



## INTERACTION OF IMPURITIES IN COTTON FIBER

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### ABSTRACT

*Several types of impurities remain in the fiber after ginning. They are divided into active and inactive. Active impurities are strongly bonded to the fiber and are difficult to clean. To make them inactive, they must be brought to the outer part of the fiber. For this purpose, instead of one foot grate, a grate drum is equipped to loosen the fibrous layer. After loosening with the help of the next foot grate, the yield of impurities increases. The article calculates the dynamic relationship between fiber and impurities.*

### Introduction

Cotton is one of most used natural fibers used for clothes, bed linen, industry and quality of fiber is crucial for its implementation. Raw cotton from harvester contains a lot of waste (fig.1), which is cleaned using various methods. There are known that loses of raw cotton reaches about 15% of a fiber, in contemporary textile enterprises. Thus because of reduction of dynamism of fibers, the fiber at spinning reduces quality of a yarn. These effects significantly decrease quality of manufactured cotton fibers and textile. During preparation process fibers should be separated from seeds and blossom debris. The crude cotton needs complex cleaning process, because just harvested crude cotton contain high percentage of organic and non-organic waste as it is shown in fig.1. Processes of cotton gathering, drying, sorting and transportation are performed at cotton cleaning factories.



**Fig.1.** Example of crude cotton

Process of cotton cleaning is performed using several units of equipment. Cotton cleaning process is based on mechanical treatment of cotton and aerodynamic cleaning using air blow. Recently, for equipment improvement to reduce mechanical damage on cotton fiber and increase efficiency of cleaning process, there are performed a lot of research for cotton treatment improvement. Direction of technology improvement is pointed to decrease of steps of mechanical treatment and increase of one machine efficiency, thus reduces mechanical damage of cotton fibers and seeds, such treatment makes process more efficient. It gives chance to think that, variable influences of forces on cotton reduces occurrence of mechanical defects. Following this paradigm, technology modification is made by replacing two machines of mechanical cleaning by one vibrating crate, which perform planar movement, ensuring jump of cotton wisp from crate surface and bump from gravity and inertia forces back to crate surface. Crate moves in horizontal and vertical planes thus ensuring proper movement of cotton wisp and ensuring efficient cotton cleaning process without mechanical smashing through metal grill.

Research and shows dependency of cotton cleaning efficiency and productivity to path of vibrating crate.

The article examines the interaction of weeds with cotton fiber. It is known that impurities are located on the feeders and inside it, having different clinging to the fiber. At the same time, weed impurities are divided into large and small. Large impurities are located on the surface of the fiber bundle and have little contact with it, while small impurities are deeply embedded in the fiber mass. To separate them, significant shock - shaking effects on the fiber are required.

According to the nature, impurities are into passive and active. Passive ones are located on the surface of the bundle, and active ones, those connected by individual fibers or located inside a layer of fibers, are difficult to distinguish. Therefore, they must first be transferred to the passive fiber surface. in subsequent processes, when struck with grates, they are

separated from the fiber. Figure -1 shows a fiber cleaner with an additional pegging drum in place of one knife grate -2, which helps to turn over certain parts of the lower layer of the fiber bundle -3, allowing, in turn, to remove active impurities into passive ones, grate-4.

The physical and mathematical model of the problem is shown in Figure-3.

When studying the dynamics of interaction of Sora-A particles (Figure 2) with a fiber bundle, the following assumptions were made:

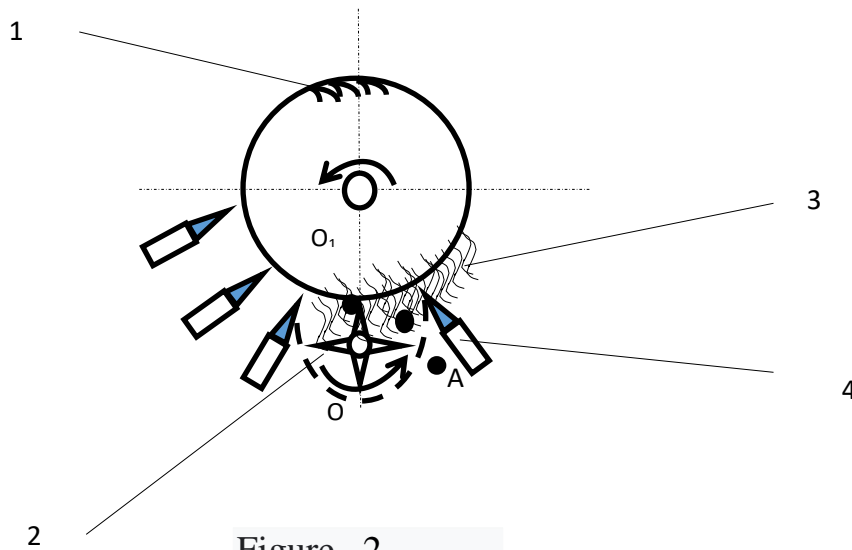


Figure -2

1. The effect of surface pressure of the fiber layer on active impurities is not taken into account.

2. Internal friction between litter and fiber obeys Coulomb's dry law.

Let us depict the impurities in an intermediate position on the fiber as particle -B (Figure 3).

The  $\tilde{i}$  and  $n$  axes are located in the plane of rotation of saw cylinder 1. The  $n$  axis forms an angle  $\varphi$  with the vertical.

[3] The initial conditions for the movement of impurities B have the form:

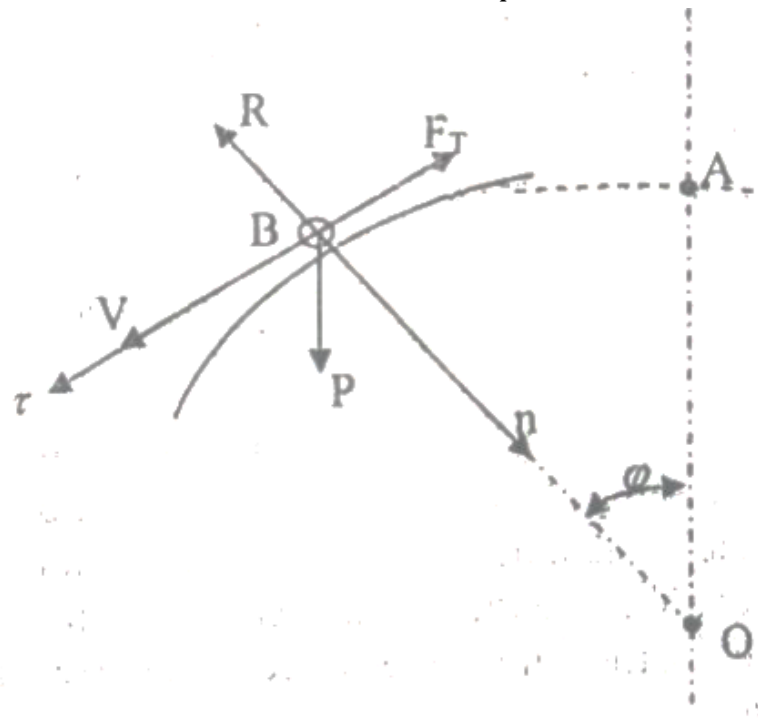


Figure 3

$$t=0; \quad \varphi=0; \quad \dot{\varphi}^1=v_0/\rho; \quad \rho=r+\Delta$$

where the length of the peg is  $-\Delta$ ;  $r$ -cylinder radius-2;  $v_0$  is the speed of cylinder-2 at point A;

The following forces are applied to impurities B:  $P=mg$ -force of gravity of the impurities,  $R$ -normal reaction of the impurities,  $F_{mp}$ -sliding friction force of the impurities directed along the tangent  $\tilde{\tau}$  in the direction opposite to the velocity  $v$ - impurities.

Applying the basic law of dynamics together with the law of independence of the action of forces, we have the following equilibrium equation, projected on the  $\tilde{\tau}$  and  $n$  axes:

$$\begin{cases} m\omega_{\tilde{\tau}} = \mathbf{m}g_{\tilde{\tau}} + R_{\tilde{\tau}} + F_{T\tilde{\tau}} \\ m\omega_n = \mathbf{m}g_n + R_n + F_{Tn} \end{cases} \quad (1)$$

Because:  $\omega_{\tilde{\tau}} = \frac{dv_{\tilde{\tau}}}{dt} = \rho\dot{\varphi}^2$ ,  $\mathbf{m}g_{\tilde{\tau}} = mg\sin\varphi$ ,  $R_{\tilde{\tau}} = 0$

$$F_{T\tilde{\tau}} = -F_{TP} - fR, \quad \omega_n = \frac{v^2}{\rho} = \rho\dot{\varphi}^2, \quad \mathbf{m}g_n = mg\cos\varphi, \quad R_n = -R, \quad F_{Tn} = 0,$$

then equations (1) take the form:

$$\begin{cases} m\rho\dot{\varphi}^2 = mg\sin\varphi + fR_{\tilde{\tau}} \\ m\rho\dot{\varphi}^2 = mg\cos\varphi - R + F_{Tn} \end{cases} \quad (2)$$

