

Study on Model of Heat and Moisture Transfer of Fractal Polyesters

Jiquan Fu*, Tianwen Chen

Beijing Institute of Fashion Technology, Beijing 100029, China

Abstract

The dynamic moisture absorption of fractal polyester was studied at a constant temperature (30°C) and humidity (80% RH). The model of heat and moisture transfer was then built based on the heat and mass transfer theories. Finite element method was used to solve the model. By comparing the moisture absorption predicted by the mechanism model and the experimental data, we concluded that variations trend of both were consistent. Besides, fields of temperature and humidity with different thickness of fractal polyester were predicted and analyzed by this model.

Keywords: Fractal Polyester; Moisture Transfer; Model; Humidity Field

1 Introduction

In recent years, researchers make great effort to develop fractal fibers in order to essentially make it surpass the nature fibers. Researchers from America and Japan have been studying the fractal structure of fibers, which is related to the correspondence between similarities of convex-concave structure on fiber surface and the shade in the nature [1]. The fractal polyester developed by Professor Xushan Gao imitates some characteristics of nature fibers. Its natural twist is a kind of fractal structure besides the oriented crystallization indicated by winding tension in the process of fractal polyester forming, with some induced crystallization caused by other conditions which was added in the process. The condition of necking position was controlled to form a 7×21 nm nano crystal structure. It's a nanoparticle gene, which can cause twists. According to fractal theory, it can scale-up 104 times on a self-similarity basis, which creates fractal twists from inside to outside (which extremely similar to twists of nature fibers). As a result, it can easily shape a “dragon wrapped around column” structure in blending fiber, which makes the synthetic fiber to essentially achieve nature structure.

Heat and moisture transfer performance of the “dragon wrapped around column” textile (fractal polyester for short) made of fractal polyester and differential fiber is one of the focal points in this study. Mass production of the fractal polyester provides a guarantee for the study of material performance. Stressed on the heat and moisture transfer model of fractal polyester, this paper

*Corresponding author.

Email address: fujq010@sina.com (Jiquan Fu).

aims to develop a model which can reveal transfer performance objectively, which has a great value to adjust the fabric structure further and develop new types of fractal polyester fabrics.

2 Experiments

2.1 Materials

Plain weave fractal polyester fabric (30% fractal polyester and 70% viscose) was provided by Beijing top new group. Its main parameters are shown in Table 1. Fabrics were purified by acetic ester solution to remove impurities such as oily wax, and then it was washed by soap bath and warm water, dried and gone through setting before it was used for this study.

Table 1: Main Fabric Parameters

Name	Structure	Thickness (mm)	Count (tex)	Area Density (g/m ²)
Polyester Fabric	Knitting	1	50D/40	196

2.2 Instruments and Equipments

A Temperature Humidity Test Chamber, (type: SDH05011) was used to do the experiments, which has the following technical features:

- (1) Precision of temperature measurement: $\pm 0.3\%$ F.S.
- (2) Precision of humidity measurement: $\pm 0.5\%$ F.S (Room Temperature between 20°C and 90°C).

2.3 Methods

Experimental Methods: According to GB/T9995-1997 “Determination of moisture content and moisture regain of textile-Oven-drying method”, low temperature humidity test chamber method was adopted to measure moisture absorption of fibers. Based on low temperature humidity test chamber, self-made moisture testing system was employed to measure dynamic moisture absorption of fabric. Conditions: temperature 35°C, wind speed 0.4 m/s, humidity RH80%.

Calculation method of fabric moisture content: Weigh the dry weight of fabric after baking in the oven for 2.5 hrs, label as W_0 , then put the fabric in the given condition, and record the value W on the electronic scale every 10 minutes. The formula of fabric moisture content is:

$$\text{Moisture content} = \frac{W - W_0}{W} \times 100\%$$