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Factors Influencing Nep and Trash Transfer from the Sliver to the Rotor Yarn

Abstract

Färber proposed the coefficient j to describe the nep and trash number; these are transferred to the yarn and identified as neps by the Uster tester in the sliver which feeds the OE spinning frame. In the Institute of Textile Architecture we have carried out research on the rotor spinning process, whose aim was to analyse the phenomenon of nep and trash transfer from the feeding sliver to the yarn, and to identify factors which influence the coefficient j value. On the basis of an analysis of yarn characteristics from the Uster tester and sliver parameters from the AFIS system, this was stated as follows. In addition to the linear density of yarn, the manner of sliver preparation and the technical shape of the spinning points influence the value of coefficient j which describes nep and trash transfer from the feeding sliver to the yarn.

Key words: *nep, trash, OE yarn, cotton, fibres, sliver.*

Introduction

The nep content influences the yarn's appearance, and thus the aesthetic properties of any fabric made of this yarn. The activity aimed at minimising the nep number in the yarn has been undertaken, among other methods, by appropriate choice of raw material or by optimising the spinning process. Experiments showed that in the ring spinning process the neps and trash contained in the sliver after finisher and in the rowing do not change significantly; almost all of them are transferred to the rowing and next to the yarn [1,2]. This allows us to predict the yarn quality in the aspect of nep number per 1000 m of yarn based on the nep and trash content in sliver measurement by the AFIS system [3,4]. The relationships for the ring spinning cannot be used for the OE spinning process, in which an additional stage disturbs the fibre structure and influences the nep and trash content.

This stage is the opening of the fibre stream by the opening roller of the rotor spinning frame. Färber proposed the φ coefficient to describe the number of neps and trash transferred from the sliver feeding the OE spinning frame to the yarn and identified as yarn neps by the Uster tester [5]. This is expressed by the ratio of the nep number per 1 gram of yarn and the nep-plus-trash content in the feeding sliver (example 1):

$$\varphi = \frac{N_n / g_y}{N_n /\ g_{sl} + T_n /\ g_{sl}} \qquad (1)$$

where:
N_n - nep number,
g_y - gram of yarn,
g_{sl} - gram of sliver,
T_n - trash number.

According to Färber [3], the coefficient φ depends on the yarn linear density and can be used for predicting the OE yarn quality. In the Institute of Textile Architecture, we carried out research on the rotor spinning process, whose aim was to analyse the phenomenon of nep and trash transfer from the feeding sliver to the yarn, and to identify the factors influencing the value of coefficient φ.

Experimental

The rotor spun yarns of normal linear density 25 tex were produced from 14 cotton slivers of the nominal linear density of 4.2 ktex. Slivers made of different raw materials, among others from Central Asia and Egyptian cotton, differ among each other in their fibre properties as well as their nep and trash content.

All the variants of OE yarns were made on the BD 200 RCE rotor spinning frame with a rotor speed of 45,000 min^{-1} and an opening roller speed of 7000 min^{-1}. Yarns were spun in identical climatic conditions on one spinning point.

Additionally, we performed a pilot production of OE yarns from one sliver on 5 different spinning points. Slivers feeding the rotor spinning frame were examined by the AFIS system with version 4.22 software. The yarns produced were analysed on the Uster tester and the following parameters were measured:

- mass variation coefficient,
- IPI (thick, thin places and the nep number per 1000 m).

Results and Discussion

On the basis of the results obtained, the coefficient of nep and trash transfer φ was calculated from equation (1) as proposed by Färber. The results are given in Table 1. Moreover the coefficient of nep transfer φ_1, which takes into consideration only the nep number in the sliver feeding the rotor spinning frame, was calculated according to equation (2):

$$\varphi_1 = \frac{(N_n / g_y)_{USTER}}{(N_n / g_{sl})_{AFIS}} \qquad (2)$$

Table 1. *Values of φ and φ_1 coefficients for one spinning point.*

Variant	φ	φ_1
1A	0.0159	0.0191
1B	0.0059	0.0064
1C	0.0027	0.0029
2A	0.0055	0.0057
2B	0.0082	0.0086
2C	0.0063	0.0067
3A	0.0299	0.0321
3B	0.0180	0.0205
3C	0.0098	0.0100
4A	0.0334	0.0366
4B	0.0466	0.0504
4C	0.0313	0.0327
5A	0.0106	0.0112
5B	0.0174	0.0202
Mean	0.0173	0.0188

