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Fabric Preparation of Stab-Resistant Functional Clothing

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Abstract: As a kind of protective clothing, anti-stab clothing is also known as anti-knife clothing, which has the functions of anti-cutting, anti-stabbing, wear resistance and anti-theft. Ultra-high molecular weight polyethylene (UHMWPE) has good wear resistance, tear resistance, cutting resistance, impact resistance, light resistance and other excellent properties, can resist acid and alkali corrosion, continuous friction, UV resistance, in various harsh environments It can withstand the test and is one of the high-quality fibers commonly used in stab-resistant clothing. In this paper, ultra-high molecular weight polyethylene (UHMWPE) is mainly used to prepare high-strength knitted fabrics and woven fabrics. Plain, twill and satin fabrics are used in woven fabrics, and 1+1 rib and plain knitted fabrics are used in knitted fabrics.

1 Introduction

Stab-proof clothing, also known as knife-proof clothing, has the functions of preventing knife cutting, preventing knife stabbing, abrasion resistance and preventing theft to a certain extent. As a kind of protective clothing, stab-resistant clothing is a clothing that can effectively protect the human body from common sharp instruments such as daggers and bayonets, provide the wearer with safer protection, and improve the defense capabilities of human body parts[1-3] . As a multi-functional protective clothing, stab-resistant functional clothing not only needs to meet its functionality, but also needs to ensure the convenience and comfort of the wearer, which puts forward higher requirements for the performance of the fabric. So far, para-aramid, UHMWPE, PBO and metal fibers are important fiber materials for making stab-resistant clothing. The puncture-resistant fabric must be able to resist extrusion and cutting effects, so the stab-resistant material must have high strength, High modulus, shear and impact resistance [4-6]. Ultra-high molecular weight polyethylene fiber (UHMWPE) is the fiber with high specific strength and specific modulus in the world, and it is also one of the high-performance fibers commonly used in stab-resistant clothing [7-8], the fabric made of UHMWPE fiber has good anti-puncture and anti-cut performance, and has the characteristics of good softness, light weight and good wear resistance. Compared with other puncture-resistant materials, using UHMWPE as clothing fabrics has higher

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comfort and durability[9]. In this study, ultra-high molecular weight polyethylene was used to prepare high-strength woven fabrics and knitted fabrics, and then the relevant properties of the prepared knitted fabrics and woven fabrics were tested and analyzed.

2 Performance comparison of yarn raw materials

Different types of yarn raw materials have very different properties of the resulting fabrics. However, high-strength stab-resistant fabrics should be wear-resistant, corrosion-resistant, and stab-resistant. Therefore, high-performance fibers with high strength, high modulus and good shear resistance should be selected. The following table 2-1 and table 2-2 are the comparison of the processing properties of several high-performance fibers and the performance comparison of the main special fibers.

Table 2-1 Comparison of processing properties of several high-performance fibers

Variety / Processability	UHMWPE	Yoshin29	Yoshin49	Carbon fiber (high strength)	Carbon Fiber (High Modulus)
Bending resistance	>240×10³	3.7×10³	4.3×10³	5	2
Durability	>110×10³	9.5×10³	5.7×10³	20	120
Collusion strengt（g/d）	10—15	6—7	6—7	0	0
Ringing strength（g/d）	12—18	10—12	10—12	0.7	0.1

Table 2-2 Performance comparison of main special fibers

Mechanical properties of fiber varieties	Density	Strength	Modulus	Elongation
UHMWPE fiber	0.97g/cm³	35g/d	1100g/d	2.3%
E glass fiber	2.60g/cm³	15g/d	315g/d	4.8%
Carbon fiber (high strength)	1.78g/cm³	22g/d	1500g/d	1.4%
Carbon Fiber (High Modulus)	1.85g/cm³	14g/d	2400g/d	0.5%
Yoshin	1.44g/cm³	23g/d	470g/d	3.6%
steel fiber	7.86g/cm³	2g/d	225g/d	1.8%

After the comparison of the fibers in Table 2-1 and Table 2-2, ultra-high molecular weight polyethylene was used as the yarn in this experiment, which was purchased from Dongguan Shengmao Special Weaving Technology Co., Ltd.

Basic properties of yarn: yarn linear density: 1000dtex, breaking tension 350N, elongation 3.5%.

3 Fabric preparation

3.1 Preparation of stab-resistant woven fabric

The basis for designing stab-resistant materials is achieved through the mechanical properties of a single-layer stab-resistant woven fabric [10]. In this fabric preparation, three weave structures of plain weave, twill weave and satin weave were set for the preparation of single-layer stab-resistant woven fabrics, and further research on stab-resistant properties was carried out.

3.1.1 Plain weave

Using a semi-automatic prototype loom, the first piece of woven fabric was prepared with a plain weave, as shown in Figure 3-1 below. The two-page heald threading method is adopted. The yarns are threaded through the heddle eyelets of the heald frame one by one in sequence, and then through the steel teeth of the reed. The number of warp yarns threaded into each reed is one. This way of putting on is simple and easy to operate, while also reducing the friction between the yarns.

