Influence of the circumferential speed of the spiked cylinders on the efficiency of cleaning raw cotton

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Abstract. The article examines the dependence of the speed of rotation of the spiked cylinder of the machine for cleaning the raw cotton from fine impurities on the cleaning efficiency of the machine by different varieties. In addition, the article plotted the speed of rotation of the spiked cylinder as a function of mechanical damage to the seed. Based on experimental studies, the operation of the machine for cleaning cotton raw materials from fine contaminants is based. Experimental studies on raw cotton of medium and fine fiber varieties of hand and machine cotton picking on the value of constant and differentiated peripheral speeds of cylinders fully confirmed the theoretical conclusions. It is recommended to use a differentiated high-speed mode of rotation of the spiked cylinders: When cleaning medium-staple cotton - 10:11:12 m / sec, when cleaning fine-stapled cotton - 9:10:11 m / sec.

1. Introduction
Cotton fiber is the main raw material used in the global textile industry. According to world statistics and the International Cotton Advisory Committee (ICAC), "the five exporters of cotton fiber include the United States, India, Australia, Brazil and Uzbekistan, as well as importers - Bangladesh, Vietnam, China, Turkey and Indonesia." In these countries, special attention is paid to the dynamic and sustainable development of the cotton ginning industry, the introduction of modern equipment at the enterprises of the industry, increasing the efficiency and rational use of production capacities, which are the basis for competitiveness in the global cotton market [1]. In this regard, a further increase in the consumer properties of cotton products on a global scale, along with an improvement in their quality indicators, a decrease in their cost, ensuring the efficiency of the ginning process, improving ginning machines and creating resource-saving technologies remains one of the important tasks [2,3].
Globally, due to the large volume of clogged cotton, especially cotton harvested on machines, with the improvement of the technique and technology of primary processing of cotton, the development of theoretical foundations for cleaning cotton from small and large litter, substantiation of motion parameters, as well as operating modes of working bodies and mechanisms, due to they are undergoing extensive theoretical and complex experimental studies to determine the optimal values of geometric and kinematic dimensions that provide loosening and cleaning of cotton [4]. At the same time, ensuring the efficiency of cleaning cotton and maintaining the preliminary quality indicators of cotton, including the creation of mathematical models that allow the selection of optimal cleaning modes from fine litter that do not negatively affect the quality of cotton and, based on their decisions, determine the recommended parameters, reduce strong impacts when loosening and cleaning from litter, the development of soft regime technologies, the creation of designs of resource-saving working bodies are especially important [5].

2. Materials and methods

Established in the practice of operating fine litter cleaners, the productivity of the cleaners is about 5-6 t / h, was adopted when testing on a bench installation. Prospecting experiments have found that when the speed of the spiked cylinder is below 7 m / s and above 14 m / s, the cleaning effect is sharply reduced. The normal operation of the installation took place in the range of the spiked cylinder speed of 7-14 m / s, which was adopted for research.

But the TITLI studies [6,7,8] the optimal speed of the spiked cylinders, from the point of view of the intensity of the release of weeds and the minimum damage to the seeds, is the speed of 9-10 m / s. On the bench installation, the spiked section differs from the cleaners of this type in the location of the mesh (the angle of the spiked cylinder wrap is 1800), therefore, the high-speed mode of the spiked cylinders was specified. At the beginning, the peripheral speed of all cylinders increased. The experiments were carried out on raw cotton of the 1st grade of hand and machine cotton picking, varieties "Buxoro-8", "Termiz-31" and "Namangan-77" in 6 agility at a productivity of 5 t / h. The parameters of the working elements of the installation were the same as those of the 1XK purifier, a perforated mesh with a mesh size was installed when passing raw cotton varieties "Buxoro-8" and "Termiz-31" and in 6 x 50 mm and "Namangan-77" in 4.5x50 mm [8.9]. The mesh was set in accordance with the result of the study with a large axis at an angle of 450 to the direction of cotton movement. Used meshes of two profiles and due to the fact that the varieties have different seed sizes. The research results are posted in Appendix 1, and the averaged data in table 1.

