Selection of the circumferential speed of the spiked cylinders of cotton cleaners - raw from small trash

O I Rajabov, F A Kurbonov, A S Abrorov and M Z Gafurova
Bukhara engineering technological institute, Bukhara, Uzbekistan

E-mail: ozodbek4103@mail.ru

Abstract. This article presents the materials of the theoretical analysis of the working bodies of the machine for cleaning cotton raw materials from small trash. And also the influence of the speed of rotation of the peel cylinder of the cleaner on the separation of small trash from raw cotton was studied. It has been proven that a differential increase in the speed of the spiked will lead to an increase in the cleaning efficiency of the machines. It is recommended that the speed of the first cylinder be 10 m / s, the speed of the second cylinder 11 m / s, the speed of the third cylinder 12 m / s, etc.

1. Introduction
Cleaning in spiked - cylinder cleaners occurs when the spiked or spiked - planc cylinder drags raw cotton along the surrounding mesh surface [1]. In this case, the raw cotton is affected by the cylinder spiked and, in addition, braking occurs by the mesh surface due to the friction force. This is confirmed by high-speed cinema - filming conducted by A Djuraev [2]. As a result, there is a loosening of raw cotton, weeds are separated from the volatiles, falling out through the cells of the mesh surface [3].

The next important elements of increasing the performance of the cotton plant is the modernization of equipment, optimization of parameters, a reasonable choice of sparing operating modes of working bodies, the creation of energy-saving drive mechanisms for cotton cleaners are considered special. At the same time, the choice of parameters and modes of movement of feed rollers, spiked and saw cylinders, grate bars should be based on deep theoretical studies based on under-ice scientific achievements in the field of machine mechanics, vibration theory, aerodynamics, higher mathematics with extensive use of computer technologies. Experimental confirmation of theoretical results on substantiating the parameters of a cotton cleaning system is considered expedient. Also important is the study of working surfaces interacting with raw cotton. Therefore, the revision and development of the theory of purification further in general, the creation of perfect scientific foundations of purification technology at a higher scientific level is a necessary problem [4-8].

Solving the set tasks, carrying out the necessary theoretical research, as well as the creation of new equipment and technology for cleaning raw cotton ultimately allows:

- creation of new highly efficient designs of working bodies and drive mechanisms for cotton cleaners;
- transition to flexible technologies for cleaning cotton;
- creation of more compact and efficient working bodies and cleaning mechanisms;
- obtaining high quality cotton fiber at the lowest cost;
• creation of new drive mechanisms that provide the necessary gentle modes of movement of the working bodies of cotton cleaners.

The release of trash depends on the debris, moisture, the nature of the adhesion of the trash to the fibrous cover of the volatiles, the physical and mechanical properties of raw cotton, its variety and other factors, and such on the parameters of the working organs of the barb - cylinder cleaners (the diameter and speed of spacing and height of the tuning spiked, the gap between them and the mesh surface, etc.) [9-12].

The higher the peripheral speed of the cylinders, the more intensive the release of trash.

However, an unlimited increase in the cylinder speed is impossible, since this entails an increase in seed damage, the formation of free fiber, and ultimately can cause a deterioration in the quality of the fiber [13, 14].

Research [15] conducted by O I Rajabov showed that an increase in the speed of the eight cylinders cleaner 1XK over 11 m / s sharply increases the damage to seeds when all 8 cylinders have the same speed.

2. Materials and methods

When meeting with the spiked of cylinders, the raw cotton undergoes a shock, a shock impulse arises. Under the action of gravity, raw cotton is fed from the mine to a spiked planc cylinder. The speed of falling in the air was found experimentally and is approximately $v_s = 2 \text{ m/s}$.

Let cotton - raw, moving at a speed of 2 m / sec, meets a spiked cylinder with a speed of $v_c$ (figure 1). At the meeting, a partially elastic impact occurs.

Impact impulse when striking a spiked with a raw cotton can be found on the basis of the main theory of impact - about the change in the momentum of the body, i.e. in projection on the "n" axis.

$$m_{co}v_{ic} - m_{cr}v_{ic} = S, \int Fdt = S$$

Where: $m_{co}$ - weight of raw cotton; $v_{ic}$ - speed of cotton - raw after impact; $v_{ic}$ - speed of cotton - raw before impact; $S$ - Impact impulse; $\tau$ - time of hitting raw cotton from spiked; $F$ - impact force.

