Таблица 1 – Результаты расчёта радиаторов с разным шагом секций

	Шаг 35 мм	Шаг 40 мм	Шаг 45 мм	Шаг 50 мм
Площадь радиатора, м^2	1,208	1,222	1,236	1,250
Средняя температура по поверхности, °С	87,280	87,132	87,083	86,971
Максимальная температура, °С	90,853	90,885	90,880	90,870
Минимальная температура, °С	81,611	80,997	80,892	78,873
Усреднённый тепловой поток через площадь поверхности радиатора, Вт	1153,369	1164,963	1177,629	1189,418

Таким образом были смоделированы реальные радиаторы, выявлены различия в тепловых характеристиках в зависимости от геометрических размеров устройств, при этом не воспроизводя каждый радиатор в реальности. Что, несомненно, является экономией материалов, косвенно – экономией топливных ресурсов, затрачиваемых на приведение в работу печей и станков. Поэтому программный подход моделирования является перспективным направлением во многих отраслях промышленности.

Список использованных источников

1. Программное обеспечение COMSOL Multiphysics. [Электронный ресурс]. – Режим доступа: https://www.comsol.ru/
2. Официальный сайт ООО «КЗТО Радиатор». [Электронный ресурс]. – Режим доступа: https://kztoradiator.ru/radiatory/

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THE PROBLEM OF CALCULATING THE PRESSURE LOSS IN THE PNEUMATIC TRANSPORT PIPE

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Abstract. *In the article, the initial collisional resistance of cotton during the transportation of cotton by air pipeline was studied. Mainly, the types of air nozzles, the speed of air and cotton in it, the resistance and the areas of damage to seed cotton were analyzed. Based on the analytical results, appropriate conclusions were drawn.*

Kev words: Air pipe, cotton initial contact area, air pipe mouth, air and cotton velocity, resistance, pressure, lemniscate, trumpet-shaped pipe.

As we know, pneumatic transport is widely used in cotton processing plants and cotton transportation. This process has several advantages over mechanical transportation of cotton: reduction of transportation time, less damage to seed and fiber, cleaning of large and small impurities [1, 2, 3, 4].

When transporting cotton by pneumatic transport, pipes with a diameter of 400 mm to 450 mm are selected. It depends on the transportation distance of the cotton. The length of the pipeline in the territory of the cotton gin can reach 200–250 meters. The pneumatic transportation device consists of movable pipes of variable length with a diameter of 400 mm, a dust collector, fixed pipes of a fixed length with a diameter of 450 mm, a separator, a centrifugal fan and a device for purifying atmospheric waste [1, 2, 3, 4].

Air transport is an efficient method of transporting cotton in primary cotton processing plants, mainly to ginning shops. As the mixture of cotton and air moves, it rubs against the walls of the pneumatic tube and loses some pressure. When the air itself passes through the pipe due to friction, the loss of pressure per meter of length h is found by the following formula:

$$h = \lambda \frac{L}{D} \cdot \frac{\rho}{2} \upsilon^2 \qquad (1)$$

where λ is the coefficient of friction; L – the length of the air pipe, m; D – pipe diameter, m; ρ – air density in the pipe, kg/m^3; υ – air speed, m/s;

The friction coefficient depends on the unevenness of the pipe wall [7, 8, 9]. This coefficient is the Shiferson formula

$$\lambda = 0{,}111\left(\frac{a}{D}\right)^{0.25} \qquad (2)$$

We can see in table 1 in different sizes of the pipe diameter when calculated with:

Table 1

Pipe diameter, mm	**Friction coefficient**	
	In the new pipeline	**In the working pipe**
	0,133	**0,044**
400	0,014989	0,011368
350	0,015498	0,011754
320	0,015849	0,01202
300	0,016107	0,012215
280	0,016387	0,012428

As can be seen from these data, as a result of the use of pneumatic transport pipes, the coefficient of friction decreases. For comparison, we can also see from the following image:

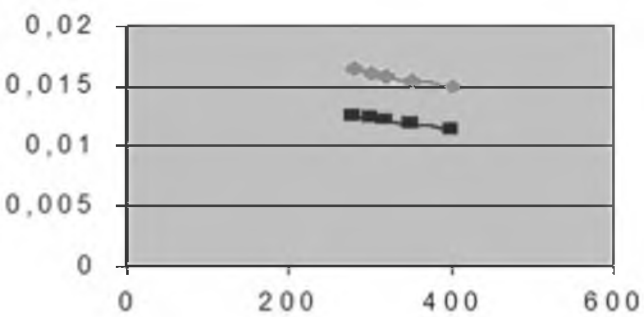

Figure 1 – Indicators of the coefficient of friction in new and used pipes

The ratio of the amount of pressure lost in the pneumatic transport of a mixture of air and cotton to the amount of pressure lost when fresh air passes through this pipe, the relative decrease in pressure is determined as follows [7, 8, 9, 10]:

$$\Pi = \frac{h_{cu}}{h} = 1 + \mu\, tg\alpha \qquad (3)$$

where $tg\alpha$ is a function of decreasing air velocity in the pipe.

