THEORETICAL STUDY OF A PAIR OF "GROOM-SAW" TO REDUCE THE WEAR OF THE GROOVES

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ABSTRACT

The paper presents the results of theoretical studies of the “grate-saw” pair of the saw gin in order to reduce the wear of the working part of the grate. The gripping ability of the saw teeth is analyzed and it is found that it depends on the angle between the direction of the relative speed and the circumference of the tops of the teeth.
It is indicated that having the general coefficient of fiber clogging by abrasive particles and knowing the number of teeth on the saw, as well as the number of revolutions of the saw shaft, it is possible to determine the wear of the grate over time.

Keywords: cotton raw, fiber, ginning, gin, grate, saw, wear.

INTRODUCTION

Cotton fiber is the main raw material of the textile industry, and in this regard, the development of the cotton ginning industry is important, namely the creation of new resource-saving equipment and technologies, which will ensure a reduction in the cost of production in the world cotton market [1].
The main machine of cotton ginning factories is gin, the main task of which is the separation of cotton fiber from cotton seeds, provided that its natural properties are preserved, and on the work of which both the quality of the fiber and the production capacity of the enterprise largely depend [2].
Modern saw gin (Fig. 1) is a high-performance, partially automated continuous-action machine, which is mainly used for ginning medium-staple varieties of raw cotton [3]. Gin consists of the following main units: a feeder 1, consisting of a peg drum 2, feed rollers 3 and a perforated mesh 4 and a weed auger 5; the gin also has a scraper 6, street conveyor 7, an air chamber 8, a saw cylinder 9, a seed comb 10, a grate 11 and a working chamber 12 [4]

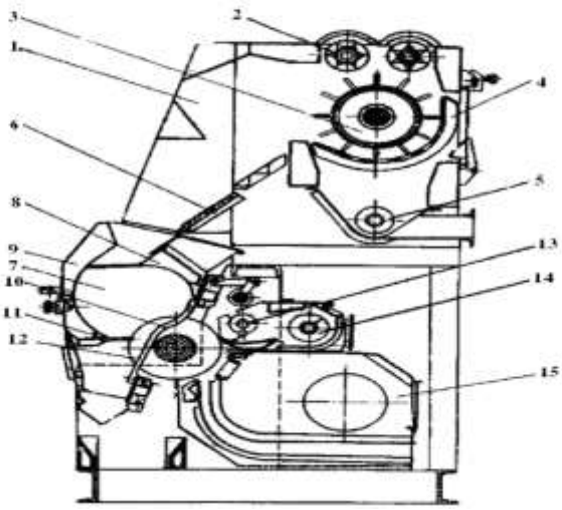


Fig.1. Saw gin

The works of a number of scientists are devoted to the issues of ginning, who have made valuable suggestions in the development of the theory and practice of ginning. Of the available works, a large number of them are devoted to the operation of the saw tooth [5], the raw roller [6], the configuration of the raw chamber [7], the productivity of the gin [8], the density of the raw roller, etc. [9].

One of the important units of the gin working chambers is the grate, the state of health of which greatly affects the qualitative and quantitative indicators of the ginning process. However, in our opinion, scientific works on a comprehensive analysis of the influence of the grate or its elements on the indicators of the ginning process are still insufficient.

Based on the foregoing, this work presents the results of studying the interaction zone of the grate with a genie saw in order to reduce its wear. The wear of the grate in its working part leads to disruption of the ginning process and to the failure of the grate.

One of the main problems with ginners is abrasive wear. The failure of technological machines, including the working bodies of the saw gin, as a result of abrasive wear is 95%, for which it is necessary to comprehensively study the process of abrasive wear in order to reduce its values to the required limits.

As a result of numerous studies carried out to improve the performance of the grate by the Tashkent Institute of Textile and Light Industry and other scientific organizations, as well as due to scientific and technological progress in the cotton industry, certain positive results have been achieved in improving the design of grates [10], saw [11], and spacers [12] used for ginning, as well as their mutual arrangement [13]. However, the issues of reducing abrasive wear are still not fully resolved, and therefore, the issues of improving the wear resistance of the working bodies of the gin, including grates, and the indicators of resource saving of the gin require further study of the process and the search for optimal structural materials for the working bodies.

In this paper, we present the results of studies on the establishment of the dependence of the indicators of the ginning process on the gap between the grate and its state.

In many works on the ginning process, it is indicated that at the moment of fiber separation, the fly, captured by the saw tooth, lingers at the grate and strongly pressing against it, forms a dense mass in this zone, which results in wear of the grate.

RESULTS

Let us consider the effect of the grate gap on the grate wear. To do this, consider the diagram shown in Fig. 3. Suppose that the flywheel hit the saw tooth, moreover, not the flywheel itself, but the fibers that are drawn into the gap of the grate.