Based on the results of experiments with constant peripheral speeds of spiked cylinders, a program was compiled on ECM, regression equations of the second degree and correlation relations \( r_{xy} \) connecting the cleaning effect ("Y") with the speed regime were obtained. The least squares method was used [10,11]. When compiling the program, a notation system was adopted to simplify it. At a constant peripheral speed: \( X = 3 \text{ m/s} \), it was equal to 1, \( X = 9 \text{ m/s} \) equaled 2, \( X = 10 \text{ m/s} \) equaled 3, \( X = 11 \text{ m/s} \) equaled 4, \( X = 12 \text{ m/s} \) equaled 5, \( X = 13 \text{ m/s} \) equaled 6.

Regression equations linking constant circumferential rotational speeds of the spiked cylinders with the cleaning effect:

Machine picking of cotton 1 grade, "Buxoro-8":

\[
Y = 25.75 + 14.27x - 1.09 \cdot \lg x - 1.33x^2; \quad r_{xy} = 0.971
\]

Hand picking of cotton 1 grade:

\[
Y = 29.8 + 17.2x - 5.71 \cdot \lg x - 2.22x^2; \quad r_{xy} = 0.964
\]

Machine picking of cotton 1 grade, "Termiz-31":

\[
Y = 29.77 + 15.13x - 5.42 \cdot \lg x - 2.11x^2; \quad r_{xy} = 0.981
\]
Hand picking of cotton 1 grade:

\[ Y = 33.05 + 14.34x - 1.15 \cdot \log x - 1.81x^2; \ r_{xy} = 0.933 \]

Hand picking of cotton 1 grade, "Namangan-77":

\[ Y = 35.96 + 15.45x - 4.71 \cdot \log x - 2.11x^2; \ r_{xy} = 0.936 \]

3. Results and discussion

The figures show graphical dependences of the cleaning effect and damage to seeds on the circumferential speed of the spiked cylinders.

From the graph (figure 1 and 2) it can be seen that with an increase in the circumferential speed of the spiked cylinders from 8 to 11 m / s, the cleaning effect of the installation increases and then decreases, regardless of the type of raw cotton. Its decrease can be explained by the fact that when the cylinders rotate, strong vortex air currents are obviously created, which interfere with the release of trash impurities.

The greatest cleaning effect with cotton of the 1st grade was obtained at a speed of the spiked cylinders of 11 m / s on raw cotton:

- "Buxoro-8", machine picking of cotton -53.3%, hand picking of cotton -53.7%;
- "Termiz-31", machine picking of cotton -54.96%, hand picking of cotton -62.7%;
- "Namangan-77", hand picking of cotton -61.7%.

### Table 1. Influence of the circumferential speed of the spiked cylinders on the technological parameters of cleaning raw cotton of the 1st grade (productivity 5 t / h).

