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Study on Development and Mechanical Properties of Linen/Nylon Wrap Yarn Weft Knitted Jersey Fabric

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Abstract*:* Linen fabric has the advantages of good moisture permeability, moisture absorption, wearing cool, with the disadvantages of poor quality of keeping shape and poor abrasion performance, we can make wrap yarn by the fine nylon coated on the surface of linen yarn, then to get the knitted fabrics, through the test, the abrasion performance, as well as the performance of strength and shape retention has been greatly improved.

Keywords: linen; wrap yarn; knitted fabrics; abrasion performance

INTRODUCTION

The initial modulus of the linen single fiber is 145~200cN/dtex. The fiber has advantages of good luster, good moisture absorption, moisture conductivity and certain bacteriostasis. However, because linen fibers are rigid, poor elastic with many hemp granules, thus the spinning yarn has poor elasticity and poor abrasion performance, with poor evenness and large surface hairiness, which affects the quality of linen yarn as well as its usage [Wu, *et. al.*, 2007]. Nylon has the advantages of high strength and high resilience. It is the best wear-resistant fiber in all fibers. It can improve the wear ability and strength of fabrics by blending and interweaving with other fibers.

In order to better improve the wear ability of linen products, we use the yarn technology, high strength and wear-resistant nylon filament as the cladding layer in a reasonable premise of linen fiber properties, spinning linen yarn by improving yarn evenness, so as to reduce the amount of hair feather yarn and improve yarn strength and abrasion performance. The products made of covered yarn have both the medical properties of linen, such as moisture absorption, air permeability, antibacterial and bacteriostasis, and good strength and abrasion performance. The tensile properties and shape retention of fabrics have been greatly improved.

PREPARATION OF COATED YARN

Selection of Raw Materials

The core yarn is 36 Nm linen yarn Y0. In order to maintain the original performance of linen fabric, the fine 15D/15f nylon filament with finer fineness is used.

Selection of Equipment and Process

The coated yarn is made by HKVI41D - I type as the coated wire machine, which is produced by China Seiko Technology Company. After several experiments, the following coated processes are formulated as follows: The wire hook distance is 50 mm, the coated degree is 500 rings / meter, and the pre-tension of the core yarn is 5 cN. The design scheme can be shown in Table 1.

Table 1 Scheme of Production Process Design

Number	Process design of coated yarn
Y1	36 Nm linen yarn in Z direction cladding
Y2	36 Nm linen yarn in S direction cladding
Y3	36 Nm linen yarn in ZS bi-direction coating

In order to prevent the excessive fluctuation of dynamic core yarn and excessive drafting, with spring type tension device to control the yarn tension and yarn tension control in 5cN, at the same time, the reasonable control of winding speed, so as to match the coating speed, the excessive drawing speed will cause the over extension of the yarn, while the low speed will cause the poor bobbin form [Zhang, et. al., 2004].

Yarn Appearance with Microscope Photography

Taking photos for 36Nm linen yarn and the coated yarn after scouring with microscope photography. As shown in Fig.1 and Fig.2.

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Fig.1 36Nm linen yarn after scouring

Fig.2 double coated yarn of 36Nm linen yarn after scouring drying and shaping.

From the above two figures, we can see that the hairiness of linen yarns after coating keeping reduced. Because using finer nylon yarn, linen yarn is also in the stretched status, with the nylon yarn wrapped outside.

TRIAL PRODUCTION OF FABRICS AND FINISHING

Trial Production of Fabrics

Equipment: single cylinder sock machine; Origin: China; Diameter of cylinder: 3.75 inch; Needle number: 176 needle

Organizational structure: Plain needle

Fabric Finishing

Fabric finishing process: pre-treatment→ water washing and softening →acid→water washing→

Formula of fabric finishing process:

Scouring agent 1g/L

NaOH 1g/L

H2O2 2.5g/

Chlorate 0.5g/L

The process curve of fabric finishing can be shown in Fig.3.

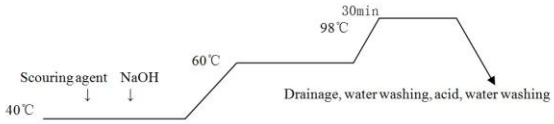


Fig.3 The Process Curve of Fabric Finishing

The density of the fabric after finishing can be shown as shown in Table 2.

Table 2 Test Result of Fabric Density

Variety of fabric	F0 (36 Nm linen knitting)	F1 (36 Nm to Z coated yarns jersey)	F2 (36 Nm to S coated yarns jersey)	F3 (36 Nm bi-directional coated yarns jersey)
Horizontal density [longitude - (5cm)]	52	53	54	54
Vertical density [row] - (5cm)	59	68	69	72

TEST AND ANALYSIS OF FABRIC

Breaking Strength Test

Instrument: YG065H type electronic fabric strength instrument; Origin: China

Experimental standard: reference standard is GBT 19976-2005 *Determination of Steel Ball Method for Top Breaking Strength of Textiles*

The experimental method: each group has nine samples to test, the diameter of the sample is 6 mm, the setting speed of the experimental machine is (300±10) mm/min, starting the instrument until the sample is broken, then the maximum value is recorded as the bursting strength of the sample. The test data can be shown in Table 3.

