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**EXPERIMENTAL STUDY OF INFLUENCE OF AIR FLOW  
OF ROTARY SPINNING MACHINE CONFUSER ON FIBER MOVEMENT**

**ЭКСПЕРИМЕНТАЛЬНОЕ ИССЛЕДОВАНИЕ ВЛИЯНИЯ  
ВОЗДУШНОГО ПОТОКА КОНФУЗОРА ПНЕВМОПРЯДИЛЬНОЙ  
МАШИНЫ НА ДВИЖЕНИЕ ВОЛОКОН**

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*This article presents information on an experimental study of the effect of different air blowing speeds on the movement of fibers in the transport channel of a rotor spinning machine. The experimental studies were conducted at different air blowing speeds  $v=10$  m/s,  $v=20$  m/s,  $v=30$  m/s and different values of the number of*

*fibers in the confuser channel. It was found that with an increase in the number of fibers and, accordingly, the coefficient of their concentration  $\mu$ , the influence of fibers on the air flow increases, and a flow line is formed in it. When the number of fibers in the transport channel is more than 30, an increase in the interaction of fibers is observed, leading to the occurrence of a compression effect. It follows that the optimal number of fibers transported in the channel should be  $n \leq 30$ .*

*В данной статье приведены сведения по экспериментальному исследованию влияния различных скоростей обдува воздуха на движение волокон в транспортном канале пневмомеханической прядильной машины. Экспериментальные исследования проводились при различных скоростях обдува воздуха  $v=10$  м/с,  $v=20$  м/с,  $v=30$  м/с и разных значениях количества волокон в канале конфузора. Установлено, что с увеличением количества волокон и соответственно коэффициента их концентрации  $\mu$  увеличивается влияние волокон на воздушный поток, происходит формирование в нем линии потока. При количестве волокон в транспортном канале более 30 наблюдается увеличение взаимодействия волокон, приводящее к возникновению эффекта сжатия. Отсюда следует, что оптимальное количество волокон, транспортируемых в канале, должно быть  $n \leq 30$ .*

**Ключевые слова:** воздушный поток, волокно, транспортный канал, пряжа пневмомеханического прядения.

**Keywords:** airflow, fiber, transportation channel, pneumomechanical spun yarn.

Scientific research is being conducted around the world to achieve high efficiency of yarn production, to develop new scientific and technical solutions for modern advanced technological machines. In this area, among other things, priority research is being conducted to create new methods that ensure high efficiency of technological processes for obtaining yarn on pneumatic spinning machines, to improve confuser and intensifier twisting devices that affect the technological properties of yarn, to develop operating parameters and modes. At the same time, one of the important tasks is to conduct targeted scientific research in such areas as a fundamental change in the quality indicators of yarn in the textile industry and to obtain yarn with competitive indicators. Justification of the technological process of production, parameters and modes of operation is considered one of the urgent tasks.

The first generation of rotor spinning machines increased the productivity of existing spinning machines by 2-3 times, and by now it has increased several times [1]. At

the same time, the appearance of the finished yarn is also improving. However, the structure and properties of rotor-spun yarn are significantly different from those of ring-spun yarn.

In the studies of Kulikova Z.I. and Barilla A. [2] the relative strength of rotor spun yarn was 15-20% lower than that of ring spun yarn. In this case it was found that the yarn strength was reduced and the fabric strength was reduced in this ratio [3]. Lord [4] argued that to produce open end yarn it is necessary to use very high elongation so that the fiber flow is reduced to a few fibers in the cross section. The study of Arain et al. [5] showed that yarn strength increases with increasing rotor speed, yarn twist and linear density. As noted by Furter [6], yarn elongation is inversely proportional to linear density. Ahmed et al. [7] considered the effect of rotor speed and thread count on the properties of rotor spun yarns, while rotor speed, twist and thread count were considered by Arain et al. [5]. Many researchers have considered rotor speed, opening roller speed, rotor diameter and combing condi-

tions, but all of them have considered at least one value or at most three factors simultaneously [8, 9]. The elongation at break of yarn produced on rotor spinning machines is 1.5-2% higher than that of yarn produced on ring spinning machines.

Rotor spinning is the most suitable and successful spinning process among many open spinning methods [10]. The principle of open spinning for the high rate of yarn production is not only acceptable by using low and medium-grade cotton but also with relatively lower cost than other existing spinning technologies [11]. Cotton yarns produced by rotor spinning are uniform, fuller, and stronger [12]. In recent years, the production volume of rotor spinning has increased [13]. Currently, the rotor spinning system is being promoted due to a significant reduction in space and other personnel [14]. The low unevenness index is considered to be a positive effect of spinning parameters on yarn properties [15]. The properties of rotor-spun yarn are affected by various factors related to raw material, machine parameters, and processing parameters. Many researchers have studied the effect of these parameters on yarn quality from different perspectives [10-15].

The importance of air confuser is also important in the formation of yarns, which affects the standard supply of fibers, linear density, and unevenness indicators. Therefore, one of the most important tasks in this process is to keep the air pressure directed to the confuser at the same level. From the above analysis, it can be seen that management of factors affecting the quality of rotor-spun yarn, stabilization of processes, and adjustment of devices affect not only the spinning process but also the subsequent technological processes. Also, the analysis shows that the geometrical structure of the confuser and the speed of the air entering it is one of the main factors affecting the yarn quality.

It is known that the fibers separated by combing with the opening roller leave it in a tangential direction and go to the transporting channel with the airflow and through it reach the spinning chamber, where the fibers are

combined to form a thin sliver and turn it into yarn. The movement of separated fibers in the conveyor channel of the rotor spinning machine plays an important role in the satisfactory passage of the specified technological process, and the concentration of fibers in it has not been sufficiently studied until now [16, 17].

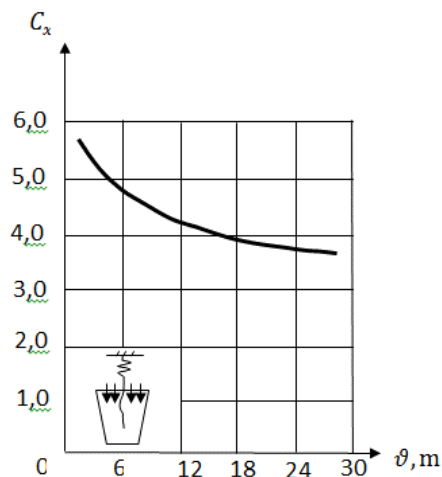


Fig. 1

Their concentration coefficient should be in the range of  $\mu=0.25\div0.55$  during the transportation of fiber products to machines for preparation, beating, and carding, as well as cotton raw materials in cotton ginning plants.

To avoid entanglement of fibers due to adhesion and tortuosity, and thus to prevent yarn quality indicators from decreasing, the fiber concentration coefficient in the transport channels of rotor spinning machines should be much lower. For example, in [18], the concentration coefficient was  $\mu=0.005$  and  $\mu=0.02$ , respectively, in the production of cotton yarns with a linear density of  $T=25\text{ tex}$  and  $T=58.8\text{ tex}$ .

In addition, it was determined that the minimum concentration coefficient in the transport channel of the rotor spinning machine should be at least  $\mu=0.0008$  [17].

The shape of the transport channel plays a decisive role in the direction of the fibers in the transport channel and the passage of air through it. All manufacturers of rotor-spinning machines use conical-cylindrical transport channels. The same channels are

used for yarn production in our improved Autocoro 9 rotor spinning machine.

The purpose of the next experiment is to determine the maximum possible number of fibers in the transport channel of a rotor spinning machine, their increase led to an increase in the allowed concentration coefficient  $\mu$  in the channel section. In addition, when the fibers swelled, their oscillating wave-like behavior was observed, which was even visually observed at high flow rates, which can lead to the entanglement of fibers moving in adjacent flow lines. This phenomenon is obvious because increasing the fiber concentration coefficient  $\mu$  increases the probability of turbulent flows in the boundary layers of fibers.

The experiment was carried out as follows. To blow rectangular fibers, a fiber was placed in the channel and blown at a certain air velocity, and the deformation of the viscoelastic element was obtained. The air velocity was gradually increased to the value  $v=30\text{ m/s}$ , and the deformation indicators of the viscoelastic element were regularly taken. To increase the pressure, several dozen fibers were hung in turn on a sensitive viscoelastic element, and the "compression effect", that is, their interaction, or the overall effect on the airflow, was studied. In our opinion, if the pressure increases linearly with the increase in the number of fibers in the blowing channel, that is, there is no compression effect proportional to the number of fibers.