| The circumferential speed of the spiked cylinders m / s | Infestation of raw cotton, % before cleaning | Seed damage, % before cleaning | Free fiber content, % before cleaning | General cleansing effect | Infestation of raw cotton, % after cleaning | Seed damage, % after cleaning | Free fiber content, % after cleaning | General cleansing effect |
|---------------------------------------------------------|-------------------------------------------|-------------------------------|-------------------------------------|-------------------------|-------------------------------------------|-------------------------------|-----------------------------------|-------------------------|
| 1                                                       | 2                                         | 3                             | 4                                   | 5                       | 6                                         | 7                             | 8                                 |                         |
| Machine picking of cotton varieties "Buxoro-8", moisture-9.23% |                                            |                               |                                     |                         |                                            |                               |                                    |                         |
| 8                                                       | 5.2                                       | 3.23                          | 0.92                                | 0.18                    | 0.19                                      | 0.19                          | 33.4                              |                         |
| 9                                                       | 5.2                                       | 2.92                          | 0.92                                | 0.18                    | 0.22                                      | 0.22                          | 45.6                              |                         |
| 10                                                      | 5.2                                       | 2.63                          | 0.92                                | 0.18                    | 0.23                                      | 0.23                          | 50.8                              |                         |
| 11                                                      | 5.2                                       | 2.50                          | 0.92                                | 0.18                    | 0.23                                      | 0.23                          | 53.3                              |                         |
| 12                                                      | 5.2                                       | 2.53                          | 0.92                                | 1.31                    | 0.18                                      | 0.22                          | 52.6                              |                         |
| 14                                                      | 5.2                                       | 2.99                          | 0.92                                | 1.46                    | 0.18                                      | 0.23                          | 43.8                              |                         |
| Hand picking of cotton varieties "Buxoro-8", moisture-8.1% |                                            |                               |                                     |                         |                                            |                               |                                    |                         |
| 8                                                       | 3.73                                      | 2.16                          | 0.11                                | 0.12                    | 0.12                                      | 0.12                          | 42.8                              |                         |
| 9                                                       | 3.73                                      | 1.39                          | 0.11                                | 0.12                    | 0.13                                      | 0.13                          | 50.2                              |                         |
| 10                                                      | 3.73                                      | 1.65                          | 0.11                                | 0.16                    | 0.12                                      | 0.13                          | 56.9                              |                         |
| 11                                                      | 3.73                                      | 1.54                          | 0.11                                | 0.23                    | 0.12                                      | 0.15                          | 58.7                              |                         |
| 12                                                      | 3.73                                      | 1.64                          | 0.11                                | 0.33                    | 0.12                                      | 0.16                          | 56.9                              |                         |
| 14                                                      | 3.73                                      | 1.89                          | 0.11                                | 0.51                    | 0.12                                      | 0.15                          | 48.7                              |                         |
| Machine picking of cotton varieties "Termiz-31", moisture-10.3% |                                            |                               |                                     |                         |                                            |                               |                                    |                         |
| 8                                                       | 7.82                                      | 4.61                          | 1.21                                | 1.23                    | 0.26                                      | 0.27                          | 42.9                              |                         |
| 9                                                       | 7.82                                      | 4.28                          | 1.21                                | 1.27                    | 0.26                                      | 0.28                          | 47.0                              |                         |
| 10                                                      | 7.82                                      | 3.75                          | 1.21                                | 1.35                    | 0.26                                      | 0.29                          | 53.0                              |                         |
| 11                                                      | 7.82                                      | 3.52                          | 1.21                                | 1.73                    | 0.26                                      | 0.29                          | 55.0                              |                         |
| 12                                                      | 7.82                                      | 3.71                          | 1.21                                | 2.16                    | 0.26                                      | 0.28                          | 53.0                              |                         |
| 14                                                      | 7.82                                      | 4.33                          | 1.21                                | 2.39                    | 0.26                                      | 0.30                          | 46.9                              |                         |
| Hand picking of cotton varieties "Termiz-31", moisture-8.5% |                                            |                               |                                     |                         |                                            |                               |                                    |                         |
| 8                                                       | 3.71                                      | 2.00                          | 0.19                                | 0.21                    | 0.10                                      | 0.11                          | 47.1                              |                         |
| 9                                                       | 3.71                                      | 1.72                          | 0.19                                | 0.23                    | 0.10                                      | 0.11                          | 53.7                              |                         |
| 10                                                      | 3.71                                      | 1.51                          | 0.19                                | 0.29                    | 0.10                                      | 0.13                          | 60.5                              |                         |
Table: Hand picking of cotton varieties "Namangan-77", moisture-8.73%

| Grade | Cleaning Effect (% | Peripheral Speed (m/s) | Circumferential Speed of Spiked Cylinders (m/s) | Cleaning Effect (%) |
|-------|-------------------|-------------------------|-----------------------------------------------|-------------------|
| 8     | 4.70              | 2.42                    | 11                                            | 62.7              |
| 9     | 4.70              | 1.98                    | 12                                            | 60.0              |
| 10    | 4.70              | 1.88                    | 14                                            | 53.4              |
| 11    | 4.70              | 1.86                    |                                               | 49.0              |
| 12    | 4.70              | 2.03                    |                                               | 59.1              |
| 14    | 4.70              | 2.22                    |                                               | 61.2              |

Figure 1. Dependence of the cleaning effect on the circumferential speed of the spiked cylinders at a constant speed of their rotation. 1) machine picking cotton of 1 grade “Buxoro-8”; 2) hand picking cotton of 1 grade “Buxoro-8”; 3) hand picking cotton of 1 grade “Namangan-77”.

Figure 2. Dependence of the cleaning effect on the circumferential speed of the spiked cylinders at a constant speed of their rotation. 1) Machine picking cotton of 1 grade “Termiz-31”; 2) hand picking cotton of 1 grade “Termiz-31”.

