A QUICK, RELIABLE, AND ECONOMIC METHOD FOR EVALUATING THE PROPERTIES OF ROTOR-SPUN YARN

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Abstract

An attempt has been made to evaluate the primary and secondary properties of blended rotor-spun yarn both quickly and reliably from only a small sample of fibre. The concept of the quickspin system of yarn production is partially utilised in this research work. The natural and synthetic fibres are blended in a 50/50 ratio according to five different methods on an Uster Micro Dust and Trash Analyser 3 (MDTA 3), and the best blending method is evaluated with the help of a suitable image analysis technique. Furthermore, the reliability of rotor-spun yarns produced from MDTA 3 slivers with conventionally produced rotor-spun yarns from card and draw-frame slivers has been checked in terms of their properties.

Key words:

quickspin, MDTA 3, Optimas, sliver

Introduction

The textile researchers in the area of yarn engineering have already realised the importance of the quickspin system in evaluating the fibre and forecasting the resultant yarn properties. This system has been divided into two modules, which are completely different from each other. The first module is based on the Uster MDTA 3. Basically it is a micro dust and trash analyser, where the fibre tufts are opened up to single fibres, cleaned, blended and formed into a sliver. The second module is a rotor-spinning unit, where the sliver is spun into quickspin model yarn. The researchers have worked on quickspin yarn produced from cotton fibres alone [1, 2]. They have paid keen interest to correlating the properties of quickspin yarn with that of conventional ring and rotor yarns. Artzt [1] has observed that the trash content of quickspin yarn is strongly correlated with that of ring-spun and rotor-spun yarns. A similar kind of observation has been reported by Yankey et al. [2], who have also claimed that the strength, elongation, and work of rupture of conventional ring-spun and rotor-spun yarns can be reliably predicted from the properties of quickspin yarns. Artzt [1] has reported very satisfactory correlations between the Uster's unevenness values of quickspin yarn and those of ring and open-end yarns. The hairiness value of conventional ring-spun and rotor-spun yarns strongly correlates with the hairiness value of quickspin yarn. In order to establish the optimum number of passages on the MDTA 3 for the production of sliver to simulate the opening and cleaning process of a spinning mill, Artzt [1] found that the trash separation process of cotton with high cleanability behaviour after the first passage on the MDTA 3 is almost 90%, and about 60% with a low cleanability behaviour, but after the third passage there is an almost complete cleaning of all types of cotton. It has been reported that there is no marked improvement in the trash separation value after the third passage, as compared to the second passage. Yankey et al. [2] have observed almost horizontal nep curves for two cotton materials after the second passage, and a positive trend after the first passage for the other variety. They have concluded that multiple passages through the MDTA 3 very closely simulate the influence of equipment in the opening of neps for certain types of cotton.

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Experimental

Raw material

In this research work, cotton (Tobi and Rival), polyester (Terital 1.5/38), and viscose (Danufil 2.4/50) fibres were used. The cotton (Tobi) and viscose fibres have been selected for the evaluation of the best blending method on the MDTA 3, and the cotton fibres were blue-dyed blue for this purpose for use in the image processing software (Optimas 6.2), because it is imperative to colour one of the components in the blend to differentiate it from a non-coloured fibre. To check the reliability of the MDTA 3 system of yarn production with the conventional method of yarn production, cotton (Rival) and polyester fibres were chosen.

Method

Cotton and viscose fibres are taken in a same proportion (50/50) and put on the MDTA 3's conveyor belt according to five different methods, as shown in Figure 1. In each trial, a sliver of 5 Ktex has been produced from a sample of 5 gm fibres.