This value is for seed cotton with 10 % moisture content. where: $tg\alpha = 11000 / \upsilon^3$ – weight concentration of the mixture; $h_{cu} = \left(1 + \mu \cdot \frac{11000}{\upsilon^3}\right)\lambda \frac{L}{D}\frac{\upsilon^2}{2}\rho$ – the weight of the $\mu = G_M / G$ material transported per unit G_M of time (kg/s) and the weight of air consumed at the same time (kg/s).

The total pressure lost by friction in a straight pipe is determined by

$$h_{cu} = \left(1 + \mu \cdot \frac{11000}{\upsilon^3}\right)\lambda \frac{L}{D}\frac{\upsilon^2}{2}\rho + (1+\mu)\rho g H \qquad (4)$$

Loss of pressure during the transfer of cotton to the pneumatic transport pipe and at the entrance to it, part of the pressure is spent to give enough speed to suck the cotton, and another part is spent to overcome the resistance of the pipe mouth. The amount of this loss is determined as follows:

$$h_м = \frac{\rho}{2}\upsilon^2 + \frac{\rho_м}{2}\upsilon_м^2 \tag{5}$$

The speed of the cotton in the pipe is less than $\upsilon_м$ the speed of the air υ. If we use the $\upsilon^2_м = (\psi\upsilon)^2$ expression: $h_{эм} = (1 + \psi^2\mu)\frac{\rho}{2}\upsilon^2$, here ψ is the coefficient used when seeded cotton is mixed with air, based on the information of TsNIIX prom, the value of ψ is taken from 0.5 to 0.7 depending on the size of the cotton pieces being transferred [9, 10].

When transferring cotton to a pipe, the resistance varies depending on the shape of the pipe end. In this case, the total pressure loss is expressed by the following formula:

$$h_{эм} = (1 + \xi + \psi^2\mu)\frac{\rho}{2}\upsilon^2 \tag{6}$$

where ξ is the coefficient of resistance of the end of the pipe to the introduction of air mixture with cotton. Usually, in cotton mills, the end of the pipe is in the form of a simple circle, that is, $\xi = 1$. The value of ξ is small when the tip of the pipe is a truncated cone or lemniscate.

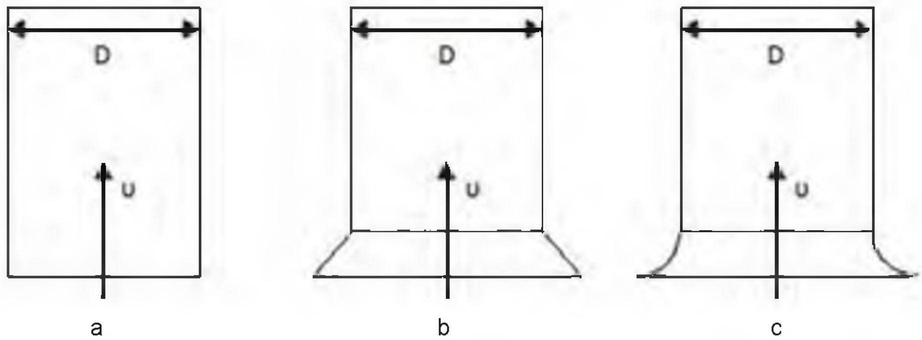

Figure 2 – Types of inlets of pneumatic pipelines: a – in a simple form, b – in the form of a truncated cone, c – in the form of a lemniscate

If we replace formula (6) above exactly,

$$\xi = \frac{h_{эм}}{\rho\upsilon^2} - 2(\psi^2\mu + 1) \tag{7}$$

We can see the resistance coefficient as a result of calculations with this formula in Table 2.

