ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX COPERNICUS INTERNATIONAL

Volume 9
Issue 4
2024

Google Scholar
Crossref doi
SLIB.UZ Scientific library of Uzbekistan

ANALYSIS OF COTTON FLOW BEHAVIOR IN DIFFERENT PNEUMATIC PIPES

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Abstract: This article presents an analysis of the flow of cotton in different pneumatic pipes in the pneumatic transport system used in the delivery of cotton to the production workshops located in the cotton gin. Despite the fact that many scientific researches have been carried out to improve the components of the pneumatic transport system in the process of transporting cotton by pneumatic transport, researches on the pneumatic pipe and its hermeticity and the friction of the pipe with cotton have not been sufficiently studied in order to ensure the efficiency of the cotton raw material transportation in the air flow. In tube mills, seeded cotton hits the working surfaces and the resulting contact stresses are a major cause of seed and fiber damage. Three types of pneumatic elbows are proposed, namely ellipse, parabola and radial elbows. The analysis of cotton movement on three types of corner section is studied. Therefore, the main goal of the article is to study the analysis of cotton flow in pneumatic pipe..

Keywords: pneumatic transport, device, pneumatic pipe, turning part, transportation process, cotton processing, research, shock impact, quality indicators, polyethylene material, density, porosity, properties.

Introduction. The Republic of Uzbekistan is one of the world's leading producers and exporters of cotton. Therefore, cotton plays an important role in the country's economy [1].

The production of high-quality fiber that meets world standards poses an important task for cotton processing specialists and scientists to improve existing equipment and technology. In turn, the increasing level of improvement of spinning and weaving equipment also requires that great attention be paid to the quality of cotton fiber [2].

Damage to cotton and cotton products occurs when the cotton hits the walls while moving in the air duct. In particular, the areas where most of the damage occurs are at these turning points. In tube mills, seeded cotton hits the working surfaces and the resulting contact stresses are a major cause of seed and fiber damage [3,4].

Also, damage occurs when cotton and cotton products hit the turning part of the 90-degree shafts in cotton gins. In order to reduce this damage, it was proposed to change the geometric shapes of the trees. Three geometric shapes were proposed: parabola, ellipse and radial shapes [5].

Methods. Based on the conducted research, the optimal shape was chosen as a parabola, and the steel material was changed to polyethylene.

The main parameters that determine the conditions for changing the direction of movement in the sections of the cotton ball transportation are the angle of impact on the working surfaces and the impact force. The diagram of the pneumatic pipeline currently used is given [6]. The impact force at the point of impact of the cotton ball P on the working surface (point A) can be divided into normal P_{η} and tangential P_{τ} components. The degree of damage to the seeds hitting the working surfaces of the pneumatic pipeline depends mainly on the value of P_{η}. If we know the force for the impact of the cotton ball P on the surface at an angle of 90°, then we can write as follows

$$\cos\left(\frac{\pi}{2}-\alpha\right)=\frac{P}{P_{\eta}} \tag{1}$$

where: α - the angle of impact of a piece of cotton on the working surface of the pneumatic tube [7]. We express the influence of the angle on the transport conditions α by the coefficient of the network shape K

$$\sin\alpha=\frac{P}{P_{\eta}}=\frac{1}{K} \tag{2}$$

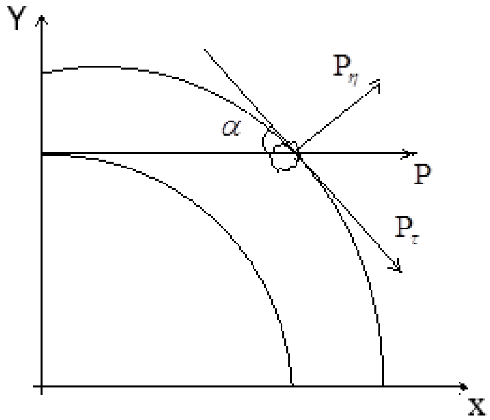

Figure 1. Scheme of the movement of cotton balls in the turning part of a circular pneumotube.

If the turning part of the pneumotube is circular, then we consider the change of the K-angle transport coefficient due to the impact of cotton particles on the tube surface [8]. Using the circular equation, we express the movement of a piece of cotton on the surface of a pneumatic tube along the OY axis.

$$x^2+y^2=R^2 \tag{3}$$

From this equation $y=\sqrt{R^2-x^2}$, we derive the derivative with respect to the variable x and determine the motion of the pneumatic tube as a result of the impact of the turning part at point A.

$$\frac{dy}{dx}=\frac{d(\sqrt{R^2-x^2})}{dx}=-\frac{x}{\sqrt{R^2-x^2}} \tag{4}$$

We determine the expression of dependence on the angle of deflection $\frac{dy}{dx}=tg\alpha$ from in equation (4).

$$tg\alpha=\frac{x}{\sqrt{R^2-x^2}}\Rightarrow\alpha=arctg\left(\frac{x}{\sqrt{R^2-x^2}}\right) \tag{5}$$

Substituting equation (5) into equation (2)

$$K_1=\frac{1}{\sin\left(arctg\left(\frac{x}{\sqrt{R^2-x^2}}\right)\right)} \tag{6}$$

(6) represents the circular motion of the cotton particles in the bend of the pipe using the equation.