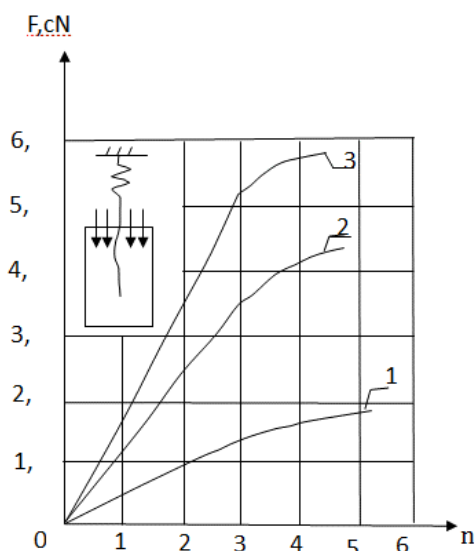


Fig. 2

Figure 2 shows the influence of the number of cotton fibers on the deformation of the viscoelastic element for blowing in a rectangular channel at different flow rates from  $v=10\text{ m/s}$  to  $v=30\text{ m/s}$ . Blowing cotton fiber at a speed of  $v=10\text{ m/s}$  showed that if the number of fibers in the blowing channel increases to  $n=30$  pieces, the change in pressure has a linear character, and a further increase in the number of fibers from  $n=30$  to  $n=60$  leads to the curvilinear dependence. Experiments were repeated at air speeds  $v=20\text{ m/s}$  and  $v=30\text{ m/s}$ .

The same phenomena were observed when repeating the experiments at the flow speed  $v=30\text{ m/s}$  (3 curves, Fig. 2). This phenomenon is explained by the fact that the number of fibers in the channel has little effect on the airflow, that is, the flow rate changes only slightly, which is explained by a straight line relationship up to the number of fibers  $n=30$ . Increasing the number of fibers leads to a decrease in the flow rate, that is, the deformation of the sensitive element changes slightly, and it falls, which is visible in the nonlinear fields of curves 1-3 shown in Fig. 2.

Studying the dependence of the number of fibers of airflow blown in conical (narrowing) channels from the data analysis of the experiments, shown in Figure 2, it can be seen that in all speed ranges ( $v=10\text{ m/s}$ ;  $v=20\text{ m/s}$ ;  $v=30\text{ m/s}$ ) the force of pulling the fiber with air (that is, the deformation of the sensitive viscoelastic element) has a linear character, the number of fibers in the channel (shown in Fig. 2) according to a similar relationship  $n \leq 30$ .

Since the airflow velocity in the narrowing channel gradually increases towards the outlet of the channel, it is desirable to keep the front end of the fibers in a taut position and partially straighten the fibers during transportation, further increasing the number of fibers will cause the linear curve to change. The increase in drag force is explained by the orderly effect of flow lines in the narrowing channel, and the difference in pressure changes of  $\Delta R_s$  in rectangular and narrowing channels (Fig. 3).

In cases where the flow velocity in the channels reached  $v=20\text{ m/s}$  and  $v=30\text{ m/s}$ , it was found that the curves (up to the number

of fibers  $n \leq 30$ ) had a linear character, when more than  $n \geq 30$  their linearity was broken (curves 1, 2, 3, Fig. 3).

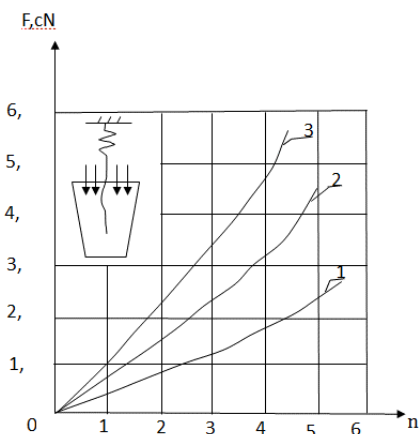


Fig. 3

## CONCLUSION

Rotor spinning machines differ in performance, number of chambers, quality control devices, and winding mechanisms, and they produce smooth, highly elastic yarns. However, the pneumomechanical yarn has a twist unevenness, and yarn strength that is less than the yarn spun by ring method is its disadvantage.

Analyzing the obtained results, it can be said that with the increase in the number of fibers and, accordingly, their concentration coefficient  $\mu$ , the influence of fibers on the airflow and the formation of a flow line in it increases. But it is known that under the influence of the airflow, the fibers vibrate at a high blowing speed (wave, longitudinal vibrations), and then, as a result of the interaction of the adjacent fibers, the last fibers can become entangled, or with each other it can stick because it is flexible.

It follows that the optimal number of fibers transported in the channel (the maximum allowed number of fibers) should be  $n \leq 30$ . Otherwise, the phenomenon of "compression effect" may be observed. The non-linear areas of the curves presented in Figures 2 and 3 show that the influence of the fibers on the flow and their general interaction increases in this space.

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