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MODELING THE PROCESS OF SEPARATING FIBER PARTICLES FROM THE MIXTURE UNDER THE ACTION OF A SCRAPER ON THE SURFACE OF A GRID CYLINDRIC

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Abstract. This article develops a mathematical model of the process of separating fiber particles from the mixture using scraper action on a cylindrical mesh surface. During the process, the laws of motion of fiber particles, the geometric parameters of the cylinder surface, and the impact forces of the scraper were analyzed. As a result of modeling, the main factors affecting separation efficiency were identified, and the possibilities for optimizing technological parameters were evaluated. The results obtained will serve to improve the processes of sorting and cleaning fibers in the textile industry.

Key words: mixture, fiber particles, mesh cylinder, scraper, mathematical model, separation process, fiber sorting, technological parameters.

In practice, it has been observed that partial fiber fragments can penetrate into the second part of the chamber during the application process. In this regard, let us examine the movement of fiber and air particles in the second part. The geometric view of the mixture of air and fibrous mass at the outlet in a chamber with a variable cross-section is shown in Fig. 1.

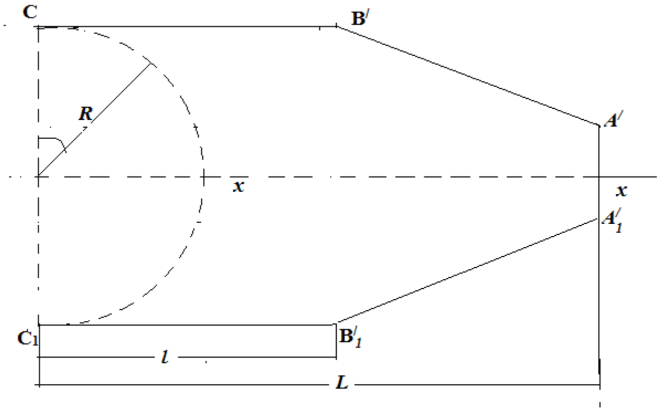

Figure 1. Geometry of the section surface of the second part of the chamber

Based on the results of the above conclusion, we assume that the air and fiber velocities remain constant throughout the interval. Let us consider a case where the mixture components interact with the mesh surface, forming a flow of only the air component from the surface, while the fiber component is completely retained on the surface. According to the law of conservation of mass, the following equality can be written:

(1)

where: - the surface area of the mesh through which the air flow in the mixture passes;
, is the density and velocity of the air component on the surface.
Determine from dependence (2).

(2)

Assuming the area of the mesh surface, this ratio determines the share of the airflow in the permeable mesh surface.

(3)

In the calculation, along with the above values, the graphs and the following relationship are used when . We get the following result.

In the case of interaction of the mixture with the mesh surface, we calculate the thickness of the fiber on its surface under the condition that the fiber is completely retained. The mass of fiber accumulated on the surface during the scraper's movement is calculated using the following integral.

(4)

where: - is the fiber thickness over the time interval of the scraper on the surface (the angular velocity of the scraper), which we determine using this relationship.

(5)

here: - is a constant coefficient that needs to be determined.

Using the expression for the above formula and the dependence, we obtain the following formula for calculating the fiber mass.

(6)

On the other hand, for a stationary flow, the mass of the fiber accumulating on the mesh surface over time is equal to . By equating the two masses, we obtain the following formula to determine the coefficient.

(7)

Figure 2 shows graphs of the change in fiber thickness at various angles.

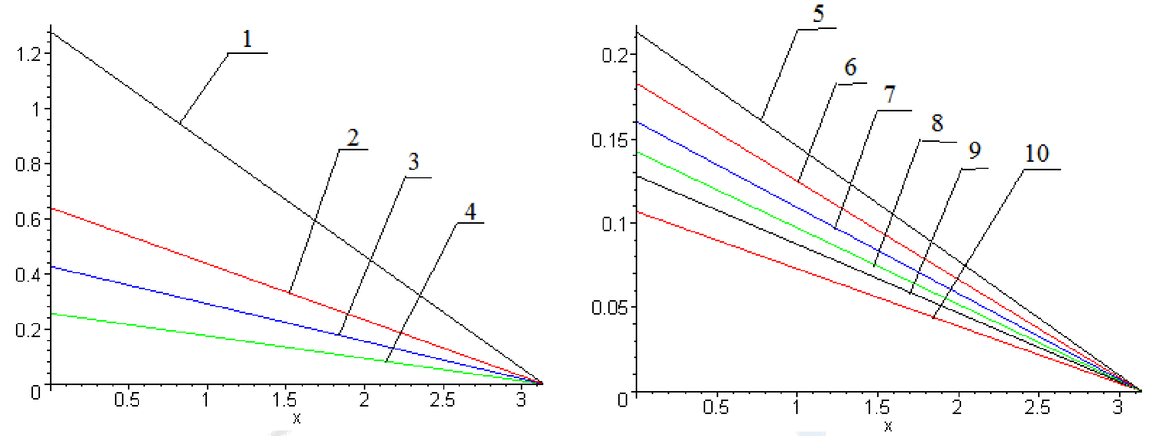

Fig. 2 Graphs of the angular change in the fiber thickness accumulated on the mesh surface at various angular speed of the scraper.