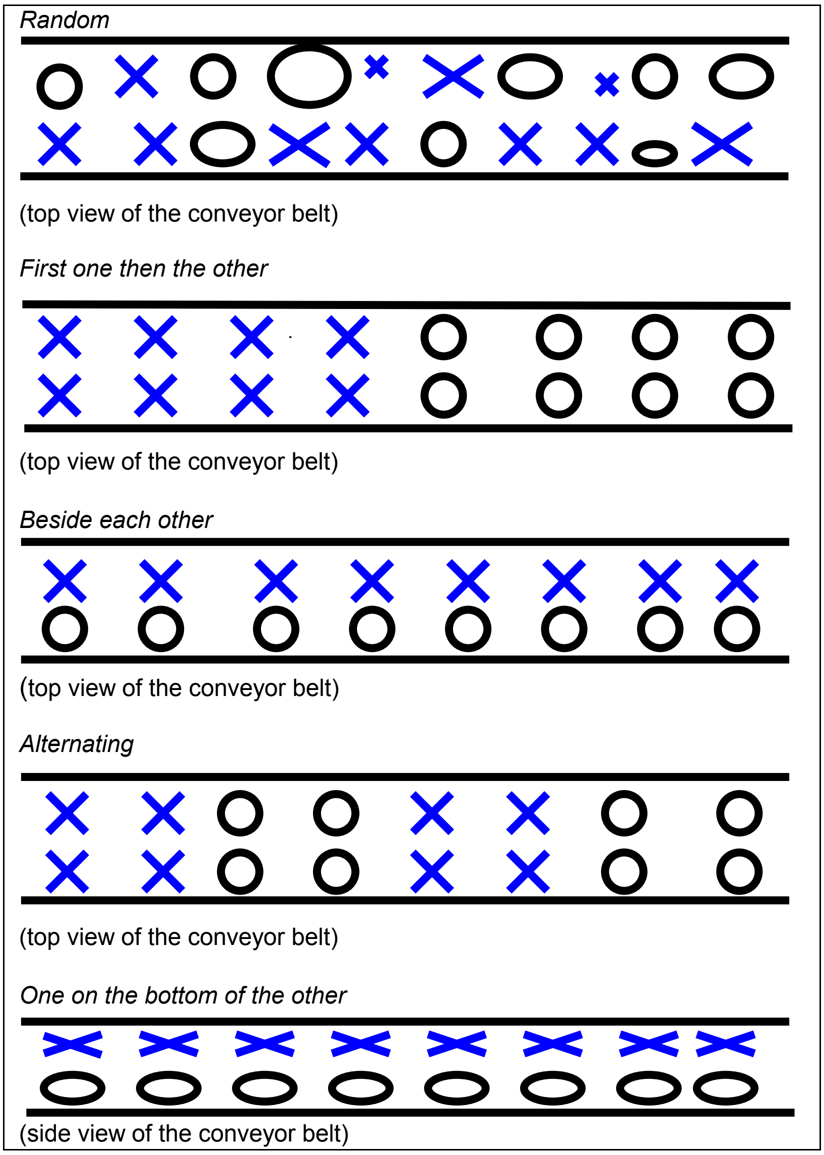


Figure 1. Different methods of fibre arrangement on the conveyor belt of the Uster MDTA 3 (**x** and **o** indicate two different types of fibres)

The working parameters of the MDTA 3 were as follows: opening roller speed 8000 rpm, rotor speed 3000 rpm, feed rate 0.6 m/min, suction pressure in the dust chamber 2.5 mbar, and suction pressure in the rotor-ring device 3.5 mbar. The sliver is then compressed and put into a black tube of 5 mm diameter. It is then placed into resin, which allows the tube with fibres to be hardened. After that, the tube is cut to a very fine thickness. The fine cross-section of the tube with fibres is put under a light microscope and studied with the help of the image processing software (Optimas 6.2) in order to investigate the best blending method on MDTA 3. The slivers were also given more passages and their cross-sections studied, to observe the effect of the greater number of passages on the blending quality.

Optimas 6.2

The best method of fibre blending is evaluated by Optimas (version 6.2) both qualitatively and quantitatively. It can differentiate a coloured material very easily from a non-coloured material, and can calculate the total number of screen objects and the area contained by those screen objects. In order to evaluate the best method of fibre blending, the small areas contained by blue-coloured fibres in the sample are counted and calculated by this software. The image analysing process of Optimas is described in the manual [3].

Production of MDTA 3 yarn and industrially spun rotor yarns

Slivers of 5 Ktex were produced on the MDTA 3 machine following the best method of fibre blending from 100% cotton and polyester fibre, and also from their 50/50 blend. Afterwards, rotor spun yarns of 50 tex were produced from those slivers on a laboratory based rotor-spinning machine (Schlafhorst SE10) using the following parameters: rotor speed 60,000 rpm, opening roller speed 8000 rpm, feed rate 894.43 mm/min, delivery rate 89 m/min. Industrially spun rotor-spun yarns of 50 tex were also produced from card and drawframe slivers of 5 Ktex from those fibres. The carding machine (Trützschler DK 703)'s parameters were selected as follows: licker-in speed 522 rpm, cylinder speed 460 rpm, doffer speed 34 rpm, delivery speed 10 m/min, production 30 kg/hr. The drawframe machine (Rieter RSB 951)'s parameters were as follows: delivery speed 650 m/min, total draft 5.81, doubling 6. The tensile properties of yarns were tested on a Statimat M Tensile Tester using the following parameters: gauge length 500 mm, testing speed 500 mm/min, number of tests 50. The hairiness of yarns was tested on an Uster Evenness Tester 3 using the following parameters: testing speed 200 m/min, testing duration 5 min. All these tests were carried out at 65±2% relative humidity and at 22±2°C temperature.

