Zdzislaw Czaplicki

Institute of Natural Fibres
ul. Wojska Polskiego 71 b
60-630 Poznań, Poland
e-mail: zczaplicki@wp.pl

A New Method of Measuring Twist of Yarn

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-tester 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 frame by measuring the revolving speed of the yarn balloon and the rate at which the strand of fibres is supplied to the twisting system, and (in the case of an open-end yarn) by measuring the yarn delivery rate and speed of the rotor.

Testing twist in a laboratory presents many difficulties, and the most common method consists in untwisting and then re-twisting the yarn in the opposite direction. This method has its advantages, among which are simple and easy procedure and short test time, but it also has certain imperfections which make the method inaccurate. Inherent in the method is the possibility of the fibres slipping along the yarn axis as the yarn is being untwisted. This results in uncontrolled elongation of the test length, the consequence of which is that the reverse twist is inserted in a greater amount than that of the original twist. Another imperfection of the untwist-twist method is that the fibres of an untwisted yarn pose a greater resistance to twisting when the yarn is being twisted in the opposite direction. The value of the resistance depends on the parameters of the fibres &the yarns, and the specificity of the 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 woollen 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 on specimens 250 mm and 500 mm long, which were subjected to varied pre-tensions. Parallel to these tests, the twist of the yarns was tested by the conventional untwist-twist method based on Zweigle's semi-automatic twist-meter.

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_{opt} at which $T_0 = T_l = T_n$. A relationship has been determined between the real initial twist T_0, the real reversed twist T_n, and the twist-meter reading T_l (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 $q < q_{opt}$, the twist-meter values, T_l, are lower than the real twist before test T_0 ($T_l < T_0$);
2. For $q = q_{opt}$, the twist-meter values, T_l, are equal to the real twist before test T_0 ($T_l = T_0$);
3. For $q > q_{opt}$, the twist-meter values, T_l, are higher than the real twist before test T_0 ($T_l > T_0$);

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

$$T_l = (T_0 + T_n[)/2, \ \text{tpm} \qquad (1)$$

were: tpm = twist per meter

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

$$T_n = 2T_l - T_0, \ \text{tpm} \qquad (2)$$

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

Conclusions

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

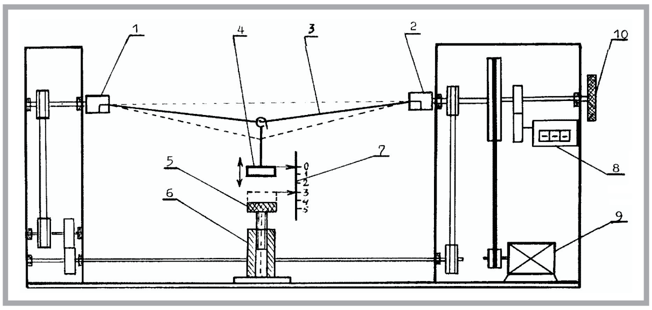

Figure 1. A schematic diagram of a device used for measuring twist with a new method [15]; 1, 2 – rotary clamps, 3 – yarn sample, 4, 5, 6 – device tensioning initial sample in its centre, 7 – elongation scale, 8 – output of twist values, 9 – motor, 10 – hand driven clamps.

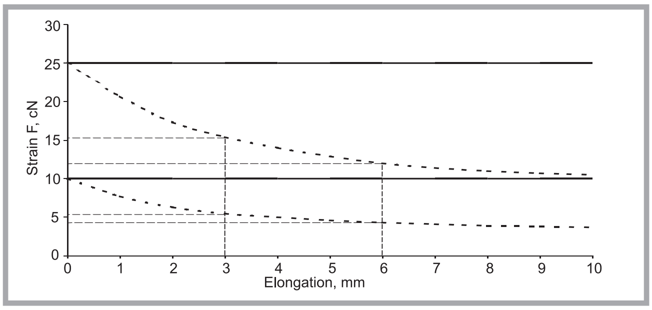

Figure 2. Changes of strain in samples of yarn as a function of elongation; For yarn 50 tex, and q = 0,2 cN/tex, F = 10 cN and q = 0,5 cN/tex, F = 25 cN, ———— - traditional method, ············· - new method.

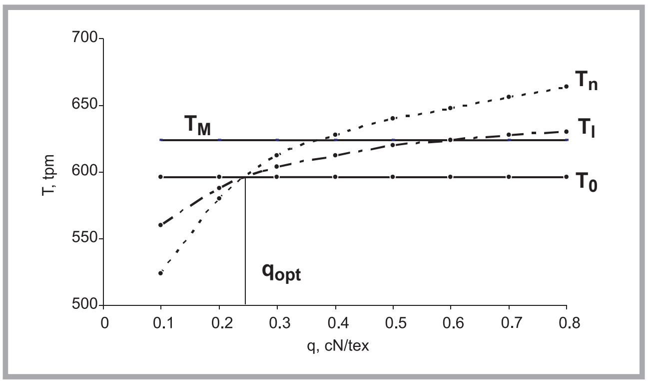

Figure 3. Inter-relationship between real initial twist T_0, real reversed twist T_n, and twist-meter reading T_l. Cotton yarn 40 tex. Traditional method.

