Research of Materials Science
December 2014, Volume 3, Issue 4, PP.87-91

The Research and Analysis of Semi-worsted Yarns under Compact Spinning Model

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Abstract

This paper introduces the main characteristics of semi-worsted yarn. By introducing the compact spinning technology, increased the fiber compact device in the semi-worsted spinning process, and basically eliminates the twisting triangle area. The strength, hairiness and evenness of the ordinary and the improved semi-worsted yarns were tested. The result shows that the strength of the improved yarns increase 10%, short hairiness reduce by 50%, and unevenness rate drops about 38%.

Keywords: Semi-Worsted; Compact Spinning; Twisting Triangle; Hairiness; Evenness; Strength of Yarn

1 INTRODUCTION

Semi-worsted spinning is China's textile industry, according to market demand for independent research and development of a new spinning process model. The spinning process model for wool, cashmere, angora, functional chemical fiber raw materials, such as multi-component characteristics, reasonably integrated wool, cotton spinning technology, creatively put forward the wool, cotton mixed spinning process technology [1].

Semi-worsted yarns have good bulkiness and softness. It uses multi-component fiber material properties of the complementary characteristics, improves the semi-worsted textile fabric wearing comfort, and improves the wearability of lack of raw materials. However, semi-worsted yarn has too much hairiness. Its evenness and yarn quality is low. The textiles which produced by semi-worsted yarn has poor appearance quality, and the product is easy to loss hair, pilling. Therefore, improving the quality of semi-worsted yarn is the key factor to drive the semi-worsted spinning technology leap to a new level [2].

2 THE CHARACTERISTICS OF SEMI-WORSTED YARN

The early semi-worsted products are mainly wool. Now it has grown to cotton, silk and hemp. The production becomes relatively complex, mainly has the following characteristics:

1) Species diversity, complex ingredients. Some fibers of raw materials have large differences in the fineness modulus and stiffness. Therefore, it is easy to form harmful hairiness. More hairiness, it will affect the yarn evenness, result in more detail and coarse yarn, damaged the strength.

2) Large discrete of fiber length, high short fluff rate. Generally the fibers are composed of loose fiber staining, mixed spinning. After dyeing, the single-fiber strength of the fiber is impaired in different degrees. Therefore, when carding, it will generate a lot of fuzz. The fuzz will have great impact of yarn hairiness, evenness, and yarn defects.

3) After dyeing, the specific resistance of fibers will become larger. The specific resistance of different fibers has a large difference. In the spinning process static phenomenon is very serious, and it will easy to have more hairiness.

4) Semi-worsted yarns are mostly double-stranded or three-ply yarn. And yarns need to go through winding, doubling and double twisting a plurality of later processing steps. It will increased friction chance and the hairiness will increase [3].

Therefore, in the production of semi-worsted, yarn is easy to appear too much hairiness, make the product even hair

loss, anti-pilling unsatisfactory, have low evenness level, have more coarse and thin section, have high strength CV level. These problems are caused by the current semi-worsted yarn production characteristics of the decision. To some extent, we can say this is the main defects of the existing semi-worsted production.

3 PROCESS AND EQUIPMENT IMPROVEMENTS

3.1 Compact Spinning Technology

Compact spinning technology means when the fiber sliver in the main drafting zone after entering the ring spinning machine twisting zone, utilization of air or mechanical action, which new ring spinning technology can make the output loose sliver gathering to the yarn center, reduce or even eliminate the twisting triangle area, thus further parallel fiber, reduce the hairiness, and make the sliver close. The yarn structure has been a qualitative change than ordinary ring yarn, which reflect a reduction in the yarn hairiness, strength increase, and that's because of compact spinning reduced the twisting triangular space of ring spinning frame front roller exit strip [4]. The different of twisting triangle area between ring spinning and compact spinning as follow Fig. 1. At present, the compact spinning technology is becoming more and more mature, and semi-worsted spinning technique is urgent to be improved. So, introducing the compact spinning idea into the semi-worsted can achieve a good result.

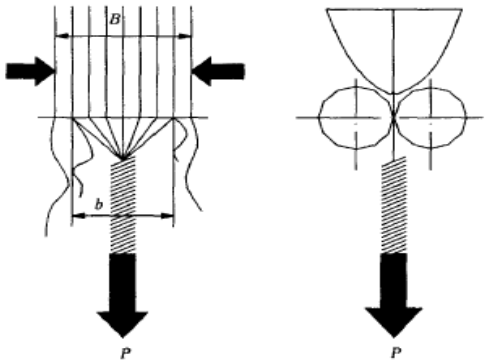


FIG.1 DIFFERENCE OF TWISTING TRIANGLE AREA BETWEEN RING SPINNING AND COMPACT SPINNING

3.2 Improvement of Semi-worsted Equipment.

Generally semi-worsted spinning process as follows:

Material ratio—loose wool—dyeing—mixing—carding—drawing—roving—spinning—winding—doubling—double twist—rewinding.

