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Effect of sliver opening on neps in rotor spun yarns

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The paper presents the dependency of neps in rotor spun yarns (cotton 100%) on variations of opening roller speed, teeth inclination of the opening roller and opening of the carded sliver. Three types of opening rollers and three levels of opening speed were used to produce 40 tex rotor yarns while keeping the other spinning parameters constant. The coefficient of points per fiber was used to evaluate the joint effect of opening parameters on the number of neps in the spun yarns

Keywords: rotor spinning, cotton spun yarns, neps, opening roller speed, coefficient of points per fiber

Introduction

Neps are one of the yarn imperfections that determine yarn quality. They are controlled via measurements on Uster apparatus. The neps cause yarn breaks during weaving and knitting due to the blocking of the holes of the yarn guides. In knitting machines, neps can also block the needle hooks, which provokes breaks and holes in the knitted fabric. The neps on the face side of the fabrics may cause unprinted or undyed spots that worsen the fabric appearance, especially when dark colors are applied.

Neps in rotor yarns are frequently observed as the carding system is applied in the open-end (OE) rotor spinning. The absence of a combing machine allows several neps from the raw material to stay in the rotor spun yarns. The winding process is also not used in the OE spinning technology, as the rotor yarns are directly winded onto a bobbing. Thus, two essential processes for eliminating the neps in the rotor spun yarns – combing and winding – are missing.

The opening of the sliver is the process in rotor spinning that can positively influence the number of neps in the spun yarn [1]. The proper opening reduces the neps and allows the separation of the imperfections in the rotor groove. It was reported in [2] that the increment of the opening roller speed (from 5000 to 7000 rpm) provoked decrement of the imperfections. Similar were the findings in [3, 4]. The study in [5] investigated the effect of the opening roller speed on the fibers' configuration in the yarn structure. The response surface methodology was applied in [6] to establish the effect of rotor spinning parameters on yarn imperfections and quality.

Our previous studies investigated the effect of the exit nozzle [7], and the cleaner [8] on the properties of rotor spun yarns. The impact of the quality of the slivers and the pre-processing line on the quality of rotor yarns was discussed in [9, 10]. The present paper deals with the influence of the opening roller in the appearance of neps in rotor spun yarns, applied for knitting and weft threads in weaving. Three different angles of the teeth inclination and three different speeds of the opening roller were used to spin the rotor yarns from 100% cotton. The influence of the studied parameters on the fiber separation was also evaluated.

Types of neps

Different types of neps can be found in the structure of the cotton rotor yarns. According to the source of their appearance, they can be evaluated as:

- Neps from the plant. Cotton fibers entangle with fragments from the seeds and seed coat. The percentage of this type of neps strongly depends on the ginning process. The imperfections can be removed during carding and combing if combing is applicable. The neps are visible as dark spots in the gray fabric.

- Neps from the raw material. Cotton bales contain a different percentage of dead or immature fibers, which easily bind in neps. The most effective way to remove these neps are the combing machines, which are not part of the technological process in OE rotor spinning. Carding machines can remove approx. 60% of all impurities in raw cotton [1].
- Neps from mechanical actions in the technological process. The opening line and carding machines can remove a significant part of the impurities and defects in raw cotton. However, improper machine settings or damaged machine parts can create additional neps in the carded sliver [9]. The immature or fine fibers tend to curl up and bend around other fibers, forming new neps.

Large-sized neps (over 1 mm) are the easiest for removing, as the centrifugal forces of the fast rotating mechanical parts of the opening and cleaning machines act successfully on them. They are usually removed after carding. Medium-sized neps (0.4-1 mm) are more difficult for eliminating and some of the neps usually continue to stay in the carded sliver. Small-sized neps (less than 0.4 mm) are the most difficult for removing and can be eliminated only after combing.

Experimental data

Cotton fibers with 201 mtex mean linear density, were used for the study. The slivers were prepared on a Rieter's Automated Line, a fully automatic production line from bale to finished draw frame sliver. The slivers (3.7 ktex linear density, 20.16 mm mean fiber length and 26.54 mm staple fiber length) were fed to a BD 200 RN rotor-spinning machine. The linear density of all rotor yarns was 40 tex, and the twist was set to 725 m^{-1}

Three different angles of the teeth inclination of the opening roller were tested: 0^o (OK61 for cotton blends with chemical fibers, 452 teeth), 9^o (OK37 for chemical fibers, 390 teeth) and 23^o (OK40 for cotton fibers, 576 teeth). Three opening roller speeds were used to open the slivers: 6000, 7000 and 8000 rpm. The speed of the rotor was kept constant: 36000 rpm.

The neps in the rotor yarns (+280%) were tested using Uster Tester 3, with measurement speed of 400 m/min. Samples from three different bobbins were tested, and the average values were determined.

To evaluate the fiber separation in each rotor yarn, the number of points per fiber C_{ppf} was calculated according to the formula [2]:

$$C_{ppf} = \frac{np_t n_t^f L}{v_f n_t^s} 10^{-6} ,$$

where n is the speed of opening roller [rpm]; p_t is the number of teeth on the surface of the opening roller; v_f is the speed of the sliver feed [m/min], n_t^f is the fiber linear density [tex]; n_t^s is the sliver linear density [tex], and L is the mean fiber length [m].

Results and discussions

Figure 1 presents microscopic images of neps in the cotton blend, used for spinning the rotor yarns. Figure 2 shows neps in microscopic pictures of the produced rotor yarns. Figure 3 illustrates neps, observed in knitted fabrics, obtained using rotor spun yarns.

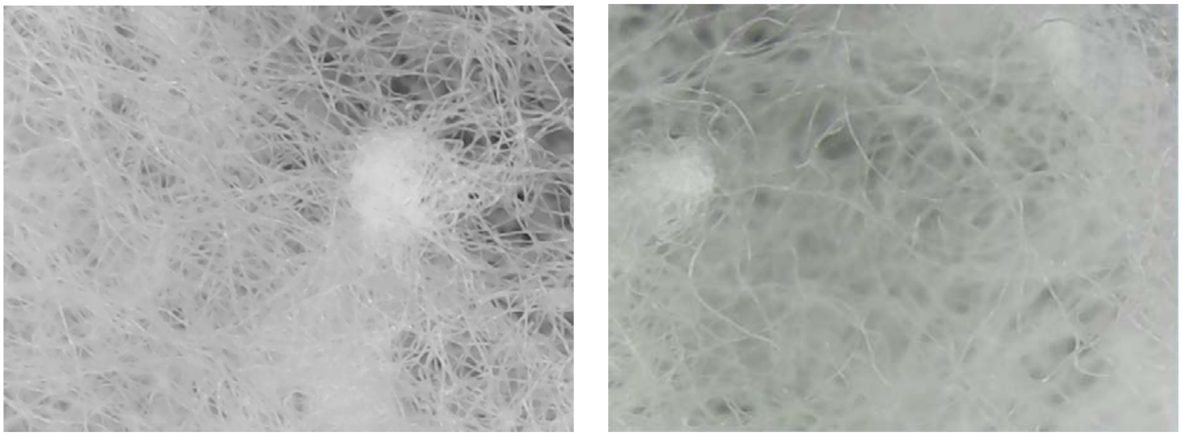


Fig. 1 Microscopic pictures of neps in the carded sliver

Figure 4 presents the results for the measured neps in the spun yarns. The results obtained show that the type of teeth and their inclination is much more important than the speed of the opening roller. The best results, concerning the number of the neps per kilometer in the spun yarn, are obtained with the opening roller OK61 with 0° inclination of the teeth, suitable for cotton blends with chemical fibers. Unexpectedly, the opening roller OK40 with 23° inclination of the teeth gave worse results, though this type of opening roller is designed for pure cotton blends. The application of the OK37 opening roller for chemical fibers (teeth inclination of 9°) led to the highest number of neps in the tested yarns.