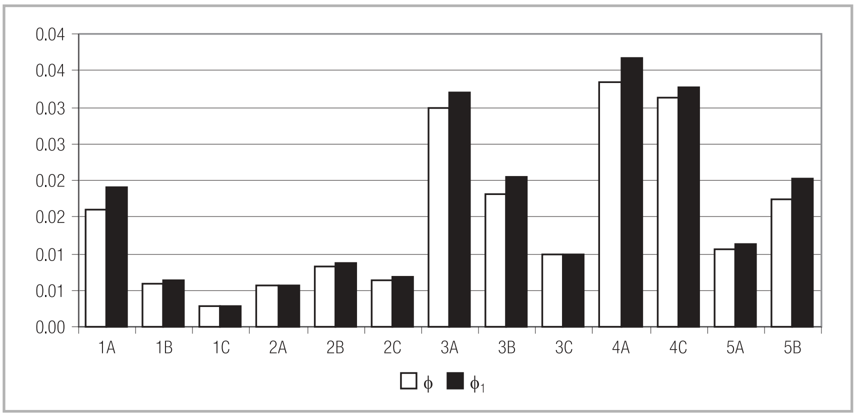

Figure 1. *The values of φ and φ_1 coefficient.*

where:
$(N_n/G_y)_{USTER}$ - nep number per 1 gram of yarn according to USTER tester,
$(N_n/g_{sl})_{AFIS}$ - nep number per 1 gram of sliver according to AFIS.

In Figure 1, the values obtained of φ and φ_1 coefficients are presented. In both cases a wide deviation of results was found. The coefficient of nep and trash transfer φ ranged from 0.0027 to 0.0466, whereas the coefficient of nep transfer φ_1 was in the interval of 0.0029-0.0504. Since all the yarns were spun in the same conditions and on the same spinning point, the reason for such variation should be looked for in the properties of the sliver feeding the rotor spinning frame.

In order to identify the factors influencing the phenomenon of the nep and trash transfer from the sliver feeding the rotor spinning frame to the produced yarn, we calculated the values of linear correlation coefficients between values of φ (or φ_1) and appropriate properties of the feeding sliver. It was stated that the higher the values of the nep transfer coefficient φ_1 as well as nep and trash transfer φ, the greater the number of neps in the sliver (Figures 2 and 3). There is a strong correlation relationship between the values of φ (or φ_1) coefficients and the number of neps in the sliver feeding the OE spinning frame (R=0.816 and R=0.810).

A similar relationship was found between the values of φ (or φ_1) coefficients and the number of hard trash particles in the sliver (Figures 4 and 5). The results obtained allow us to assess how significant an influence on cotton rotor yarn quality the appropriate process of sliver preparation has, especially regarding the efficient removal of nep and trash. The higher the efficiency of the scutching and carding machines, the lower the nep and trash number in the sliver feeding the rotor spinning frame, and – by extension, the lower the values of the φ and φ_1 coefficients. This means that the lower nep and trash number is transferred to the produced yarns.

The mean value of the coefficient of nep and trash transfer φ was 0.0173, whereas that of φ_1 was 0.0188. It was also stated that there is a strong correlation relationship (R=0.9984) between both coefficients (Figure 6).

Thanks to this, the coefficient of nep transfer φ_1 can be used instead of the

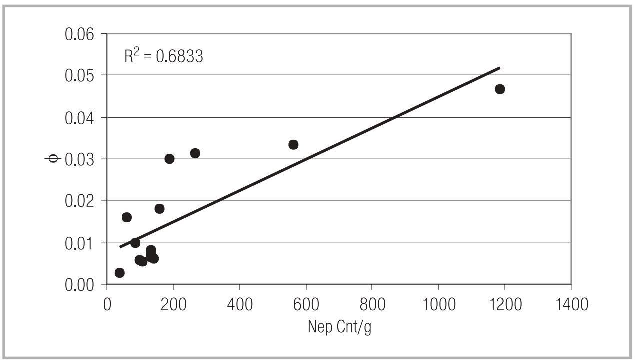

Figure 2. *The relationship between φ coefficient and the nep number in the sliver feeding the rotor spinning frame.*

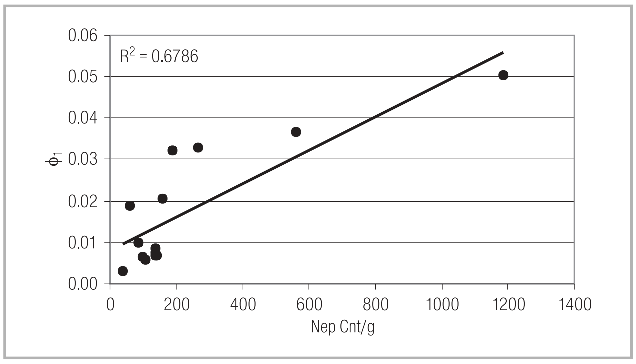

Figure 3. *The relationship between φ_1 coefficient and the nep number in the sliver feeding the rotor spinning frame.*

