The Oretic Observation of the Cotton Movement in the Operating Camera of the New Separator

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Abstract--- *The Studies moving the pat product in its raw state in worker to camera of the separator to new design. In given article explored moving the pat-product in its raw state in worker to camera of the separator in new designs. Will Formed differential equation moving the pat and are received analytical decision, characterizing laws motion from time.*

Keywords--- *Fiber, Separator, Cotton, Pneumatic, Mechanical, Pneumamechanical, Element, Drum, Equipment, Camera, Separation.*

I. INTRODUCTION

The initial procession of the cotton includes a number of technological processes (piling, keeping, carrying, drying, cleaning, separating fiber and so on) and is a unique technological chain. This chain is related to the efficiency of each equipment and work quality of machines in it. Considering this matter, it can be concluded that technological chain equipment have a vast impact on the quality of the cotton [1].

In cotton processing plants, cotton is usually carried by pipes using air. Possibility of the distribution of the cotton to any direction and to arranged places and without any damage made this technology to be widespread in the cotton procession industry [2].

It is important to study the influence of the operating parts of the separator that is considered the main element of the machine which carries cotton through air. The particles of the cotton in the operating camera of the separator hit to various surfaces and stick to them in the process of separation from the air. It will be separated using a breaker. In addition that, the cotton particles, which exit from the air and the separator, will be under the influence of the vacuum-valve propellers. Because of the result of the influence of these machines to the cotton, it is an important task to preserve the quality of the cotton by decreasing breakage of cotton and damaging fiber [3,4].

It is important to consider the preservation of the natural quality of the cotton in the process of carrying it through air. Thus, the deterioration of the cotton quality may take place in the fanning system of the technology. Therefore, the construction of the separator that separates the cotton from air was changed. In the separator, the

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cotton is separated based on its gravity from air and the distancing power from the center. Therefore, separators are divided into: (1) gravitational, (2) inertial, and (3) distancing from the center [5,6].

II. Significance Of The System

The construction of the above-mentioned separators is not fully developed. The high aerodynamic forces may appear that cause the air pressure to be lost. In addition to that, the technological damage will be caused to the fiber and result in the deterioration of the cotton quality. Also, the flying of the fiber can be observed from the various holes of surfaces. Although some research has been done in the area of studying the separation process, the process of separation of cotton from the netted surface and dropping it to the vacuum valve has not been fully studied. Considering what is mentioned above, the new separator machine that is projected and implemented into the practice has a horizontal cylindrical camera that has a material giving pipe and doubly netted and surfaced disks. There is an opening in a particular distance in the webbed disks and the passing air from the openings of the webbed disks will be directed to the air emitting pipe [7]. Under the air passing camera, emitting camera – vacuum-vale the raw cotton that comes from the webbed disks will be sent to the next process. In order to boost the productivity of the cotton, separating camera and cotton emitting camera are constructed perpendicularly and this difference of this separator makes it different from other ones. The cotton entering pipe is situated horizontally between separating camera and vacuum valve. In this case, the separating camera will have an additional pipe in its central part. The cleaners of the disks are installed so that they can clean all the surfaces at the same time [8].

III. Literature Survey

This article studies the movement of the cotton in the separator in the operating camera through the entering pipe and the inter influence of the cotton and parts of the propelling drum. In this article, raw cotton is viewed as a system that is equally estimated and in undivided movement [9].

Aerodynamic and gravitational forces influence the cotton in the operating camera of the separator. The difference between the speed of the air current V_x and the speed of the raw cotton V_n will be determined as the following:

$$\Delta V = V_x - V_n$$

Here V_x - speed of the air current, m/sec;

V_n - speed of the raw cotton, m/sec

Because of the differences in the speed, the aerodynamic force will be created. It will be divided into F_x and into lifting aerodynamic force, F_y.

In general situation, forces with three components as a result of the current $F_{y,}$ $F_{y,}$ F_z and moments with components $M_м$, $M_{y,}$ M_z will appear. In an individual situation ХОУ – we will examine the movement principles of the raw cotton in the coordination system.

In this case gravitation - F_x and lifting force - F_y will be identified based on this formula.

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$$\begin{cases} F_x = \dfrac{F_м S}{2} C_x (\Delta V)^2 \\ F_y = \dfrac{F_м S}{2} C_y (\Delta V)^2 \end{cases} \tag{1.1}$$

Here, C_x, C_y - coefficient of the aerodynamic force;

$F_м$ - Horizontal surface of the cotton, (m^2)

S – Air pressure, kg/m^3.

At the mean time the movement direction of the matter, equals F_x force. However, because this force blocks the movement in our case, it will have a direction that is opposite to the movement direction.

F_y - always force movement is perpendicular F_x - force. Flow, as a rule, fluctuating, it creates α angle with opposition force.

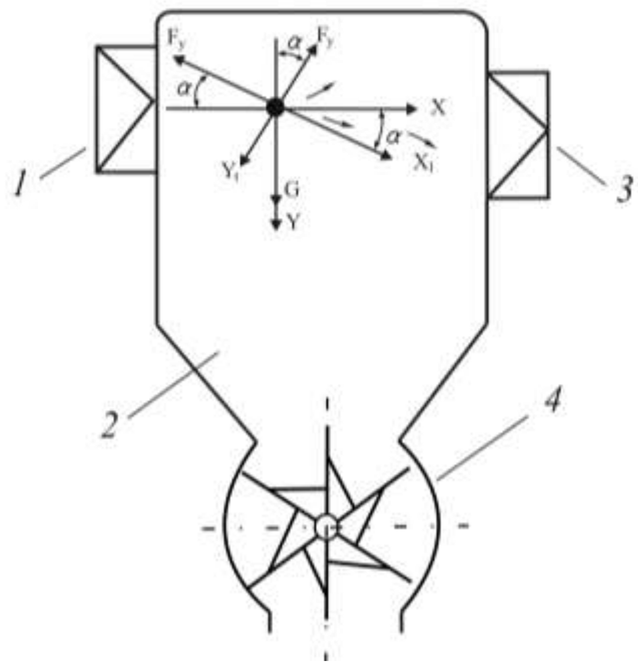

Figure 1

OX and OУ – arrows are accepted as shown in the picture. Because of the expansion of the passing horizontal parts, the speed of air current decreases. The cotton raw material will go on moving at the same speed with the initial speed. Therefore (V-V_n) differences of speeds – negative suppression and air flow will decrease the movement speed of the cotton raw material. In addition to that, the cotton raw material will fall down based on the gravity force and it will be bigger in the upper part of the air current than the lower part. The lifting force will affect the upper case and it will block the cotton raw material from falling on the cells of the paddle drum of the separator [10].

In general, although V and V_n speeds are changing, in some cases the air current can be continuous.

We assume that, in a short period, it will be possible to change the forces with the following figure with lines:

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$$\begin{cases} F_X = m \cdot K_X \cdot V_n \\ F_Y = m \cdot K_Y \cdot V_n \end{cases} \qquad (1.2)$$

The lifting force will appear in symmetrical particles. The particles of the materials flow with the air in different speeds. Also, the particles of the cotton raw material are not symmetrical as per the rule. If they have at least one symmetric arrow, in that case, it will turn through the current on the plain surface. It will try to place into the symmetric arrow. The attacking angle α is equal to zero and lifting force is also equal to zero. But this situation will not happen. Because the particles of the cotton raw material will fall into the asymmetric zone being affected by the gravitational force. They will have lifting force anew. So, the irregular flow will cause to create the lifting force. But, cotton particles, on the horizontal movement of the flow or in angle situation, inertial force will be created. The (1.2) formula should be used in the first approach; there is no sense from separating two force components flow and inertia [11, 12].