Results and discussion

Evaluating the best method of fibre blending

The cross-sectional view of the slivers produced from a 50/50 combination of blue-coloured cotton and white viscose after only one passage through the MDTA 3 is shown in Figure 2. It can be subjectively observed from the cross-sectional view of slivers that the blue-coloured fibres are randomly distributed in the sliver produced by the *random* and the *one on the bottom of the other* method of blending, whereas, in the case of the slivers produced by the *first one then the other* and the *beside each other* methods of blending, that the fibres are occupied in some specific places by the entire cross-sectional area of sliver. In the *alternating* method of blending, the strips of blue-coloured fibres are alternately positioned throughout the cross-sectional area of the sliver. It can thus be inferred that both the *random* and the *one on the bottom of the other* methods give better blending as compared to the other methods of fibre blending on the MDTA 3.

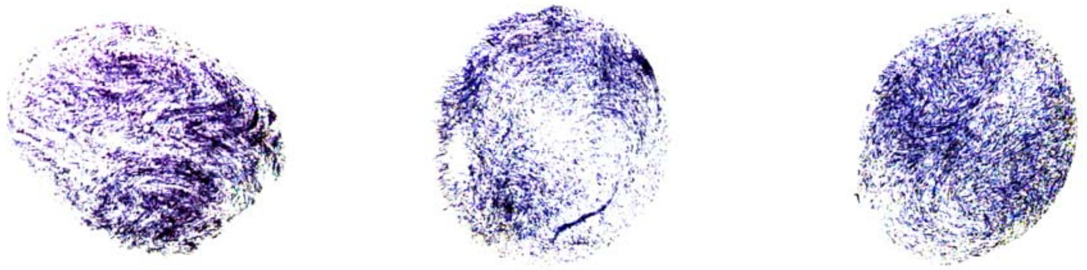
In order to carry out an objective measurement of the distribution of blue-dyed fibre particles throughout the cross-sectional area of the sliver, all the area values measured with respect to the particular type of fibre arrangement on the conveyor belt of MDTA 3 were arranged in descending order, and the first twenty large areas in each case were analysed in Microsoft Excel, but no remarkable difference in the area profile of the different fibre arrangements was obtained. This infers that the MDTA 3 acts similarly to the five proposed arrangement of fibres as far as the breaking of fibre clusters is concerned. But significant differences were observed among the number of blue-dyed particles in the cross-section of the slivers produced from the five different fibre arrangements. Optimas calculated the number of blue-dyed fibre particles in the sliver cross-sections as follows:

random - 313, *first one then the othe*r - 124, *beside each other* - 142, *alternating* - 222, *one on the bottom of the other one* - 332. It is quite clear from Figure 2 that in three methods, namely *first one then the other*, *beside each other* and *alternating*, the number of dyed particles found by the image processing software is far less than that found in the *random* and *one on the bottom of the other one* methods of fibre blending. Thus, it can be said that a more intimate and homogeneous blending of fibres is possible in the *random* and *one on the bottom of the other one* methods of blending. The total number of dyed particles calculated by the software is slightly higher in the *one on the bottom of the other one* type of blending than in the *random* method, but this difference is not statistically significant. Hence, either the *one on the bottom of the other one* or the *random* method of fibre blending can be chosen as one of the best methods of fibre blending on the MDTA 3. Mac has also observed a similar type of result with different kinds of fibres [4]. However, the *random* method of fibre blending has been chosen for further research work.

