Increasing the performance of the raw material wheel and fiber quality when processed by the sawing machine

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Abstract. The saw gin, the primary technical device used in the cotton ginning process, is responsible for separating the cotton fiber from the cotton seed. After being cleansed of khaschops and dried to the desired humidity in the drying, cleaning, and cleaning shops, seeded cotton is transferred to the main building of the business for ginning (separation of fiber). Up to now, 4DP-130, 5DP-130, and DPZ saw gins have been employed in cotton ginning operations to spin medium fiber seeded cotton. The ginning machine's operation, which separates the fiber from the seed in cotton gins, is largely responsible for the creation of high-quality fiber. Maintaining natural quality indicators during the technical process of first processing of cotton, i.e. the appearance, length, and presence of minute impurities in the fiber, is key to ensuring the competitiveness of cotton fiber produced in our nation on the global market. One of the most crucial processes is the ginning of seeded cotton with the appropriate amount of moisture and dirt, which involves removing the fiber from the seed. The length of the fiber, the impurities in the content, the absence of damage, and the hairiness of the seed all play a significant role in this process.

1 Introduction

Saw gin is the main technological machine of the cotton ginning enterprise, and its task is to separate the cotton fiber from the seed. Seeded cotton is dried in the drying-cleaning and cleaning shops to the condition of humidity and after it is cleaned of khaschops, it is sent to the main building of the enterprise for ginning (separation of fiber). Up to now, ginning of medium fiber seeded cottons in cotton ginning enterprises; 4DP-130, 5DP-130, DPZ saw gin machines are being used. The production of quality fiber depends mainly on the working process of the ginning machine, which does the main work in cotton gins, which separates the fiber from the seed.

Ensuring the competitiveness of cotton fiber produced in our country in the world market is mainly determined by maintaining its natural quality indicators in the technological process of initial processing of cotton, i.e. the appearance, length, and content

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of small impurities in the fiber [1]. The ginning process of seeded cotton with the required level of moisture and dirt, that is, the process of extracting fiber from the seed, is one of the most important processes, in which the length of the fiber, the impurities in the content, the absence of damage, and the hairiness of the seed are of great importance.

The working chamber of the saw fiber separators consists of a colossal grid, a roof brush, a cotton entrance to the chamber and a front apron bordered by a seed comb. These elements of the working chamber, their structure, size and location relative to the saw affect the process of saw fiber separation [2, 3].

Also, the saw fiber separation process is based on cutting the fiber from the seed while dragging the fiber on the saw teeth and passing it through the boundary of the barr fence. As a result of this process, raw materials are formed in the working chamber.

As the saw teeth separate the fiber from the seed and take the next fiber out of the colostrums, the seed is trapped in it. In addition to this function, the barr grid forms a part of the working chamber when producing dense cotton or seed rollers and helps the cleaned seed to slide along it and exit the machine.

It is known that cotton fiber of medium fiber grade is separated from seed by a sawed fiber separator machine; long time of hairless seeds separated in the working chamber during the process of fiber separation has a negative effect on the productivity of this machine, fiber and seed quality. In addition, hairless seeds are removed through the seed comb [4, 5].

2 Materials and methods

The fibers adjacent to the saw teeth are carried between the barrs, and the seeds cannot pass without fitting into the barrs, at which point they are separated from the fiber (Figure 1).

The rotation of the raw material roller in the working chamber of the sawing machine, the change of its density and many technological indicators are the mutual friction during the movement of the roller, which leads to a large energy consumption for its rotation. Through energy, the state, speed, density and pressure of movement between layers are determined. This makes it possible to control the quality of fiber and seed [6-8].

The surface of the new seeding device is in the form of a cylinder, it is located along the total length of the working chamber, fixed on the left and right sides with the help of ball bearings and in a position where it is possible to rotate in the working chamber. There are elliptical holes along the length of the surface of the device, and the holes are arranged in a checkerboard pattern [9-11].

It is known that the following equation can be formulated for a stable fiber spinning process:

\[ P = \frac{QA}{t_{aver}} \]

Where, the seeded cotton mass in the Q-chamber, kg; A-characteristic of the change of the aging process; and, \( t_{aver} \) - the average residence time of fiber and seed in the working chamber, min.

According to this equation, productivity can be increased by increasing the mass of seed cotton in the chamber or by reducing the time the fiber and seed stay in the chamber.
To increase the mass of seed cotton, it is necessary to increase the cross-section of the working chamber, which (if the diameter of the saw does not change) increases the force of friction of the seed cotton roller against the walls of the chamber and prevents its rotation. In the seeded cotton roller in the chamber, the hairless seed, which is ready to be completely separated from the fibers, makes up more than 50% of the mass of the roller. Therefore, productivity can be increased only by reducing the time the seed stays in the chamber [11, 12].