As seen from the graph, at an angular speed of 10 $^{s-1,}$ the thickness of fibrous waste accumulated on the mesh surface exceeds 1.2 mm; at an angular speed of 20 $^{s-1,}$ the thickness of fibrous waste accumulated on the mesh surface is 0.65 mm with a sharp decrease; at an angular speed of 30 $^{s-1,}$ the thickness of fibrous waste accumulated on the mesh surface is 0.41 mm with a sharp decrease; at an angular speed of 50 $^{s-1,}$ the thickness of fibrous waste accumulated on the mesh surface is 0.28 mm with a sharp decrease; at an angular speed of 60 $^{s-1,}$ the thickness of fibrous waste accumulated on the mesh surface is 0.21 mm with a sharp decrease; at an angular speed of 70

In conclusion, it can be said that taking the fiber thickness into account, it is necessary to have a fiber thickness of 3-4 in order to prevent the mesh surface holes from getting clogged. This requires a minimum sweeper angular velocity of 60^{-1}. If it is less than that, the surface of the holes will be covered.

In order to determine the reduction of fibrous waste passing through the mesh surface, a model of the movement of the chamber's outlet porosity, air, and fiber was developed.

We place the origin on the end section of the camera and direct the axis along the central line of the camera. Let us assume that the cross-section of the chamber changes according to the law, and we shall denote the motion parameters in any of its sections as: air velocity (index 0), and fiber particle velocity (index 1). Suppose that a mass moving in the section of the chamber is influenced by an airflow with velocity v.

For the stationary motion of a two-component medium across the chamber to be justified, the law of conservation of mass must be satisfied in each of its sections. Therefore, this equality holds true for the exit of the medium from the chamber.

(8)

Based on the results obtained in practice using the equations obtained in the first part of the chamber, we obtain the graphs shown in Figure 3 based on the calculation of the movement of porous air and fibrous mass on the "Maple-8" electronic machine.

$m_0 = 0{,}8$ $m_0 = 0{,}9$

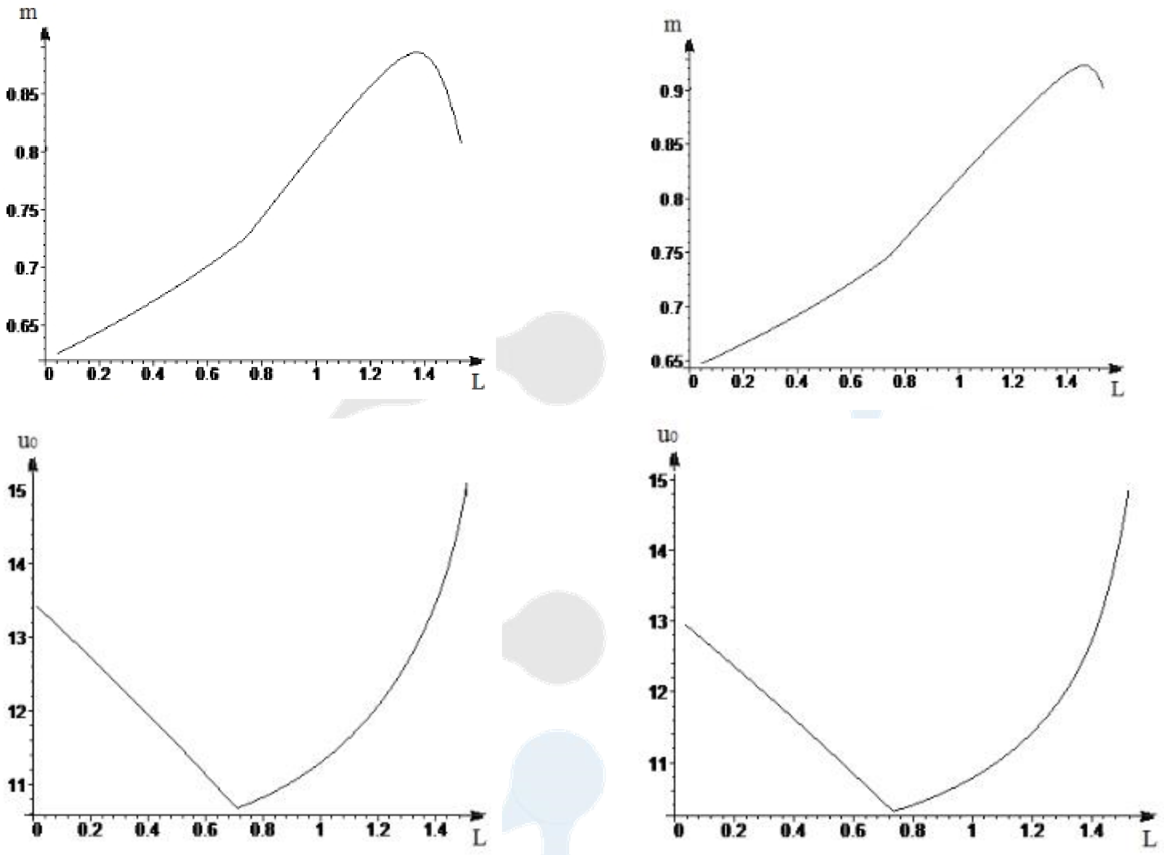

Figure 3. Graphs of changes in the initial porosity of the mixture, air, and fiber components in the chamber and gaps along the chamber axis in two sections.

From the analysis of the graphs, the following conclusions can be drawn. Since the velocity of the fiber component at the end of the third stage of the chamber is very small (), and taking into account the compression of the chamber, it is observed that the porosity increases linearly without changing. After passing through the mesh surface, the air flow velocity decreases linearly in the interval from 13.5 m/s to 11.6 m/s, and after a sharp increase in the distance, the air velocity in the inlet pipe increases to 15 m/s. Due to a sharp decrease in the concentration of the fibrous mixture passing through the mesh surface, the fiber velocity before the mesh surface was 0.0002 m/s, but after the mesh surface, it decreased to 0.0022 m/s, which shows that 90% of the fibrous mass cannot pass through the holes of the mesh surface.

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