We will create a movement formula considering the forces that affect the cotton raw material [13] (Figure 1).

We will place the coordinate arrows as following: OX – arrow should be horizontal to the initial speed direction; OУ arrow should be directed low vertically.

We create a differential formula of its movement principle of forces that affect the cotton raw material based on the Dalamber principle [14]:

$$\begin{aligned} m\frac{d^2x}{dt^2} &= F_X \cdot \cos\alpha + F_Y \sin\alpha \\ m\frac{d^2y}{dt^2} &= -F_X \cdot \sin\alpha + Fy \cdot cos + G \end{aligned} \qquad (1.3)$$

Here V_n – the speed of the cotton raw material, m/sec;

m – Its weight, kg;

K_x, K_y - elastic coefficients, 1/sec.;

It is possible to write the differential formula considering (1.2) and (1.3) as following:

$$\begin{cases} m\dfrac{d^2x}{dt^2} = -mK_X V_n \cdot cos\alpha + m \cdot Ky\, V_n \cdot \sin\alpha \\ m\dfrac{d^2y}{вe^2} = -mK_X V_n \cdot \sin\alpha - mKyV_n cos\alpha + mg \end{cases} \qquad (1.4)$$

We will bring (1.4) to the following state dividing both formulas by m and considering the following elements:

$$\begin{cases} V_n \cdot cos\alpha = V_x = \dfrac{d_x}{dt} = \dot{X} \\ V_n \cdot \sin\alpha = V_y = \dfrac{d_y}{dt} = \dot{Y} \end{cases} \qquad (1.5)$$

$$\begin{cases} \ddot{X} + K_x \dot{X} - K_y \dot{Y} = O \\ \ddot{Y} + K_x \dot{Y} + K_y \dot{X} - g = O \end{cases} \quad (1.6)$$

(1.6) we will indicate the speeds as following in the differential formulas system:

$$\dot{X} = U; \qquad \dot{Y} = \omega \quad (1.7)$$

If (1.7) we consider, (1.6) it will have the following:

$$\begin{cases} \frac{dU}{dt} = -K_x U + K_y \omega \\ \frac{d\omega}{dt} = -K_x \omega - K_y U + g \end{cases} \quad (1.8)$$

(1.8) we will have the following (1.9) system of formulas by differentiating all states with the time t:

$$\begin{aligned} \frac{d^2U}{dt^2} &= -K_x \frac{dU}{dt} + K_y \frac{d\omega}{dt} \\ \frac{d^2\omega}{dt^2} &= -K_x \frac{d\omega}{dt} - K_y \frac{dU}{dt} \end{aligned} \quad (1.9)$$

We will have the system of differential formulas that are second ordered un-gendered non-changing coefficient and lined putting (1.8) to (1.9).

$$\begin{cases} \frac{d^2U}{dt^2} \left(K_X^2 - K_Y^2\right) U - 2K_X K_Y \omega + K_Y g \\ \frac{d^2\omega}{dt^2} K_X^2 \omega + 2K_X K_Y U - K_X g \end{cases} \quad (1.10)$$

In the result of entering the following elements, (1) will pass to the (1.12) second ordered un-gendered non-changing coefficient and lined differential formula.

$$\begin{array}{cc} a_{11} = K_x^2 - K_y^2 & a_{21} = 2K_x K_y \\ a_{12} = -2K_x K_y & a_{22} = K_x^2 \\ \hline b_1 = K_y g & b_2 = K_x g \end{array} \quad (1.11)$$

$$\begin{cases} \frac{d^2U}{dt^2} = a_{11}U + a_{12}\omega + b_1 \\ \frac{d^2\omega}{dt^2} = a_{21}U + a_{22}\omega + b_2 \end{cases} \quad (1.12)$$

1-CASE

From (1.11) we will move on to second ordered un-gendered non-changing coefficient formula and seek its solution:

