DETERMINATION OF THE WATER VAPOUR PERMEABILITY AND WATER VAPOUR RESISTANCE FACTOR OF SHEEP WOOL – METHODOLOGICAL DESIGN OF MEASUREMENTS

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INTRODUCTION

From a methodological point of view, the following questions were asked:
- Is the temperature and relative humidity constant during the experiment?
  - Are stationary conditions created in the experimental setup?
  - Does a constant diffusion flux occur?
- What will be the difference between the values obtained by calculations according to the standard (constant environmental conditions) and calculations according to variable environmental conditions?

MATERIAL AND METHODS

The basic procedure for performing the experiment was obtained from EN ISO 12572. Silica gel was placed in aluminium cups and a temperature and relative humidity sensor was inserted in the space between the material to be tested to capture the actual values of the boundary conditions during the experiment. The specimens were placed in an air conditioning chamber where the humidity and temperature sensors were also placed.

Air conditioning chamber with test samples. Boundary conditions are achieved in the chamber by using a suitable saturated solution. The required air circulation is achieved in the chamber by two fans. The sensors from each sample are connected to a datalogger which is connected to a PC to enable the values to be recorded at 10 minute intervals.
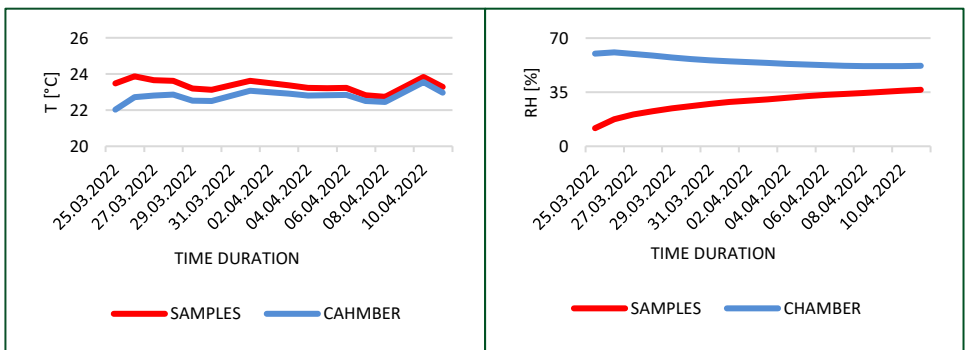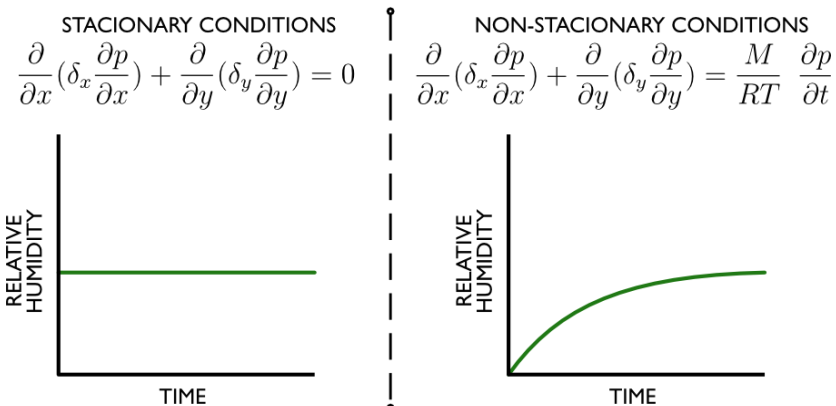
During the experiment, a constant air temperature was achieved (the measurement conditions were isothermal). The relative humidity varied, both in the chamber and in the bowl. The measurement conditions are in fact non-stationary.

$$\vec{j} = -\delta \ \frac{\partial p}{\partial x} \qquad \left[\begin{aligned} &\vec{j} = diffusion\ flux \\ &\delta = water\ vapour\ permeability \\ &p = partial\ pressure\ of\ water\ vapour \end{aligned} \right.$$

If both the water vapour partial pressure gradient and the diffusion flux are variable in time (non-stationary), a normative procedure based on constant conditions cannot be used. The relative humidity of the air in the cup, and hence the gradient of the partial pressures of water vapour, cannot be considered constant. Therefore, the calculation of the monitored quantities cannot be performed according to a normative procedure.

STACIONARY CONDITIONS

$$\frac{\partial}{\partial x}(\delta_x \frac{\partial p}{\partial x}) + \frac{\partial}{\partial y}(\delta_y \frac{\partial p}{\partial y}) = 0$$

NON-STACIONARY CONDITIONS

$$\frac{\partial}{\partial x}(\delta_x \frac{\partial p}{\partial x}) + \frac{\partial}{\partial y}(\delta_y \frac{\partial p}{\partial y}) = \frac{M}{RT} \ \frac{\partial p}{\partial t}$$

The standard is based on the premise that the conditions are stationary during the experiment, constant in time. Therefore, it does not specify the need for measuring the conditions inside the test specimens, i.e. between the desiccant and the test material.

RESULTS

Water vapour permeability δ [kg·m⁻¹·s⁻¹·Pa⁻¹]		Water vapour resistance factor μ	
EN ISO 12572	modified method	EN ISO 12572	modified method
1,59E-11	2,52E-11	12,3	7,8

The experiment showed that the theoretical assumptions on which the normative procedure is based cannot be met in the case of measuring the moisture properties of sheep wool. After interpreting the continuous data obtained from the measurements, we can refute the stationary behaviour of the experiment. If the non-stationary conditions of water vapour permeability of sheep wool are not taken into account in the calculation, the error rate of such a procedure is approximately 58 %.

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