

Development of Regenerated Polyester Flash Ultraviolet Resistant Fabric

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Abstract: *The characteristics of renewable polyester and the production points of developing renewable polyester flash ultraviolet resistant fabric are discussed. This paper introduces the production characteristics of weft of warp and weft yarn and analyzes the twist direction. Through reasonably adjusting the technological parameters of winding, double twisting and setting, the slitting warping is adopted to properly increase weaving*

Keywords: *recycled polyester; SPH filament; Fabric weave; Weaving process; Dyeing and finishing; flash of light; UV protection*

1. Introduction

According to the statistics of the China Chemical Fiber Industry Association, the total output of polyester in China from 2018 to 2022 was 40.1487 million tons.^[1]The polyester fiber has high strength, good heat resistance, high acid and alkalinity resistance, and is widely used in the fields of clothing, shoes and hats, medical treatment, construction and national defense. However, due to the environmental pressure and environmental investigation in recent years, the waste of resources and environmental pollution caused by polyester waste and waste clothing are also becoming increasingly serious. China's waste textiles exceed 20 million tons every year, but the recovery rate is less than 10%, and the stock of waste polyester has exceeded 100 million tons. The International Bureau of Recycling (BIR) and related research show that every 1 kg of waste textile can reduce the use of 3 kg of oil, 3.6 kg of carbon dioxide emissions, 6000 L of water, and 0.3 kg of chemical fertilizer and 0.2 kg of pesticide. Therefore, strengthening the recycling and reuse of waste textiles not only has a very important contribution to building a resource-saving and environment-friendly society, but also has a positive role in promoting the healthy and sustainable development of the textile and chemical fiber industries. At present, the physical method accounts for about 80% in China, and still plays a leading role in the commercial recycling of waste polyester.^[2]Although the chemical recovery method is more conducive to the improvement of product quality and theoretically can realize the complete recycling in the real sense, it also faces the challenges of economic benefits, raw material supply and processing technology. At this stage, polyester is faced with the problem that waste clothing cannot enter the market, the recovery method is insufficient, and the sorting and other processes rely on more labor, so there is less research on the development of new materials. The corresponding research abroad has entered the high-end market development.

Regenerated polyester refers to the renewable polyester fiber made from waste polyester bottle chips after crushing, cleaning and melting spinning, which is a renewable resource and has great advantages for environmental protection. It saves about 80% of energy compared with conventional polyester fiber, and has broad prospects. Based on recycled polyester, this paper discusses how to weave flash anti-UV fabric with recycled polyester diamond yarn and recycled polyester triangle bright anti-UV FDY as warp yarn and recycled polyester semi-light SPH as weft yarn. The finished product not only has the glittering visual effect like diamonds, but also has the anti-ultraviolet function, which is suitable for high-end leisure clothing.

2. Material performance

2.1. Characteristics of renewable polyester material

The strength of recycled polyester is one time higher than that of cotton, its heat resistance can be

used at 70-1700 °C, its heat resistance and stability are good, its elasticity is close to wool, its wrinkle resistance is higher than other fibers, and its wear resistance is second only to nylon in synthetic fibers. Renewable polyester has poor water absorption. Its dyeing performance is poor due to large static electricity. Renewable polyester materials have low strength, high acid and alkalinity stability, high temperature resistance and light texture. The dimensional change rate, tear strength and breaking strength of the fabric in the weft direction are lower than those in the warp direction; With the increase of recycled polyester content, the warp and weft directions of the above three properties gradually decrease. Compared with the original polyester fabric, the warp and weft dimensional change rate of 100% recycled polyester fabric is less than 1%, which is better than 2.2% and 2.9% of the original polyester fabric; However, the weft tearing strength and breaking strength are about 20.33% and 79.36% of the weft direction of the original polyester fabric, and the warp tearing strength and breaking strength are about 36.58% and 90.72% of the warp direction of the original polyester fabric. The reason may be that the original polyester has better crystallinity and orientation properties than the recycled polyester. The seam slip performance of the fabric is not significantly different from that of the recycled polyester fabric and the original polyester fabric in different proportions, no matter in the warp or weft direction, which indicates that the recycled polyester fabric and the original polyester fabric have little difference in the use performance. Compared with low concentration of alkali, the tear strength and breaking strength of polyester memorylike fabric decreased to a certain extent after high concentration of alkali treatment. With the increase of the proportion of recycled polyester, the tear strength and breaking strength decreased after the alkali concentration treatment under the same conditions. The same kind of polyester memory-like fabric has no change in seam slip after low and high concentration alkali treatment; The test results of fabrics with different proportion of recycled polyester are similar to those of original polyester, indicating that alkali treatment has little effect on the seam slip property of fabrics.