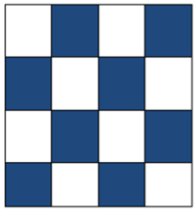

Figure 3-1 Plain weave

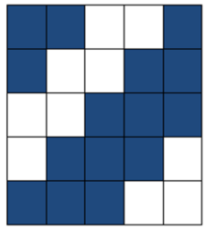

Figure 3-2 Three up and two down right twill

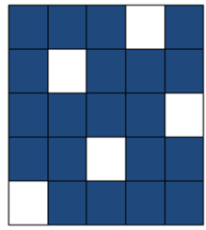

Figure 3-3 Five three-flying warp satin

3.2 Weaving of stab-resistant woven fabrics

During the weaving process, UHMWPE yarn is susceptible to minor damage for some reason, but it does not break the entire yarn. Hairiness tends to form in damaged filaments or fiber surfaces. With the deepening of the weaving process, the adjacent yarns and hairiness are intertwined with each other, causing more damage to the yarn, resulting in serious yarn fluff, which leads to the entanglement of the yarn and the hairiness into a ball, sticking to each other. Together, weaving is not possible. Therefore, in a series of operations of warping, harnessing, reeding, and weaving, it is necessary to ensure that the single strands in the yarn are not hung up or pulled out, and that there is no pilling between the tows. Need to be more careful in this process, and if necessary, take some measures to make the weaving work go smoothly.

3.2.1 Warping

The quality of warping will determine whether the subsequent weaving can be carried out smoothly to a certain extent, so warping should be carried out before weaving. First of all, during the warping process, it is necessary to ensure that the warp yarns are arranged in order and evenly within the width of the fabric, which can reduce the defects caused by warp yarn problems in the subsequent processing. Second, since the warp tension during weaving is determined to a certain extent by the strength of the warping, increased warp tension during warping is required. In this process, because

UHMWPE has ultra-high breaking strength, there is no need to worry about fiber breakage. Finally, the warp length needs to be shortened because when the warp length is reduced, the fluctuations in the warp tension can also be reduced.

3.3.2 Weaving

Since UHMWPE is woven on a semi-automatic sample loom, it is not easy to control at first. There will be some small problems in the process of weaving. First: when the warp yarn tension is not uniform, one or two warp yarns are of low tension and loose, and a certain weight can be placed on the warp yarn with low tension at the rear of the heald frame. , so that the yarn tension is uniform. Second: Due to the relatively large tension of the warp yarn, it will make it difficult to pass through the weft insertion, so pay attention to straightening the weft yarn during weft insertion, and avoid the weft yarn from wrinkling and forming defects.

3.3 Preparation of stab-resistant knitted fabrics

The experimental weaving was set up on the Qili plate making system, and the computerized flat knitting machine (model LXC-252SC 12G) of Jiangsu Jinlong Technology Co., Ltd. was used to weave plain stitch and 1+1 rib weaving.

3.3.1 Plain needle tissue

The plain stitches are set up on the Keeley plate making system before weaving, the number of rows is 206mm, and the total width is 145mm. The following figure 3-4 is the front of the plain needle weave process, and Figure 3-5 is the simulation diagram of the plain needle weave.

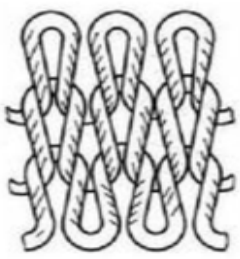

Figure 3-4 The front of the flat needle process needle structure

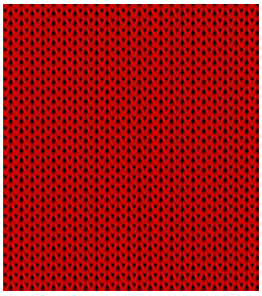

Figure 3-5 The simulation diagram of the flat

3.3.2 1+1 rib weave

The 1+1 rib weave is set on the Keeley platemaking system before weaving, the number of rows is 182mm, and the overall width is 189mm. Figure 3-6 below is the front of the 1+1 rib process, and Figure 3-7 is the 1+1 rib simulation diagram.

Figure 3-6 1+1 Rib Process Front structure

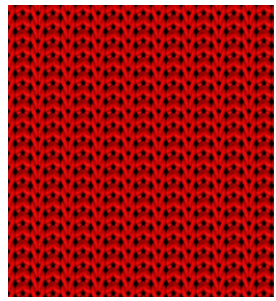

Figure 3-7 Simulation diagram of 1+1 rib

3.4 Weaving of stab-resistant knitted fabrics

After passing the yarn to the No. 3 yarn feeder as required, turn on the machine, import the layout drawing into the machine, set the parameters, set the knitting mesh to 90, and set the row to 60. During the knitting process, there will be problems, such as: the needle is broken due to the high yarn strength. At this time, the machine needs to be stopped, repaired, reloaded, and lubricated, and then continue to start.

4 Conclusion

In this paper, five kinds of fabrics were prepared by using ultra-high molecular weight polyethylene to prepare fabrics, including satin weave, plain weave, twill weave, and knitted fabrics, including plain weave and 1+1 rib weave. The fabric woven by UHMWP has strong wear resistance, and the wear rate is very low, almost all wear, regardless of woven fabrics and knitted fabrics.The following conclusions are drawn, the fabric woven by UHMWPE this time:

(1) It has strong wear resistance, and the wear rate is very low, almost all wear, regardless of woven fabrics and knitted fabrics.

(2) The air permeability of knitted fabrics is better than that of woven fabrics. It is affected by the tightness of the fabrics. The woven fabrics are denser and therefore less breathable.

(3) The softness of knitted fabrics is better than that of woven fabrics, the woven fabrics are stiffer and the softer properties are relatively poor.

(4) The breaking strength of woven fabrics is higher than that of knitted fabrics, and woven fabrics are less prone to breakage.

(5) Affected by the thickness of the fabric, the bursting strength of the knitted fabric is greater than that of the woven fabric.

The woven fabrics made of UHMWPE yarns are more rigid and are used in stab-resistant clothing, and are more suitable for stab-resistant jackets, stab-resistant windbreakers, etc. to be worn on the outermost layer; The knitted fabric woven from UHMWPE yarn is soft and breathable, and is used in stab-resistant clothing, and is more suitable for stab-resistant vests and other clothing that are close to the human body. After experiment and practice, the woven UHMWPE fabric can be used in clothing to achieve the effect of stab-proof.

Acknowledgment

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