Figure 3 shows that with an increase in the circumferential speed of the spiked cylinders, the damage to the seeds in the refined raw cotton increases. The growth of damage to seeds during cleaning of medium staple varieties of raw cotton “Buxoro-8” and “Namangan-77 is at a speed of 11-12 m / s a slight value of 0.1-0.2. When cleaning fine-staple raw cotton “Termiz-31”, the growth of seed damage is more noticeable than in medium staple varieties. This can be explained by the absence of fine-staple cotton cushion in the seeds and their lower strength.

The content of free fiber in refined cotton - raw with an increase in the circumferential speed of the spiked cylinders almost does not change (0.19-0.22%).

Thus, with an increase in the circumferential speed of the spiked cylinders from 8 to 11 m / s, the cleaning effect will increase, a further increase in the circumferential speed of the cylinders leads to a decrease in the cleaning efficiency. However, the achieved level of cleansing effect is insufficient.

Selection of the optimal differentiated speed modes of the spiked cylinder cleaner. The assumption about the possibility of increasing the efficiency of cleaning raw cotton in spiked cylinder cleaners with a decrease in the layer thickness of the processed raw cotton by using differentiated speed modes of spiked cylinders was carried out during an experiment on a bench installation with the same raw cotton through a bench installation with speed modes starting from the first cylinder, namely 7: 8: 9; 8: 9: 10; 9:10:11; 10:11:12 and 11:12:13 m / sec.

![Figure 3. Dependence of seed damage on the circumferential speeds of spiked cylinders at a constant speed of their rotation. 1) hand picking cotton of 1 grade “Buxoro-8”; 2) hand picking cotton of 1 grade “Namangan-77”; 3) hand picking cotton of 1 grade “Termiz-31”; 4) Machine picking cotton of 1 grade "Buxoro-8", 5) Machine picking cotton of 1 grade "Termiz-31", 6,7,8) initial damage to seeds.](image)

The primary research results are included in Appendix 2, and the averaged ones in table 2.

Based on the results of experiments with the differentiated peripheral speeds of spiked cylinders, a program was compiled on ENM Minsk-22, regression equations of the second degree and correlation relations (rxy) connecting the cleaning effect (“Y”) with the speed regime (“X”) were obtained: least squares method.

When compiling the program for its multiplication, a notation system was adopted. With a differentiated peripheral speed, in a ratio of 7: 8: 9 m / s was equated to one, X = 8: 9: 10 m / s equals 2, X = 9: 10: 11 m / s equals 3, X = 10: 11: 12 m / s equals 4, X = 11: 12: 13 m / s equals 5

Regression equations linking the differentiated speed modes with the cleaning effect:

Machine picking of cotton 1 grade, "Buxoro-8":

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Regression equations linking the differentiated speed modes with the cleaning effect:
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\[ Y = 30.6 + 17.2x - 0.41 \cdot \log x - 2.1x^2; \quad r_{xy} = 0.981 \]

Hand picking of cotton 1 grade, "Buxoro-8":
\[ Y = 31.99 + 18.79x - 1.96 \cdot \log x - 2.35x^2; \quad r_{xy} = 0.975 \]

Machine picking of cotton 1 grade, "Termiz-31":
\[ Y = 39.23 + 15.29x - 1.75 \cdot \log x - 1.92x^2; \quad r_{xy} = 0.983 \]

Hand picking of cotton 1 grade, "Buxoro-8":
\[ Y = 42.54 + 16.21x - 3.15 \cdot \log x - 1.39x^2; \quad r_{xy} = 0.969 \]

Machine picking of cotton 1 grade, "Namangan-77":
\[ Y = 25.66 + 17.32x - 5.21 \cdot \log x - 2.17x^2; \quad r_{xy} = 0.973 \]

Hand picking of cotton 1 grade, "Namangan-77":
\[ Y = 29.63 + 16.76x - 0.92 \cdot \log x - 2.09x^2; \quad r_{xy} = 0.986 \]

In figures 4 and 5 shows the dependences of the cleaning effect on the circumferential speed of the spiked cylinders.

Figures 4 and 5, it can be seen that the cleaning effect of the spiked section during peeling of both medium and fine-staple varieties of raw cotton with an increase in the circumferential speed of the spiked cylinders, respectively, in the order of installation of the cylinders, from 7: 8: 9 to 10:11:12 m / s, increases and then decreases.

**Table 2. Influence of the differentiated speed mode of the spiked cylinders on the technological indicators of the cleaning of raw cotton of the 1st grade (productivity 5 t / h).**

| Varieties                  | The circumferential speed of the spiked cylinders m/s | Infestation of raw cotton % before cleaning | Infestation of raw cotton % after cleaning | Seed damage, % before cleaning | Seed damage, % after cleaning | Free fiber content, % before cleaning | Free fiber content, % after cleaning | Cleaning effect, % before cleaning | Cleaning effect, % after cleaning |
|---------------------------|------------------------------------------------------|-------------------------------------------|------------------------------------------|-------------------------------|-------------------------------|--------------------------------------|-------------------------------------|-----------------------------------|-----------------------------------|
|                           | 1 2 3 4 5 6 7 8 9 10                                   |                                           |                                          |                               |                               |                                      |                                      |                                   |                                   |
| **Machine picking of cotton, moisture-9.1%** |                                                      |                                           |                                          |                               |                               |                                      |                                      |                                   |                                   |
| "Buxoro-8"                |                                                      |                                           |                                          |                               |                               |                                      |                                      |                                   |                                   |
| 7:8:9                     | 5.16                                                 | 2.86                                      | 2.17                                     | 2.17                          | 0.16                          | 0.17                                 | 45.8                                 | 23.8                              |                                   |
| 8:9:10                    | 5.16                                                 | 2.33                                      | 2.17                                     | 2.20                          | 0.16                          | 0.18                                 | 56.9                                 | 33.1                              |                                   |
| 9:10:11                   | 5.16                                                 | 1.96                                      | 2.17                                     | 2.25                          | 0.16                          | 0.20                                 | 63.2                                 | 36.1                              |                                   |
| 10:11:12                  | 5.16                                                 | 1.84                                      | 2.17                                     | 2.32                          | 0.16                          | 0.18                                 | 65.6                                 | 41.9                              |                                   |
| 11:12:13                  | 5.16                                                 | 2.03                                      | 2.17                                     | 2.45                          | 0.16                          | 0.17                                 | 62.0                                 | 47.6                              |                                   |
| **Hand picking of cotton, moisture-8.23%** |                                                      |                                           |                                          |                               |                               |                                      |                                      |                                   |                                   |
| 7:8:9                     | 2.7                                                  | 1.46                                      | 0.02                                     | 0.02                          | 0.14                          | 0.14                                 | 43.8                                 | 22.6                              |                                   |
| 8:9:10                    | 2.7                                                  | 1.08                                      | 0.02                                     | 0.03                          | 0.14                          | 0.15                                 | 60.8                                 | 30.3                              |                                   |
| 9:10:11                   | 2.7                                                  | 0.92                                      | 0.02                                     | 0.08                          | 0.14                          | 0.17                                 | 66.7                                 | 34.0                              |                                   |
| 10:11:12                  | 2.7                                                  | 0.87                                      | 0.02                                     | 0.20                          | 0.14                          | 0.15                                 | 63.2                                 | 35.2                              |                                   |
| 11:12:13                  | 2.7                                                  | 0.96                                      | 0.02                                     | 0.4                           | 0.14                          | 0.14                                 | 65.1                                 | 30.2                              |                                   |
| **Machine picking of cotton, moisture-10.1%** |                                                      |                                           |                                          |                               |                               |                                      |                                      |                                   |                                   |
| "Termiz-31"               |                                                      |                                           |                                          |                               |                               |                                      |                                      |                                   |                                   |
| 7:8:9                     | 13.2                                                 | 6.77                                      | 1.32                                     | 1.33                          | 0.25                          | 0.26                                 | 52.3                                 | 26.2                              |                                   |
| 8:9:10                    | 13.2                                                 | 5.58                                      | 1.32                                     | 1.36                          | 0.25                          | 0.26                                 | 61.0                                 | 34.6                              |                                   |
| 9:10:11                   | 13.2                                                 | 4.66                                      | 1.32                                     | 1.48                          | 0.25                          | 0.31                                 | 67.8                                 | 45.0                              |                                   |
| 10:11:12                  | 13.2                                                 | 4.28                                      | 1.32                                     | 2.0                           | 0.25                          | 0.46                                 | 70.6                                 | 43.1                              |                                   |
Table 1. Dependence of the cleaning effect on the speed of rotation of the circular spiked cylinders at a differentiated speed of their rotation.