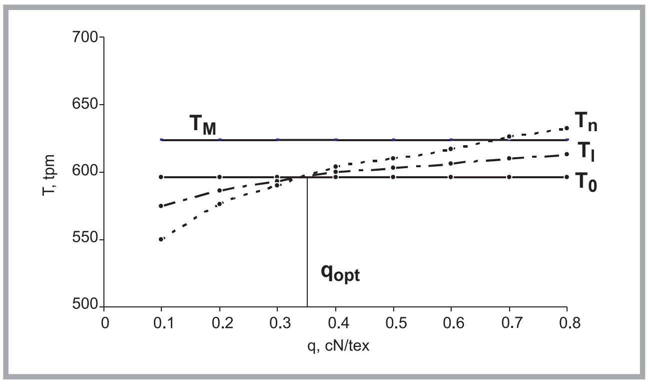

Figure 4. Inter-relationship between real initial twist T_0, real reversed twist T_n, and twist-meter reading T_l. Cotton yarn 40 tex. New method.

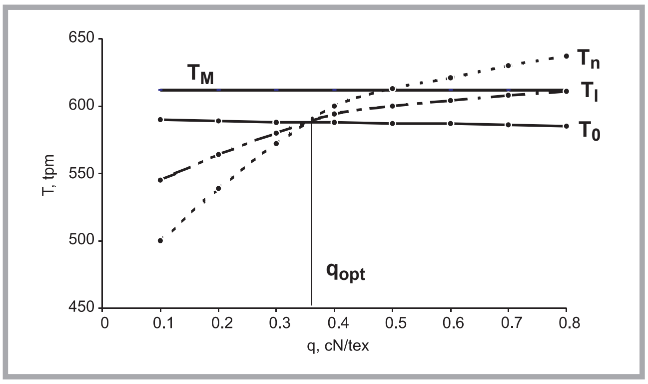

Figure 5. *Inter-relationship between real initial twist T_0, real reversed twist T_n, and twist-meter reading T_l. Wool yarn 25 tex. Traditional method.*

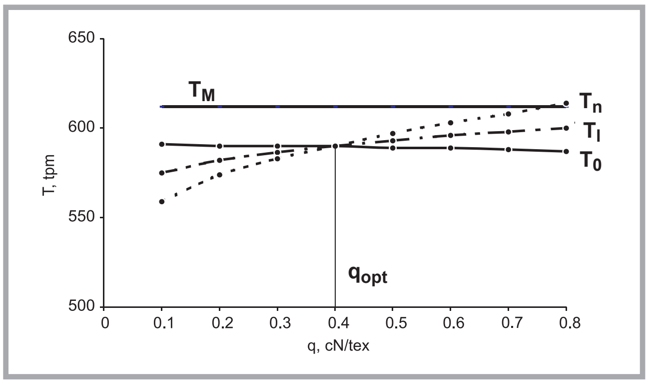

Figure 6. *Inter-relationship between real initial twist T_0, real reversed twist T_n, and twist-meter reading T_l. Wool yarn 25 tex. New method.*

sitive' to the amount of pre-tension applied to the test specimen. In addition, the untwisting-twisting process in the new method was more regular, owing to the apparent shortening of the test specimen and the dual untwisting-twisting drive arrangement.

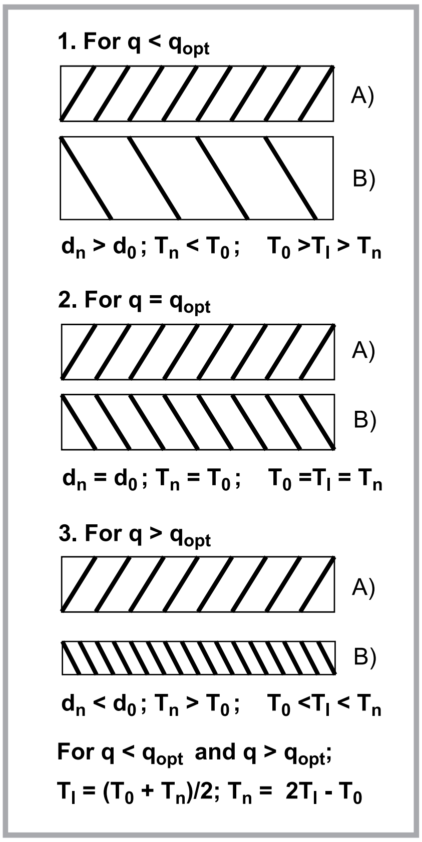

Figure 7. *Values of twist T_l obtained by the reverse twisting method, depending on the value of pre-tension q; A - yarn sample before test on twist-meter (d_0, T_0); B - yarn sample after test on twist-meter (d_n, T_n, T_l); d_0 – initial diameter of yarn (before measurement of twist by reverse twisting); T_0 – real initial twist arrived by direct counting; d_n – diameter of yarn after measurement of twist by reverse twisting; T_n – real twist of yarn arrived by direct counting; T_l – value of twist read from twist-meter*

- By using test yarns with marked fibres, it was possible to establish the real twist without the need for untwisting the yarn. The real twist was used as a reference for the measurements performed in parallel by the new and conventional untwist-twist methods.
- The results obtained confirmed the suitability of the new method, and its superiority in terms of accuracy by at least 50% over the conventional untwist-twist method. Both the method and apparatus are new, original, and heretofore unknown.

- We have applied for a patent for the twist measurement method and apparatus at the Patent Office.

Acknowledgment

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Editorial note

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