



## Analysis of Factors to Influence Single Yarn Strength CV Value

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### Abstract

The single yarn strength CV value is one important index to measure the quality of yarn. Taking pure cotton and polyester cotton blended yarn as research objects, in this article, we systematically analyze the effects of some factors such as raw material blended ratio, yarn unevenness and twist unevenness on single yarn strength CV value, and use the mathematic analysis method to obtain the relationships between various influencing factors with single yarn strength value, and the result possesses directional meanings to enhance the quality of yarn in actual production.

**Keywords:** Yarn, Single yarn strength CV value, Yarn unevenness, Twist unevenness

The single yarn strength CV value is one important index to measure the quality of yarn. At present, certain deficiencies still exist to improve the yarn strength CV in China textile enterprises, and some enterprises can not achieve the national standards in the index and induce the demotion of yarn. The single yarn strength CV value influences not only the production efficiency of working procedures such as machine weaving and knitting, but also the appearance quality of finished products. Therefore, it is a necessary work to analyze the influencing factors of the single yarn strength CV value and discuss the measures to reduce the finished yarn single strength CV value in order to enhance the quality of the finished yarn.

### 1. Experiment

#### 1.1 *Experimental equipments and experimental conditions*

Experiment materials: carded polyester cotton blended yarn T/C 80/20 13tex, T/C 90/10 13tex, combed polyester cotton blended yarn T/CJ 40/60 13tex, T/CJ 65/35 13tex.

Experiment equipments: single-yarn strength tester, Uster III yarn evenness tester, Y331 twist tester, one ten-thousandth electronic scale, oven.

Sampling method: sampling in the spinning locale (including the raw material and sample yarn), and every group quantity is confirmed by the national standards GB 3916-83, GB/T 398-83.

Experiment conditions: balanced sample in the room with constant temperature and constant wetness which can fulfill the condition of the primary standard atmosphere, and implementing evaluations of single yarn strength, yarn evenness, single yarn twist and single yarn hectometer weight.

#### 1.2 *Experiment results*

##### 1.2.1 Single yarn strength CV value test to the yarns with different blended ratios

The results are seen in Table 1.

##### 1.2.2 Yarn evenness CV value, hectometer weight CV value and twist CV value test to the yarns with same blended ratio

In order to make clear the relationships between the yarn evenness CV value which reflects the thickness unevenness of the short segment of the yarn, the single yarn hectometer weight CV value which reflects the thickness unevenness of the long segment of the yarn, and the yarn twist unevenness ratio with the single yarn strength CV value, we choose the single yarn T/CJ 65/35 13tex to implement various tests, and the results are seen in Table 2.

### 2. Experiment results and analysis

#### 2.1 *The relationship between the blended ratio and single yarn strength CV value*

From Table 1, the blended ratios of the carded polyester cotton blended yarn are different, so the single yarn strength CV values are different, and the single yarn strength CV value of T/C 90/10 13tex is smaller than the value of T/C 80/20 13tex. The reason is that the content of short fiber in the cotton string before blending is more, and with the increase of cotton fiber content, the fiber length tidiness in the blended material deteriorates, and because the carder yarn lacks short fiber ridding function, so in the extension process, the fiber shift points are dispersive, and the move distance warp

is large, so the yarn evenness is relatively bad and its single strength CV value is big.

However, the blended ratios of the combed polyester cotton blended yarn are different, so the single yarn CV values are different, and the single yarn strength CV value of T/CJ 40/60 13tex is smaller than the value of T/CJ 65/35 13tex. The blended ratios of these two sorts are near the critical blended ratio, and they are combed polyester cotton blended yarns with low short cotton fiber rate, so the reason to induce the difference of single strength CV value is not the short fiber rate, but the blended evenness degree of two sorts of fiber in the cotton strings. Some researches indicate that for the blended spinning of cotton and chemical fiber, when the proportions of two fiber contents are equal, the blended unevenness rate is minimum, and the proportions are more different, they are more difficult to be blended (Shi, 2003, p.36-40). Because the content proportion differences of these two sorts of fiber in T/CJ 40/60 13tex are relatively small, and the blended unevenness rate is small, so its single yarn strength CV value is small.