Among them, the spinning process is one of the most important processes of yarn forming. Its main functions are drafting twisting and winding. At the same time it also keep entering the draft zone of fiber in a sliver of closely spaced, strengthen the control of the pelagic zone fiber, control the weaker fluff, let fluff cluster or outward transfer, so that distribution[5]. Spinning process is one of the major steps to alleviate the defects such as hair loss, more hairiness and pilling resistance unsatisfactory when the raw product is determined. And now we are mainly for improving the twisting triangle which generated in semi-worsted spinning process.

In the traditional ring spinning and twisting process, fiber sliver enter the twisting area with flat ribbon shape. Fiber produce radial transfer during twisting, at the same time it is easy to form hairiness. In the twisting triangular area, edge fibers are easy to separate from the body of fiber, and the fiber tip can not be twisted into sliver subject and become hairiness [6]. During twisting, part of the fiber tip is easy to adhere the surface of drawing front roller while the fiber end link with sliver body. So they will constitute a three-dimensional twisting triangle. This part of the fibers may form free hairiness and circle hairiness on the surface of the yarn. The hairiness is easy to form neps on the surface of textile, and cause hair loss and pilling.

The solution idea of compact spinning technology is adding a compact device before drafting front roller in the traditional ring spinning machine. So that the silver which outputs from the front roller narrows gradually, and form

a very narrow strip enter into the twist grip jaws. So compact spinning technology can essentially eliminates twisting triangle, the yarns with high compactness, less hairiness and good evenness.

The improvement equipment by compact spinning needs to add compact device before the traditional three roller double short apron. The compact device contain a combination of profiled straw, mesh rings and rubber roller. The device is arranged in the front of drawing roller. The profiled straw installed in front of front roller, above the profiled straw is output rubber roller. The output rubber roller and profiled straw contact with pressure, they formed the twisting blocking jaw when twisting.

Compact spinning device successfully used in the production of semi-worsted, which can effectively reduce yarn hairiness, improve yarn evenness, enhance yarn strength, and reduce the pressure in the after process. So it can make the quality of semi-worsted yarn rise to a new level.

4 PROPERTIES TESTING AND COMPARATIVE ANALYSIS

For better to see the changes in the improved yarn, we selected ordinary semi-worsted yarn and the improved semi-worsted yarns to test the strength, hairiness and evenness.

4.1 Yarn Preparation

We selected the experimental material proportion as the following Table 1:

TABLE 1 YARN MATERIAL PROPORTION

	Wool	**Viscose fiber**	**Cotton**
Ordinary yarn	30%	40%	30%
Improved yarn	30%	40%	30%

The spinning process as follow:

Material ratio—loose wool — dyeing—mixing—carding—drawing—roving—spinning—winding—doubling—double twist—rewinding.

Two kinds of yarn are 48metric count double yarn. As follow Fig. 2 and Fig. 3:

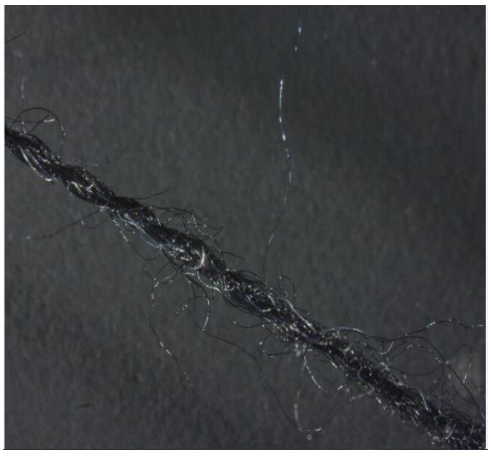


FIG.2 ORDINARY YARN



FIG.3 THE IMPROVED YARN

4.2 Yarns Properties Testing

1) Tensile Strength Testing.

Experimental standard as GB/T3916-1997<Determination of textile yarn breaking strength and elongation at break>

Experimental instrument: XL-2 Yarn strength and elongation tester.

Experimental conditions: temperature of 20 degrees Celsius, relative humidity 65%, before the test material balance

in this condition for more than 24h.