2.2. Recycled polyester flash anti-ultraviolet fabric

In order to make recycled polyester flash anti-UV fabric have special functions and unique appearance style, recycled polyester with different properties is selected as warp and weft yarn respectively. Diamond yarn is a kind of bright flat fully drawn yarn with a flat cross section and a glossiness superior to conventional FDY, with a strength of 3.81 cN/dtex and an elongation at break of 18.2%. Shiny profiled fiber is an important variety of differentiated fiber, among which triangular profiled fiber can produce silk luster, and inorganic ceramic particles with anti-ultraviolet function are added into polyester, which has a high degree of application in China's clothing field. Weft yarn SPH filament is a crimped elastic fiber made by juxtaposing PTT and PET with different thermodynamic properties. Its elastic durability, dyeability and color fastness are better than those of spandex. It is considered as an ideal raw material to replace spandex. The polyester semi-gloss SPH specification selected in this paper is 80 D/24 F, strength is 3.23 cN/dtex, and elongation at break is 40.8%.

2.3. Performance analysis

The developed regenerated polyester flash anti-UV fabric was tested, and the main index test results were as follows: 347 warp density/10 cm, 126 weft density/10 cm; Dimensional stability of warp washing - 1.7% and weft washing - 1.8%; The warp breaking strength is 442 N, the weft breaking strength is 312 N, the warp tearing strength is 16.3 N, and the weft tearing strength is 15.8 N; Class 4 pilling; The color fastness to light, water, soaping, perspiration (acid and alkali), dry cleaning, heat pressing, saliva and rubbing are all 4 to 5 grades; The tidal pressure and wet pressure are both of grade 4; pH 6. 6; Formaldehyde content is not detected; UPF value 100+, T (UVA) 0.50%. According to the experimental date the relevant properties of the developed fabrics can meet or exceed the requirements of the standard value according to the requirements of the first class of GB/T 17253-2018 Synthetic Fiber Silk Fabrics, Class A of GB 18401-2010 National Technical Code for Basic Safety of Textile Products, and GB/T 18830-2009 Evaluation of Ultraviolet Protection of Textiles.

3. Key points of product technology

3.1. Production process flow

Technological process: winding → double twisting → setting → warping → weaving → dyeing and finishing → inspection.

Processing equipment: SF858 high-speed computer winding machine, QZD full-automatic vacuum setting steamer, SHGA218 high-speed slitting warping machine, HW5012-230 water jet loom, XH-800 loose alkali deweighting machine, STF3 2HT high temperature and high pressure air flow dyeing machine, MEGATE setting machine.

3.2. Key points of weaving preparation process

After data investigation, the winding process parameters are: speed 800 r/min, winding tension 29.4 cN, winding length 780 m. The spindle speed of the twister is 10 000 r/min. The setting process parameters are: temperature 95 °C, time 90 min, initial vacuum 0.07 MPa. Due to the different twist, variety and twist direction, split warping is adopted. In order to ensure the uniform tension, winding and arrangement of the sheet yarn, a one-time drum change is adopted, the warping speed is 85 m/min, and the warping tension is 14.7 cN.

3.3. Weaving process

Due to the characteristics of small warp and weft yarn fineness and large warp density, as well as the severe friction of warp yarn, the opening is clear and the fabric flash effect is good, so the water pressure of the water jet loom should be appropriately increased. The technological parameters of weaving process are: loom speed 530 r/min, heald leveling time 320°, opening travel 100 mm, back beam height 2 grids, heald frame height 100 mm; The number of buffer spring coils is 9, and the water pressure is 333 Pa.

3.4. Dyeing and finishing process

In order to improve the overall performance and appearance of recycled polyester flash anti-UV fabric, the post-finishing process is as follows: scouring → pre-shaping → alkali reduction → dyeing → setting. The oil stains on the fabric can be removed by scouring, and the change and shrinkage of the fabric can be initially produced. The scouring method is machine cylinder scouring, and the process formula is: soda ash 27.5 g/L, deoiling TF101 1.5 g/L, hydrogen peroxide 4 g/L. In order to consider the instability of the fabric, during the process of the rise and fall of the straight crepe on the surface of the scouring fabric, the treatment is returned to the cylinder for proper heat preservation. In addition, it is necessary to consider that the cloth surface should be fully cleaned during the washing process to prevent the formation of color spots due to the residual alkali that may affect the temperature rise dyeing of subsequent work. In production, the intermolecular force in the fiber can be eliminated and the fabric width stability can be improved by pre-shaping. The pre-defined process parameters are: temperature 200 °C, speed 41 ° 45 m/min, fan speed 1200 r/min. The handle of the shaped fabric is relatively hard, so the expected setting can be improved by alkali deweighting. The survey data showed that the process parameters needed for alkali reduction were: caustic soda 10 g/L, accelerator ADP 1.0 g/L, temperature 90 °C, time 2.0 h. High-temperature and high-pressure air flow dyeing uses high-speed air flow to atomize the dye, which improves the kinetic energy and permeability of the dye molecules, significantly improves the advantages, greatly reduces material consumption and dyeing time, improves the levelness of the product, and is not easy to produce dyeing creases and color flowers.