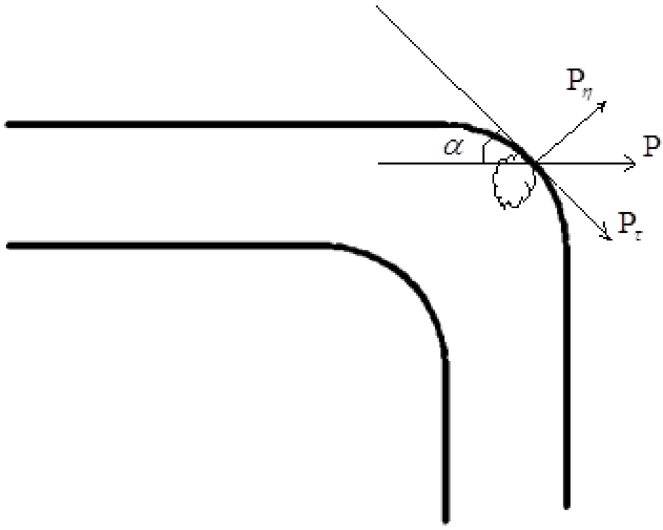

Figure 2. Scheme of movement of cotton particles in the turning part of an elliptical pneumotube

Let's consider the movement of a piece of cotton on the surface of an elliptical pneumatic tube. If the turning part of the pneumotube is elliptical, then we consider the change of the K-angle transport coefficient due to the impact of cotton particles on the tube surface [9]. Using the ellipse equation, we express the movement of a piece of cotton on the surface of a pneumatic tube along the OY axis.

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1 \tag{7}$$

From this equation $y=b^2\cdot\sqrt{1-\frac{x^2}{a^2}}$, we derive the derivative with respect to the variable x and determine the motion of the pneumatic tube as a result of the impact of the turning part at point A.

$$\frac{dy}{dx}=\frac{d(b^2\cdot\sqrt{1-\frac{x^2}{a^2}})}{dx}=-\frac{x\cdot b^2}{a\cdot\sqrt{a^2-x^2}} \tag{8}$$

We determine the expression of dependence on the angle of deflection from $\frac{dy}{dx}=\mathrm{tg}\alpha$ in equation (8).

$$tg\alpha=\frac{x\cdot b^2}{a\cdot\sqrt{a^2-x^2}}\Rightarrow\alpha=arctg(\frac{x\cdot b^2}{a\cdot\sqrt{a^2-x^2}}) \tag{9}$$

Substituting equation (9) into equation (2)

$$K_2 = \frac{1}{\sin(arctg(\frac{x \cdot b^2}{a \cdot \sqrt{a^2 - x^2}}))} \quad (10)$$

Using the equation (10), the effect of cotton particles on the bending part of the pipe is represented by the movement along the ellipse.

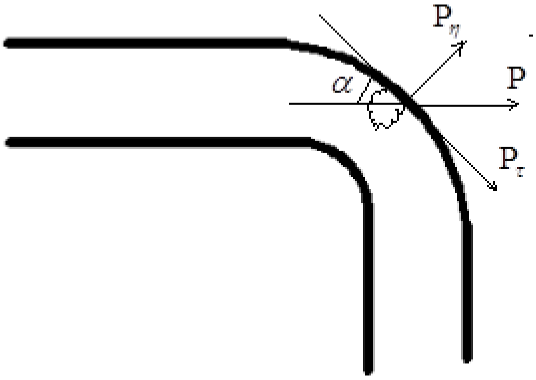

Figure 3. Scheme of the movement of cotton particles in the turning part of a cylindrical pneumatic tube.

Let us consider the motion of a cotton ball on the surface of a parabolic-shaped pneumatic tube. If the turning part of the pneumatic tube is parabolic-shaped, then we will consider the change in the coefficient of the K-angle transport effect as a result of the impact of the cotton ball on the pipe surface. Using the parabolic equation, we express the motion of the cotton ball on the surface of the pneumatic tube along the OY axis [10].

$$y = a \cdot x^2 + b \cdot x + c \quad (11)$$

We determine the motion of the pneumatic tube as a result of the impact of the turning part at point A by taking the derivative with respect to the variable *x*.

$$\frac{dy}{dx} = \frac{d(a \cdot x^2 + b \cdot x + c)}{dx} = 2 \cdot a \cdot x + b \quad (12)$$

We determine the expression $\frac{dy}{dx} = tg\alpha$ for the dependence of the angle on the deflection from in equation (12).

$$tg\alpha = 2 \cdot a \cdot x + b \Rightarrow \alpha = arctg(2 \cdot a \cdot x + b) \quad (13)$$

Substituting equation (13) into equation (2)

$$K_3 = \frac{1}{\sin(arctg(2 \cdot a \cdot x + b))} \quad (14)$$

Using the equation (14), the effect of the cotton particles on the bend of the pipe is represented by the movement along the sphere.