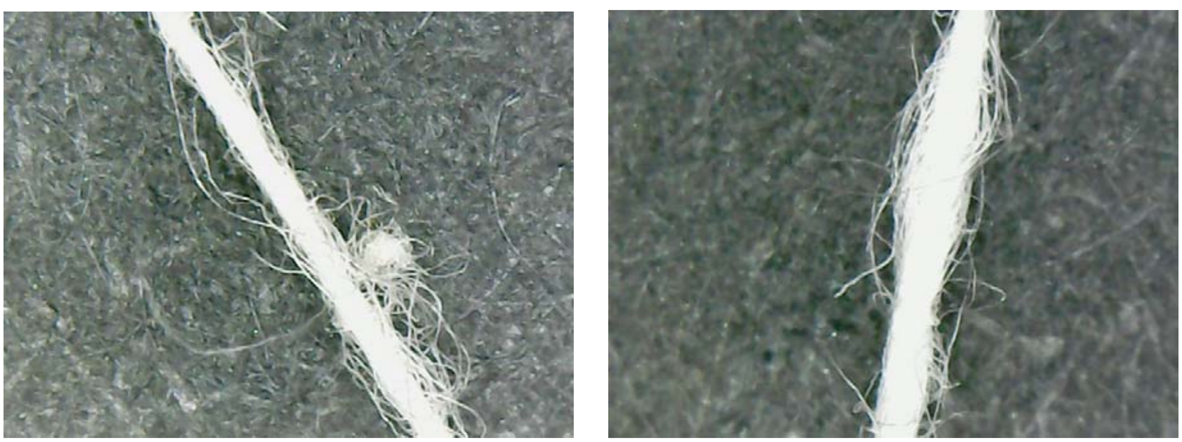


Fig. 2 Microscopic pictures of neps in the rotor spun yarns

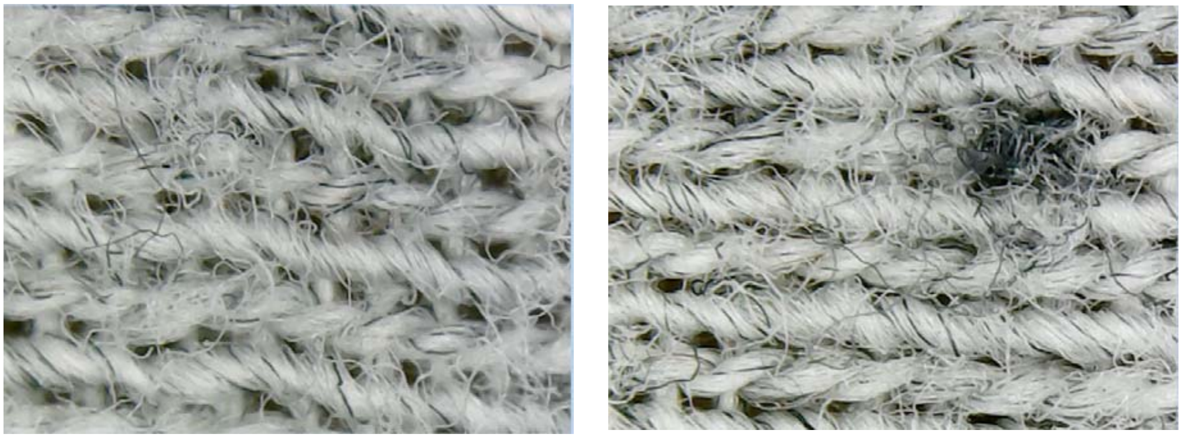
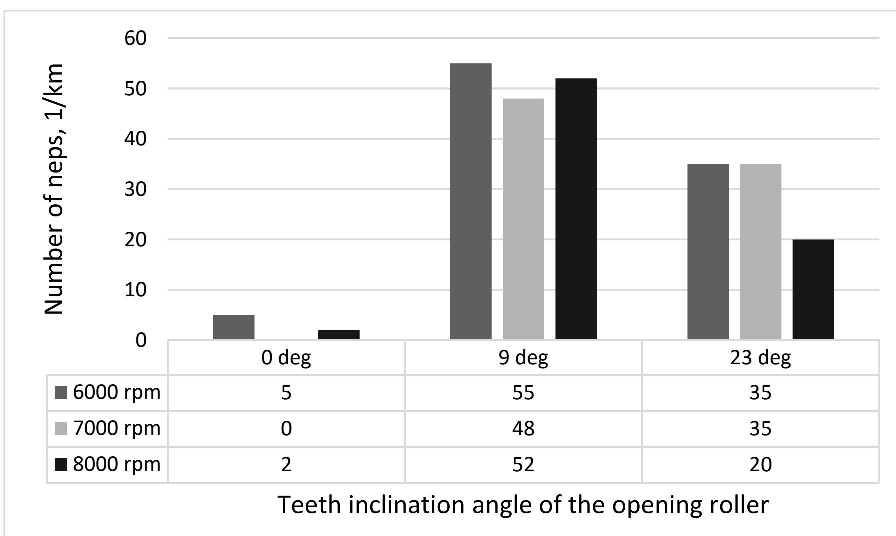


Fig. 3 Microscopic pictures of neps in knitted fabrics

The change of the opening roller speed did not provoke statistically proven differences between the number of the neps in the yarns, produced with the same opening roller type.