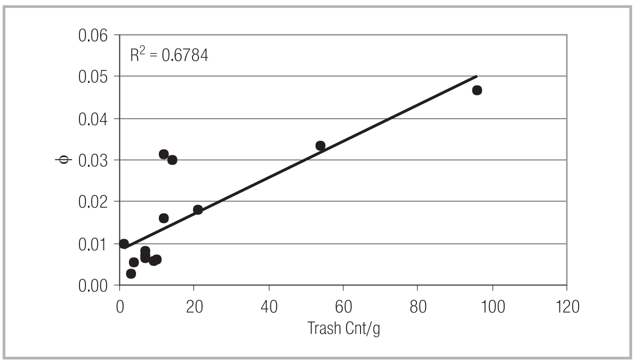

Figure 4. *The relationship between coefficient φ and the trash number in the sliver feeding the rotor spinning frame.*

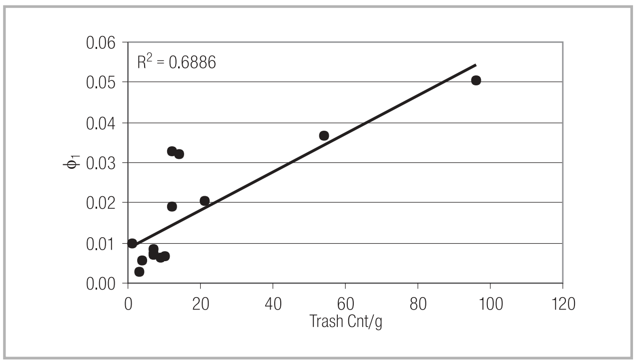

Figure 5. *The relationship between coefficient φ_1 and the trash number in the sliver feeding the rotor spinning frame.*

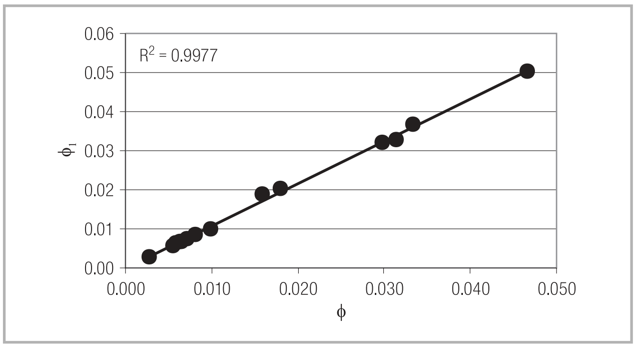

Figure 6. *The correlation relationship between the coefficients φ and φ_1.*

Table 2. *The nep and trash number in slivers after successive stages of processing and values of coefficients φ and φ_1.*

Cotton	Half products	Nep, Cnt/g	Dust, Cnt/g	Trash, Cnt/g	VFM, %	φ	φ_1
Egyptian cotton	Sliver after carding	61	95	12	0.18	0.0159	0.0191
	Sliver after drawing	97	114	9	0.17	0.0059	0.0064
	Sliver after combing	37	38	3	0.05	0.0027	0.0029
Central Asian cotton	Sliver after carding	189	87	14	0.25	0.0299	0.0321
	Sliver after drawing	157	115	21	0.39	0.0180	0.0205
	Sliver after combing	87	53	1	0.03	0.0098	0.0100

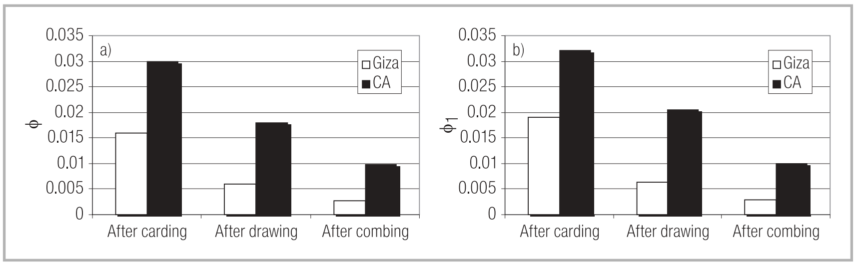

Figure 7. *Values of the coefficients of φ and φ_1 for OE yarns of linear density 25 tex made from slivers after different processing stages.*

coefficient of nep and trash transfer φ, which facilitates prediction of the OE yarn quality, because the coefficient φ_1 can be calculated much more easily than the coefficient φ. Moreover, by applying the nep transfer coefficient φ_1 we can predict the nep number per 1000 yarn meters with the use of the module AFIS-N only.