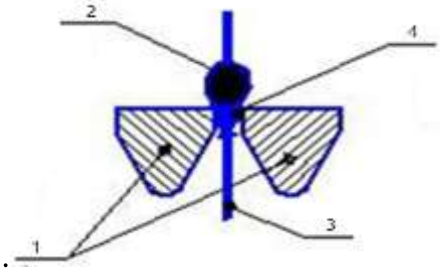


Fig 3. Working area of ginning

1-grate 2-fly 3 saw 4,5 fibers.

It can be seen from the figure that when the fibers are pulled in, they interact with the grate, since the fly is much larger than the inter grid gap. In addition, not only the separation of the fibers contributes to the wear of the grate, there is also a moment when, in addition to the poisoned fibers, fibers scraped off in the chamber and not penetrated into the gap get into the gap. Let's consider a diagram of such a case, which is shown in Figure 4.

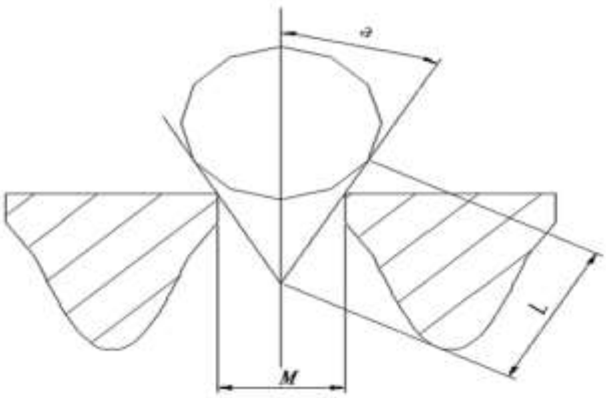


Fig 4. Design diagram of raw material and grate bars

Let's say the case when the angles between the fibers are equal. Moreover, separation will occur when the capture point is further than the staple length of the fiber, i.e.:

$$\theta = \arcsin\frac{2L_1}{M} \qquad (3)$$

Where L1 is the staple length of the fiber, mm;

M - grategap, mm.

Taking into account the values of the force of separation of the fiber from the seed, we compose the following equation:

$$Q = P_{impact}\sin\theta \qquad (4)$$

Where Q is the reaction of the fiber support to the grate, N;
P_{impact} - - the force of fixing the fiber on the seed, N.

Knowing the reaction force of the support on the grate, you can find wear if you set that wear can be caused by two factors:
-contact of the fiber with the grate;
-abrasivewear.

In the event of abrasive wear, dust and particulate impurities fall on the fiber and press against the grate, creating micro cuts.

Consider the case of a micro-notch. Suppose that an abrasive particle gets on the fiber, so that it remains on the fiber, its size should be no more than the thickness of the cotton fiber. Suppose that a particle has a cross-sectional size equal to the thickness of the fiber, and the hardness of the particle is 11000-11300 kg / mm², and the hardness of the bleached cast iron is 950 kg / mm², this means that there is wear, but the question remains about the size of the microcut: it will depend on the degree of indentation of the abrasive into the working surface, which in turn depends on the fiber tension. In this case, the force of pressure of the particle on the working surface will be equal to the following:

$$R = \frac{Q}{S} = \frac{P_{impact} \sin\theta}{S} \quad (5)$$

Where R is the force of pressing the particle into the working area of the grate;
S is the area of the transverse size of the particle; we will take it equal to the thickness of the fiber.

Knowing the hardness of the working area, you can find the value of penetration.

The difference between pressure and hardness shows the redundancy of the bond, by which one can judge the introduction of one material into another, and given this difference, one can find the notch coefficient using the following formula:.

$$J = \frac{HB - r/0.3}{HB} \quad (6)$$

The J value indicates the intensity of wear. Consider Figure 5. Knowing the force of pressure of the particle on the fiber, we can assume that it looks like a hacksaw tooth. It will not be able to cut to its full width, since the tensile force on the fiber does not create sufficient pressure on the particle, but a micro-cut will be observed.

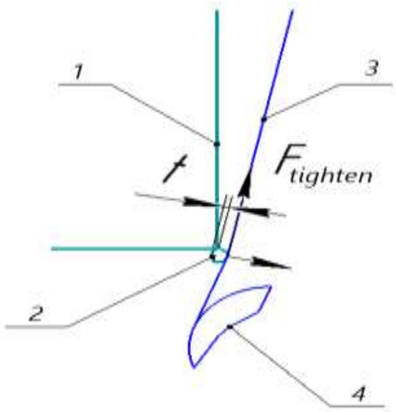


Fig 5. Particle in the ginning process

1 grate; 2 abrasive particle; 3 fiber; 4 seed.
Its value can be calculated using the following formula:

$$\tau_{sl} = \frac{F_{shar}}{S} = \frac{F_{shar}}{h*b} \quad (7)$$

Where F_{shar} - is the pulling force, N;
h-depth, which the particle should cut, mm;
τ_{sl} - cutoff limit, Pa
b-is the maximum size across the abrasive particle, mm.
To find the tightening force, consider Fig. 6, in which the tightening forces are presented in a simple manner.