|                | 11:12:13 | 13.2 | 4.30 | 1.32 | 2.5 | 0.25 | 0.38 | 67.0 | 36.1 |
|----------------|----------|------|------|------|-----|------|------|------|------|
| Hand picking of cotton, moisture-8.5% |          |      |      |      |     |      |      |      |      |
| 7:8:9          | 3.72     | 1.63 | 0.18 | 0.19 | 0.10| 0.11 | 57.0 | 18.2 |
| 8:9:10         | 3.72     | 1.30 | 0.18 | 0.20 | 0.10| 0.12 | 65.7 | 30.3 |
| 9:10:11        | 3.72     | 1.32 | 0.18 | 0.35 | 0.10| 0.14 | 69.0 | 36.8 |
| 10:11:12       | 3.72     | 1.06 | 0.18 | 1.02 | 0.10| 0.18 | 72.2 | 37.3 |
| 11:12:13       | 3.72     | 1.12 | 0.18 | 1.65 | 0.10| 0.17 | 70.5 | 35.8 |
| Machine picking of cotton, moisture-8.7% |          |      |      |      |     |      |      |      |      |
| “Namangan-77”  |          |      |      |      |     |      |      |      |      |
| 7:8:9          | 7.2      | 4.42 | 1.42 | 1.43 | 0.40| 0.42 | 40.3 | 25.7 |
| 8:9:10         | 7.2      | 3.32 | 1.42 | 1.49 | 0.40| 0.48 | 43.8 | 24.8 |
| 9:10:11        | 7.2      | 3.30 | 1.42 | 1.73 | 0.40| 0.53 | 56.0 | 27.5 |
| 10:11:12       | 7.2      | 3.08 | 1.42 | 2.07 | 0.40| 0.48 | 58.8 | 32.5 |
| 11:12:13       | 7.2      | 3.20 | 1.42 | 2.43 | 0.40| 0.36 | 57.3 | 34.6 |
| Hand picking of cotton, moisture-8.1% |          |      |      |      |     |      |      |      |      |
| 7:8:9          | 4.71     | 2.70 | 0.04 | 0.06 | 0.14| 0.15 | 43.7 | 20.1 |
| 8:9:10         | 4.71     | 2.31 | 0.04 | 0.08 | 0.14| 0.16 | 52.2 | 24.2 |
| 9:10:11        | 4.71     | 2.0  | 0.04 | 0.12 | 0.14| 0.17 | 58.7 | 28.0 |
| 10:11:12       | 4.71     | 1.44 | 0.04 | 1.31 | 0.14| 0.16 | 63.5 | 31.7 |
| 11:12:13       | 4.71     | 1.53 | 0.04 | 1.55 | 0.14| 0.14 | 61.2 | 30.1 |

Figure 4. Dependence of the cleaning effect on the circular spiked cylinders at a differentiated speed of their rotation. 1) Machine picking cotton of 1 grade “Namangan-77”; 2) hand picking cotton of 1 grade “Namangan-77”; 3) Machine picking cotton of 1 grade “Buxoro-8”, 4) hand picking cotton of 1 grade “Buxoro-8”, 5,6,7,8) initial seed damage.
Figure 5. Dependence of the cleaning effect on the circular spiked cylinders at a differentiated speed of their rotation. 1) Machine picking cotton of 1 grade “Termiz-31”; 2) hand picking cotton of 1 grade “Termiz-31”.

This is not observed in terms of the cleansing effect of large litter. The greatest cleaning effect, both general and for coarse litter, was obtained with a differentiated speed of the spiked cylinders of the bench installation in the range from 9:10:11 to 10:11:12 m/sec.

From table 2 and figure 1 shows that when cleaning medium-staple varieties of raw cotton “Buxoro-8” and “Namangan-77” with an increase in the circumferential speed of the spiked cylinders from 7:8:9 to 10:11:12 m/s, there is an insignificant increase in seed damage in the cleaned cotton. When cleaning fine-staple raw cotton “Termiz-31”, there is also a slight increase when the cylinder speed is increased to 9:10:11 m/sec.