Random First one then the other Beside each other

Alternating One on the bottom of the other

Figure 2. Cross-sectional view of MDTA 3 slivers produced by different blending methods



Random (One passage) Random (Two passages) Random (Three passages)

Figure 3. Cross-sectional view of MDTA 3 slivers produced by the *random* method of fibre blending depending on the number of passages

In order to study the effect of the number of passages through the MDTA 3 on the quality of blending, the sliver produced after the first passage was given more passages, but no significant difference in the cross-sectional views of sliver has been found. Figure 3 supports this statement. The number of coloured fibre particles as calculated by Optimas is as follows: for one passage 313, two passages 344, and three passages 354. This shows that there is a marked difference between the total number of coloured fibre particles in the cross-section of the slivers produced after single and double passages on the MDTA 3, but this difference is insignificant in the case of slivers produced after double and triple passages on the MDTA 3. Hence, it has been decided to produce slivers by the *random* method of blending after double passages through the MDTA 3 machine for further research work.

Comparison of the MDTA 3 system and conventional methods of yarn production

The yarn strength profile (Figure 4) reveals that the yarn produced from 100% polyester fibre is the strongest of the
three yarns. In the case of cotton material, it is evident that a single passage drawframe sliver gives maximum yarn strength among all three yarns. A trend to increase is clearly observed in the case of yarns produced from the MDTA 3 sliver as the percentage of polyester fibre in the blend increases. This is true of carded yarns as well as yarns made from drawframe slivers. The yarn elongation profile (Figure 5) shows an increasing trend in elongation as the percentage of polyester fibre in the blend increases, which is true for all three kinds of yarns. The hairiness profile (Figure 6) indicates the increasing trend in hairiness spun from the MDTA 3 sliver as the percentage of polyester fibre in the blend increases, and this is also true in the case of yarns spun from card as well as drawframe slivers. All of these trends observed persuade us that the fibre properties affecting strength, elongation, and hairiness values of yarns spun from MDTA 3 sliver play similar roles to those properties of yarns produced from card as well as drawframe slivers.

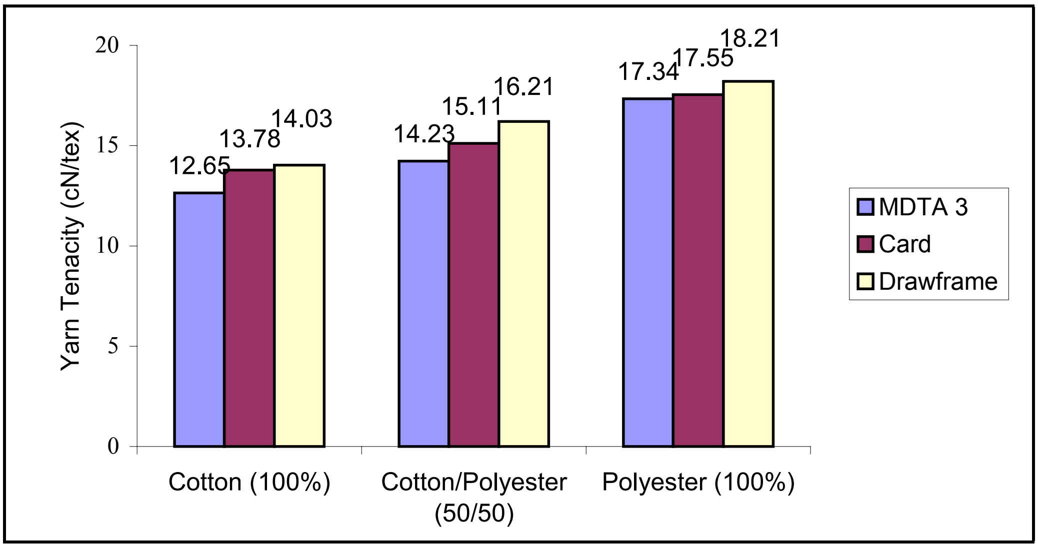


Figure 4. Comparison of yarn tenacity produced from MDTA 3, card, and drawframe slivers

