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SEPURATE FIBER FROM GIN SAW CYLINDER OF TEETH WITH AIR

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Abstract:
After the process of separating the cotton fiber from the seed, various models of structures for extracting fiber from the saw teeth were theoretically analyzed, the proposed device for extracting fiber from the saw teeth was tested, and a new design was developed based on the results. A new design is simulated after determining the factors that increase the efficiency of fiber extraction.

Keywords: saw cylinder, impact force, fiber damage, air, fiber quality analysis.

INTRODUCTION

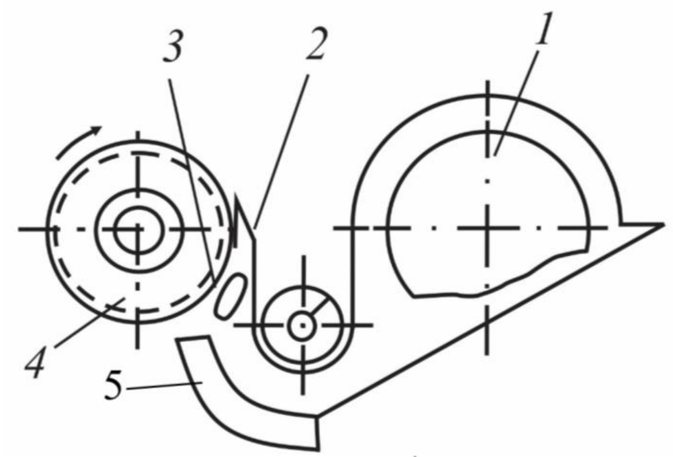
In the working chamber, the saw teeth of the saw cylinder draw fiber from the raw material shaft consisting of cotton, pull the fiber through the slits of the grate, and the process of separating the fiber from the seed occurs. Fiber adjacent to the saw teeth is removed from the saw teeth using a removal device. [1]

One of the main technical requirements when removing fiber is to completely remove the fiber from the saw teeth and transfer the fiber to the take-up pipe. If the fiber is not completely removed from the saw teeth by the removal device, the remaining fiber on the saw teeth is transported back to the working chamber and the re-ginning process occurs.

According to the method of removing fiber from the saw teeth, removal devices are divided into removing fiber from the saw teeth using a rotating brush drum and removing fiber from the saw teeth using an air stream. In this case, the air flow is directed from the nozzle slot to the teeth of the saw cylinder. The method of removing fibers using air is divided into two types: inflate and suction.[2] Air fiber output devices are divided into upper and lower fiber output devices according to the type of design.

MATERIAL AND METODS

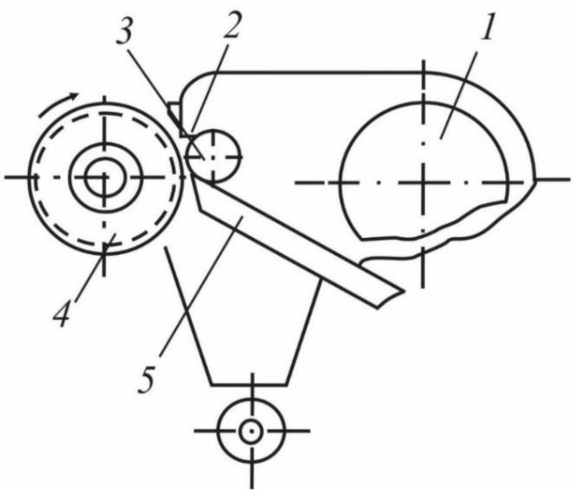
The cotton industry had long relied on brush-type cotton gins, but the high operating costs and unreliability of the brush drum forced designers to look for better methods of removing fiber from saw teeth. Leading US industrial companies remove fibers from saw teeth using a rotating brush [3].



1-Fig. Scheme of removing fiber from the bottom of the saw cylinder.

1-air supply chamber, 2-slotted nozzle, 3-guide, 4-saw, 5-fiber reception pipeline

The most common method in the construction of modern ginning machines is the method of removing fiber from the top of the nozzle. But in order to reduce the waste of fiber removal air flow, the fiber effective removal method is considered to the fiber in the lower state of the nozzle (Figure 1).[4]



2-Fig. Scheme of removing fiber from the top of the saw cylinder.

