# Modeling Of the Process of Interaction of the Saw Cylinder with the Raw Material In The Process Of Ginning

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***Article Info***
***Volume 83***
***Page Number: 27386– 27391***
***Publication Issue:***
***May - June 2020***

***Article History***
***Article Received**: 11 May 2020*
***Revised**: 19 May 2020*
***Accepted**: 29 May 2020*
***Publication**: 12 June 2020*

***Abstract:***
This research work is focused on studying the influences to velocities of the rotation of the platen and corner of the deflection to lines, connecting centre of the platen and ware of the cylinder from vertically, on contact power of the interaction raw materialrollwith by cylinder.

***Keywords**: The Cotton, Gin, Seed, Fiber, Saw, Gridiron, Roll Box, Seed Roller, Speed, Quality, Efficiency, Productivity, Equation, Pressure, Density, Strength.*

## INTRODUCTION

The productivity of ginneries and the quality of the product depends on the smooth operation of the machines installed in the technological process. It is due to the efficient operation of the gin machine, which separates the fiber from the seed, which is installed in the technological process. After the cotton is dried in the cleaning departments and cleaned of various contaminants, it is sent to the main body of the enterprise to separate the fiber from the seeds. Ginning is the main process in cotton processing technologyin which the fiber is separated from the seed by mechanical force.

The formation of the raw material roller in the process of separating the cotton fiber from the seed in the gin machine depends on a number of factors. The most important of these are the speed of rotation of the raw material roller, fiber, density, the amount of seeds separated from the fiber and so on. It is also necessary to take into account the frictional force created by the walls of the working chamber under the influence of pressure created in the raw material roller. These factors have an impact on the performance of the gin machine and the quality of the fiber obtained.

It is known that in the process of ginning, the seeds separated from the fiber begin to accumulate in the central part of the raw material roller. As a result, the density of the raw material roller increases, leading to an increase in seed and fiber damage. Under the influence of the pressure of the raw material roller, friction is formed on the sides of the working chamber apron. This frictional force significantly affects the rotation of the raw material shaft. Especially when DP-130 ginners work with low-

TEST Engineering & Management
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ISSN: 0193-4120 Page No. 27386– 27391

grade cotton, there are frequent blockages in front of the side walls of the working chamber. '

The authors [1] studied the condition of the raw material roller, which is formed in the working chamber during the ginning process. The accumulation of fiber-separated seeds in the working chamber, resulting in an increase in the density of the raw material roller and its dependence on the productivity of the gin machine, has been studied theoretically, linked to fiber output and the results obtained.

In [2, 3] stake accelerator has proposed on the side of the roll box in order to increase the productivity of the gin machine. The effect to the raw material of the proposed stakes was studied. Movement differential equation ofthe seed roller was made up and necessary graphics were taken based on laws.

In [4], the influence of the density of the seed roll, which is formed in theroll box of the saw gin, on the load of the saw cylinder drive and on the technological characteristics of the machine is considered. As a result of the research, in order to preserve the quality characteristics of fiber and seeds, theauthor proposes a gin stand with a system for regulating the position of theroll box.

In [5],the analysis of the roll box of saw gins of different companies was carried out, given the results of studies to determine thespeed and density of the seed roll in the roll box of the saw gin. A diagram isgiven for the dependence of the speed of the feed rollers on the incomingsignal.

In [6],the differential equations of movement along the concave profile of the grate,consisting of three broken lines, are integrated on Maple 9.5 under initialconditions, using separate functions, and graphs of the dependence of movement and speed over time are presented. The graphs show the patterns ofchange in displacement and speed at different angles, friction coefficient ofseeds along grate with a broken line of a concave profile.

In [7],studied the principles of movements in the horizontal part of thenewly constructed ginning camera, which is created by the authors, of thecotton particles. During the movement, the cotton particles get affected bypressing to various surface and forceful turbulent and horizontal movementsof the surface. Some foreign mixtures and additional unnecessary objects getseparated by the turbulence of the various surfaces and movement of the paneled stripes. Ginning efficiency and the quality of the cotton will be improvedas the defects of the cotton particles are removed. “Cotton particle + net surface” movement principle of the Cartesian coordinate system was examinedbased on the rows of Cartesian coordinate system, by dividing all sides of thesystem by m weight and has the following second ordered multiple genderdifferential formula.

In the process of ginning, a mechanical separation of the fiber from the seeds occurs with the help of saw teeth, which occurs in the zone of their interaction with the raw roller and grates in the working chamber. The mechanism of fiber removal from the surface of the raw roller is rather complicated and has been little studied at present [8].

In [9], the values of the siltration between the fibers and the saw teeth were determined, it was found that this force is variable along the interaction arc and plays a significant role in the dynamics of separation of the fiber from the seeds. In this work, the law of the distribution of the contact force of the interaction of the raw roller with the teeth of the saw cylinder, which affects the value of the separation force, is not analyzed.

In [10], a “spring” model was proposed for describing the pressure distribution in the contact zone, where the dependence of the depth of the teeth was drilled in a raw roller and normal force was adopted according to a linear law. In this paper, the issues of the appearance of the slip zone in the contact area and the assessment of its influence on the magnitude of the separation force are not considered. She studied the rolling of an absolutely rigid roller over a relaxing medium, and the

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ISSN: 0193-4120 Page No. 27386– 27391

occurrence of friction forces is explained by the asymmetric distribution of the pressure forces of the roller on the medium over the contact surface.

In this paper, we studied the effects of the speed of rotation of the roller and the angle of deviation of the line connecting the centers of the roller and the saw cylinder from the vertical to the contact force of the interaction of the raw roller with the saw cylinder.

Let the raw roller, modeled by a deformable cylindrical body of radius, $R_c$, roll without sliding with a constant linear speed $v_c$ to the rotating saw cylinder. The radius and linear velocity of the cylinder are denoted, respectively, denoted by $R_b$ and $v_b > vc$. In the stationary state of the process of interaction of the raw roller with the cylinder, all the forces acting on the raw roller will be balanced. We list these forces (Fig. 1):

1. Forces externally applied to the roller (including gravity), which, being reduced to the geometric center of the roller, form a pair of moments, $L$, horizontal force $F$ and vertical force $Q$.

2. The adhesion force of the raw roller to the cylinder, which holds the roller against sliding and is determined in the contact zone by the introduction of the teeth of the saw cylinder into the raw roller and separation of the fibers from the seeds

3. The distributed surface normal contact force. The specific pressure $p$, produced by these forces will be assumed constant along the generatrices of the cylindrical surface of the raw roller.

We direct the axis $\xi$ along the contact line, denote by $\xi_2 > 0$ and $\xi_1 < 0$ respectively, the coordinates of the beginning and end of contact of the saw cylinder with the raw roller. The equilibrium conditions of the forces applied to the saw cylinder (driven wheel) have the form

$$F - P\sin\alpha = 0 \quad (1)$$

$$Q - b\int_{\xi_1}^{\xi_2} p(\xi)d\xi + P\cos\alpha = 0 \quad (2)$$

$$F(R_b - u_0) - b\int_{\xi_1}^{\xi_2} \xi p(\xi)d\xi = 0 \quad (3)$$

Where $P = mg$ - the force of the weight of the raw roller, $b$ - the width of the roller, $u_0 = BB_0$ - the approximation of the centers of the saw drum and the raw roller

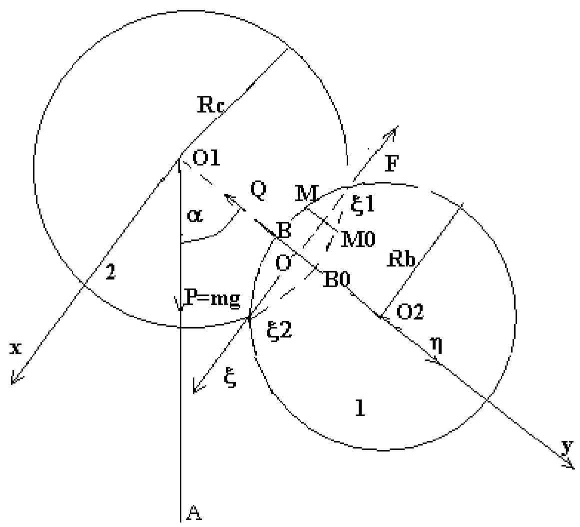


Fig. 1: Scheme of the distribution of forces in the contact zone $-\xi_2 < \xi < \xi_1$ of the saw cylinder 1 with the raw roller 2.

To make the raw roller contact with the saw cylinder without slipping, it is necessary to satisfy the inequality

$$F < fQ$$

Where $f$ - coefficient of sliding friction of the surface of the saw cylinder on the surface of the raw roller. Otherwise, slippage occurs, and the efficiency of separating the fiber from the seeds decreases. When the saw cylinder is pressed in, the raw roller its most distant point $B$ is embedded into the deformable roller in depth $BB_0 = u_0$. Find the value of the recess of the saw cylinder at some other point

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ISSN: 0193-4120 Page No. 27386– 27391

$M_0$ on the roller. We write in the coordinate system $x0_1y$ the equations of circles with centers at points $O_1(0,u0)$ и $O_2(0,R_b+R_c)$

$(y_2-u_0)^2+x^2=R_c^2$, $(y_1-R_c-R_b)^2+x^2=R_b^2$

The depth of the saw cylinder will be equal to $u=y_2-y_1=u_0+\sqrt{R_c^2-x^2}+\sqrt{R_b^2-x^2}-R_c-R_b$

(4)Up to small fourth order ($\frac{x^4}{R_c^4}\approx 0$, $\frac{x^4}{R_b^4}\approx 0$) we have

