THE CLOTHING COMFORT PROPERTIES OF LINEN FABRICS AT DIFFERENT MOISTURE LEVELS

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Introduction

The importance of clothing functionality has increased over the years with the development of textile technology. Clothing should be a barrier to the outside environment and should also transport heat and moisture from the body to the surrounding environment. The performance of garments is affected by their comfort properties in dry and wet state. The water vapour permeability depends on the increasing moisture regain and affects the thermos-physiological comfort of the wearer. That is why the knowledge about the fabric behaviour in wet state is an important parameter.
The thermal exchange between the body and the environment is done through heat convection, conduction and radiation, the moisture transport occurs through perspiration [1].
There are a lot of factors, which influence the clothing comfort. For the fabrics these are the structure of the textile and the fibre material. Natural fibres present excellent comfort for the body, adsorbing some parts of the moisture. As the production of flax was common in some part of Europe and it is renewable resource with very good mechanical properties, the interest on it is increasing [2].

Experimental

The aim of this work is to investigate the comfort related properties of linen were fabrics at different moisture levels. Therefore two different linen fabrics were tested in wet and dry state. Measurements were repeated six times for each sample.
An overview of the fabrics parameters are given in table 1.

Table 1: Fabric parameters

	Square mass	Thickness	Warp	Weft	Yarn density	
	g/m²	mm	tex	tex	warps/cm	wefts/cm
Plain weave 1	250	0,47	80	80	16	15
Plain weave 2	240	0,47	68	68	19	16

The samples were first tested after the conditioning in lab humidity of 65% and 20°C room temperature for 24 hours. In the second step, they were dried in an air conditioner at 105°C, in order to get rid of all moisture for the second trial. For the determination of wet state, the samples were consequently wetted with the same amount of water like their weight and tested immediately, after one hour, two hours, 20 hours and 24 hours. During the measurement procedure, each sample was stepwise weighed and tested to the comfort related properties.

Results

First, the fabrics were weighted and afterwards directly tested on the other devices. By increasing of moisture, the weight is decreasing. While the fabrics are drying, the weight is decreasing. It isn´t changing between the measurements after 20 hours to the conditioned samples. To evaluate the swelling of the fabric structure pores by liquid water, also the air permeability of wet fabrics was investigated [3]. The used instrument was the FX 3300 (Textest Switzerland). Its principle depends in the measurement of air
Flow passing through the fabric at certain pressure gradient of 100 Pascal.
The following graph shows, that with growing percentage of moisture in the fabrics the air permeability decreases.

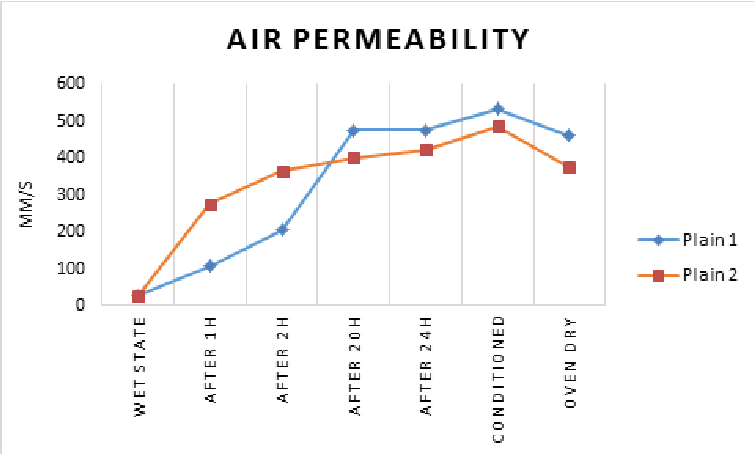

Figure 1: Air permeability

The relative water vapour permeability [%] and evaporation resistance Ret [m2Pa/W] of dry and wet fabrics were tested on the PERMETEST instrument [4], which enables the determination of within some minutes. The instrument provides measurements according to the DIN EN ISO Standard 13092:2013 [5]. In the following Figure 2, the results of the water vapour permeability are presented. The results show, that the values of air permeability and the water vapour permeability are increasing during the drying process.