![Figure 1](image.png)
From the theory of impact it is known \cite{16,17} that the impact process is divided into two stages. During the first stage, the deformation of the colliding bodies occurs, during the second, partial restoration of the unrefomed state. At the end of the first stage and the beginning of the second, the bodies have the same velocities that they would have at the end of the corresponding inelastic impact. At the end of the second stage, the bodies already have different speeds.

Since the mass of the cylinder is very large compared to the part of the cotton (0.2 g) or lumps (up to 30 g) of raw cotton meeting the cylinder, the former does not change its speed.

\[ U = \frac{m_{\text{cyl}} v_{\text{cyl}} + m_{\text{cot}} v_{\text{cot}}}{m_{\text{cyl}} + m_{\text{cot}}} = \frac{v_{\text{cyl}} + \frac{m_{\text{cot}} v_{\text{cot}}}{m_{\text{cyl}}}}{1 + \frac{m_{\text{cot}}}{m_{\text{cyl}}}} \]  

(2)

But \( \frac{m_{\text{cot}}}{m_{\text{cyl}}} \to 0 \) and then \( U = v_{\text{cyl}} \).

The speed of the raw cotton after hitting the spiked can be determined from the formula:

\[ v_{\text{lc}} = U + c(U - v_{\text{cot}}) \]  

(3)

Where: \( U \) is the overall speed at the end of the first stage and the beginning of the second, \( c \) is the recovery factor of cotton-raw, \( v_{\text{cot}} \) is the speed of cotton-raw, \( v_{\text{cyl}} \) is the speed of the cylinder.

But, \( U = v_{\text{cyl}} \) and then:

\[ v_{\text{lc}} = v_{\text{cyl}} + c(v_{\text{cyl}} - v_{\text{cot}}) \]  

(4)

The projection of the speed of the raw cotton on the “n” axis will be \( v_{\text{lp}} = -v_{\text{cot}} \sin \phi \). Then, in the projection onto the “n” axis, we will have:

\[ v_{\text{lp}} = v_{\text{cyl}}(1 + c) + c \cdot v_{\text{cot}} \sin \phi \]

Substituting \( v_{\text{lp}} \) into formula (1) we get:

\[ m_{\text{cot}} v_{\text{cyl}}(1 + c) + cm_{\text{cot}} v_{\text{cot}} \sin \phi + m_{\text{cot}} v_{\text{cot}} \sin \phi = S \]

\[ m_{\text{cot}} v_{\text{cyl}}(1 + c) + m_{\text{cot}} v_{\text{cot}} \sin \phi(1 + c) = S \]

Or,

\[ m_{\text{cot}}(1 + c)(v_{\text{cyl}} + v_{\text{cot}} \sin \phi) = S \]  

(5)

Thus, the formula of the shock impulse at the impact of raw cotton from the spike of a spiked-plancylinder is obtained.

To determine the force of the blow, you need to know the time of hitting the raw cotton from the spiked cylinder. If the time of the impact of the raw cotton from the spiked cylinder is known, then the force of the impact of the spike on the cotton can be found, i.e.

\[ F = \frac{S}{\tau} = \frac{m_{\text{cot}}(1 + c)(v_{\text{cyl}} + v_{\text{cot}} \sin \phi)}{\tau} \]  

(6)

It is rather difficult to determine the time of impact alone. Find an approximate value.
Suppose that a raw cotton bat or a lump is fixed and brought to the spiked cylinder, then the time of striking can be taken as the time of stripping or splitting of raw cotton. This time will depend on the size of the part of the cotton or a piece of cotton. But since the flaps or lump remain loose, you can take:

\[ \tau \leq \frac{h}{v_{cyl}} \]

Where: \( h \) is the size of the bat or lump of raw cotton; \( v_{cyl} \) - the speed of the spiked-planc cylinder.

The size of the part of the cotton is approximately equal, if it is considered a piece of cotton, \( h \approx 20 \text{ mm} \). The size of a lump of different weight, feeding on a spiked - planc cylinder, ranges from 20 to 40 mm.

Substituting in (6) the value:

\[ \tau \approx \frac{h}{v_{cyl}} \]

We get that the impact force of the spike (and the bar) of the cylinder but the cotton - raw will be equal to:

\[ F = \frac{m_{cot}(1 + c)(v_{cyl} + v_{cot} \sin \phi)}{h} \]  

(7)

As you can see, the force of the spike impact on raw cotton is directly proportional to its mass, which meets the spike (or bar).