The diameter of the pipe installed in the mentioned structure is 165 mm, and the diameter of the screw is 154 mm. Experimental results have shown that the removal of hairless seed with the help of pincers reduces the amount of damage to the seeds, because the pincers remove the seeds by overlapping and moving them.

Thanks to the use of the new device, it is possible to reduce the weight on the saw cylinder due to the quick removal of hairless seeds, to extend the service life of the seals between the saws, which in turn increases the productivity of the machine and extends the service life of the machine, as well as improves the quality of the output product. According to the obtained results, if the rotation speed of the seeding device increases, the productivity of the machine increases and the weight and density of raw materials decreases. As machine performance increases, raw material weight and density also increase.

3 Results and discussion

From the above, it became clear that due to the increase in the density of the raw material in the working chamber, the rotation of the saw cylinder slows down and stops when the
density increases. Despite the fact that there are practical and scientific works dedicated to the study of these situations from a physical and mechanical point of view, the issue has not been fully resolved. In addition, the seeded cotton coming to the working chamber of the ginning machine falls from the top, as a result, the unginned seeded cotton in the raw material shaft is mixed with the partially ginned raw material shaft, and as a result, a part of the seeded cotton faces the saw and the rest remains in the raw material shaft. With these in mind, our new working camera will help prevent problems. In this case, reducing the size of the gin working chamber, seed cotton is fed from the lower part, that is, it is fed directly to the saw, and 30-40% of seed cotton is fed in the direction of rotation of the saw cylinder due to the fact that the saw cylinder teeth warm the seed cotton. The worker enters the chamber and the initial ginning takes place and ensures that the seed cotton is less in the raw material stock.

The results of theoretical and practical testing showed that in production, it is possible to improve the productivity of the machine, the quality of fiber and seed by installing a new seed removal device in the central part of the working chamber of the saw fiber separator.

Studies have shown that 30-saw ginning replicates traditional industrial 80-saw and 130-saw ginning methods. The discrepancies in the results of the experiment are within the limits of permissible errors. As a result, a 130-saw gin was adopted for research, which is shown in Figure 2.

Hairless seeds in the working chamber always move towards the center of the raw material shaft. That's why it is advisable to install a new additional device for seeding in the center. Through the holes of the device, the hairless seed falls into the chamber, and then it is taken out with the help of blades (Fig. 2).

In all studies, the diameter and parameters of the saw, as well as the speed of rotation of the saw cylinder, were maintained as in existing production gins. To conduct experimental studies, several variants of the working chambers of gins with different geometric dimensions were made according to the results obtained. In addition, it was planned to test various designs of accelerators installed in the working chamber of the gin, while taking into account the speed of the raw roller and its density, as well as the yield of seeds from the raw roller.

Based on the tasks set, taking into account foreign research experience, the diameter of the raw roller rotation accelerator was taken with variation: 180, 200, 220 and 270 mm. The accelerator was installed in the center of rotation of the raw roller and had the ability to move horizontally and vertically by 50 mm.

In this case, there was a gap between the ends of the accelerator blades and the saw cylinder for diameters of 180, 200 and 220 mm, respectively 22-24; 12-14 and 2-4 mm. At 270 mm, the accelerator blades deepened into the space between the saw blades by 21÷23 mm. The gap between the accelerator blade and the frontal part of the working chamber was 80, 70, 60 and 35 mm with diameters of 180, 200, 220 and 270 mm, respectively, the apron was 100, 90, 80 and 55 mm and the center of the seed shaft combs-147; 137; 127 and 102 mm.
Fig. 2. Scheme of the seeding device.

Under the steady-state operation of the gin, the raw roller is characterized by a number of parameters: mass, density, rotation speed and fiber content. All these parameters of raw roller are interconnected. In addition, the raw roller is characterized by pressure on the enclosing surfaces of the working chamber, which consists of normal (P
) and tangential (P
) pressures arising from any mutual movement of two contacting surfaces of bodies. Tangential pressure is a frictional force that depends on normal pressure and many other parameters.

Therefore, in the steady state of the genie, to ensure the rotation of the raw roller with a constant angular velocity, it is necessary to overcome the friction force of the fibrous mass on the inner surface of the chamber. Having determined the normal and tangential pressures, it is possible to calculate the coefficient of friction of the movement of the raw roller against the walls of the working chamber of the gin.

Experimental studies were carried out on raw cotton of the 175-F variety with a moisture content of 7.9-8.1%, contamination of 0.75-0.80% and seed crushing of 0.96-1.10%. The diameter of the cylindrical pipe significantly affects the technological parameters of the ginning process, that is, the density, the speed of rotation of the raw roller, the residence time of the seeds in the working chamber and the productivity of the gin. The rational values of the diameter of the cylindrical branch pipe are determined, which during the experiment varied from 56 to 126 mm.

Experimental results were obtained based on the conducted research and are presented in Tables 1 and 2.

When the productivity of the machine is 14.4 kg/hour and the rotation speeds of the new seeding device are 1.9, 2.1, 2.42, 3.3, 3.63 m/sec, the weight and density of the raw material is 20.3, 16, 20.3, 16, Increases by 13.7, 10.7, 10.4%.
Table 1. Output of analysis on raw cotton of the 175-F variety.

<table>
<thead>
<tr>
<th>#</th>
<th>Shares of defects and impurities, %</th>
<th>Growth of seed injury, %</th>
<th>Raw material mass, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.0 2.1 2.07</td>
<td>1.22 1.20 1.20</td>
<td>40 41.7 42.0</td>
</tr>
<tr>
<td>2</td>
<td>2.3 2.4 2.5</td>
<td>1.48 1.50 1.49</td>
<td>34 36 35.2</td>
</tr>
<tr>
<td>3</td>
<td>2.62 2.61 2.6</td>
<td>1.94 1.90 1.90</td>
<td>32.6 31.8 33.7</td>
</tr>
<tr>
<td>4</td>
<td>3.03 3.2 3.23</td>
<td>2.96 2.89 2.9</td>
<td>39.7 42.0 40.8</td>
</tr>
<tr>
<td>5</td>
<td>2.97 2.84 2.96</td>
<td>2.10 2.14 2.05</td>
<td>45.3 44.7 47.0</td>
</tr>
<tr>
<td>6</td>
<td>2.78 2.78 2.81</td>
<td>2.76 2.86 3.10</td>
<td>33.7 34.9 33.0</td>
</tr>
<tr>
<td>7</td>
<td>2.94 2.95 2.89</td>
<td>1.76 1.73 1.73</td>
<td>39.0 38.5 39.4</td>
</tr>
<tr>
<td>8</td>
<td>2.80 2.75 2.68</td>
<td>3.00 3.20 3.20</td>
<td>41.4 39.3 37.2</td>
</tr>
</tbody>
</table>

When working with the new device of seeding in the working chamber, the density of the raw material is reduced compared to the conventional sawing machine 4DP-130. For example, when the productivity of the machine is the same - 13.5 kg/saw-hour, the density of raw materials is 6.6, 12.3, 16, 20 compared to the normal 4DP-130 when the new seeding device rotates at different rotation speeds of 1.9, 2.1, 3, 3.63 m/sec, decreases by 18.1%.

Table 2. Output of analysis on new device of seeding in the working chamber

<table>
<thead>
<tr>
<th>#</th>
<th>Speed of raw material, m/sec</th>
<th>Amount of depilated seed, %</th>
<th>Load at break, Gs</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>1.58 1.56 1.52</td>
<td>60.5 58.2 56.3</td>
<td>4.0 4.1 4.1</td>
</tr>
<tr>
<td>2</td>
<td>1.47 1.41 1.40</td>
<td>54.7 57.1 50.4</td>
<td>4.2 4.19 4.17</td>
</tr>
<tr>
<td>3</td>
<td>1.3 1.35 1.31</td>
<td>34.7 36.8 33.3</td>
<td>4.24 4.27 4.2</td>
</tr>
<tr>
<td>4</td>
<td>1.39 1.38 1.35</td>
<td>29.7 30.5 27.0</td>
<td>4.0 4.1 4.1</td>
</tr>
<tr>
<td>5</td>
<td>1.48 1.42 1.38</td>
<td>33.7 28.5 36.7</td>
<td>4.29 4.25 4.26</td>
</tr>
<tr>
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<td>1.37 1.33 1.36</td>
<td>30.0 32.8 34.7</td>
<td>3.97 3.96 3.98</td>
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<tr>
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<td>50.7 52.6 48.5</td>
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<tr>
<td>8</td>
<td>2.10 2.00 2.20</td>
<td>55.2 54.3 57.6</td>
<td>4.01 4.03 4.02</td>
</tr>
</tbody>
</table>

4 Conclusions

As we know, in the process of ginning, seeds are placed in the middle of the raw material causes an increase in the density of accumulation. As a result of the increase in density, fiber and as a result of the sawdust meeting the saw cylinder rotating at 730 rpm fiber breakage, that is, the increase of short fibers and at the same time the seed defective fibers and seeds are observed as a result of damage. As a result the density of raw materials increases, the damage of seed and fiber increases will bring. From the conducted experiments and obtained results, it can be seen that the increase in the speed of revolutions of the additional seed removal device installed in the working chamber increases the productivity of the machine. This, in turn, affects the speed, weight and density of the raw material.

References