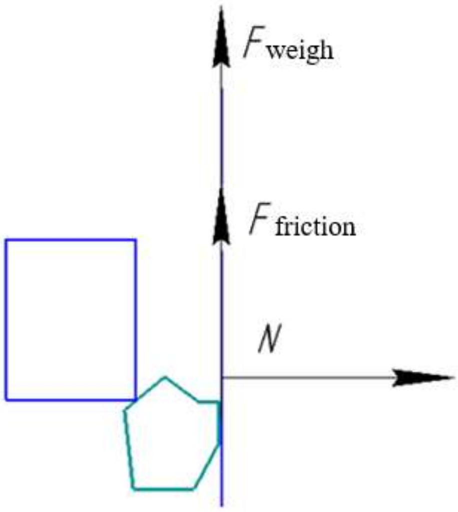


Fig. 6. Retraction of abrasive particles

It can be seen from the figure that the pulling force of the abrasive particle will be equal to the friction force between the particle by the fiber and the cutting force. Based on it can be expressed as follows:

$$F_{cutting} = \mu Q = \mu P_{impact} \sin\theta \quad (8)$$

Substituting (8) into (7), we can find the penetration depth of the particle:

$$h = \frac{\mu P_{impact} \sin\theta}{\tau_{sl} * b} \quad (9)$$

Taking into account the area of the gripping power of the teeth (1) and the diameter of the fiber and setting the coefficient of dustiness and coefficient of clogging, it is possible to determine the amount of wear of the working surface during the passage of one tooth. To begin with, we will determine the number of fibers on the tooth and, since we are considering the wear of the grate from one side, we can divide the number in half:

$$N = \frac{S_{acd}}{d} = \frac{t^2 \sin\gamma_1}{4d}\left(\frac{\cos\alpha}{\cos(\alpha+\gamma_1)} - \frac{\cos\varphi}{\cos(\varphi-\gamma_1)}\right) \quad (10)$$

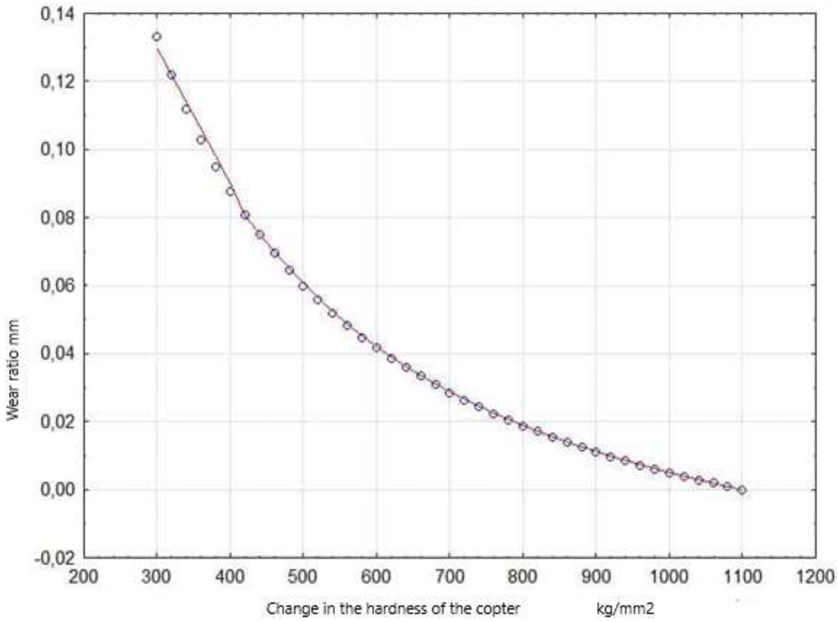
Having the general coefficient k of clogging and dustiness of the fiber with abrasive particles and knowing the number of teeth on the saw, the number of spindle revolutions can be found wear in time, for this we combine (3), (9) and (10) into one formula:

$$h = 60nz\frac{\mu P_{impact}\sin\left(\arcsin\frac{2L_1}{M}\right)}{\tau_{sl} * b} * \frac{t^2\sin\gamma_1}{4d}\left(\frac{\cos\alpha}{\cos(\alpha+\gamma_1)} - \frac{\cos\varphi}{\cos(\varphi-\gamma_1)}\right)kJ \qquad (11)$$

Here n - is the number of shaft revolutions, min^{-1};
z- is the number of saw teeth.

DISCUSSION

From formula (11) it can be seen that the factor with which we can adjust the parameters to reduce the wear of the grate is its hardness, which is taken into account by the wear intensity factor. However, that wear is exponentially dependent on the hardness of the grate.



Relative wear and tear

CONCLUSIONS

As a result of the research carried out, it was possible to determine what is the service life of the grate in time. It was determined that the wear is inversely proportional to the hardness of the material of the working part of the grate and the fiber diameter.

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