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Sorption isotherms for textile fabrics and foam used in the indoor environment

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1 INTRODUCTION

Today there is an increasing interest in moisture buffering in the indoor environment including the traditional building materials as well as furniture and furnishing. With new building physical calculation tools developing there is a need for material properties for the materials used in the indoor environment. Moisture material properties for textile materials suitable for building physical calculations are scarce (Harderup 1999; Svennberg 2003).

The moisture properties of a textile fabric are determined by the fiber type, the spin and twist of the yarn, the weaving technique and the fabric weight. The fiber will to a great extent govern the equilibrium moisture content together with the yarn properties. The transport properties will be governed by the yarn and weave characteristics. In this paper the sorption isotherms for cold cured polyether foam and five textile fabrics, all typical for the indoor environment are presented.

2 TEXTILE FIBERS

Textile fibers are divided in two main groups - natural and man-made depending on their origin. Each of these groups can be divided into two sub groups due to the "raw-material" of the fiber. The natural fibers are divided into cellulose and protein fibers, and the man-made fibers into regenerate and synthetic fibers (Reis 2003).

Cotton, flax, ramie, sisal and jute are cellulose fibers, wool and silk are protein fibers. Viscose, acetate, lyocell and modal are all regenerated fibers of cellulose origin giving them properties similar to the natural cellulose fibers. The synthetic fibers are a large group including common fibers as polyester, polyamide, acrylic and polypropylene as well as more specialized fibers as aramides with extreme tensile strength or very good flame retarding properties.

3 MATERIALS

In this study the sorption isotherm for polyether foam and 6 textile fabrics was determined.

The foam was a 31 mm thick cold cured polyether foam used as padding in a chair seat. The textile fabric were two textiles for home furnishings (cotton calico and warp union linen), and three furniture fabrics ranging from 50% viscose – 50% wool to 100% wool. Table 1 gives the thickness the density and the material composition of the materials.

Table 1. Thickness and density

Material	Thickness (mm)	Density (kg/m ³)
Polyether foam	31	36
100% Cotton	0.4	563
50% Cotton - 50% Flax	0.5	605
50% viscose - 50% wool	1.2	346
15% polyamide - 85% wool	1.0	313
100% wool (felt)	2.5	176

4 METHODS

A sorption balance (DVS 1000, Surface measurements Systems, London, UK) was used to determine sorption isotherms. Sorption isotherms for various materials such as inorganic building materials (Janz and Johannesson 2001; Anderberg 2004; Anderberg 2204), soil materials and food stuff (Arlabosse, Rodier et al. 2003; Wadsö, Svennberg et al. 2004) have been done on the same type of instrument.

The sorption balance is a highly sensitive balance placed in a climate chamber with good climatic control. The RH is generated through a flow of dry nitrogen gas that is divided into two gas streams of which one is saturated with water vapor and the other left dry. By mixing different proportions of the gases, RH between 0 and 98% can be generated. The trueness of RH is 1.0%. The sample is weighed on the instrument balance continuously. The resolution of the balance is 0.1 µg.

From each of the five fabrics a sample 20 mm in diameter was used. The polyether foam was cut into

a sample cube each side being approximately 10 mm. The samples were exposed to step changes from 0% - 95% - 0% RH and the equilibrium moisture content was determined for each step.

5 RESULTS

Figure 1-3 shows the sorption isotherms for the polyether foam (Fig.1), the home furnishing textiles (Fig.2) and the furniture fabrics (Fig.3). Note the scale on the y-axis in figure 1 is only 1/10 of the one used in figure 2 and 3.