The speed of the cylinder and cotton is raw, and is inversely proportional to the size of the part of the cotton or a piece of cotton, i.e. the impact force, with other values being equal \( m_{cot}, c \) and \( h \), will be the greater, the higher the peripheral speed of the spiked - planc cylinder.

Since the release of trash from raw cotton depends on the impact force experienced by it, the intensity of their release is related to the rotation speed of the spiked - planc cylinders, the higher their speed, the higher the cleaning effect should be.

Earlier, the case was considered when raw cotton is fed from a mine and meets a spiked cylinder. But then he moves along the grid.

According to the research of A Djuraev [18], when cleaning raw cotton with planc cylinders, raw cotton is braked on one side due to friction force with the mesh, on the other hand the spiked cylinder hit it. Cotton - raw when cleaning and braking with a net has, as shown by filming, a speed of \((0.6 \div 0.7)v_{cyl}\).

Let's analyze this case:

Let the raw cotton move along the net with this speed. This means that the splits overtake the raw cotton.

Then, when meeting with a raw cotton, having a speed of \((0.6 \div 0.7)v_{cyl}\), the next spike, having a speed of \( v_{cyl} \), hit the cotton. The calculation scheme can be adopted according to figure 2.
Figure 2. The speed when a spiked cylinder hits the raw cotton when it moves along the net.

Let us also apply to this case the theorem on changes in the moment of quantities of motion, i.e.

\[ m_{\text{cot}}v_{lc} - mv_1 = m_{\text{cot}}v_{lc} - m(0.6 + 0.7)v_{cyl} = S \]  
(8)

Where: \( v_1 = (0.6 + 0.7)v_{cyl} \) - the speed of the clap before the impact, \( v_{lc} \) - the speed of the clap after the impact, \( m_{\text{cot}} \) - the mass of the lump of cotton - raw, \( S \) - Impact impulse.

The speed of the clap - the raw impact, in this case, can be found by the formula projected onto “n”.

\[ v_{2n} = u + c(0.6 + 0.7)v_{cyl} \]

But in the projection on the "n" axis \( v_{in} = v_1 \) a "U" as shown above equals \( v_{cyl} \), then.

\[ v_2 = v_{cyl} + c(v_{cyl} + v_1) \]

Consequently:

\[ S = v_{cyl} + c(v + v_1) + v_1 m_{\text{cot}} = m_{\text{cot}}(1 + c)(v_{cyl} + v_1) \]  
(9)

In this case, the impact force, if you count \( \tau \leq \frac{h}{v_{cyl}} \), will be equal to:

\[ F_1 = \frac{mv_{cyl}^2}{h} (1 + c)(v_{cyl} + v_1) = m \frac{h(1 + c)}{h} (v_{cyl}^2 + v_{cyl}v_1) \]  
(10)

Consequently, in this case, the impact force and the cleaning effect will depend on the circumferential speed of the spiked - planc cylinders.

As it was shown [19,20], an increase in speed can increase the cleaning effect, but it can also worsen the physical and mechanical properties of fiber and seeds, which is undesirable.

3. Conclusions

Currently, in cotton cleaners from fine trash (1HK), eight spiked - planc cylinders are used, rotating at the same speed. Differentiation of the speed mode, for example, its gradual speed at a speed of 10 m/s
on the first cylinder, 11 m / s on the second cylinder and 12 m / s on the third, will cause a gradual thinning of the layer of moving raw cotton, which will have a beneficial effect on the release of trash.

In addition, when pulling raw cotton along the grid of the first cylinders, the adhesion forces of the specks with the cotton are weakened and when they meet the second cylinder rotating at a higher speed, they will be subjected to a large impact.

If there was a decrease in the speed of the cylinders during the transfer of raw cotton, then its "thickening" would occur, the thickness of the layer would increase and the release of trash would worsen.

Consequently, better trash separation is to be expected in purifiers with an increasing speed of the picking cylinder.

References
[1] Shodiyev Z, Shomurodov A and O Rajabov 2020 The results of the experimental nature of the vibrations of the grid cotton cleaner IOP Conference Series: Materials Science and Engineering 883 012169
[2] Jurayev A and Rajabov O I 2019 Experimental study of the interactional of multifaceted and cylindrical spiky cylinder in cotton cleaner from small waste International Journal of Advanced Research in Science, Engineering and Technology 6(3) 8376-81
[3] Rajabov O I, Fazliddin F A, Gapparova M H and Shakhrillo J 2020 The influence of the location of the cells on the allocation of weed impurities for cleaning raw cotton from fine waste IOP Conference Series: Materials Science and Engineering 862 032027
[4] Rajabov O I, Abrorov A S, Mirzaqulova N I, Zaripov G B and Ziyodullaeva Kh S 2020 An experimental study of the location of the grid bars cells installed under spiked cylinders in a cotton cleaner from small waste IOP Conference Series: Materials Science and Engineering 862 032049
[5] Ozod Rajabov, Ziyodullo Shodiyev, Ikrom Inoyatov and Mastura Gapparova 2020 Analysis of the Technological Process of Cleaning Raw Cotton from Small Trash International Journal of Emerging Trends in Engineering Research 8(9) 6022-9
[6] John D W, Gregory A H, Mathew G P and Jeffery A C 2011 Influence of Grid Bar Shape on Field Cleaner Performance – Laboratory Screening Test Journal of Cotton Science 15 144-53
[7] Murodov O 2019 Perfection of designs and rationale of parameters of plastic Koloski cleaning cleaners International Journal of Innovative Technology and Exploring Engineering 8(12) 2640-6
[8] Abduqaffarov Kh J, Safoev A A and Murodov O J 2020 Improving the quality of lint by strengthening the cleaning of cotton seeds from waste IOP Conf. Series: Materials Science and Engineering 862 032026
[9] Rajabov O I 2019 The influence of the mode of movement of the pieces cotton when interacting with a cotton grid International Journal of Advanced Research in Science Engineering and Technology 6(3) 8455-60
[10] Ozod Rajabov Shukhrat Khayitov and Mukhriddin Yokubov 2021 The results of practical research of the separator in an efficient design that separates the raw cotton from the air EPRA International Journal of Multidisciplinary Research 7(1) 304-8
[11] Rajabov O and Shodiyev Z 2020 Analysis of Small Fluctuations of a Multifaceted Mesh under the Influence of Technological Load from the Cleaned Cotton – Raw International Journal of Advanced Research in Science Engineering and Technology 6(10) 11396-9
[12] B Gaybulloev, N Ergasheva and O Rajabov 2020 The Structure of the Embroidery Machine and Dynamic Analysis of the Needle Mechanism International Journal of Advanced Research in Science, Engineering and Technology 7(1) 8376-81
[13] Rakhmonov Kh K and Fayziyev S Kh 2020 Study of Effect of Speed and Temperature of the Drying Agent in the Feeder-Loosened of New Design on the Quality of Fiber International Journal of Emerging Trends in Engineering Research 8(10) 7008-13
[14] Abrorov A S, Kuvoncheva M, Rajabov O I, Mukhammadov M and Jumaev Sh 2020 Method of thermal treatment of saw disk teeth of fiber processing machines by laser Quenching IOP Conference Series: Materials Science and Engineering 862 032034
[15] Rajabov O I, Kurbonov F and Salimov Sh 2020 Substantiation of Parameters of the Fibrous Material Cleaning Zone International Journal of Engineering and Advanced Technology 9(3) 1052-7
[16] Fayziyev S Kh and Rakhimov Kh K 2019 Creation of a New Design of a System for Feeding raw Cotton to a Cylinder International Journal of Recent Technology and Engineering 8(4) 12753-9
[17] Shin I G, Maksudov R, Milasius R, Mominov M R, Shukhatov Sh and Rajabov O I 2020 Energy relations in the contact interaction of fractions with the surface of machine parts to be strengthened International Journal of Advanced Research in Engineering and Technology 11(12) 1008-17
[18] Juraev Anvar and Rajabov Ozod 2019 Analysis of the Interaction of Fibrous Material with a Multifaceted Grid of the Cleaner International Journal of Recent Technology and Engineering 8(1) 2661-6
[19] Majitov J A, Komilov O S, Sharipov M Z, Nazarova N M and Raupova I B 2020 Bioenergy plant for climatic zones of the Republic of Uzbekistan with a solar heating system for individual use European Journal of Molecular & Clinical Medicine 7(2) 6321-7
[20] Marupov I et al. 2020 Research of vertical forces for acting tractor unit IOP Conf. Series: Earth and Environmental Science 614 012153