The number of operations applied during sliver preparation is also important. There is a tendency to shorten the technological process by eliminating drawing frame passages after carding up to their total elimination. This is due to economical reasons, because it allows the costs of processing to be reduced, especially of energy and labour costs. Nevertheless, the shortening of the technological process influences the quality of yarn produced.

In our research, we used slivers produced from the same blend, but from a different stage of sliver preparation, i.e., after carding, drawing and combing. Slivers were made from two different blends, Egyptian and Central Asian cotton. The nep and trash number in the slivers and values of φ and φ_1 coefficients are presented in Table 2.

On the basis of the results presented above, we can state that the manner of sliver preparation influences the value of φ and φ_1 coefficients, and by extension the appearance of the produced rotor yarn. In both of the analysed cases, the highest values of transfer coefficients were obtained for the sliver after carding (Figure 7).

For slivers after drawing, the nep and trash transfer to the yarn was 2-3 times lower in comparison to slivers after carding, although these slivers were characterised by the same level of trash and nep content.

Moreover, on the basis of the results mentioned above, it can be stated that the biggest influence on φ and φ_1 values is the nep content in the sliver. For slivers from the medium staple cotton from Central Asia, which were characterised by a higher nep content per gram in comparison to the sliver from Egyptian cotton, we noted a 2-3 times higher value of transfer coefficient. Dust and trash content in slivers made of both kind of raw materials were on the same level, which was not reflected in values of φ and φ_1 coefficients. Table 3 presents the set of values of coefficient φ and φ_1 obtained during the experimental production of OE yarn of linear density of 25 tex from one feeding sliver on 5 randomly chosen spinning points.

We can obtain different levels of yarn quality depending on the technical shape of spinning points. On the basis of the example of only 5 spinning points, we can see that the number of neps per 1000 yarn meters can vary by a few times. Similarly, the values of φ and φ_1 coefficients differ. The best working spinning point (no. 8) was characterised by the transfer coefficients of φ_1=0.0033 and φ=0.0032. These values were several times higher (φ_1=0.0198 and φ=0.0188) for the worst working spinning point (no. 9).

On the basis of the analysis performed of coefficient φ and φ_1 values, we can state the variation in these coefficients, and at the same time the variation in quality of the OE yarns produced on particular spinning points. Each of the 200 spinning points of the rotor spinning frame is fed by a sliver which can have a different nep number level. This is caused by different work quality of the particular spinning points. There is a probability that yarns arising from the same spinning frame but from different spinning points can differ greatly in the aspect of the nep number per 1000 m. This should be taken into consideration when planning the laboratory checking frequency.

Summary

On the basis of the experiments carried out we can state the following:

- nep and trash transfer from the sliver feeding the rotor spinning frame is higher, the higher the nep and hard trash particle content in the sliver is;
- the manner of sliver preparation influences the values of nep and trash transfer coefficients;
- there are variations in φ_1 and φ values for the same spinning frame, depending on the technical shape of spinning points,
- there is a strong linear correlation relationship (R=0.998) between the coefficient of nep and trash transfer φ and the coefficient of nep transfer φ_1,
- the proposed coefficient of nep transfer φ_1 enables prediction of the nep number per 1000 m of yarn,

Table 3. *The values of coefficient of φ and φ_1 for OE yarn of linear density 25 tex produced on 5 spinning points.*

Spinning point	Sliver properties		Nep number /1000m of yarn	φ	φ_1
	Trash, Cnt/g	Nep, Cnt/g			
3	7	135	28.0	0.0066	0.0069
6	7	135	30.7	0.0072	0.0076
8	7	135	13.3	0.0032	0.0033
9	7	135	78.7	0.0188	0.0198
10	7	135	40.4	0.0082	0.0086
Mean value	7	135	38.1	0.0088	0.0092

based on the assessment of the nep number in the sliver feeding the rotor spinning frame, which facilitates the process of prediction. ❑

References

1. Furter R., Frey M., Analyse des Spinnprozesses durch Messung von Zahl und Grösse der Nissen, Melliand Textilberichte 7, (504-510), 1991.
2. Święch T., Properties of the sliver feeding the rotor spinning frame and of the yarn, STRUTEX, Liberec 1999.
3. Frydrych I., Matusiak M., Influence of Fibre Parameters on the Quality of Cotton OE Yarns, International Conference "The Textile: Research in Design and Technology", Kaunas, Lithuania, July, 2000.
4. Święch T., Prediction of OE Yarn Neppiness Basing on Investigation of Properties of a Sliver Feeding the Spinning Frame, International Conference "The Textile: Research in Design and Technology", Kaunas, Lithuania, July, 2000.
5. Färber Ch., Einfluss des AFIS - Störpartickelgehaltes auf Imperfektionen von Baumwoll Ring und Rotorgarnen, Melliand Textilberichte, 10, 1996.

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