## 2.2 The relationships among single yarn evenness CV value, twist CV value and hectometer weight CV value with single yarn strength CV value

In order to make clear the relationships between three influencing factors and the single strength CV value, we use the single linear correlation analysis method to analyze the result, and use the software of SPSS, the correlative coefficient  $r$  and the significance level  $t$  in the statistics to implement the significance test.

The statistics points out that if  $|r| < r_{0.05}$ , the correlation coefficient is not significant, and if  $r_{0.05} \leq |r| \leq r_{0.01}$ , the correlation coefficient  $r$  is significant, and if  $|r| \geq r_{0.01}$ , the correlation coefficient is very significant.

### 2.2.1 The relationship between yarn evenness CV value and single yarn strength CV value

According to the data in Table 2, we adopt the single linear correlation analysis to analyze the relationship between single yarn evenness CV value and single strength CV value, and the result is seen in Table 3.

From Table 3, we can obtain the regression equation:

$$y = -6.911 + 1.017x.$$

Where,  $y$  is the single strength CV value,  $x$  is the yarn evenness CV value.

The correlation coefficient  $r$  is 0.927, from table we can get  $r_{0.01} = 0.834$ .  $|r| \geq r_{0.01}$ , which indicates that the single yarn evenness CV value and the single strength CV value present significant positive correlative, that is to say, the yarn evenness CV value is bigger, the single strength CV value is bigger. The result further shows the evenness CV value which reflects the unevenness of short segment of the yarn is bigger, the thin nodes and the thick node of the yarn are more, which will certainly increase the yarn strength and make the difference of yarn strength bigger (Liu, 1989). Therefore, the decrease of yarn evenness CV value can reduce the single yarn strength CV value.

### 2.2.2 The relationship between twist CV value and single yarn strength CV value

From the data in Table 2, we adopt the single linear correlation analysis to analyze the relationship between twist CV value and single strength CV value, and the result is seen in Table 4.

From Table 4, we can obtain the regression equation:

$$y = 4.717 + 1.096x.$$

Where,  $y$  is the single strength CV value,  $x$  is the twist CV value.

The correlation coefficient  $r = 0.921 > 0.834 = r_{0.01}$ , which presents very significantly positive correlation, that is to say, the unevenness of the twist is bigger, the single strength CV value is bigger. Therefore, the decrease of the twist unevenness rate possesses important meaning to reduce the single strength CV value.

### 2.2.3 The relationship between hectometer weight CV value and single yarn strength CV value

The yarn hectometer weight CV value, i.e. the thickness unevenness of long segment, is the important factor to influence the strength among pipe yarns. Some experiences showed that usual think yarn weight unevenness rate must be stabilized in 2%, and can avoid that the paroxysmal CV value exceeds the standard (Yu, 2002, p.22-25). However, sometimes the single strength CV value is high, but the hectometer weight unevenness rate doesn't change, because the yarn segment in which the "paroxysmal strength" occurs always is about half meter, which requires that when we reduce the unevenness of long segment of the thin yarn, we also should reduce the unevenness of the segment with about half meter.

The analysis result is seen in Table 5.

From Table 5, we can obtain the regression equation:

$$y = 7.461 + 0.798x.$$

Where,  $y$  is the single strength CV value,  $x$  is the hectometer weight CV value.

The correlation coefficient  $r = 0.841 > 0.834 = r_{0.01}$ , which presents very significantly positive correlation, that is to say, the single strength CV value increases with the increase of hectometer weight CV value. Therefore, the decrease of hectometer weight CV value has important meanings to reduce the single strength CV value.

#### 2.2.4 The relationships among three influencing factors

From the regression equations established between three factors with single strength CV value and the obtained correlation coefficients, we can get:

$$r_{\text{evenness}} > r_{\text{twist}} > r_{\text{hectometer weight}}$$

That shows the yarn evenness CV value has the most important influence to the single strength CV value, then the twist CV value is the second one, and then the hectometer weight CV value.

We utilize the SPSS software to implement correlation analysis between every two factors, and the results are seen in Table 6, Table 7 and Table 8.

From above analysis, the twist CV value, the hectometer CV value and the yarn evenness CV value are highly significant, the correlation coefficients are all above 0.9. Therefore, in the twist CV value, the hectometer CV value and the yarn evenness CV value, the yarn evenness CV value is the root of all problems, so to improve the yarn evenness CV value can not only reduce the twist CV value and the hectometer CV value, but also these three factors can exert functions to improve the single strength CV value together.