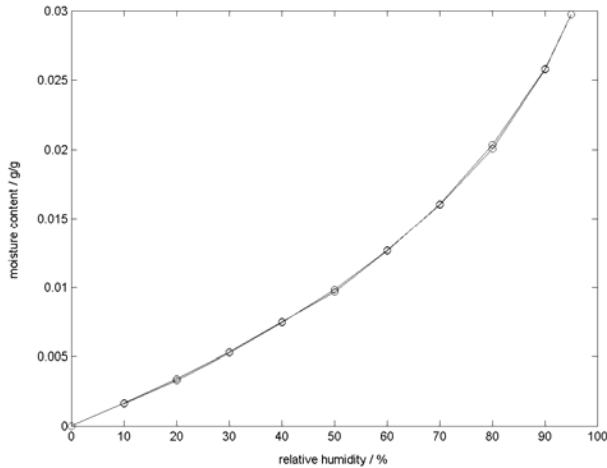


Figure 1. The sorption isotherm for cold cured polyether foam (density 36 kg/m^3). Note the scale on the y-axis.

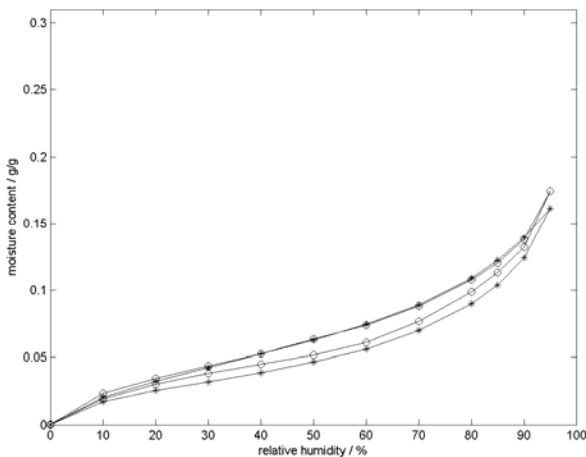


Figure 2. The sorption isotherms for (o) 100% cotton fabric (plainweave, density 563 kg/m^3) and (*) 50% cotton - 50% flax (plainweave, warp linen union, density 605 kg/m^3).

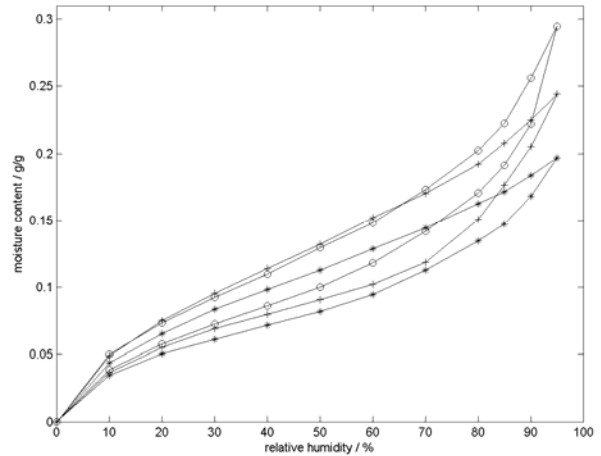


Figure 3. The sorption isotherms for (o) 50% viscose - 50% wool (plainweave, density 297 kg/m^3), (*) 15% polyamide - 85% wool (twisted together, jacquard weave, density 313 kg/m^3) and (+) 100% wool (felt, density 176 kg/m^3).

6 DISCUSSION

The polyether foam has a low moisture uptake and shows no hysteresis.

The two textiles for home furnishing show very similar sorption isotherms. The pure cotton fabric shows a larger hysteresis.

The highest equilibrium moisture content at high RH was found for the 50% viscose- 50% wool fabric, followed by the pure wool fabric and the wool fabric mixed with 15% polyamide. In the lower RH regions the viscose-wool mix and the pure wool look very similar. The polyamide-wool mix had a slightly lower moisture uptake for the lower RH compared with the other two furniture fabrics. The three wool mixes show the expected differences since viscose fibers have a larger moisture capacity than the wool fibers (Reis 2003). On the other hand the polyamide fibers have a lower moisture capacity. The mix of wool and man-made fibers seem not to affect the hysteresis.

The home furnishing fabrics have, as expected, a lower moisture uptake than the wool-mix fabrics (Reis 2003).

I plan to continue this study to determine sorption isotherms for textile materials. A special interest will be paid to bed materials both mattresses and bedding fabrics. I will also extend the study to include the determination of moisture transport properties for textile materials.

ACKNOWLEDGEMENTS

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