Microporous and Mesoporous Materials 163 (2012) 76–84

Contents lists available at SciVerse ScienceDirect

Microporous and Mesoporous Materials

journal homepage: www.elsevier.com/locate/micromeso

Influence of geometrical structure on sorption isotherms of Jersey and yarns made of cotton at two temperatures

N. Bhouri [a,b,*], S. Bennasrallah [b,c], P. Perre [a]

[a] LERMaB, Agro PARIS TECH-ENGREF, 14, rue Girardet, 54042 Nancy Cedex, France
[b] LESTE, ENIM Avenue IBN ELJAZZAR, 5019 Monastir, Tunisia
[c] CRTE, Centre de Recherche et des Technologies de l'Energie, Technopôle de Borj Cedria, Tunisia

ARTICLE INFO

Article history:
Received 9 February 2011
Received in revised form 17 April 2012
Accepted 5 July 2012
Available online 17 July 2012

Keywords:
Sorption isotherms
Magnetic suspension balance
Jersey
Cotton
Hysteresis

ABSTRACT

This paper presents comparison between sorption isotherms of a Jersey knitted fabric and frayed yarns which constitute. An experimental device, built around a magnetic suspension balance, was conceived to determine the sorption kinetics. This device is used to measure the moisture content of bleached textile samples made of cotton at temperatures of 25 °C and 35 °C. The results show coincidence between adsorption and desorption isotherms of knitted fabric and frayed yarns at weak humidity. The difference between sorption isotherms of the two samples, at high humidity, is explained by geometrical consideration. The knitting infects the swelling of yarns then it decreases their sorption capacity. BET and GAB models are used to fit experimental results.

Published by Elsevier Inc.

1. Introduction

Since the clothing materials ensure a maximum of comfort to human bodies, they should have a high moisture retention capacity and high moisture transportation properties, to maintain a constant temperature and humidity between skin and fabric [1–3]. Cotton, composed essentially on cellulose, is very hydrophilic textile fiber [4–6]. It was used in several forms such as flocks in hygienic products; yarns at embroideries and absolutely ready to wear clothing in form of woven or knitting fabrics [7–12]. Nevertheless, moisture changes the physical properties such as density, shape, stiffness and crystal structure of the fibers [13,14]. Indeed, the adsorbed moisture causes a swelling of the fibers [15]. Mechanical properties, e.g. fiber–fiber friction [16], tensile modulus [17] and stress cracking [18,19] are also altered by adsorbed water. This strongly affects the general dyeing behavior of the fibers, the finishing processes of textiles, e.g. resin-coating treatment, and the wrinkle resistance of the structure.

Many works studied the coupled heat and mass transfer phenomena in woven fabrics using laws of the water transport [20–22] and the steam's adsorption/desorption phenomena [23–25]. Few of them were interested in the modeling of the sorption's kinetics to determine the steam diffusion in textile materials [26–29]. Others were interested in the modeling of the adsorption and the desorption isotherms to study the evolution of the sorption hysteresis according to the temperature [30,31] the product structure [32,33] or the material's history [34]. Nevertheless, literature remains poor concerning technological properties such as shrinkage or swelling according to hygrometric variations [35–37]. This field of interest is widely treated in case of others hygroscopic materials such as wood [9,18,38], concrete [39,40], or agro alimentary materials [32,34,41,42].

In this paper, the sorption isotherms of knitted fabric and the frayed yarns made of the same bleached cotton are determined and compared for different relative humidities at temperature of 25 °C and 35 °C. The GAB and BET models will be used to fit the experimental curves by a developed program using inverse method. The parameters of two models will be compared.

2. Experimental set-up

2.1. The magnetic suspension balance

A schematic representation of the device is depicted in Fig. 1. The balance and the electromagnet are completely disconnected from the measuring cell in order to avoid disturbance that may be generated by high values of temperature and pressure [43,44]. The balance and the upper part of the electromagnet are in an ambient environment. It is coupled to a permanent magnet placed inside

* Corresponding author at: LESTE, ENIM Avenue IBN ELJAZZAR, 5019 Monastir, Tunisia. Tel.: +216 97 23 85 15/+33 (0)3 83 39 68 00; fax: +216 73 50 15 97/+33 (0)3 83 30 22 54.
E-mail address: bhourinaoufel@yahoo.fr (N. Bhouri).