Excluding  $R$  from system (2), after reducing by mass  $m$ , we obtain:

$$\dot{\varphi}^2 - f\dot{\varphi}^2 = \frac{g}{f}(\sin\varphi - f\cos\varphi) \quad (3)$$



By introducing the notation  $f = tg\alpha$ , where  $\alpha$  - is the friction angle, we write equations (3) in the form:

$$\varphi'' - f\varphi'^2 = \frac{g \sin(\varphi - \alpha)}{f \cos \alpha} \quad (4)$$

To integrate this nonlinear equation, we use the substitution:

$$\varphi'^2 = \varphi \quad (5)$$

where  $\varphi$  is equal to the function  $\varphi_0$  from (5):

$$2\varphi \varphi'' = \frac{d\varphi}{d\varphi} \varphi' \rightarrow \varphi'' = \frac{1}{2} \frac{d\varphi}{d\varphi} \quad (6)$$

$$\frac{d\varphi}{d\varphi} - 2f\varphi = \frac{2g \sin(\varphi - \alpha)}{\rho \cos \alpha} \quad (7)$$

this is a first order linear differential equation with respect to  $\varphi$  with argument  $\varphi$ .

Multiplying the equation (7)  $e^{-2a\varphi}$ , we get:

$$e^{-2f\varphi} \frac{d\varphi}{d\varphi} - 2f\varphi e^{-2f\varphi} = 2 \frac{g \sin(\varphi - \alpha)}{P \cos \alpha} e^{-2f\varphi}$$

$$e^{-2f\varphi} \frac{d\varphi}{d\varphi} - 2f\varphi e^{-2f\varphi} = \frac{d}{df} \varphi e^{-2f\varphi} \quad (8)$$

Let us write equation (8) in the form:

$$d(\varphi e^{-2f\varphi}) = 2 \frac{g \sin(\varphi - \alpha)}{P \cos \alpha} e^{-2f\varphi} d\varphi \quad (9)$$

After integrating (9), taking into account (5), we obtain:

$$\varphi'^2 = -\frac{2g}{\rho(1+4f^2)\cos\alpha} [2f\sin(\varphi - \alpha) + \cos(\varphi - \alpha)] + C_1 e^{2f\varphi} \quad (10)$$

the unknown C is determined from the initial conditions:

$$C_1 = \frac{v_0^2}{\rho} + \frac{2g}{\rho(1+4f^2)} (1 - 2ftg\alpha) \quad (11)$$

Substituting the value of  $C_1$  into equation (10), we find:

$$\varphi' = \sqrt{(v_0^2 + 2gP \frac{1-2f^2}{1+4f^2}) e^{2f\varphi} - \frac{2gP}{1+4f^2} [3f\sin\varphi + (1-2)\cos\varphi]} \quad (11)$$

Here the speed  $v$  is expressed depending on the angle  $\varphi$ , the determining position of the litter.

We find the desired reaction of the R-fiber to impurities from equation (2)



$$R = mg\cos\varphi - m\rho\varphi^2 = mg\cos\varphi - m\rho\frac{v^2}{\rho} = mg\cos\varphi + \frac{m}{\rho}\left[\frac{2gP}{1+4f^2}[3f\sin\varphi + (1-2)\cos\varphi] - \left(\sqrt{v_0^2 + 2gP\frac{1-2f^2}{1+4f^2}}\right)\right]e^{2f\varphi} \quad (12)$$

Using formula (12), one can determine the reaction of the fiber to impurities depending on the angle  $\varphi$ .

### Conclusion:

Thus, from the condition  $R \leq 0$ , the selection zone is determined, as well as the points of contact with the grate.

At present, it is important to improve the efficiency of cotton fiber cleaning. The improvement of the spinning looms does not require a high level of fiber.

1. Separation of defects - large and immature pieces of fiber - is important in fiber cleaning. At the same time, it is important to separate the lumpy fibers, seed pods and fiber bundles and other defects formed during the ginning process. Because such defects reduce the efficiency of the spinning process and negatively affect the quality of the final product.

2. It is possible to conclude based on theoretical studies that improving the blade in fiber cleaning and improving its effect on the fiber will have a great effect.

During the process of ginning, the mixing of impurities into the fiber complicates the process of cleaning the fiber. Therefore, the introduction of active compounds into inactive compounds creates conditions for increasing the cleaning efficiency.

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