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# The Influence of a Two-card Unit and Three-card Unit on the Irregularity of Wool Yarn

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**Abstract**
*The goal of this research work was an exhaustive analysis of the influence of carding units (double and triple ones) on the quality of wool yarn. Certain factors that greatly influence the inequality of woolen yarn were analysed. A description of measurement methods used for the determination of the inequality of linear density are presented in this article. The technological parameters of double and triple carded units, as well as their influence on the production of woollen yarns is discussed. For measurement of differences in the inequalities of yarns of the same linear density but produced form different carding units an Uster testing set was used. The influence of three carding units of different technological parameters on the formation of periodic irregularity in the yarn linear density was exhaustively analysed.*

**Key words:** *three card unit, two card unit, yarn quality, irregularity.*

## Introduction

Carding is the most important process in spinning as it contributes a lot to yarn quality. The following process parameters and specifications must be properly selected to produce a good quality yarn at a lower manufacturing cost [1].

The main aim of woolen yarn manufacturing is to produce high quality yarn, which is the most important production feature in the product creation, manufacturing, safe keeping, transportation and selling process.

Experts' sayings such as "The Card is the heart of the Spinning Mill" and "Well Carded is half spun" demonstrate the immense significance of carding for the final result of the spinning operation. There is a strong relationship between an increase in production and a reduction in quality: the higher the performance, the more sensitive the carding operation becomes and the greater the danger is of a negative influence on quality [1 - 3].

Woollen yarn is one of the oldest reprocessible yarns existing today. Yet, despite this lasting tradition, high quality yarn carding i.e. using the right technologies to obtain fabrics with the qualities required, is still heavily researched today [2 - 5].

A set of cards is one of the main factors of high quality woollen yarns [1]. Today sets of cards are identified under the trade marks HDB, FOR, TATHAM.

## Experimental results and discussions

In this work we accept conditions, allowing spinning sets working on the optimal mode without adding negative qualities to the spun yarns, exactly matching the quality of roving produced in the cards. Investigation of the unhemogenity of threads was performed using the 'Uster' complex, system provided for the automatic unhemogenity control of parameters of a spinning product's program. The 'Uster' program allows to investigate mass diagrams of fabrics with respect to factor variation of the various lengths (1 cm up to 50 m) of mass unhemogenity waves, the number of defects according to class: thick places, thin places, neps; and spectrograms of the fabrics. It also allows analyse the diagnostics of equipment with respect to the mass unhemogenity spectrum of the length of waves. Furthermore, calculation of the fluctuation of lengths of periodical linear density waves obtained from the 'Uster' system was performed [6, 7]. The length $\lambda$ of the periodical linear density fluctuation wave is calculated according to the formula (***Table 1***).

This work analyses the influence of triple-unit carding sets with a transmitting roller and of double-unit carding sets on yarn production. ***Figure 1*** includes schemes of a triple-unit carding set (a) and double-unit carding set (b), in which you can see that they are of a typical structure: main drum, worker rollers, stripper rollers, fancy roller and dismounting drum. A triple-unit carding set has 15 carding points, making a base for good carding. The advantage of this carding set is that between the first and second carding sets there are transmitting rollers that have a rotation frequency which can be adjusted. If the rotation frequency of the transmitting rollers is not chosen correctly, the piles of woollen yarn are chopped, ripped and felted, determining the periodical linear density fluctuation.

The imperfection of a double-unit carding set – a small or too small number of carding points, i.e. 10 - can be compensated by making the span between the main drum and worker rollers smaller and lowering the rotation frequency of worker rollers, thereby activating the carding. In some cases it gives satisfactory results. Because the carding piles of

***Table 1.*** *Length of periodical linear density fluctuation wave; $l_1$ - length of periodical linear density fluctuation wave; $d_1$ - diameter of transmitting roller; $n_1$- rotation frequency of transmitting roller; Vp - production delivery speed; $d_2$ - diameter of worker roller; $n_2$ - rotation frequency of worker roller; l - length of circle of working part; $d_3$ - diameter of fancy roller; $n_3$ - rotation frequency of fancy roller; $d_4$ - diameter of main staff; $n_4$ - rotation frequency of main staff; $d_5$ - diameter of card doffer; $n_5$ - rotation frequency of card doffer; $d_6$ - diameter of stripper roller; $n_6$- rotation frequency of stripper roller; $d_7$ - diameter of pressure roller; $n_7$ - rotation frequency of pressure roller.*

| | |
|---|---|
| Transmitting roller | $\lambda_1 = (d_1 \cdot \pi \cdot V_p)/(d_1 \cdot \pi \cdot n_1) = V_p/n_1 = 35/50 = 0.7$ m |
| Worker roller | $\lambda_2 = (d_2 \cdot \pi \cdot V_p)/(d_2 \cdot \pi \cdot n_2) = V_p/n_2 = 35/6.5 = 5.38$ m |
| Fancy roller | $\lambda_3 = (d_3 \cdot \pi \cdot V_p)/(d_3 \cdot \pi \cdot n_3) = V_p/n_3 = 35/600 = 0.06$ m |
| Main staff | $\lambda_4 = (l \cdot V_p)/(l \cdot n_4) = V_p/n_4 = 35/100 = 0.35$ m |
| Card doffer | $\lambda_5 = (l \cdot V_p)/(l \cdot n_5) = V_p/n_5 = 35/6.5 = 5.38$ m |
| Stripper roller | $\lambda_6 = (l \cdot V_p)/(l \cdot n_6) = V_p/n_6 = 35/500 = 0.07$ m |
| Pressure roller | $\lambda_7 = d_7 \cdot \pi = 8 \cdot \pi = 0.25$ m |

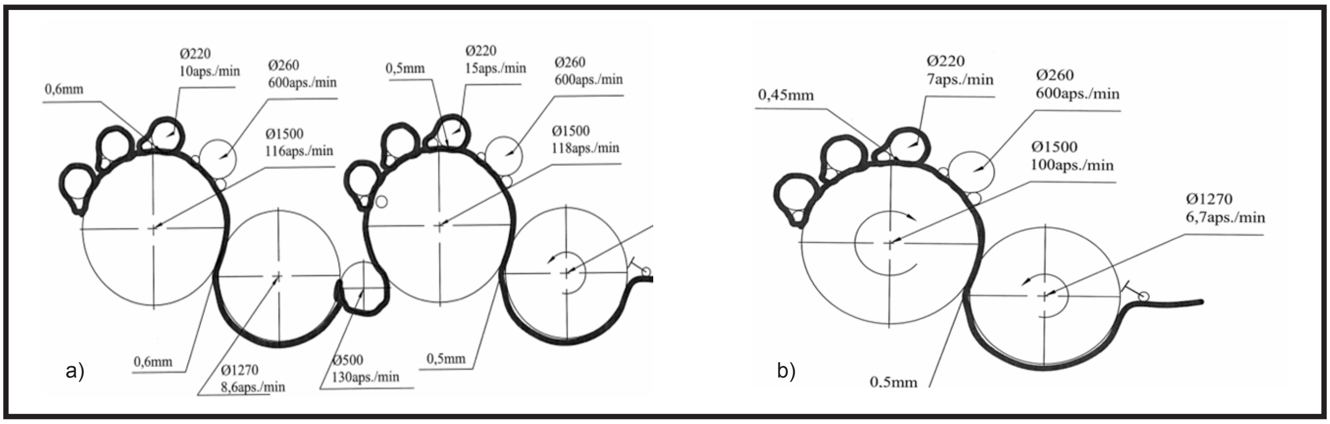


***Figure 1.*** *Analysis of a) triple-unit carding sets and b) double-unit carding sets.*

yarns undergo substantial stresses, piles are deformed, and spindle and larger rend of yarn piles occur.

According to the formulas given in ***Table 1***, we can calculate the length of the wave that shows the diameter of the working surface, which is the reason for the fluctuation peak of periodical linear density that appears in the spectrogram. The drum diameters are of a steady size, meaning that it is possible to change only the *Vp* speed of the issue or the linear speed of the working surface that impacts fluctuations. In this case the change in the rotation frequency of the transmitting roller is needed. As we can see in ***Figure 2***, the rise in periodical fluctuations is repetitive, and for this reason fluctuations repeat in the next wave length. If we delete the first peak, we eliminate its repetitive deviations as well, and hence the quality of yarns produced improves.

In ***Figure 2.a*** we can see the cause of typical periodical fluctuations in linear density. It is very important to monitor the appearance of these fluctuations and note the optimal rotation rate while performing blend carding so as to avoid quality deviations in later production of the same composition parcels. Yarns produced by double-unit carding sets in later technological phases are mostly folded (production of recovered yarns), in an attemp to hide linear density fluctuations.

In ***Figure 3.a*** linear density fluctuations are clearly seen, meaning that technological parameters should be changed, which is not so easy to do if the gears of the carding set are electrical. In this case the drum rotation frequency can be changed by hundredths of revolutions. This regulation is leveled, and we can see that periodical fluctuations of linear density increase or decrease depending on whether we increase or decrease the rotation frequency evenly. From the diagram of linear density fluctuations (***Figure 3.b***), we see the bad quality of carding confirmed; the fluctuation amplitude is big. and fluctuations are frequent.

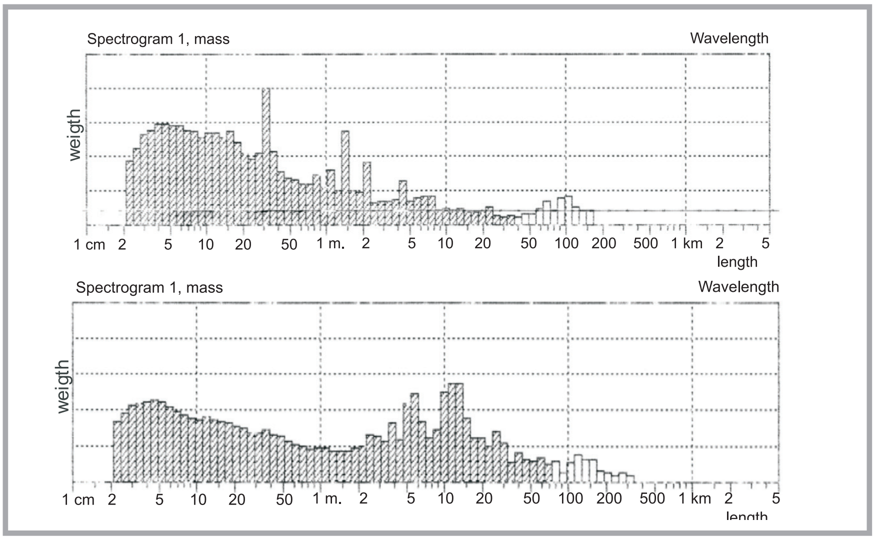


***Figure 2.*** *Spectrogram of yarn linear density: (a) triple-unit carding set; (b) double-unit carding set.*

For more accurate analysis a control chart of linear density fluctuations was made (***Figure 4***).

On the control chart of linear density fluctuations (***Figure 4.a***) we see that linear density fluctuations are big, and the limits of intervals are quite far from the max and min points. The positioning of averages is close to the nominal rate of linear density fluctuation, which means that in long segments the irregularity decreases rapidly, and the separate rates analysed show that it conforms to 90 - 95% of the interval measures counted. The carding process is optimal, and it is possible to produce high quality yarns.

As we see in ***Figure 4.b*** fluctuations are not within the limits of the interval; they are sharp, fluctuate to both sides of the nominal and go beyond critical limits. This shows that technological process is unstable. As even the inner meanings of linear density are higher than the interval limits counted, linear density fluctuations, even in long segments, stay visible. These linear density fluctuations are caused by the linear speed of the worker roller in the second carding set, which is even two times smaller than in the triple-unit carding set. The speeds of the main drums are equal. Moving two times slower, worker rollers slow the main fiber stream down, carried by the main drum. The felting of worker rollers with fiber is much bigger than with a triple-unit carding set, hence the quantity of fiber in the carding zones in between working rollers and the main drum is bigger. This influ-

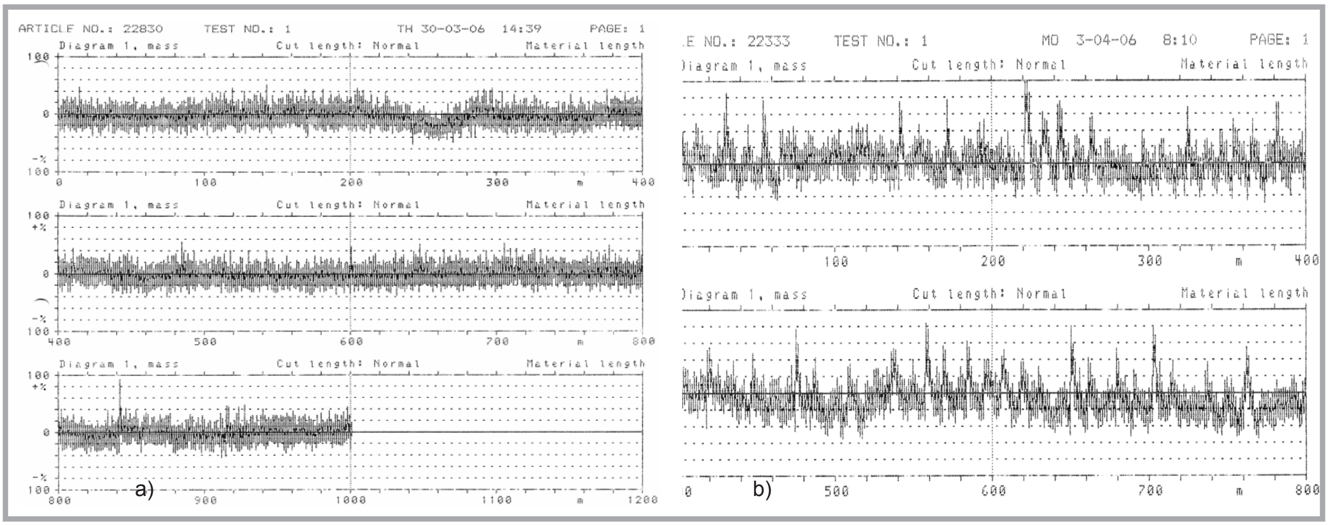


*__Figure 3.__ Diagram of deflection of yarn linear density: (a) triple-unit carding set; (b) Double-unit carding set*

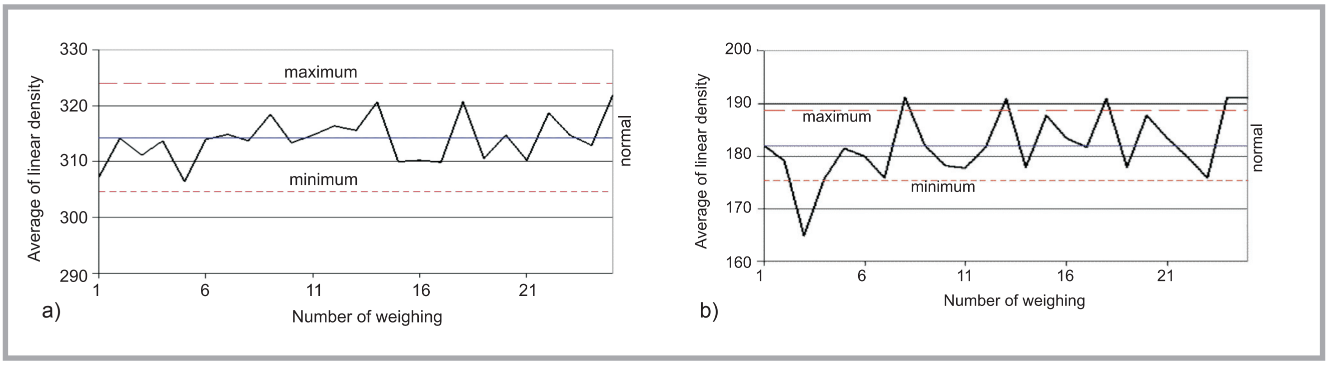


*__Figure 4.__ Control cards of linear density: (a) triple-unit carding set; (b) double-unit carding set*

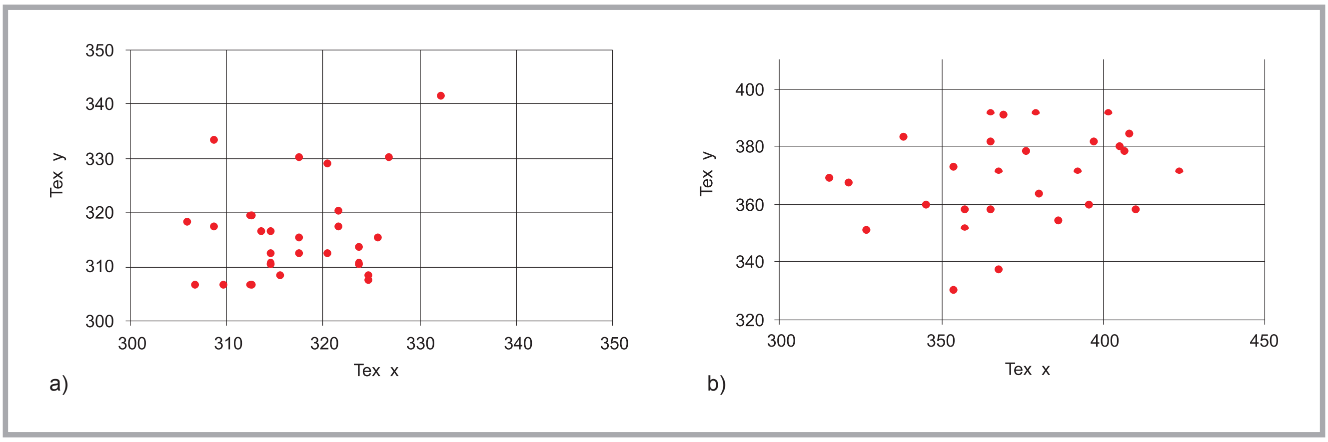


*__Figure 5.__ Diagrams of dispersion: (a) triple-unit carding set; (b) double-unit carding set.*

ences the bad carding of fibres, and the stripper rollers sends the fibre back in tufts, which is one of the main reasons for originating irregularity in the linear density.

To make sure that linear density fluctuations are not accidental, a comparison was made of two different portions of results of weighting pairs of the same linear density for woollen yarns (***Figure 5***).

In the scatter diagram (***Figure 5.a***) we see that most of the points are spread around one linear density value. Linear density is a quality indicator that depends on many factors: raw materials, carding, the functioning of rubbing apron, the rolling on the roving roller, and the spinning frame [3]. That is why the spread is sufficiently large, and the relations are weak. The main fluctuation origin is seen in the spectrogram, which is influenced by the incorrectly adjusted rotation frequency of the transmitting roller, but there are many unclear factors that have an influence on linear density inequality, which is why the relations between unequal density values are weak.

As we see in ***Figure 5.b***, there is no relation between the inequalities of linear density originated.. That is why this technological process is unstable and unpredictable. To produce high quality yarns is very difficult or impossible; hence, the strains of carding zones are very unstable. From the spectrogram we see that there are many reasons for fluctuations, all of which influence big fluctuations. But we cannot separate one main reason for fluctuations. Therefore we need to take a lot of factors into account if we want to produce quality yarns. Even if we clarify most reasons for fluctuations, after the next blend has started to be carded, earlier fluctuations may show again. Because fluctuations are incidental and there are no dominating factors, the carding process is unstable and unpredictable.

## Conclusions

After analysing the results of the trial research, we can make the following conclusions:

- The appearance of most of periodical linear density fluctuations is typical, and taking these regularities into account, it is possible to avoid these fluctuations.
- Not only is the number of carding points important for the quality of yarns but also the correct transportation of fiber in between the carding sets.
- Incorrectly adapted parameters of carding sets have the biggest impact on linear density fluctuations in rubbing carding systems.
- The biggest linear density fluctuations are produced when yarns are ironed in short segments of 0.01 m, while in long segments of 50 m, linear density imports become equal.

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