A New Method of Measuring Twist of Yarn

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Abstract
The paper presents a new method for determining yarn twist that eliminates the drawbacks of the presently used ‘reverse-twisting method.’ The new method may be described as a ‘two-end untwisting/twisting method’. In this method, the test sample of a yarn is subjected to untwisting and twisting by two clamps rotating in opposite directions. Pre-tension of the test sample is effected by loading it at its mid-length point, by virtue of which the sample takes the shape of a broken line instead of a straight line. Owing to the use of two rotating clamps and pre-loading the sample at its middle point, there is no ‘ballooning’ of the sample during testing. The ballooning phenomenon occurring in the reverse twisting method is responsible for uncontrolled elongation of the test sample, due to slippage of the fibres. The two end untwisting/twisting method is much less sensitive to the amount of pre-tension applied to the test sample. For the purposes of this method a special twist-meter, described as CZ/V-1, was designed and made. On comparing the results of testing twist by the ‘reverse twisting method’ on the Zweigle twist-meter D-314 and the results obtained by the ‘two-end twisting method’ on twist-meter CZ/V-1, it was found that the new method of two-end twisting was at least 50% more accurate than reverse twisting.

Key words: twist, new method, twist-meter CZ/V-1, test yarns, test methods, optimum pre-tension.

Introduction
The twist of yarn is one of its more important morphological properties. This property has so far been difficult to test, and the methods employed for that purpose continue to be a matter of dispute. The amount of twist inserted in a yarn is a factor on which are dependent not only the tensile properties of the yarn but also a number of other properties which qualify the yarn for a particular use in weaving or knitting. One can say no more about the twist and measurement of a given yarn than that it can be pre-selected in the so-called spinning plan and checked on a ring spinning system. It has been shown that the results of the untwist-twist method vary with the value of the pre-tension applied to the test specimen [1, 5-14]. Various modifications of this method have been reported, some of the authors using conventional twist meters, and others using automatic twist meters [2-5]. None of these modifications has provided an answer to the question of how to determine the real number of turns the yarn has been given in twisting. The explanation lies in the design of the twist testing devices, all of which cause ‘ballooning’ of the test specimen while it is being untwisted and twisted, resulting in uncontrolled elongation of the yarn. The results are also affected by the amount of pre-load applied to the test specimen.

Observing the behaviour of the cotton and woolen yarns in twist tests by various untwist-twist methods inspired us to undertake a project aimed at developing a new modification of the twist measurement method, as well as a twist meter that would measure twist by the modified untwist-twist method.

New method for measurement of yarn twist
The modification would consist in the untwisting and twisting of the test specimen being induced from both ends, instead of from one end only. The guidelines for the development of the new twist measurement method were as follows:

- Untwisting and twisting the test yarn specimen takes place at both ends of the specimen, and is effected by two clamps revolving in opposite directions;
- Pre-load is applied to the test specimen at its centre;
- The axis of the test specimen is bent at the centre of the specimen, i.e. at the point the pre-load is applied;
- The cut length of the test specimen is 250 mm or 500 mm;
- The rotary speed at which the specimen is untwisted and twisted is adjustable, and is constant during measurement;
- The test is abruptly stopped by an automatic control as soon as the test specimen reaches its initial, starting length;
- Control of the test is semi-automatic.

To meet the guidelines, a special twist meter was developed [15] and adapted to measure twist by the new method (Figure 1). The new twist meter had two rotary clamps revolving in opposite directions, so that the test specimen was untwisted and twisted from both ends. The twist meter was also provided with a special tension-imparting system for applying pre-tension to the test specimen at its centre. The system incorporated elements for imparting tension and elements for supervising specimen elongation during untwisting. The points which must be supervised are the beginning and end of the test, the measurement of twist being performed automatically.
The rotary clamps and central application of the pre-load (at the bending point of the specimen) helped eliminate the so-called ‘ballooning’ of the yarn during test. In this way, the undesirable phenomenon of uncontrolled elongation of the test specimen during untwisting and twisting was also eliminated.

Figure 2 shows how tension strength $F$ acts on a sample during its elongation over the untwisting time and its shortening (with respect to initial length) over the re-twisting time.

The new method was tested on model, ring and spinning machines, on which yarns of three different classes of linear density and with three different twist factors were made. The yarns were spun from cotton, viscose and wool & polyester, and from blends of these fibres with man-made fibres. The twist of the yarns was tested by the conventional untwist-twist method (Zweigle’s twist-tester) [16] and a new one (Czaplicki’s twist-tester). The pre-tension was assumed to be $q = 0.1$ to 0.8 cN/tex. The length of yarn samples was the same as those used in the ‘direct counting’ method.

The results obtained suggest that for every yarn there is – for the ‘reverse twist’ method – an optimum pre-tension $q_{\text{opt}}$ at which $T_0 = T_1 = T_n$. A relationship has been determined between the real initial twist $T_0$, the real reversed twist $T_n$, and the twist-meter reading $T_1$ (Figures 3 to 6) [16]. The relationship presented in Figures 3 to 6 suggest the following three cases regarding the reverse twist method:

1. For $q < q_{\text{opt}}$, the twist-meter values, $T_1$, are lower than the real twist before test $T_0$ ($T_1 < T_0$);

2. For $q = q_{\text{opt}}$, the twist-meter values, $T_1$, are equal to the real twist before test $T_0$ ($T_1 = T_0$);

3. For $q > q_{\text{opt}}$, the twist-meter values, $T_1$, are higher than the real twist before test $T_0$ ($T_1 > T_0$);

For pre-tension values that are greater or less than $q_{\text{opt}}$, the twist-meter reading does not represent the real twist of the yarn. For $q < q_{\text{opt}}$ and $q > q_{\text{opt}}$, the twist-meter readings $T_1$ are the mean values of $T_0$ and $T_n$.

$$T_1 = \left( T_0 + T_n \right)/2, \text{tpm} \quad (1)$$

If the real initial twist $T_0$ and the twist-meter reading $T_1$ are known, the formula (1) can be used to calculate the real reverse twist $T_n$:

$$T_n = 2T_1 - T_0, \text{tpm} \quad (2)$$

The exact analysis of determined inter-relationship between $T_0$, $T_1$ and $T_n$ is presented in Figure 7.

Conclusions

The results obtained showed that the new method was about 50% less ‘sen-

Experimental research

The aim was to produce ring-spun yarns of a known machine twist $T_M$ with a proportion of coloured fibres. The real initial twist $T_0$ was determined by ‘direct counting’ on samples 250 mm long, using a pre-tension $q = 0.3$ cN/tex. The yarn twist was also tested by the ‘reverse twist’ (i.e. the traditional) method (Zweigle’s twist-tester) [16] and a new one (Czaplicki’s twist-tester). The pre-tension was assumed to be $q = 0.1$ to 0.8 cN/tex. The length of yarn samples was the same as those used in the ‘direct counting’ method.

The results obtained suggest that for every yarn there is – for the ‘reverse twist’ method – an optimum pre-tension $q_{\text{opt}}$ at which $T_0 = T_1 = T_n$. A relationship has been determined between the real initial twist $T_0$, the real reversed twist $T_n$, and the twist-meter reading $T_1$ (Figures 3 to 6) [16]. The relationship presented in Figures 3 to 6 suggest the following three cases regarding the reverse twist method:

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The exact analysis of determined inter-relationship between $T_0$, $T_1$ and $T_n$ is presented in Figure 7.


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