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$$\begin{cases} \dfrac{d^2U}{dt^2} = a_{11}U + a_{12}\omega \\ \dfrac{d^2\omega}{dt^2} = a_{21}U + a_{22}\omega \end{cases} \qquad (1.13)$$

Solutions:
$$U = \alpha\ell^{kt}$$
$$\omega = \beta\ell^{kt} \qquad (1.14)$$

$$(1.14) \rightarrow (1.13): \qquad \left.\begin{aligned} \alpha k^2 \ell^{kt} &= a_{11}\alpha\,\ell^{kt} + a_{12}\beta\,\ell^{kt} \\ \beta k^2 \ell^{kt} &= a_{21}\alpha\,\ell^{kt} + a_{22}\beta\,\ell^{kt} \end{aligned}\right\} : \ell^{kt}$$

$$\left.\begin{aligned} (a_{11} - k^2)\alpha + a_{12}\beta = 01 \\ a_{21}\alpha + (a_{22} - k^2)\beta = 0 \end{aligned}\right\} \qquad (1.15)$$

α, β - in comparison will create an algebraic system of formulas.

We will find the main determinant of (1.15):

$$\Delta(k) = \begin{vmatrix} a_{11} - k^2 & a_{12} \\ a_{21} & a_{22} - k^2 \end{vmatrix} \qquad (1.6)$$

If $\Delta(k) \neq 0$, $\alpha = 0, \quad \beta = 0$.

Trivial solutions: $U(t) = 0, \ \ \omega(t) = 0$ will have.

To the contrary $\Delta(k) = 0$ we will find solutions that are not trivial:

$$\Delta(k) = 0 \Rightarrow \begin{vmatrix} a_{11} - k^2 & a_{12} \\ a_{21} & a_{22} - k^2 \end{vmatrix} = 0 \qquad (1.17)$$

We will have (1.16) $\rightarrow$ (1.10)- or the following characteristic formula:

$$\left(a_{11} - k^2\right)\left(a_{22} - k^2\right) - a_{12}a_{21} = 0$$

$$k^4 - (a_{11} + a_{22})k^2 - a_{12}a_{21} = 0 \qquad (1.18)$$

We will find the solutions of K^1, K^2, K^3, K^4:

Here:

$$\left.\begin{aligned} a_{11} + a_{22} = 2k_x^2 - k_y^2 \\ a_{12} + a_{21} = 4k_x^2 - k_y^2 \end{aligned}\right\} \qquad (1.19)$$

Special values that are similar to characteristic values: $\alpha^{(1)}, \alpha^{(2)}, \alpha^{(3)}, \alpha^{(4)}; \quad \beta^{(1)}, \beta^{(2)}, \beta^{(3)}, \beta^{(4)}$ will be found and solution formula will as following:

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$$\left.\begin{aligned} U(t) &= c_1\alpha^{(1)}\ell^{k_1 t} + c_2\alpha^{(2)}\ell^{k_2 t} + c_3\alpha^{(3)}\ell^{k_3 t} + c_4\alpha^{(4)}\ell^{k_4 t} \\ \omega(t) &= c_1\beta^{(1)}\ell^{k_1 t} + c_2\beta^{(2)}\ell^{k_2 t} + c_3\beta^{(3)}\ell^{k_3 t} + c_4\beta^{(4)}\ell^{k_4 t} \end{aligned}\right\} \quad (1.20)$$

There are solutions of one gendered differential formulas.