Table 3 Result of Breaking Force of Fabric

Fabric variety	F0	F1	F2	F3
Breaking force /N	226	237	238	260

From the testing data in Table 3, it can be seen that the strength index of coated fabric is increased, and the bi-directional coated is more obvious. That is because the outer threads not only share part of the

tensile force, but also it can increase the cohesion between fabrics.

Abrasion Performance Test

Instrument: YG401D type Fabric Leveling Instrument; Origin: China

The standard of test: Reference Standard GB/T 13775-92 *Abrasion Performance Test Method of Cotton, Hemp, Silk Woven Fabrics*

The experimental method: 3 samples are taken from each group, the average value is taken. The 2000 mesh sandpaper is used as the abrasive material in the test. After two or more than two coils of the sample are worn, the experiment can be terminated, record the number of times of friction [Xu, *et. al.*, 2008]. The test result can be shown in Table 4.

Table 4 Test Result of Friction Performance

Variety	F0	F1	F2	F3
Times of friction	26	38	39	52

From the data in the table we can see that: three kinds of coated methods can improve the abrasion performance of wrapped yarn, the effect of bi-directional wrapped yarn is more obvious, this is because the outer wrapped nylon yarn can increase the cohesion between fabrics, while it can share the external forces of friction of the fabric. Compared with the abrasion performance of yarn, the abrasion performance of fabric is improved more prominently.

Tensile Performance Test

Instrument: KES-F B1 Origin: Japan

Experimental method: This tensile test is a fixed load test (When the tensile force reaches 20cm*500gf=10Kgf, it can go back again.)

The four fabrics are tested for longitudinal and transverse tensile performance, and the test result can be shown in Table 5 and Fig.4 - 11.

Table 5 Data Table if Fabric Tensile

	LT(-)	WT(gf/cm2)	RT(%)
F0-WARP	0.466	37	18.38
F1-WARP	0.968	49.5	25.25
F2-WARP	0.881	54.85	20.24
F3-WARP	0.784	31.2	26.92
F0-WEFT	0.531	32.5	25.85
F1-WEFT	0.957	41.95	28.37
F2-WEFT	0.994	45.65	30.12
F3-WEFT	0.926	36.6	28.69

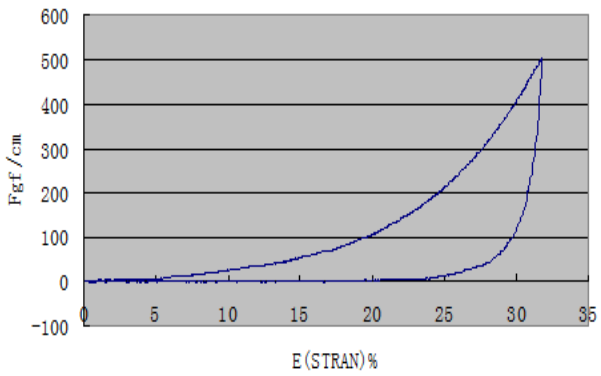


Fig.4 FO Meridian Drawing

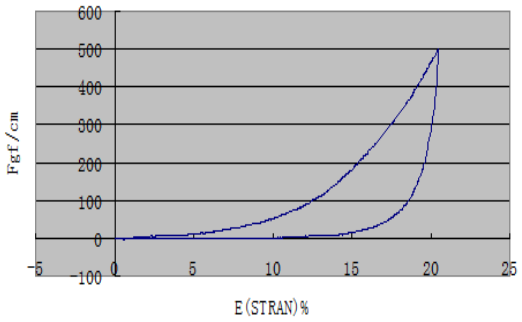
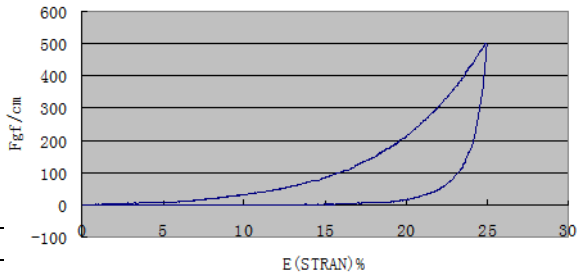