Increasing the speed of cylinders for medium staple raw cotton over 10:11:12 m/sec, and for fine staple raw cotton over 9:10:11 m/sec, sharply increases seed damage in refined raw cotton. Consequently, it is impractical to apply high speed modes.

From table 2 it can be seen that the content of fiber in refined raw cotton at any speed of rotation of the spiked cylinders is almost at the same level, but there is no free fiber formation when cleaning the raw cotton with the spiked working bodies.

Thus, the effect of spiked cylinders was investigated: when their speeds are the same, when a differentiated speed mode of rotation was applied. At the same time, another advantage of the intensity of the release of trash impurities was revealed in all cases of using the differentiated speed mode of the spiked cylinders, which is also confirmed by theoretical considerations.
Figure 6. Dependence of seed damage on the circumferential speed of spiked cylinders at a differentiated speed of their rotation. 1) hand picking cotton 1st grade “Buxoro-8” 2) hand picking cotton 1st grade “Termiz-31”; 3) cotton picking machine 1 grade "Termiz-31"; 4) cotton picking machine 1 grade “Buxoro-8”, 5, 6,7,8) initial damage of seeds.

Table 3. Cleaning effect of cylinders depending on the peripheral speed for cotton of the 1st grade, variety “Buxoro-8”.

| Spiked cylinder speed m / s | Cotton picking type | Initial contamination of raw cotton, % | The cleaning effect of individual cylinders | General cleansing effect, % |
|----------------------------|---------------------|----------------------------------------|---------------------------------------------|---------------------------|
| 11                         | Cotton picking machine | 5.2                                    | 24.7                                       | 18.2                      | 10.6                       | 53.5                       |
|                            | Hand picking cotton  | 3.73                                   | 27.2                                       | 23.0                      | 7.5                        | 58.7                       |
| 10:11:12                   | Cotton picking machine | 5.16                                   | 22.2                                       | 26.7                      | 16.9                       | 65.8                       |
|                            | Hand picking cotton  | 2.7                                    | 25.8                                       | 29.4                      | 12.3                       | 67.5                       |

The damage to the seeds and the amount of free fiber in the refined raw cotton are practically the same, regardless of the use of differentiated or the same speeds of the picking cylinders.

At a speed of 11 m / s for all three cylinders on a bench installation and a differentiated speed mode of the cylinders at 10:11:12 m / s in the order of installation, the cleaning effect of each cylinder was determined.

The separated litter from each cylinder was collected separately, and taking into account the data on the contamination of the cleaned raw cotton, the cleaning effect of the cylinders was determined (in six replicates).

As the data in table 3 show, at a constant speed of their rotation, the cleaning effect of the first cylinder is greatest, in the second it decreases, and in the third it is minimal. This is due to less contamination of the raw cotton as it moves through the cleaner. In this case, the first cylinder in the differential mode calls a smaller cleaning effect than at the same cylinder speeds.

The second and third cylinders with a differential speed mode have a greater cleaning effect than at the same speed (11 m / s).

Thus, it is possible to recommend a differentiated high-speed mode of rotation of the spiked cylinders in the spiked cylinder cleaners.
The optimal differentiated speed mode of the spiked cylinders should ensure, with a high cleaning effect, minimal damage to seeds and the formation of free fiber. With a gradual increase in the speed of the cylinders to a certain limit, a tendency towards an increase in the cleaning effect is observed.

4. Conclusions
Based on the theory of impact, the formulas of the impact force of splitting on cotton were derived, which made it possible to establish the dependence on its release of trash impurities.

It was found that with an increase in the rotation speed of all cylinders in the range from 8 to 11 m/s, the cleaning effect increases, the damage of seeds increases slightly, the formation of free fiber practically does not change.

It is recommended to use a differentiated high-speed mode of rotation of the spiked cylinders: when cleaning medium staple cotton - 10:11:12 m/s, when cleaning fine-staple cotton - 9:10:11 m/sec.

When using differentiated high-speed modes of rotation of the spiked cylinders, the cleaning effect of the spiked cylinder cleaner increases. Experimental studies on raw cotton of medium and fine fiber varieties of hand and machine harvesting on the value of constant and differentiated peripheral speeds of cylinders fully confirmed the theoretical conclusions.

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