2-CASE

We will search the solution of the formula system that is not one gendered and differential:

$$\left.\begin{aligned} \overline{U} &= A \\ \overline{\omega} &= B \end{aligned}\right\} \qquad (1.21) \begin{pmatrix} A = const \\ B = const \end{pmatrix}$$

(1.21) - (1.13) will find the individual solutions:

$$\left.\begin{aligned} a_{11}A + a_{12}\beta + b_1 &= 0 \\ a_{21}A + a_{21}\beta + b_2 &= 0 \end{aligned}\right\} \begin{vmatrix} a_{21} + \\ -(a_{11}) \end{vmatrix} \begin{matrix} a_{22} \\ -a_{12} \end{matrix}\Bigg| +$$

$$A(a_{11}a_{22} - a_{12}a_{21}) = -b_1 a_{22} + b_2 a_{12}$$

$$B(a_{12}a_{21} - a_{11}a_{22}) = -b_1 a_{21} + b_2 a_{11}$$

$$\begin{cases} B = \dfrac{b_1 a_{21} - b_2 a_{11}}{a_{11}a_{22} + a_{12}a_{21}} \\ A = \dfrac{b_1 a_{22} - b_2 a_{12}}{a_{12}a_{21} + a_{11}a_{22}} \end{cases} \quad (1.22)$$

So, the solutions of the none-one-gendered differential formula will be as following:

$$\begin{aligned} \overline{U} &= \frac{b_1 a_{22} - b_2 a_{12}}{a_{12}a_{21} + a_{11}a_{22}} \\ \overline{\omega} &= \frac{b_1 a_{21} - b_2 a_{11}}{a_{11}a_{22} + a_{12}a_{21}} \end{aligned} \quad (1.23)$$

Here: $a_{11}a_{22} - a_{12}a_{21} \neq 0$ the condition should be completed

$$\begin{aligned} &(K_x^2 - K_y^2)\ \ K_x^2 + 4K_x^2 K_y^2 \neq 0 \\ &K_x^2 (K_x^2 - K_y^2 + 4K_y^2) \neq 0 \\ &\qquad \textit{бундан} \\ &\begin{cases} K_x^2 \neq 0 \\ K_x^2 + 3K_y^2 \neq 0 \end{cases} \end{aligned} \quad (1.24)$$

So, we have the following general solutions:

$$\begin{aligned} U &= U(t) + \overline{U}(t) \\ \omega &= \omega(t) + \overline{\omega}(t) \end{aligned} \quad (1.25)$$

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The basic conditions are set as following in the problem:

$$t = 0$$

$$\dot{X}(0) = U(0) = V_0 \cos\alpha$$

$$\dot{Y}(0) = \omega(0) = V_0 \sin\alpha$$

$$\dot{U}(0) = 0$$

$$\dot{\omega}(0) = 0$$

V_0 - the speed of the air current.

In the following solutions, by choosing the air speed and other particles optimally, we may choose the acceptable regime of the process.

From this:

$$\begin{cases} U(0) = C_1\alpha^{(1)} + C_2\alpha^{(2)} + C_3\alpha^{(3)} + C_4\alpha^{(4)} = V_0 \cos\alpha \\ \omega(0) = C_1\beta^{(1)} + C_2\beta^{(2)} + C_3\beta^{(3)} + C_4\beta^{(4)} = V_0 \cos\alpha \\ \dot{U}(0) = K_1C_1\alpha^{(1)} + K_2C_2\alpha^{(2)} + K_3C_3\alpha^{(3)} + K_4C_4\alpha^{(4)} = 0 \\ \ddot{\omega}(0) = K_1C_1\beta^{(1)} + K_2C_2\beta^{(2)} + K_3C_3\beta^{(3)} + K_4C_4\beta^{(4)} = 0 \end{cases}$$

From these algebraic system of formulas, we will find the unchanging coefficients of one gendered differential formulas and put to the (1.25) formula.

IV. Conclusion And Future Work

Structures and working processes of local and foreign machinery cleaning cotton from fine impurities have been thoroughly studied and models have been developed to improve its efficiency. It has been shown that changing the shape of piles, increasing useful surface of the net surface and ensuring that the cotton stays longer on the net surface under the influence of piled drums are necessary.

The author suggested increase in efficiency by moving cotton on the sloped net surface under the influence of its own weight. As a result, it will be possible to increase the time during which raw cotton stays on the net surface.

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