1- air supply chamber, 2- slotted nozzle, 3- guide, 4- saw, 5-fiber reception pipeline

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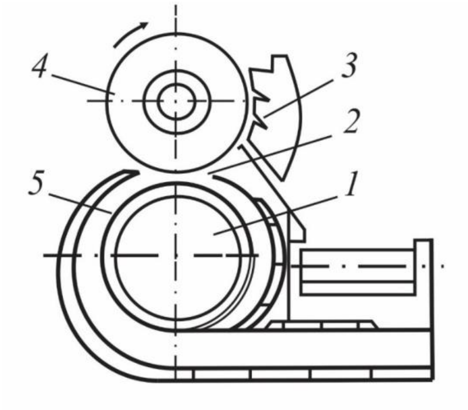
In the study of air-assisted fiber removal devices, the inflate and suction methods of removing fiber from the saw teeth of the saw cylinder were tested. Experimental studies and calculations have shown that the energy consumption increases significantly (from 0.88 to 21 kW) when comparing fiber removal with suction air. and the air consumption for removing the fiber increases (from 0.45). 2.0m3/sec for each gin), so in the existing constructions of cotton ginning plants, mainly air flow blowing devices are used [5].

In 2-figure shows, the devices for removing fiber from saw teeth. The air sent by the pneumatic system is delivered to the air chamber. The fiber is transferred to the removal chamber 1, the air flow from it through the slotted nozzle 2 and the guide part 3 moves in this direction and is directed to the saw teeth 4. the fiber is removed from the saw teeth by the air stream and sent to the receiving pipe 5 [6].

In figure 4 shows the device for removing the fiber from the saw cylinder. Air supplied to the chamber is sent by the pneumatic system. Fiber removal is carried out from the air blowing chamber 1, the air flow from it through the ring nozzle 2 is directed to the saw teeth, the air adjuster 3 adjusts the air pressure, the fiber adjacent to the saw teeth 4 is taken out of the working chamber and directed from the saw teeth due to a significant difference in the speed of the air flow. the fiber is removed by the air flow and sent to the receiving ring tube 5[7].



3-Fig. The device for removing the fiber from the saw cylinder.
1-air supply chamber, 2-ring nozzle, 3-air adjuster, 4-saw, 5-fiber receiving pipe

RESEARCH RESULTS

An air jet fiber removal device is classified as an ejection device. In order to fully ensure the removal of fiber from the saw teeth, it is ensured by creating an ejection state.[8] In the fiber removal zone, two air streams are observed: the active air stream is supplied from the air chamber through the nozzle slot, and the ejector is sent from the gap between the saw cylinder to the fiber removal zone. Both streams mix to form the working air stream, which is sent along with the fiber to the intake pipe.[9]