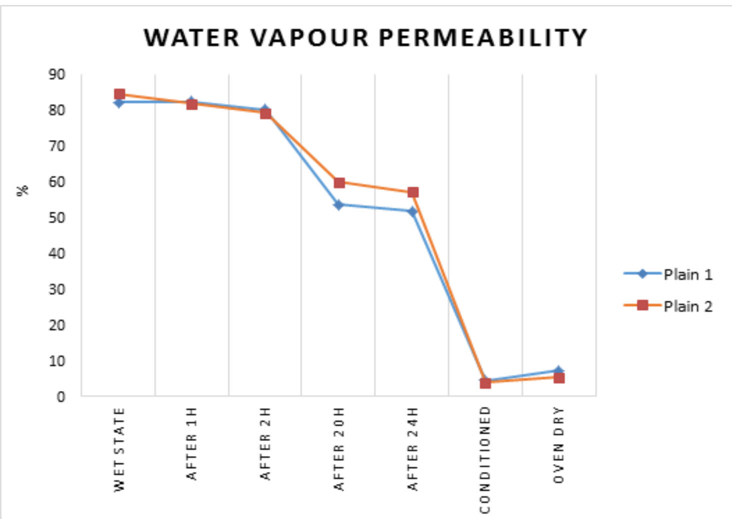

Figure 2: Water vapour permeability

It is assumed, that the fibres in the fabric swell under moisture, which leads to smaller porosity. Therefore the porosity is calculated and compared to the air permeability.

The porosity is calculated like follows:

$$V_{PX} = \frac{\varrho N - \varrho RX}{\varrho N} \tag{1}$$

Where ϱ_N is the normal density and ϱ_{RX} the bulk density.

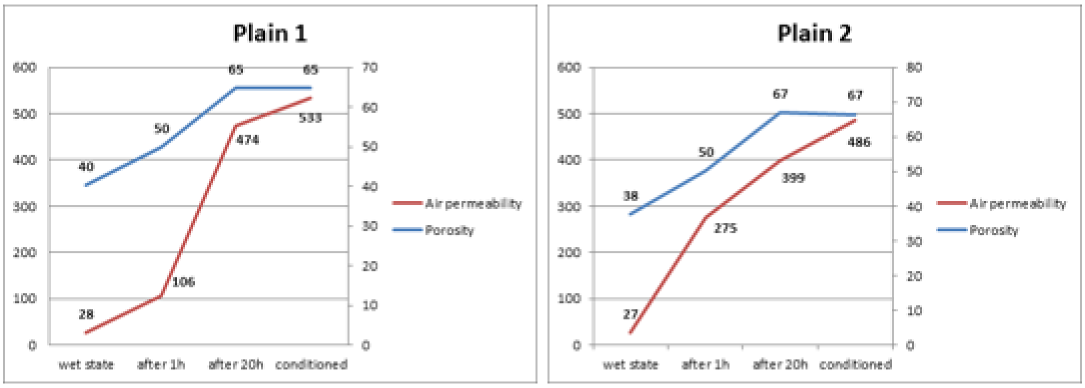

Figure 3: Porosity of plain 1 and plain 2

The results, presented in Figure 3 show the dependency between the porosity and the air permeability. In wet state the porosity is much lower than in dry state, which leads to a smaller amount of air, which can pass through the fabric.
Both samples show the same behaviour.

Conclusions

While the water vapour resistance gives no trend of a dependency of the water amount and the resistance, the water vapour permeability decreases, when the fabrics dry. This means also that the physiological properties of the fabrics are affected by the moisture state and thereby the quality of the apparel.
The air permeability presented the opposite behaviour. The wet samples showed lower results than the drying ones, why it was assumed, that the porosity of the fabrics was much higher in wet state, due to the fibre swelling.
The knowledge of these phenomena is a very important factor for the production of garments, especially for sports or outdoor garments.

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