1387-1811/$ - see front matter Published by Elsevier Inc.
http://dx.doi.org/10.1016/j.micromeso.2012.07.024

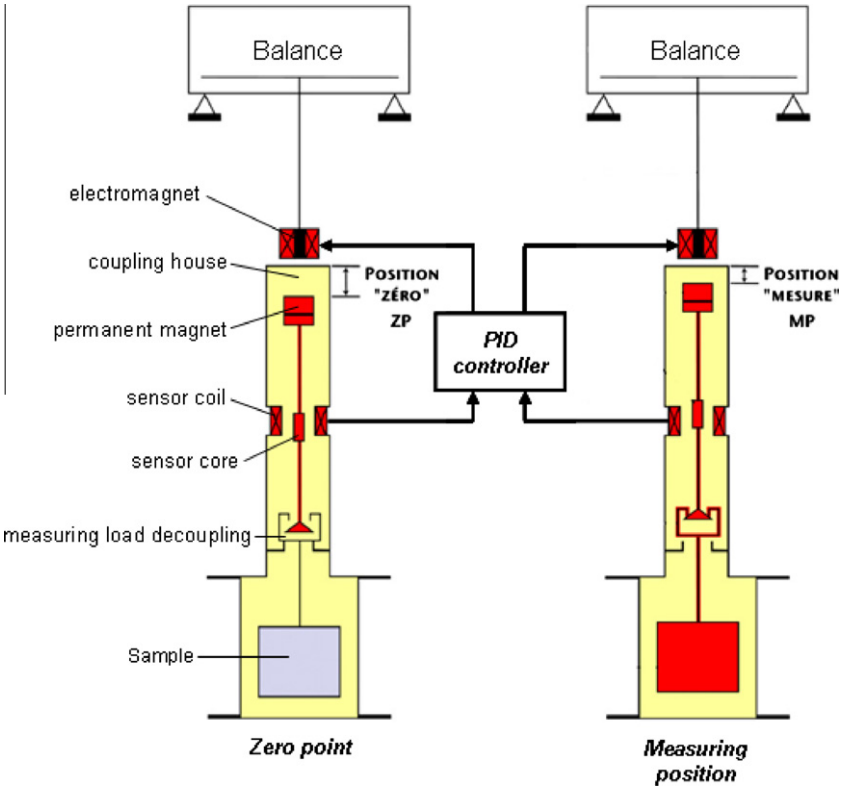

Fig. 1. Schematic representation of the magnetic suspension balance.

the measuring chamber which is therefore at the experimental temperature. The force change during the adsorption or desorption process is transmitted from the measuring chamber to the analytical balance by magnetic suspension. The position of the permanent magnet is kept constant by a regulation system including the sensor coil and the sensor core, which detects the position of the perma-

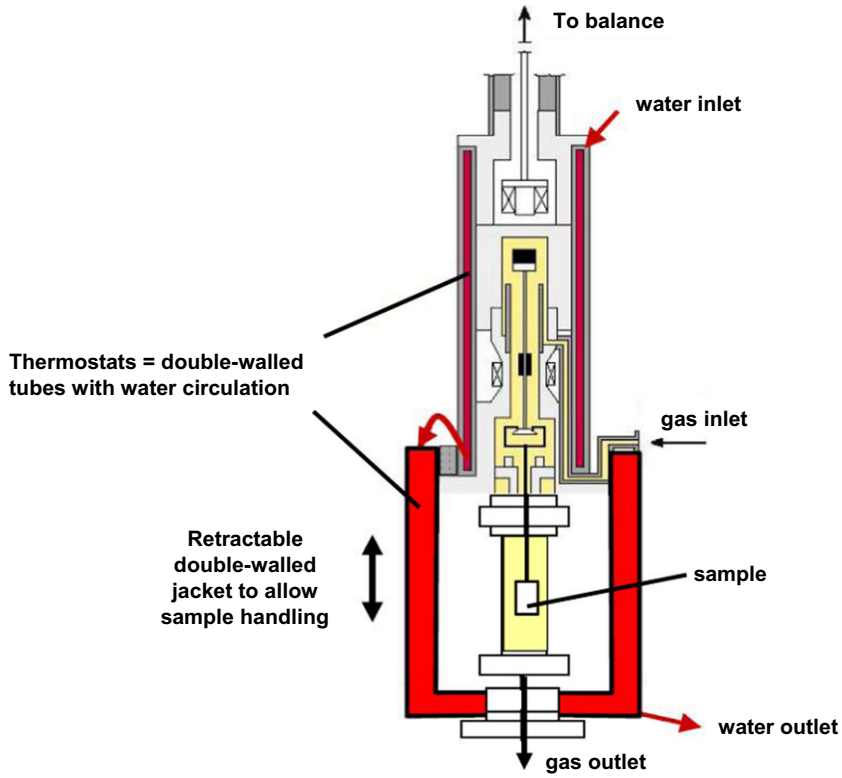

Fig. 2. Double-walled tubes system with water circulation used to ensure isothermal conditions of the measuring chamber and to avoid any condensation.