The calculated coefficient of points per fiber C_{ppf} for each of the studied regimes is shown in Fig. 5. The most effective opening of the sliver was assured by the opening roller, meant for cotton blends (23° teeth inclination). The opening roller type that gave the lowest results for neps in the yarn (0° teeth inclination) is on the second place. In fact, this type of opening roller (OK61), working with 7000 rpm and 8000 rpm gave similar results for C_{ppf} as the OK40 opening roller, working with 6000 rpm. The opening roller, designed for chemical fibers, assured lowest values of the opening of the carded sliver.

Obviously, the increment of the opening roller speed from 6000 rpm to 7000 rpm and 8000 rpm led to increased $C_{ppf.}$ However, the increment of C_{ppf} cannot be an end in itself, because the studies in [5, 6] show that the increment of the opening roller speed leads to in deterioration in yarns strength due to fiber breaks.



	0 deg	9 deg	23 deg
6000 rpm	5	55	35
7000 rpm	0	48	35
8000 rpm	2	52	20

Fig. 4 Effect of teeth inclination angle and opening roller speed on the number of neps in the rotor spun yarns

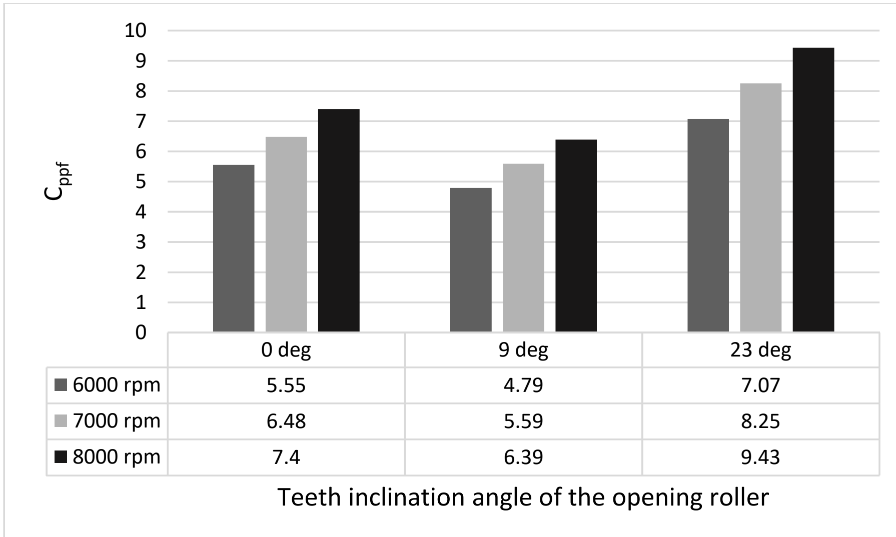


Fig. 5 Effect of teeth inclination angle and opening roller speed on the opening of the carded sliver

Conclusions

We have investigated the effect of the opening roller speed, the angle of the teeth inclination of the opening roller and the sliver opening effect on the number of neps in rotor spun yarns made of cotton 100%.

It was found that the type of opening roller had a more significant effect on the neps in the yarn than the speed of the opening roller. The highest opening effect of the sliver was obtained using opening roller speed of 8000 rpm and using the opening roller type for cotton fibers, followed by the opening roller type meant for blends of cotton with chemical fibers.

Best results concerning the number of neps per kilometer in the rotor yarn were obtained using the opening roller for blends of cotton and chemical fibers. This result could be addressed to the joint effect of the teeth inclination and the opening effect. It can be assumed that the highest opening (highest C_{ppf}), obtained by using opening roller for cotton blends, leads to unwanted effects (e.g. fibers breaking) that precondition neps formation.

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