The test results and the average shown in Table 2 and Table 3:

TABLE 2 YARN BREAKING STRENGTH TEST RESULTS

Samples	1	2	3	4	5	6	7	8	9	10
Ordinary yarn	535	569	657	626	515	580	536	574	595	524
Improved yarn	591	681	605	664	712	624	599	594	640	603

TABLE 3 THE AVERAGE OF TEST RESULTS

Samples	Breaking strength /cN	Elongation /%
Ordinary yarn	571	26.1
Improved yarn	631	24.8

The above table shows the improved yarn strength significantly increased by 10%, and elongation reduced about 5% because of adding the compact device.

2) Hairiness Test.

Experimental standard is FZ/T 01086-2000<Test method for yarn hairiness projection notation>.

Experimental instrument: YG171B-2 Yarn hairiness tester

Experimental conditions: temperature of 20 degrees Celsius, relative humidity 65%, before the test material balance in this condition for more than 24h.

The test results show in Table 4 and Table 5.

TABLE 4 ORDINARY SEMI-WORSTED YARN HAIRINESS TEST DATA

	1mm	2mm	3mm	4mm	5mm
average	5513	1412	415	104	34
hairiness index	3675.33	941.11	276.44	89.11	22.44
irregularity	4.95	10.47	13.13	17.15	23.10

TABLE 5 THE IMPROVED SEMI-WORSTED YARN HAIRINESS TEST DATA

	1mm	2mm	3mm	4mm	5mm
average	2484	551	179	55	21
hairiness index	1657.56	376.33	119.33	36.44	13.78
irregularity	4.85	8.35	10.8	13.82	23.66

According to the results obtained in Fig. 4:

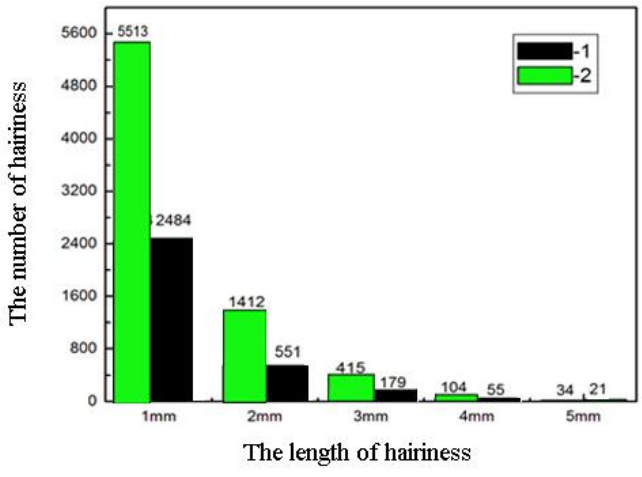


FIG.4 COMPARISON CHART OF ORDINARY AND THE IMPROVED YARNS

In Fig. 4, 1 means the improved yarns, 2 means the ordinary yarns. We can see the hairiness of the improved yarns reduced obviously. Especially 1mm to 3mm hairiness, basically reduce more than 50%.

3) Yarn Evenness Testing.

Experimental standard is FZ/T 01086-2000<Test methods of textile yarn unevenness capacitance method>.

Experimental instrument: YG138 Yarn evenness tester

Experimental conditions: temperature of 20 degrees Celsius, relative humidity 65%, before the test material balance in this condition for more than 24h.

Each yarn was tested 10 times, the results and the average shows as follow Table 6 and Table 7.

TABLE 6 THE TEST RESULTS OF YARN UNEVENNESS RATE

Samples	1	2	3	4	5	6	7	8	9	10
Ordinary yarns	9.7	9.8	8.6	10.5	10.6	10.5	9.7	9.6	8.9	10.3
Improved yarns	6.5	6.4	6.3	6.3	7.2	7.1	6.9	6.5	6.4	6.8

TABLE 7 THE AVERAGE OF TEST RESULTS

Samples	Unevenness rate(CV %)
Ordinary yarns	9.8
Improved yarns	6.0

With the Table 7, we can see the improved yarn evenness rate can be reduced by about 38%, make yarn evenness greatly increased.

5 CONCLUSIONS

Semi-worsted spinning is the process of wool industrial innovation and the production of a novel spinning technique. After years of development, the variety continues to enrich. But there are still some problem like much hairiness and unsatisfactory evenness. With the introduction of compact spinning technology, improve the ordinary semi-worsted spinning and optimize the semi-worsted processes. Experimental results show that the improved yarns enhance the strength, reduce the hairiness and yarns unevenness rate obviously. Therefore, it has a good effect to semi-worsted spinning by introduction of compact spinning technology, and greatly improved the quality of semi-worsted yarn.

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