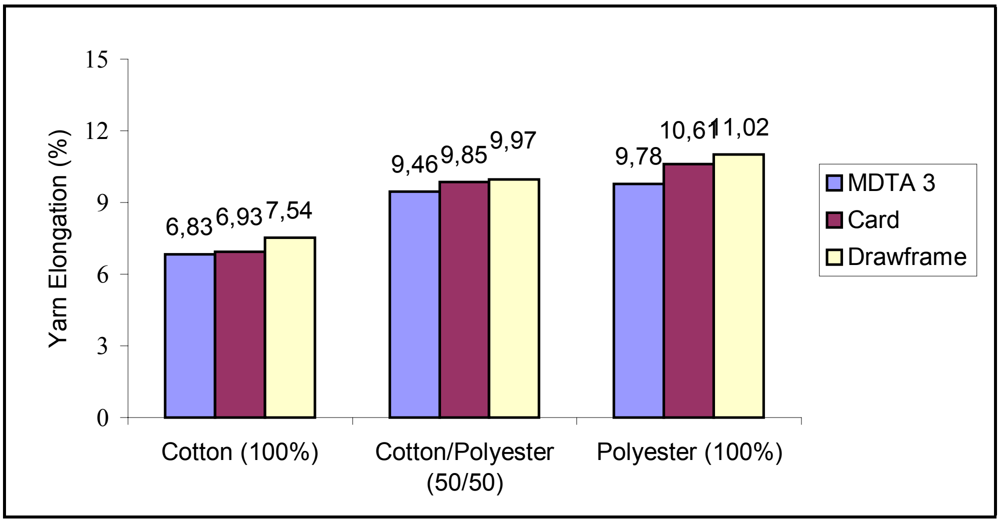


Figure 5. Comparison of yarn elongation produced from MDTA 3, card, and drawframe slivers

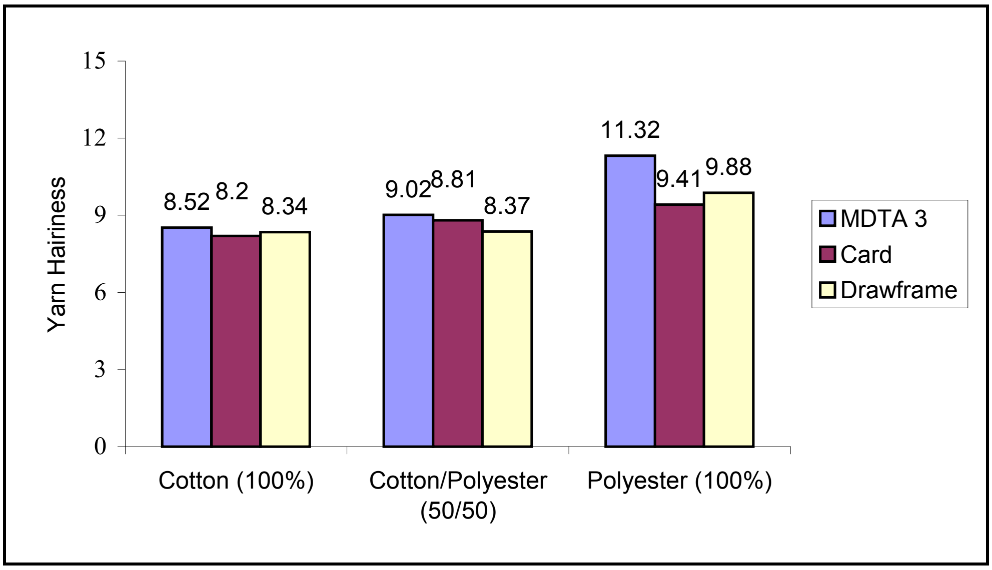


Figure 6. Comparison of yarn hairiness produced from MDTA 3, card, and drawframe slivers

Conclusions

The *random* or the *one on the bottom of the other one* method are the best of all the proposed methods of fibre blending on the Uster MDTA 3 regarding the distribution of fibres throughout the cross-sectional area of the sliver. A marked improvement in fibre blending has been found in the MDTA 3 sliver after a second passage in comparison to the single passage, but no such strong improvement is obtained after triple passages in comparison to double passages. The yarns produced in this way are highly comparable with industrially produced yarns in terms of their properties. The trend indicating the effect of fibre characteristics on industrially-spun yarn properties can be predicted quickly and reliably from the MDTA 3 data.

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References

1. *Artzt, P., Quickspin Method - A Praxis Proved Method For Qualification of Raw Material, Beltwide Cotton Conferences (Proceedings), (1998), 713-719.*
2. *Yankey, J.M., Quickspin/MDTA 3, Beltwide Cotton Conferences (Proceedings), (1994), 1628-1630.*
3. *Optimas (version 6.2) software, Stemmer Imaging GmbH, Puchheim (1997).*
4. *Mac, T., Gries. T., Wulfhorst, B., Methode zur Bestimmung der Qualitätsmerkmale von Fasermischungen und Garnen auf Basis der Eigenschaften der Einzelkomponenten, Final Report AiF 12051 N at the Institute for Textile Technology Aachen, RWTH Aachen University of Technology, Germany, 2001.*

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