### 3. Conclusions

(1) The blended ratio of polyester cotton blended yarn influences the single yarn strength CV value, and with the increase of cotton fiber content of the carded polyester cotton blended yarn, the single strength CV value increases, and when the blended ratio of the combed polyester cotton blended yarn is close the critical blended ratio, the single strength CV value is smaller.

(2) Three influencing factors including the yarn evenness CV value, the twist CV value, the hectometer weight CV value are all positive correlative with the single strength CV value, and  $r_{\text{evenness}} > r_{\text{twist}} > r_{\text{hectometer weight}}$ , and the correlation coefficients among three factors are all above 0.9, and they are high correlative. To improve the yarn evenness CV value can not only reduce the twist CV value and the hectometer CV value, but more important, these three factors can exert functions to improve the single strength CV value together.

### References

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Table 1. Single yarn strength CV values of the yarns with different blended ratios

Sort	Carded polyester Cotton blended yarn		Combed polyester Cotton blended yarn	
	T/C 80/20 13tex	T/C 90/10 13tex	T/CJ 40/60 13tex	T/CJ 65/35 13tex
Single strength/cN	301.2	344.0	183.5	237.7
Single strength CV/%	10.38	8.71	8.97	10.11

Note: Data in Table 1 are averages from the data of 60 sub-samples.

Table 2. The relationships between three factors and single yarn strength CV

Item	Group							
	1	2	3	4	5	6	7	8
Yarn evenness CV/%	15.23	15.76	15.77	15.90	16.08	16.31	16.60	16.85
Twist CV/%	3.61	3.72	4.04	4.25	4.43	4.64	4.76	4.90
Hectometer weight CV/%	1.59	1.79	1.88	2.69	2.83	2.91	2.99	2.99
Single strength CV/%	8.85	8.90	8.97	9.01	9.74	9.58	10.02	10.31

Note: Data in Table 2 are averages from the data in former 8 groups of 30 sub-samples.

Table 3. Analysis result between yarn evenness CV and single yarn strength CV

Item	Non-standardization coefficient		Standardization coefficient	T	Level of significance
	B	Standard error	Beta		
Yarn evenness CV	-6.911	2.696	0.927	-2.564	0.043
	1.017	0.168		6.602	0.001

Note: The attributive variable is the single yarn strength CV, and B indicates the uncertain coefficient value and the constant value.

Table 4. Analysis result between twist CV and single yarn strength CV

Item	Non-standardization coefficient		Standardization coefficient	T	Level of significance
	B	Standard error	Beta		
Yarn evenness CV	4.717	0.817	0.921	5.776	0.001
	1.096	0.189		5.793	0.001

Note: The attributive variable is the single yarn strength CV.

Table 5. Analysis result between hectometer weight CV and single yarn strength CV

Item	Non-standardization coefficient		Standardization coefficient	T	Level of significance
	B	Standard error	Beta		
Hectometer weight CV	7.461	0.528	0.841	14.121	0.001
	0.798	0.210		3.806	0.001

Note: The attributive variable is the single yarn strength CV.

Table 6. The relationship between yarn evenness CV and twist CV

Item	Non-standardization coefficient		Standardization coefficient	T	Level of significance
	B	Standard error	Beta		
Yarn evenness CV	-9.817	1.831	0.953	-5.360	0.002
	1.017	0.168		6.602	0.001

Note: The attributive variable is the twist CV.

Table 7. The relationship between yarn evenness CV and hectometer weight CV

Item	Non-standardization coefficient		Standardization coefficient	T	Level of significance
	B	Standard error	Beta		
Yarn evenness CV	-13.708	3.734	0.870	-3.672	0.010
	1.007	0.232		4.332	0.005

Note: The attributive variable is the hectometer weight CV.

Table 8. The relationship between twist CV and hectometer weight CV

Item	Non-standardization coefficient		Standardization coefficient	T	Level of significance
	B	Standard error	Beta		
Twist CV	-2.660	0.688	0.950	-3.863	0.008
	1.192	0.159		7.474	0.000

Note: The attributive variable is the hectometer weight CV.