Fig.5 F1 Meridian Drawing



20.45 Fig.6 F2 Meridian Drawing 2.5

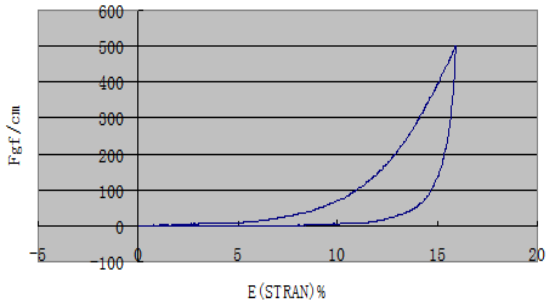


Fig.7 F3 Meridian Drawing

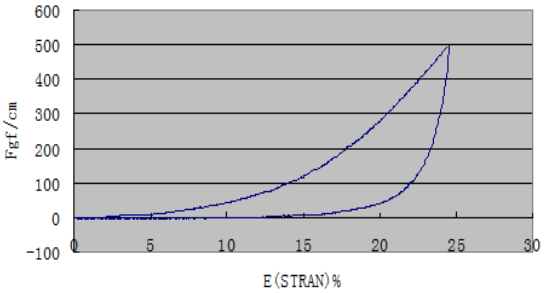


Fig.8 F0 Latitudinal Drawing

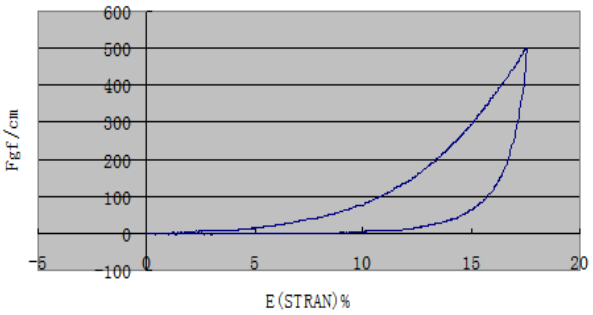


Fig.9 F1 Latitudinal Drawing

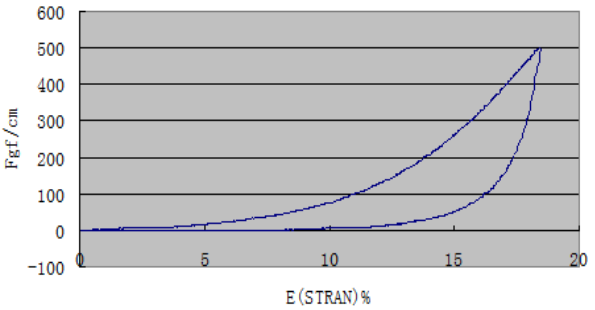


Fig.10 F2 Latitudinal Drawing

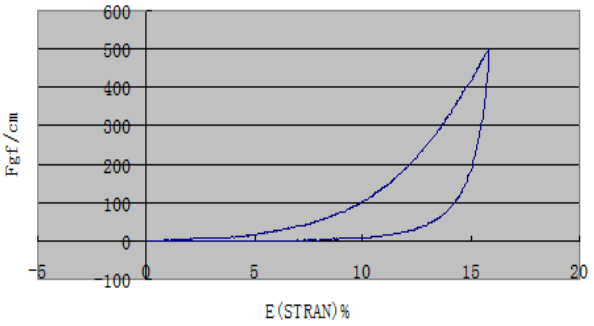


Fig.11 F3 Latitudinal Drawing

From data in Table 5 and Fig.4 - 11, we can see: the fabric tensile performance of woven yarn by nylon coated and tensile resilience performance has been greatly improved, this is because under the force of the outer covered nylon yarn, the cohesion between the fibers is increased, coil fabric combined with each other more closely, the fabric elasticity is also increased, under the external force, the fabric is easier to return to the previous state.

From Table 5 and Fig.5, Fig.6, Fig.9, Fig.10, we can see that under the constant load deformation tensile condition , the deformation of F1 fabric is smaller than that of F2 fabric, because F1 fabric used covered yarn for nylon yarn for bedding coating, i.e. the direction of the coated is the same with the flax yarn twist, while part of the nylon fiber and linen fiber is mutually embedded with each other, F2 fabric used the reverse coated nylon steering and linen yarn twist to the contrary, thus the basic yarn coated on the surface is without embedding phenomenon.

Comparing Fig.6-11 we can see: the deformation of F3 fabric under the constant load tensile state is smaller than that of F1 and F2 fabric, this is because the yarn that F3 fabric used is the bi-directional wrapped yarn, while F1 and F2 fabric used unidirectional covered yarn, the nylon filament increases the effect of the tensile performance of fabrics.

CONCLUSION

Although the fineness of outer covered the nylon filament is fine, but the hairiness is decreased through linen yarn coated with nylon filament, which can increase the interaction between fiber and yarn as well as coil, both the abrasion performance and strength of the woven knitted fabric are improved, meanwhile the tensile performance and the performance of keeping shape of fabric is largely improved. By using this kind of covered yarn, it can not only increase the weaving rate of poor quality yarn, but also can improve the wear performance of the fabric.

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