Transactions on Engineering and Computer Science

Research | Vol 1 Iss 1

# Production of Fancy Yarn on Spinning Machines

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**Received:** April 28, 2020; **Accepted**: May 15, 2020; **Published:** May 22, 2020



## Abstract

***This article discusses the production of fancy yarns on a ring spinning machine by installing the special pressure rollers on the drafting rollers. Recommendations for adjusting the load of exhaust devices to reduce breakage are indicated. The dynamics of uneven rolling motion of a non-cylindrical roller along the cylinder is considered.***

**Keywords:** ***Pressure roller; Cylinder; Elastic coating; Fancy yarn; Needle roller; Thickening frequency.***

## 1. Introduction

Fancy yarn is a separate category of threads, opening up incredible scope for creativity. Its isolation in fancy is associated with a specific production technology, when in the process of creating yarn, yarns of different composition, nature and color are mixed. Fancy yarns are frequently used for fabric production [1].

The principle of most previously known devices for obtaining periodic thickening of yarn used on roving and ring spinning machines is based on a periodic or random change in the length of the hood [2-4]. Our development is based on the principle of periodic changes in wiring between drafting rollers.

## 2. Materials and Methods

Changing the wiring can be achieved by varying the clamp width of one of the drafting rollers. To this end, we have developed a special design of the pressure roller of the drafting rollers (Fig. 1).

On the surfaces of the cups of the roller 1, longitudinal grooves are cut into which steel needles are installed (cylindrical rods) 2. Elastic coatings 3 are put on top of the cups with needles.

**Citation:** Butovskiy PM and Agzamov MM. Production of Fancy Yarn on Spinning Machines. Trans Eng Comput Sci. 2020;1(1):105.

Due to the installed needles, the working surfaces of the pressure roller acquire a new profile. During the operation of the pressure roller with needles, the width of its contact with the corrugated cylinder will periodically change from a certain value $b_{min}$ - in the places set under the roller coating, with needle, to $b_{max}$ -in the areas of the pressure roller coating without needles (Fig. 2). In this case, the wiring between the clamps of the drafting rollers (denoted by $L$) will range from $L$ to $L+(b_{min}-b_{max})/2$.

For all the above indicated parameters of the elements of the drafting rollers and the load, the limiting values of the width of the contact strip in its middle part corresponded.

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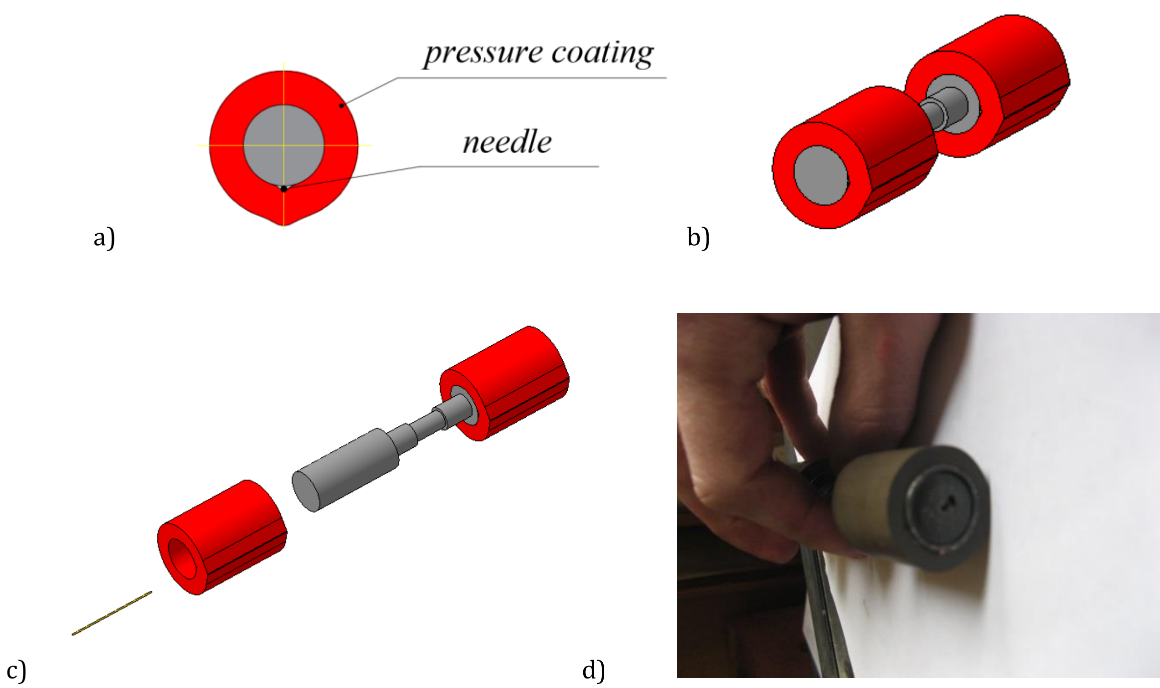
$b_{max} = 4{,}5\ mm$ and $b_{min} = 2{,}5\ mm$

The change in the width of the contact is 2 mm, it follows that the change in the wiring between the clamps of the drafting rollers is equal to:

$$\Delta l = \frac{\Delta b}{2} = 1\ mm$$




a) frontal view; b) isometric view; c) detailed view; d) realistic foto

**Fig. 1.** Pressure rollers with needles to produce fancy yarn

To understand how the wiring variation between the clamps of the drafting rollers affects the unevenness of the yarn obtained, it is necessary to analyze the movement of fibers in the studied front zone of the exhaust device.

a) b)

a) imprint of the contact strip of the drafting rollers in the place of the needle-free working surface of the roller; b) imprint of the contact of the strip of the drafting rollers in the place of the needle roller installed under the cover

**Fig. 2.** Imprints of the contact strips of the pressure roller with a reef cylinder

The diameter of the needles affects the effect of fancy yarn, but also affects the life of the roller. Table 1 shows the dependence of the diameter of the rod on the durability when working with a single needle.

Fig. 2. shows the types of destruction of the elastic coating of the roller with a needle diameter of 3 mm after 80 hours of operation.

**Table 1:** Pressure Roller Operating Life Data with Various Needle Diameters.

| Diameter of a needle, mm | Number of hours |
|---|---|
| 0,5 | 480 |
| 2 | 140 |
| 3 | 80 |

As can be seen from the table, the working life of the pressure roller depends on the diameter of the needles. With increasing diameter of the needles decreases the service life.

Yarn breakage depends on the diameter of the needle, as well as the load on the pressure roller. Table 2 shows the dependence of yarn breakage on the load on the pressure rollers and the diameter of the needles per 1000 spindles per hour.

**Table 2:** Discontinuity Data on a Spinning Machine When Using A Pressure Roller With Inserted Needles at 1000 Spindles Per Hour

| Needle diameter | Load | The number of breaks per hour per 1000 spindles |
|---|---|---|
| 0,5 | 12 | 1 |
| 2 | 4 | 10 |
| 3 | 4 | 16 |

The gap of the elastic coating of the roller with a needle diameter of 0.5 mm after 48 hours of operation, is shown in Fig. 3.

**Fig. 3.** The gap of the elastic coating of the roller with a needle diameter of 0.5 mm after 48 hours of operation.

The optimum needle size has been experimentally established; it fluctuates between 0.5-1 mm with a load on the pressure roller of 120 N. The yarn obtained, with this method, is shown in Fig. 4.

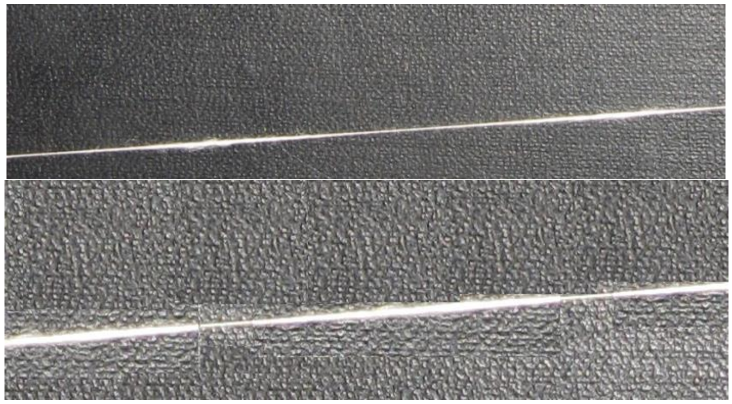


**Fig. 4.** Fancy yarns obtained with a first needle roller.

Table 3 shows the dependence of breakage on the produced linear density of the yarn with a needle diameter of 0.5 mm.

**Table 3:** Dependence of Breakage on the Produced Density of Yarn.

| Density of yarn, Tex | The number of breaks per shift per 1000 spindles |
|---|---|
| 20 | 11 |
| 40 | 6 |
| 60 | 0 |

As mentioned above, the nature of the occurrence of the periodicity of thickening of the yarn is caused by a change in the width of the contact between the roller and the cylinder. The width of the contact for the roller with the needle decreases when the roller rises the convex part.

Along with the needles, a pressure roller with a segment was used (Fig. 5). If the pressure roller with a needle makes yarn shaped by changing the width of the contact, then the roller with the segment imposes the effect of fancy yarn by changing the stretch and width of the contact. Since during rolling, there is a short-term appearance of a gap between the cylinder and the pressure roller (Fig. 5). When a gap appears, the hood between the second and the drafting rollers does not occur, due to this there is a thickening on the yarn (i.e. the effect of fancy yarn).

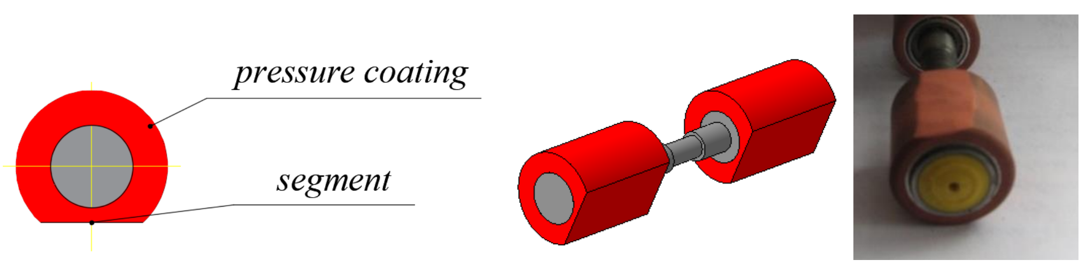



**Fig. 5.** Pressure roller with segment.

When the yarn was run by a roller with a segment, the number of breaks increased in comparison with a roller with needles. To eliminate the cliffs, the pressure on the pressure roller was reduced, which averaged 60N. Table 4 shows the number of breaks depending on the load and the width of the segment.

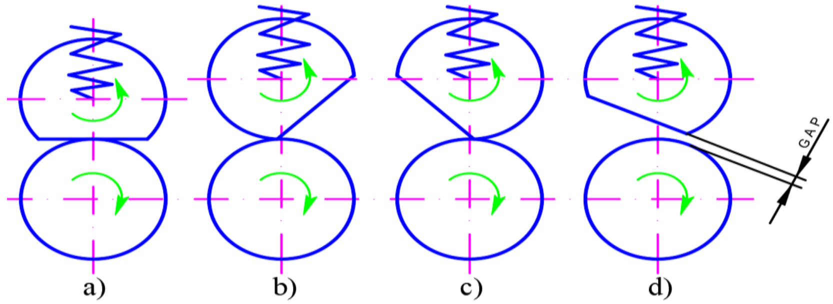



**Fig. 6.** Rolling a roller with a segment along the cylinder.

The table shows that the breakage depends on the width of the segment. The larger the segment, the greater the breakage.

The frequency of thickening is directly related to the width of the segment and to a lesser extent depends on the load. Compared with a roller with needles, a roller with flats has a significant resource of work. Rolling a roller with a segment along the cylinder, is shown in Fig. 6.

The advantage of the roller with the segment over the roller with needles is damage to the pressure coating, the disadvantage is the high frequency of yarn breakage. To reduce breakage, an increase in the linear density of the produced yarn is required.

The frequency of occurrence of the effect of the frequency of thickening depends on the number of flats or needles on the roller.

The optimum segment width should be 1mm with a load of 60N and a yarn density of 40 Tex. The yarn obtained in this way is shown in Fig. 7.

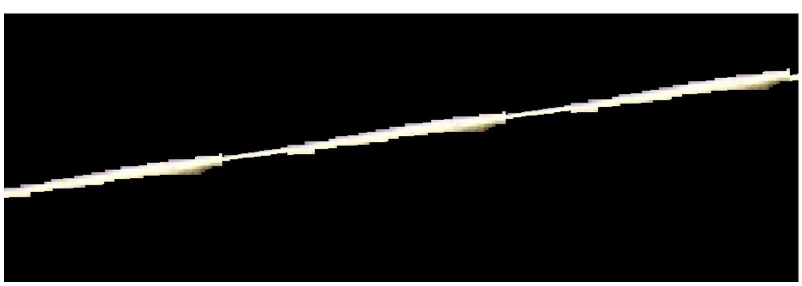


**Fig. 7.** Fancy yarn obtained using a roller with a segment

**Table 4:** The Dependence of the Type of Fancy Yarn Linear Density 20 Tex and its Clippings From the Width of the Segment.

| Segment width, mm | The load on the roller, N | Openness per hour per 1000 spindles | Visibility of the effect of the frequency of thickening of yarn |
|---|---|---|---|
| 0,5 | 80 | 4 | Visible very poorly |
| 0,5 | 60 | 2 | Almost invisible |
| 1 | 80 | 6 | Visible very poorly |
| 1 | 60 | 2 | Visible very poorly |
| 2 | 80 | 30 | Is visible |
| 2 | 60 | 23 | Is visible |
| 3 | 60 | 55 | Expressed clearly |

## 3. Theoretical Research

To solve this problem, we consider the equation of forced oscillations of a system with one degree of freedom (Fig. 7) which has the form [3]:

$$\frac{Q}{g}\ddot{x}+cx=P\cos pt \qquad (1)$$

where Q- force, pressing the roller to the cylinder, N.

c- spring stiffness, N/m;

$P\cos pt$ - periodic disturbing force from uneven coating of the roller, N.

Having solved these equations, we obtain the following:

$$x=A\cos\omega t+B\sin\omega t+\frac{q}{\omega^2-p^2}\cos pt \qquad (2)$$

The first two terms on the right-hand side of (2) characterize free oscillations, which usually decay quickly; the latter characterizes the forced steady-state oscillations with an angular frequency $p$ (with a period $T_1 = 2\pi/2$) and the amplitude of the forced oscillations $C = q/\omega^2 - p^2$ substantially depends on the ratio of the natural and forced p oscillation frequencies and can be characterized by the so-called coefficient of rise of oscillations or dynamic amplification coefficient.

$$\beta=\frac{C}{x_{cm}}=\frac{1}{1-\frac{p^2}{\omega^2}} \qquad (3)$$

The frequency of natural oscillations can be calculated by the following formula:

$$p=\alpha\sqrt{\frac{gE}{WL^3}} \qquad (4)$$

where $L$ - shaft length, mm.

$\alpha$ - deflection of the middle section of the shaft from the action of a unit force

$$\alpha=\frac{L^3}{48EI}\ \text{мм} \qquad (5)$$

$E$ - modulus of elasticity, Pa;

W- shaft weight and pressure force on the cylinder, N.

Putting the value in (4) we obtain the following:

$$p = \frac{1}{48I}\sqrt{\frac{gL^3}{W\,\mathrm{E}}} \qquad (6)$$

Now we determine the frequency of forced oscillations of the roller

$$\omega = \frac{n\pi}{30i} \qquad (7)$$

where $n$ - shaft revolutions, rpm; $i$ - the number of needles or segment in the roller, pcs.

## 4. Results and Discussion

During the experiments, it was revealed that when using such rollers, forced vibrations appear that can cause equipment breakdown in the event of resonance.

If the shaft span is 600 mm, the modulus of elasticity of steel is 200,000 mPa, the diameter of the shaft is 28 mm, the load on the shaft is 250 N, the speed is 230 rpm. Substituting the value in (5) we obtain the natural frequency of the shaft oscillation of 0.003 Hz, and the forced oscillation frequency is 6 Hz. No resonance conditions wouldn't observed. The study of the strap wear process when interacting with the product was carried out on a stand specially made. To test the effect of magnetic clamping of various shapes like a prism (with a trapezium base) on the quality of the product, carried out experimental studies [5-7].

## 5. Conclusion

- Optimum parameters for the production of fancy yarn on a spinning machine by rollers with needles, needle size from 0.5-1 mm at a load of 120N
- Optimum parameters when producing fancy yarn with a roller with a segment: the segment width should be 1mm at a load of 60N.

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**Citation**: Butovskiy PM and Agzamov MM. Production of Fancy Yarn on Spinning Machines. Trans Eng Comput Sci. 2020;1(1):105.