Fibers and Polymers 2008, Vol.9, No.1, 97-100

Study on the Wicking Property of Polyester Filament Yarns

Ni Wang*, Anxia Zha[1], and Jinxiu Wang[2]

College of Textiles, Donghua University, Shanghai, 200051, China
[1]*Nanjing Institute of Industry Technology, Nanjing, 210046, China*
[2]*Wuhan University of Science and Engineering, Wuhan Hubei, 430073, China*
(Received October 16, 2006; Revised November 3, 2007; Accepted November 19, 2007)

Abstract: In this paper, the capillary rise method was applied to evaluate the wicking property of polyester filament yarns. Effects of twist, monofil cross sectional shape and texturing on the wicking height were discussed in details. The results indicated that with the increase of twist level, the wicking height ascends until reaching the maximum height, and then descends. It is also observed that under the same twist level, the wicking height of the five-leaf low-stretch yarn is the largest among all those three kinds of yarns, and then is that of the conventional low-stretch yarn. The wicking height of the parallel-drawn yarn is the smallest.

Keywords: Wicking, Polyester, Yarns

Introduction

Heat and moisture transition is one of the most important factors that affects both the comfort and wash-wear of textiles for apparel. It has long been assumed that a fiber that absorbs moisture tends to be more comfortable than a fiber that does not absorb moisture. Thus, in many articles, the moisture absorbencies of fibers, yarns or textiles related to their comfort have been stressed. With the development of the comfort theory, people have realized that the relationship between moisture and comfort is more complex than that. The moisture transition is as important as absorption, especially for underwear and sportswear. When the metabolism is very high, perspiration like water spreads all over the skin, in this case, if the clothes worn could not transfer the perspiration outside for evaporation, people would feel very uncomfortable no matter in winter or summer. This is perhaps one of the reasons for the coming forth of the fibers like Coolmax™ and other similarity fibers, which have very low moisture regains, but are perceived as being comfortable to wear because of wicking.

To yarns, as the semi-finished product between fibers and fabrics, their moisture transition property play an important role on that of the fabrics and Wicking is often employed to express the moisture transition of yarns. There are three methods to study the wicking properties. The first one can be performed on yarns kept vertically with the lower end immersed in liquor, a spontaneous wicking would occur due to capillary penetration and the adsorption height is recorded as a function of time and the absorption rate is calculated [1]. The second one consists of weight variation measurement by a Wilhelmy balance during capillary wicking [2,3]. The last one is using image analysis technique, which was recently used to study the capillary rise in polyester yarns and was used to determine the influence of yarn torsion on the liquid distribution [4]. In this paper, the first simplest capillary rise method was applied to evaluate the effect of twist, cross section and texturing on the wicking property of polyester filament yarns.

*Corresponding author: wangni@dhu.edu.cn

Experimental

Materials

The yarn samples used were: Two kinds of false twisted polyester filament yarns, one with five-leaf cross section illustrated in Figure 1 and the other with circular cross section, parallel-drawn polyester filament yarn with circular cross section. Linear density of those yarns mentioned above was the same as 334 dtex/144 f. Before twisted, the yarns were washed with aqueous detergent solution to remove any remaining finishing oil, then thoroughly rinsed and dried in air.

Twisting

For twisting, small laboratory equipment Y331 twist tester was utilized. Under the conditions that the pre-tension is 9.8 cN and the clamp distance is 700 mm, the yarns were

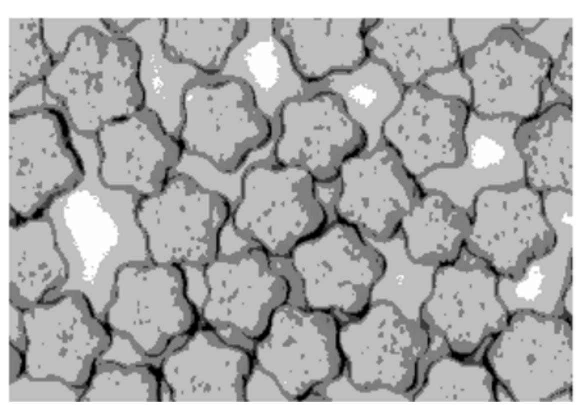

Figure 1. Five-leaf cross section of the monofil in yarns.