$u\approx u_0-\frac{x^2}{2R_c}-\frac{x^2}{2R_b}$ or putting $x=\xi$, we get

$$u\approx u_0-\frac{\xi^2}{2R_c}-\frac{\xi^2}{2R_b} \quad (5)$$

We introduce a moving coordinate system $\xi 0\eta$. coordinate system moves to the right with linear velocity $v_c$ the abscissa of a point $M$ cdecreases over time and therefore $\frac{d\xi}{dt}=-v_c$. At the beginning of the contact of the saw cylinder with the roller ($\xi=\xi_2>0$) the size of the recess is zero, and therefore, according to (5), we have

$$u_0=\xi_2^2\frac{R_c+R_b}{2R_cR_b} \quad (6)$$

Where $\xi_2$ can be expressed through $u_0$

($\beta=R_cR_b/(R_c+R_b)$)

$\xi_2=\sqrt{2\beta u_0}$

To determine the specific pressure, we use the "spring" model [10] according to which the pressure in the contact zone is proportional to the size of the recess, ie $p=Ku=K[u_0-\xi^2(R_b+R_c)/2R_cR_b]$

The resultant pressure force on the raw roller and the friction moment according to (2) and (3) are determined by the formulas

$$Q_0=\int_{\xi_1}^{\xi_2}bp(\xi)d\xi=bK\left(u_0(\sqrt{2\beta u_0}-\xi_1)-(2\beta u_0\sqrt{2\beta u_0}-\xi_1^3)/6\beta\right)$$

$$M_0=\int_{\xi_1}^{\xi_2}b\xi p(\xi)d\xi=bK\frac{(2\beta u_0-\xi_1^2)^2}{8\beta^2}$$

By supplying the expressions for $Q_0$ and $M_0$ in formulas (2) and (3), we obtain

$$Q+P\cos\alpha=bK\left(u_0(\sqrt{2\beta u_0}-\xi_1)-(2\beta u_0\sqrt{2\beta u_0}-\xi_1^3)/6\beta\right) \quad (7)$$

$$P(R_b-u_0)\sin\alpha=bK\frac{(2\beta u_0-\xi_1^2)^2}{8\beta} \quad (8)$$

Equations (7) and (8) for given values of forces $Q$ ,andangle $\alpha$ form a system of nonlinear equations for determining displacement $u_0$ andcoordinate $\xi_1$. Excluding, for example, the coordinate $\xi_1$ from this system, one transcendental equation can be obtained to determine the displacement $u_0$. The table shows the values of $u_0$, $\xi_1$, $\xi_2$ and the length of the contact zone $a=\xi_2-\xi_1$ for various values of the dimensionless parameter $\lambda=P/KbR_b^2$ and angle $\alpha$.

**Table. Data for $u_0$, $\xi_1$, $\xi_2$ and $a=\xi_2-\xi_1$ for various values, the angle parameter $\lambda$ angle $\alpha$**

| | $\alpha=0^0$ | | | | | $\alpha=15^0$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $\lambda$ | 0.1 | 0.2 | 0.3 | 0.4 | 0.55 | 0.1 | 0.2 | 0.3 | 0.4 | 0.55 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $u_0(м)$ | 0.028 | 0.044 | 0.058 | 0.070 | 0.087 | 0.033 | 0.052 | 0.064 | 0.076 | 0.092 |
| $\xi_1(м)$ | -0.069 | -0.867 | -0.099 | -0.109 | -0.121 | -0.127 | -0.136 | -0.141 | -0.146 | -0.153 |
| $\xi_2(м)$ | 0.069 | 0.0866 | 0.099 | 0.109 | 0.121 | 0.075 | 0.091 | 0.104 | 0.114 | 0.124 |
| $a(м)$ | 0.137 | 0.173 | 0.198 | 0.218 | 0.242 | 0.202 | 0.227 | 0.245 | 0.260 | 0.277 |
| | $\alpha = 30^0$ | | | | | $\alpha = 45^0$ | | | | |
| $\lambda$ | 0.1 | 0.2 | 0.3 | 0.4 | 0.55 | 0.1 | 0.2 | 0.3 | 0.4 | 0.55 |
| $u_0(м)$ | 0.035 | 0.052 | 0.065 | 0.077 | 0.091 | 0.034 | 0.052 | 0.064 | 0.074 | 0.088 |
| $\xi_1(м)$ | -0.144 | -0.150 | -0.154 | -0.158 | -0.162 | -0.153 | -0.158 | -0.162 | -0.165 | -0.168 |
| $\xi_2(м)$ | 0.077 | 0.094 | 0.106 | 0.114 | 0.125 | 0.078 | 0.094 | 0.104 | 0.112 | 0.121 |
| $a(м)$ | 0.221 | 0.244 | 0.260 | 0.272 | 0.267 | 0.231 | 0.252 | 0.266 | 0.287 | 0.289 |

## CONCLUSION

From the analysis of the tabular data it follows that with an increase in the parameter $\lambda$, which means an increase in the weight of the raw roller or a decrease in the stiffness coefficient of the mass of raw cotton, the length of the contact zone also increases. If $\alpha > 0$ the distribution law is symmetric, the pressure distribution is violated by increasing the angle of inclination $\alpha$ an intense increase in the length of the contact zone is first observed $\alpha > 45^0$ and when it practically remains constant.

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