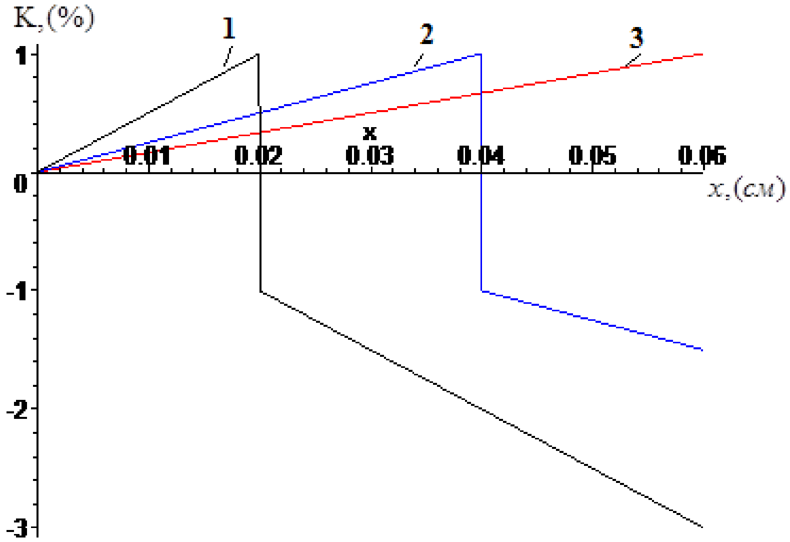

Figure 4. Graph of the dependence of the angular movement of a piece of cotton in a pneumatic tube on the corner transport coefficient.

1 - circle, 2 - ellipse, 3 – parabola

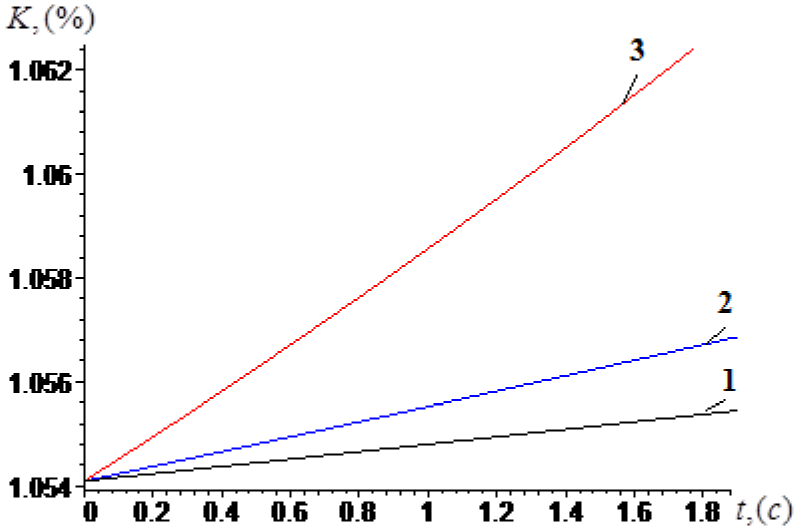

Figure 5. Time dependence of the rotational motion of a cotton ball in a pneumatic tube at different values of the surface impact angle

1-circle, 2-ellipse, 3-parabola

Results. As a result of the theoretical research carried out, the parabolic shape of the pneumatic outlet was chosen. Based on the results of theoretical studies, the design of a parabolic pneumatic vent was developed. Further, according to the design, a parabolic pneumatic drain was developed, which significantly reduces the damage to seeds and fibers. And this, in turn, affects the economic efficiency of the cotton gin plant. The design of the pneumatic actuator is shown in Fig.6.

Figure 6. Proposed parabolic elbow view

A material selection has now been made to create an elbow that minimizes seed damage in the pneumatic transporter.

Discussion. The test work of the scientific research work was carried out with the new polyethylene pipe shell installed in the installed pneumatic transport system and the results were obtained. During the initial tests, there were no interruptions or interruptions in the processes during the operation of the new pipe shells, they worked with a productivity of 4800 tons during each experiment, there were no blockages in the pipe, and the work process was carried out without stopping [12].

Testing of pneumatic pipe shells in production conditions was carried out based on the developed methodology. The experimental test work was carried out on cotton raw materials of the Bukhara-102 selection II grade 2 class, with impurities up to 12-16%, humidity 10-14%, at an air flow speed of 22-26 m/sec.

Figure 7. Improved pneumatic tube shell

The new pneumatic tube shell has been shown to significantly reduce cotton seed damage in the air stream during cotton transportation.

Conclusions/recommendations. Theoretical studies have shown the possibility of choosing a rational value of the grid using the shape coefficient, which provides small angles of impact of cotton slivers with the surface of the pneumatic pipe. This allows you to maintain the quality of the transported cotton slivers and seeds. For this, the parabolic shape is the best shape. In order to analyze the compactness and technological feasibility of the design when assembling the pipeline and manufacturing a parabolic grid, the dimensions of the radial grids were compared. The graph of the dependence of the shape coefficient of the parabolic grid on the parabolic parameters was determined using the Maple program, the K-coefficient increases, which allows you to maintain the quality of the cotton slivers at high speeds of transportation.

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C O N T E N T S

PRIMARY PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY