period for the moisture variations needs to be taken into account, which is not considered on the material level since the properties are obtained from a steady state. Likewise, other parameters such as the air velocity, have a significant effect on the results.

The last level considers the whole room, including the parameters of ventilation, heating, and cooling as well as all the building materials and interior objects.

The developed tool is focused on the material and system level where the MBV depends on the standard properties of the material analyzed and the tests conditions respectively.

The first definition, the ideal MBV, is calculated by the Fourier transform when the material is exposed to a periodic variation of relative humidity (33-75%) and constant temperature, which is defined as theoretical or ideal MBV. The definition assumes that the material has a thickness equal or greater than the moisture penetration depth. Furthermore, the surface film resistance and the nonlinearity of the material properties are negligible.