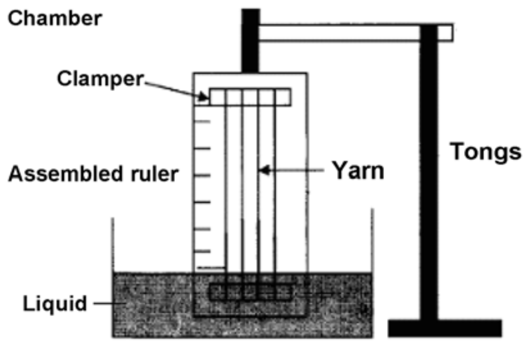

Figure 2. Capillary rise measurement.

twisted with twist levels as 0,42,83,125,167,208,250,292, 333,375,475,575,675,775,875,975,1075 and 1175 twists per meter respectively.

Cross Sectional Shape

The cross sectional shapes of the monofilament in the three yarn samples are two kinds, one is five-leaf cross section as shown in Figure 1, and the other is circular cross section.

Texturing

The yarn samples with five-leaf cross section and circular cross section are all false twisted with the same processing parameters and equipment.

Capillary Rise Measurements

For capillary rise measurement, YG (B) 871capillometer was utilized. The samples were placed vertically with the lower end dipped in a thin layer of a diluted potassium chromate aqueous solution (0.5 percent, about 0.01 m high) as shown in Figure 2. The capillometer was set in a closed chamber in order to keep a saturated vapour atmosphere.

Potassium chromate was chosen instead of the usual dye solution since the potassium chromate is an inorganic salt without affinity toward synthetic fibers. The yellow coloration of chromate solution on white yarns clearly indicated the height of capillary rise, and a ruler marked off in millimeters assembled along the yarn can make the height measurement easier. Height readings were recorded 30 minutes after the yarns dipped in the liquid. Each measurement was carried out 5 times and the average height values were regarded as the final results.

Results and Discussion

Effect of Twist on the Wicking Property of Yarns

Some results of wicking height or capillary rise in polyester filament yarns at various twist levels are reported in Figure 3 as wicking height vs. twist. Evidently the effect of twist levels on wicking property of these three kinds of polyester filament yarns shows the same tendency. That is with the

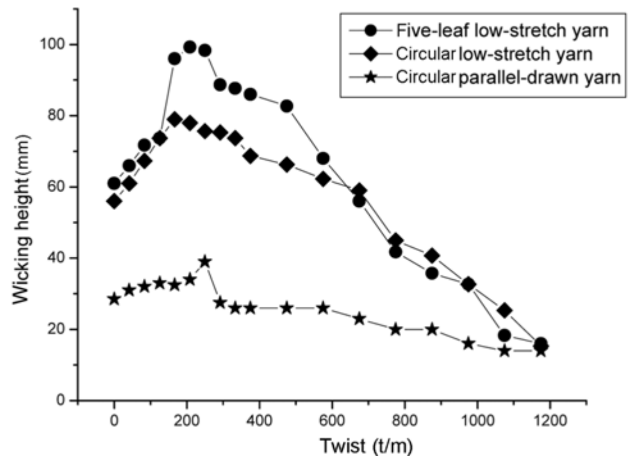

Figure 3. Effect of twist on wicking height of yarns.

increase of twist, the wicking height ascends until the maximum height is reached, then it descends with the increase of the twist. For different yarns, the twists corresponding to the maximum wicking height are different too.

Wicking is the property of keeping the liquid migration in the capillary pores. That is also means water molecules ascends along the capillary pores formed between the surface of fibers and emanating water drops at the other end [5]. To yarns, their wicking property is very complex, which is determined by the fiber parameters, liquid characteristics and yarn structure [6].

According to the Hagon-poiseuille's law, the rate of liquid capillary rise in porous media is given by:

$$\frac{dh}{dt} = \frac{R_D^2}{8\eta} \cdot \frac{\Delta P}{h} \tag{1}$$

where h is the height reached by the liquid at time t, R_D is the mean hydrodynamic radius of pores, η is the viscosity of the liquid and ΔP is the pressure difference.

For vertical wicking with gravitational effect, ΔP can be expressed by:

$$\Delta P = \frac{2\gamma\cos\theta}{R_S} - \rho g h \tag{2}$$

where γ and ρ are the surface tension and density of the liquid. θ is the advancing contact angle of the liquid on the solid, g is the acceleration due to gravity and R_S is the mean static radius of the pores.

Substituting the capillary pressures into the Hagon-poiseuille's equation, the vertical wicking equation becomes as follows:

$$\frac{dh}{dt} = \frac{R_D^2}{8\eta h} \cdot \left(\frac{2\gamma\cos\theta}{R_S} - \rho g h\right) \tag{3}$$

In the early stages of the process, the hydrostatic pressure in equation (2) can be neglected and equation (1) yields by integration the Washburn's equation: