Methods to improve hackles in the production of quality yarn

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Abstract. The article covers the analysis of work members and mechanisms of hackles, substantiation of technical parameters and modes of operation in order to improve the quality of yarn, to eliminate thread irregularities, to reduce thread breakage and defects by changing the hackling segments and supply table spacing. The work members of the hackles, the traction forces of the roving and the hackle, as well as the productivity of the machine are theoretically determined. The hackling level indicates the thickness of the fiber layer on the surface of the main drum, or how many fibers fit into a single headset tooth. By varying the spacing between the receiving drum and the supply table, the fibers are better hackled, the degree of hackling increases - the higher the quality of the hackle and the effect on the quality of the roving has been determined theoretically and experimentally.

1. Introduction
Production control of the stationary hackling segments and the supply table work on the hackles until the yarn was spun was carried out, and results obtained by analyzing the mathematical experimental indicators of indicators and functions.

Coatings for work members of hackles. On the hackle, the surface of the fibers is hackled under the influence of elastic needles or a coated metal coating wrapped parts and cleaned of defects. The term “snow” for a machine is actually derived from the coating of its work members. Since the surfaces covered with these coatings are needle-shaped, they are called carding hackles, which is a translation of the Latin word “cardos”, i.e. “needle” [1].

Generally, the coatings are in the form of a continuous wick with needles or sharp stones on one side. Their size is very small, allowing rapid vibration of the fibers in accordance with the purposes of hackling [2]. Depending on the type and location of the working part of the hackle, the following types of coatings, depending on the type of combed fiber are used:

- hard;
- elastic;
- needle (semi-hard).

2. Materials and methods
Hard metal coatings is made of steel wire. First, the cross section of the wires is brought to the required shape [3,4]. The bottom of the form is thicker the top is thinner. In the second stage, sharp teeth are cut at the top. The result is a saw-toothed coating (Figure 1).
In the industry, pure metal saw tape is produced under CMPL brand. Such coatings are made in the form of sharp-toothed saws with a height of 1.2-2.3 mm and a thickness of 0.7-1.2 mm. The upper part of the tooth does not require sharpening as it is refined. Since the base of the coating teeth is not hardened, they can be tightly packed evenly on the surface of the drum (figure 1).

The size and type of coating is selected according to the properties of the fibers and the function of the work member. Table 1 shows some dimensions of several types of coatings. The hard gear coatings are divided into two, where the saw gear is pulled to the large headset receiving drum, the metal saw gear set (CMPL) is pulled to the main drum and the separating drum surface.

The relative position of the hackling surfaces, the direction of movement. As the surface of the main work members involved in the hackling process is covered with coatings, they become a needle or toothed surface. Such surfaces are called hackling surfaces [5].

There are many options for exposure to hackling surfaces. Some of them are the main types of impact on hackles. These include interactions with the purpose of transmitting the fibers, brushing, lifting the fibers to the tip of the teeth, or inserting them between the teeth, separating them [6].

To ensure that the fibers are hackled and separated, it is sometimes necessary to lift them to the surface of the coating or insert them inside. In this effect, the working edges of the teeth are parallel and the surface on which the fiber is to be held moves relatively slowly [7].
Figure 3. The forces generated between the fibers and the teeth.

Conditions for the transfer of fiber flow from one hackling surface to another. One of the important conditions for the hackles to be smooth, not filled or clogged is to transfer all the fibers from the receiving drum to the main drum [8]. The passage of the fibers occurs on the surface where the drums are located close together. The following conditions must be met in order for the fibers to pass completely:

- the distance between the receiving drum and the main drum teeth is minimal;
- the teeth of the drums are located at the intersection of each other;
- the height of the receiving drum tooth should not be less than 2.5 mm;
- the speed of the main drum teeth must be greater than the speed of the receiving drum.

The distance between the two drums equal to the fiber transition arc $S$ (Figure 3) passes through the receiving drum in time:

$$t = S / \varphi_{bd}$$

(1)

The main drum must travel the distance $S + \ell \eta$ at the same time to separate the fibers. In this case:

$$t = (S + \ell \eta) / \varphi_d$$

(2)

Therefore, the ratio of drum speeds is expressed as follows:

$$\varphi_o / \varphi_{bd} = (S + \ell \eta) / S$$

(3)

For a fiber with a length of 30 mm, the speed ratio is 1.25 when there is a flattening coefficient $\eta = 0.5$ and a transition point $S = 60$ mm.

The type of coatings used in this expression and calculations do not take into account the forces acting. In practice, this ratio can be set much smaller if they are taken into account.

Hackling frequency: The hackling rate is adopted to evaluate the performance of the hackle. The hackling level indicates the thickness of the fiber layer on the surface of the main drum, or how many fibers fit into a single headset tooth. As the supply cylinder speed is increased, the amount of fiber layer supplied to the machine increases and the number of fibers per tooth increases. This means that the fiber does not hackle well, the level of hackling decreases. Conversely, when the speed of the
supply cylinder is reduced, the fiber layer supplied to the machine becomes thinner, resulting in less fiber per tooth. This means that the fibers are better hackled, the level of hackling increases and the quality of the strand (roving) is higher.

3. Results and discussion

By analyzing the data of the final experiment results, it can be noted that at the same time there is a significant decrease in the yield of hat lines. Because of the changes in the hackling process mentioned above, the flatness of the yarn along the linear density can be slightly improved.

The calculation of the cost-effectiveness of modern hackles was carried out in accordance with the “Method for determining the cost-effectiveness of the application of new techniques, inventions and rationalization proposals.” The cost-effectiveness of the production and use of new tools of improved quality is determined by a formula according to the method.

Table 1. Indicators of the distance between the receiving drum and the supply table on the carding machine.

| No. | Indicators                                                                 | Before experiment | After experiment | By State Standards |
|-----|----------------------------------------------------------------------------|-------------------|------------------|--------------------|
| 1   | The distance between the receiving drum and supply table of the hackle     | 3.4 mm            | 4 mm             | 3-4 mm             |
| 2   | The defects of roving and hackles came out from the hackle machine 30*40 cm | 84                | 60               | 90-60              |

Table 2. Indicators of the thread made of roving from the hackle machine with a change in the spacing of the supply table.

| No. | Indicators            | Before experiment | After experiment | By State Standards |
|-----|-----------------------|-------------------|------------------|--------------------|
| 1   | Number of neps:       | 400               | 380              | 360                |
|     |                       | 280               | 250              | 230                |
|     |                       | 200               | 180              | 160                |
|     |                       | 140               | 120              | 100                |
| 2   | Number of breakage:   | 14                | 12               | 12                 |
|     |                       | 66                | 62               | 60                 |
|     |                       | 214               | 210              | 200                |
|     |                       | 887               | 878              | 850                |

At present, the implementation of changing the distance between the receiving drum and the supply table in hackling machines increases the economic efficiency.

4. Conclusions

The optimal application of the hackling segment on the hackling machine allowed obtaining an increase in the physical-mechanical performance of the yarn in comparison with the control option.

The application of the hackling segment reduced the output percentage of the hat hackles. In the experimental variant, the unevenness of the hackling roving was significantly reduced.
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