After high temperature and high pressure air flow dyeing, the width of the fabric will shrink to a certain extent. In order to obtain the finished product with stable size, good handle and anti-static effect, it is also necessary to carry out setting processing. The setting process parameters are: antistatic agent GH-580 20 g/L, softener H-432 10 g/L, temperature 180 °C, speed 40 m/min.

4. Clothing application design

In the research and development of new materials, design and other related fields have been developed at home and abroad, and their applications are extensive^[3].

It is applied to umbrellas, sports equipment and clothing accessories, which greatly increases its utilization rate and conforms to the advantages of environmental protection. Recycled polyester has high oil content, high rigidity, and lower strength and heat resistance than ordinary polyester, which brings some difficulties to the subsequent processing. The dyeing color of recycled polyester is not as bright as that of ordinary polyester, and the existing dyeing process risks are high. Through fabric

research, this paper improves and increases its specific properties, which has certain advantages for the development of design products. This study shows that this material can be widely used in the production and development of clothing products. The product designed in this paper is positioned as high-end leisure clothing. In consideration of the requirements of the fabric's tightness, surface density and elasticity, the strong twist warp and weft yarn is used with the random hemp weave to make the fabric wrinkle naturally. In order to highlight the characteristics of diamond yarn and triangular profiled yarn in the design, and to better realize the complementary advantages of different raw materials, and ensure the weaving efficiency, after repeated tests and conclusion inspection results and optimization, the final selection of two kinds of warp yarns is 5:2.

4.1. Impact on clothing materials

Regenerated polyester flash anti-UV fabric can have specific color changes according to different external stimuli, so it can sense the specific environment. When using recycled polyester flash anti-UV fabric for clothing design, we should make full use of this feature. At the same time, different occasions have different requirements for clothing styles,^[4] and designers should also take this into full consideration when designing such clothing. For example, in eye-catching and striking vision. When designing this kind of clothing, designers should not only use the color-changing characteristics of color-changing fiber materials, but also use the clothing required for the catwalk, stage and other occasions only to watch, display or highlight the stage effect. Whether this kind of clothing is comfortable and fit does not need too much consideration. Therefore, the design of clothing needs to be bold, eye-catching and unique to absorb and match this feature with the clothing style, give full play to the uniqueness of recycled polyester flash anti-ultraviolet fabric, thus producing a strong visual feeling. When designing sportswear, relative to the style of such clothing, comfort and wearability are the links that designers must consider.

The fiber of this kind of clothing is added and fused with thermo-sensitive liquid crystal material. Compared with other materials, the color change fiber material is less skin-friendly, so its scope of application is small. When using this kind of material for clothing design, designers should not only make full use of its reversible change of color due to external stimulation, but also consider its poor skin-friendly characteristics, especially for clothing close to the human body. More attention should be paid to the safety and stability of color-changing fiber materials to avoid human injury. When using color-changing fiber materials for clothing design, designers should not only fully combine the relevant characteristics of such materials, but also design different styles according to different applications, so as to meet people's various requirements for clothing. In addition, we can also carry out the development and join our country to study the photochromic acrylic yarn.^[5]When it is applied to clothes, it will change the color when the external light source changes. Japan has developed a photochromic dye, and the color of clothes after dyeing will merge with the scenery in the surrounding environment. In addition, a Japanese company produced a color-changing fiber material. The color of the material is white when it is dry, but it will be colored when it is wet, and the color change is reversible. Combining it with the color-changing paint in the printing paste, it can be used for the design of bathing, swimwear and other clothing,

4.2. Design renderings

The design rendering is shown in Figure 1.



Figure 1: Design hand.

4.3. Design description

In this design,^[6] recycled polyester flash anti-UV fabric is fully considered. The material properties are fully considered. In the design, the Star River element is used to maximize the material advantages, which not only expresses the concept of ocean and biology, but also fully demonstrates the flash characteristics of the material. From the design and application, we want to fully express our call for environmental protection,^[7] and we should pay attention to the development and application of new materials.

5. Conclusion

In this paper, the research and analysis of renewable polyester yarn, renewable polyester diamond yarn and renewable polyester triangle light anti-UV FDY as warp yarn, and the development of flash anti-UV fabric with renewable polyester semi-light SPH as weft yarn are carried out, and the key technologies are investigated. It is analyzed that the combination of warp and weft yarns with different twist direction and twist will help to form the "visual difference" of the reflective effect and highlight the flash effect of the fabric; It greatly increases its artistry and design, and selects the random weave to highlight the flash effect and elastic wrinkling effect; In order to ensure the characteristics and stability of the two kinds of warp sheets, the yarn tension is uniform, the winding is uniform, and the arrangement is uniform; In order to make the opening clear and make the fabric flash better, the investigation shows that the water pressure of the water jet loom can be appropriately increased; Scouring can remove oil stains on the fabric, pre-shaping process can improve the width stability of the fabric, and alkali deweighting process can improve the feel of the fabric;^[8] After high temperature and high pressure air flow dyeing and setting processing, the fabric with properties meeting the requirements of relevant national standards is obtained. The research can fully show that this material can be used to make high-grade leisure clothing and its design application.

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