Table – 2

Pipe diameter, mm	**Resistance coefficients of different shapes of the pipe end, ξ**		
	A simple pipe	**A truncated cone-shaped pipe**	**Lemniscate-shaped pipe**
400	1	0,15	0,08
350	1,1	0,17	0,1
320	1,15	0,18	0,11
300	1,2	0,19	0,12
280	1,25	0,2	0,13

In some places of pneumatic transport pipes, there are bends, where pressure loss occurs. These pipe sections, called shells, are usually used at an angle of 90°. In order to reduce the pressure loss coefficient in this right-angled bend, it is recommended to make the ratio of the bending radius R to the pipe diameter D as $R : D = 6$. The pressure loss in the shells is determined by determining the coefficient of friction of the pipe with the following formula:

$$\xi = \frac{h_K}{\frac{\rho}{2}\upsilon^2} \quad (8)$$

When the air itself moves, the resistance in the shells is determined by the following formula:

$$\xi = \frac{\delta}{\pi}\left(\frac{D}{R} + \lambda\frac{R}{D}\right) \quad (9)$$

where δ is the angle of inclination of the shell, λ is the coefficient of resistance

To calculate the diameter of the pnvmatransport pipeline conditionally $D = 1$ unit and the bending angle $R = 6$ (in the ratio $R : D = 6$),

1. For the case where $\delta = \pi / 2$ and $\lambda = 1$, $\xi = 3\frac{1}{2}$
2. For the case where $\delta = \pi / 2$ and $\lambda = 1{,}1$, $\xi = 3\frac{23}{60}$
3. For the case where $\delta = \pi / 2$ and $\lambda = 1{,}15$, $\xi = 3\frac{8}{15}$
4. For the case where $\delta = \pi / 2$ and $\lambda = 1{,}2$, $\xi = 3\frac{41}{60}$
5. For the case where $\delta = \pi / 2$ and $\lambda = 1{,}25$, $\xi = 3\frac{5}{6}$.

Let's do the calculations for an angle greater than a right-angled tilt angle.

In this case, when the bending moment is $\delta = \pi / 4$, we have the following values

1. For the case where $\delta = \pi/ 4$ and $\lambda = 1$, $\xi = 1\frac{13}{24}$
2. For the case where $\delta = \pi / 4$ and $\lambda = 1{,}1$, $\xi = 1\frac{9}{13}$
3. For the case where $\delta = \pi / 4$ and $\lambda = 1{,}15$, $\xi = 1\frac{23}{30}$
4. For the case where $\delta = \pi / 4$ and $\lambda = 1{,}2$, $\xi = 1\frac{16}{19}$
5. For the case where $\delta = \pi / 4$ and $\lambda = 1{,}25$, $\xi = 1\frac{11}{12}$

From these values, we can conclude that the smaller the angle of inclination of the shells, the less the pressure loss. We have a choice in reducing the overall damage rate of seed cotton. Depending on the length of the system and the number of turns, it is determined what the shape of the pipe inlet, the number of shells and the angle of inclination will be. As a result, the degree of damage to seed cotton that has passed through the system will be minimal.

Reference

1. Sarimsakov, O. Sh., Muradov, R., Mardanov, B. Study of the process of supply and movement of cotton particles in the pipeline of pneumatic transport. – Dep. UzNIINTI, No. 1743 Uz. 1992.
2. Sarimsakov, O. Sh., Muradov, R. Improving the process of supplying cotton to pneumatic transport. // Zh. Cotton industry, No. 3, 1992. – S. 110–112.
3. Марданов, Б., Мурадов, Р., Саримсаков, О. Ш. О работе узла разравнивания питателя. Деп в УзНИИНТИ. 1992, № 1746-Уз.
4. Muradov, R., Sarimsakov, O. Sh. On the loss of pressure for the acceleration of particles in the process of pneumatic transport – Dep in UzNIINTI, 1992. No. 1745 – Uz.
5. Sarimsakov, O. Sh., Muradov, R., Kadirkhodzhaev, S. Kh., Saidakhmedov S. Mobile pneumatic feeder. // A.S. No. 1694727. Bull. No. 44 – 1991.
6. Burkhanov, A. Improving the working elements of the pneumatic conveying system in order to preserve the natural properties of processed cotton seedlings. Diss. 1987.
7. Handbook of primary processing of cotton. Under the general editorship of Professor Maksudov I.T. «Cotton industry». 1994.
8. G.I. Miroshnichenko. On some physical and mechanical properties of raw cotton. Diss. candidate of technical sciences – Tashkent, 1956.
9. Жабборов, Ғ.Ж., Отаметов, Т.У., Хамидов, А. Чигитли пахтани қайта ишлаш технологияси. Тошкент. "Ўқитувчи". 1987.
10. Muradov, R. Fundamentals of improving the efficiency of the air-borne cotton transporter. «Science». Tashkent-2014.