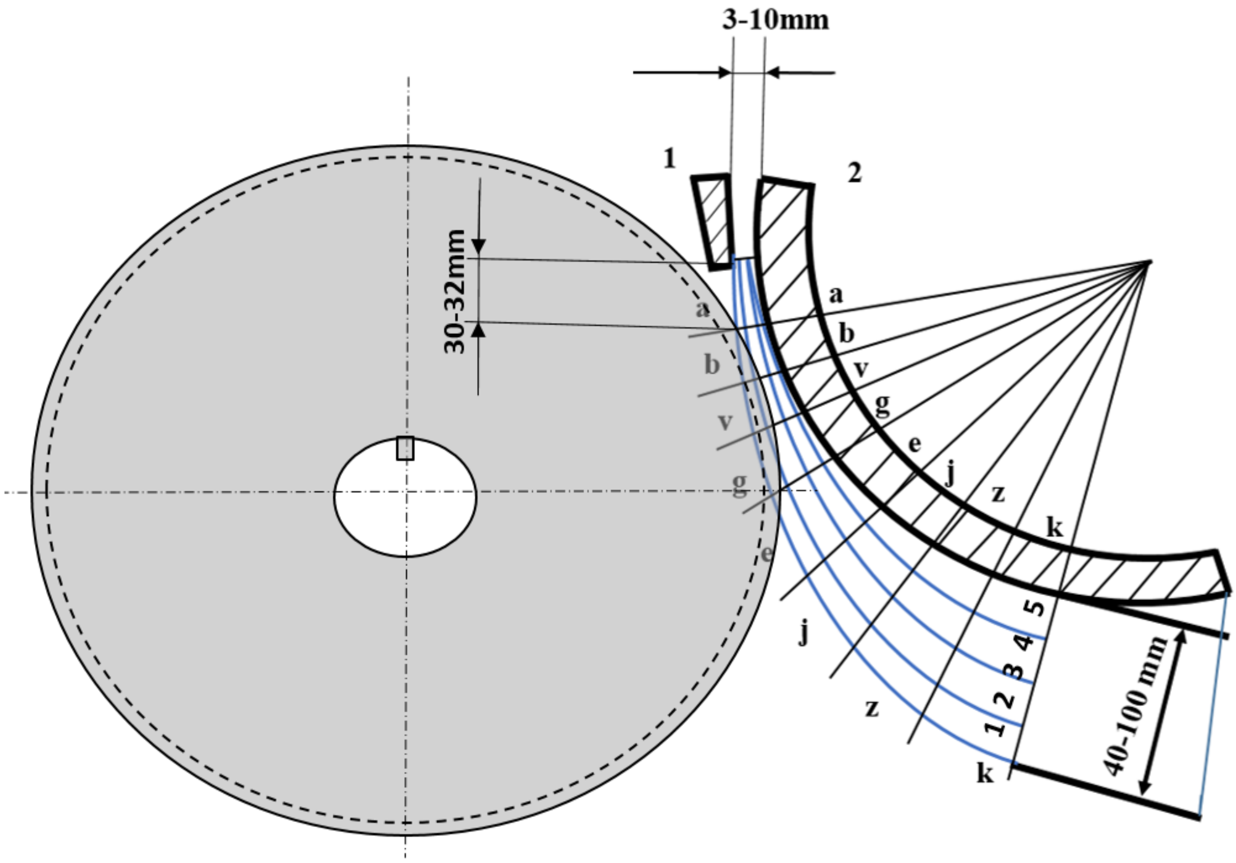


Fig-4. Scheme of separating fiber

1-nuzzle; 2-konstruktion of air flow;

(a-a, b-b….. k – k- shears static pressure; 1 ,2 ,3 ,4 ,5-the direction of the air flow along the lines)

Here, lines 1-5 of the static pressure profiles describe the operating modes of air-assisted fiber stripping. The ejection boundary is a pipe that receives air from the guide nozzle in the open part of the air extraction device, where active air flow and ejection air flow are mixed.[10] The process of mixing these streams continues at the beginning of the intake pipeline. In the air chamber, the air is under static pressure in the nozzle slot. When the air moves through the nozzle slot, the air stream is compressed at the tip of the nozzle, its speed increases, and after the air stream exits the slot, the pressure in it decreases sharply and is released in the fiber removal zone [11].

The efficiency of the fiber removal device with the help of air flow depends on the width of the nozzle opening, the active flow rate, the contact time of the saw teeth of the saw cylinder with the working air flow, the length and curvature of the guide part, the ejection coefficient, the shape and location of the opening of the intake pipe. [12].

The width of the nozzle slot depends on the active air flow consumption and fiber removal efficiency. In order to reduce the air consumption and improve the mixing process of the active air flow and the injection air flow, it is desirable to have the smallest value of the air flow exit slot width, but the experience has shown that if the slot width is less than 4 mm, the saw teeth of the fiber normal removal is disturbed. [13]

When the width of the hole exceeds 6 mm, the air consumption by the active stream increases and the air suction from the gap between the saws in the saw cylinder increases, therefore, in the existing designs of devices for removing fiber from the saw teeth, the width of the nozzle slot is taken up to 5-5.5 mm .[14]

The distance between the surface of the nozzle guide edge and the minimum gap between the teeth of the saw cylinder is 30-32 mm. To ensure the normal state of fiber extraction, the current of active fiber extraction must be $V_c=55 \div 60$ m/sec. If the flow active fiber removal current is $V_c<55$ m/sec, then the fiber removal is partially impaired and the fiber removal rate from the saw teeth decreases. The length of the zone of intensive fiber removal is $L = 89$ mm, and the time spent by the saw teeth in the zone of intensive contact is 0.0113 s for the existing designs of devices with a lower position of removal from the saw cylinder saw teeth. For the existing designs of the devices with saw cylinder removal above the saw teeth, the length of the intensive fiber removal zone is $L = 56$ mm and the time is 0.0071 sec [15].

The removal device in the lower position from the saw cylinder saw teeth provides the best cleaning of fiber removal, which is explained by the extended zone of active fiber removal and the long time of the saw teeth in it. When designing air-assisted fiber removal devices, it is necessary to try to increase the active contact time of the saw teeth with the working air stream [16].

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We determine the diameter of the turning cylinder

$d = \frac{R_{e}v}{v_c}$; (1)

v — Kinematic viscosity of air at air temperature of 25^0 C v=1,56;

ϑ_c— Airflow velocity in the nozzle slot.

With a large value of the Reynolds number Re = $5 \cdot 10^3$ we can find the maximum value of the diameter of the nozzle:

$$d_{max} = \frac{5 \cdot 10^3 v}{\vartheta_c} = 130mm \quad (2)$$

However, the negative pressure on the surface of the tilting cylinder and at the mouth of the intake pipe can change or eliminate the separation point of the airflow [17]. Taking the Reynolds number for the plate as Re = $2 \cdot 10^3$, we can determine the minimum value of the diameter of our tilting cylinder [18].

$$d_{min} = \frac{2 \cdot 10^3 v}{v_c} = 80mm \quad (3)$$

Approximate diameter of the guide cylinder

$$d_{cp} = \frac{d_{max} + d_{min}}{2} = 105mm \quad (4)$$

As the d_{cp} decreases, the cleaning effect can be expected to increase due to the increase in centrifugal forces, so the diameter size should be taken closer to the minimum value.[19]

The ejection coefficient is determined by the following ratio.

$$K_{э} = \frac{Q_{э}}{Q_c} \quad (5)$$

$Q_{э}$ i Q_s — the amount of air released in the separating zone and supplied to the separating zone by active flow.[20]

RESEARCH RESULTS ANALYSIS

According to research, the ejection coefficient for normally adjusted exhaust devices is Ke = 1.9 ÷ 2 for the lower exhaust, and K_э = 1.5 ÷ 1.6 for the upper one.

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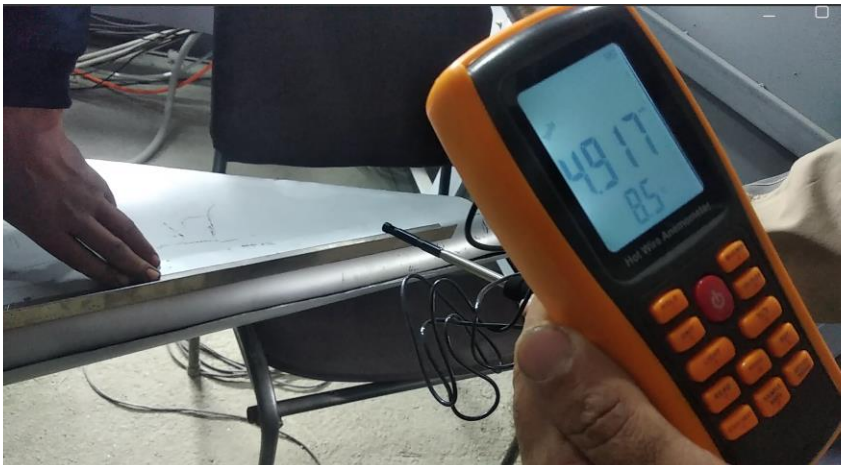
5-Fig. The air gap system is 5 mm and the distance to the saw tooth is 45 mm

The discharge capacity of existing devices, as can be seen from these data, is extremely high, which significantly increases the need for filter surfaces necessary for exhaust air treatment [21]. The air spray system showed a result of 53 meters/second at a distance of 45 mm to the notch 5 mm saw (Figure 5).



6-Fig. The air gap system is 5 mm and the distance to the saw tooth is 65 mm

The air-push system showed 49 meters/second at a distance of 65 mm to the notch 5 mm saw.

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7-Fig. The air gap system is 5 mm and the distance to the saw tooth is 85 mm

The air spray system showed a result of 33 meters / second when the distance to the slot 5 mm saw was 85 mm.

Modeling of air blowing chamber and fiber receiving chamber

We determine the surface of the inlet pipe b=250mm x h=250mm = 25cm x 25cm

$S= 25x25=625cm^2$

We determine the surface of the exit slot b=1500mm x h=5mm =150cm x 0.5cm

$S=150cm \times 0.5cm= 75cm^2$

Characteristics of the VTS-10 ventilator

The fan speed is 1500 metr/min

Pressure P=1800Pa

Work volume $L=3450m^3$/hour

$$v_k = \frac{L}{(3600 \cdot b \cdot h)} = \frac{3450}{(3600 \cdot 0{,}25 \cdot 0{,}25)} = 15{,}33 \text{metr sec}$$

$$v_{CH} = \frac{L}{(3600 \cdot b \cdot h)} = \frac{3450}{(3600 \cdot 1{,}5 \cdot 0{,}005)} = 127 \text{metr sec}$$

We are completely satisfied with the characteristics of the VTS-10 fan, since the air blowing system and the intake system are two sets in our new construction gin machine.

CONCLUSION:

The air spray system showed a result of 53 meters/second at a distance of 45 mm to the notch 5 mm saw. The air-push system showed 49 meters/second at a distance of 65 mm to the notch 5 mm saw. The air spray system showed a result of 33 meters / second when the distance to the slot 5 mm saw was 85 mm. We extended the intake pipe from the fan to allow air to flow through the air intake slot at a speed of 63 meters per second, and we achieved a high pressure build-up in the air intake system. In our new construction machine, the air blowing system collects the air flow coming from the fan through a rectangular tube of b=250mm x h=250mm and collects it in the whole air blowing system through a slot with a size of S=150cm x 0.5cm= 75cm2. sends The air flow comes out of the slot of the air blowing system at a speed of 63 meters per second and removes the fiber from the saw teeth and transfers it to the air intake system. In this case, we take the diameter of the guide pipe as 105 mm.

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