

THEORETICAL AND MATHEMATICAL MODULE OF THE FIBER PROCESSING PROCESS IN MEASURING THE QUALITY INDICATORS OF COTTON FIBER USING A UNIVERSAL DEVICE

Axmedov A, Djunayeva L.A., Mannopov B.A

Axmedov Akmal- scientific consultant

Djunayeva Lola Anvarovna- Head of Laboratory.

Mannopov Bexzod Abdumalikovich - Head of Laboratory

Scientific-Research Institute of Fiber Crops

Abstract: In the article, a universal device is used to determine the fiber micronizer index using the fiber cross-sectional area and diameter. In determining the fiber micronizer index, the wavelength and chamber size are mainly important. One of the most important conditions is the use of low-frequency waves. Also, the microcontroller inside the device automatically controls the data obtained from the temperature indicator.

Key words: cotton fiber, micronaire indicator, ripeness coefficient, sound propagation, phase speed, fiber layer

The micronair value is a comprehensive indicator reflecting the linear density and maturity of cotton fibers. It is one of the important intrinsic indicators of cotton fiber quality, closely related to the consumption cost of cotton fibers. Intrinsic quality attributes of cotton fiber mainly include fiber length, fiber linear density, fiber strength, and fiber maturity.

The micronair score and maturity ratio can provide an accurate basis for the distribution of cotton in textile mills to ensure optimal use of cotton. Splitting and applying according to the micronair cost index can improve and stabilize the quality of gauze. The microneira value indicator is in the test, the operation of the device is simple, and the data is clear, convincing.

Micronair depends on the quality of the yarn and the spinning process. When determining cotton grades, the addition of the micronair indicator can reduce the

quality of disputes between buyers and sellers and can effectively prevent the phenomenon of secondary charging.

The measurement accuracy of the universal device directly depends on the value of the sound speed ϑ , which is determined by the frequency of the sound and the change in the phase velocity in the fiber layer. When remotely studying the fiber maturation, the sound speed $\vartheta=340\text{m/s}$, the following parameters are important for the device to give accurate results under standard conditions. Room temperature $t=20^\circ\text{C}$, relative humidity 65%, sound speed $\vartheta =343\text{m/s}$. If the temperature increases, the sound speed increases according to the following formula:

$$\vartheta = 331,5 \sqrt{1 + \frac{t}{273,15}} \quad (1)$$

The microcontroller inside the device also automatically controls the data received from the temperature indicator.

The wavelength and chamber size are mainly important in determining the microneural index of the fibers. One of the most important conditions is the use of low-frequency waves.

Sound propagation and spatial velocity in cotton fiber. The speed of sound propagation inside cotton fiber (space velocity ϑ_p) is slower than in open air [1].

$$\vartheta_p = \frac{c_0}{\sqrt{a_\infty}} \quad (2)$$

Here: c_0 - speed of sound in free air (m/s), a_∞ - the coefficient of friction of fibers.

We determine the microneural index of fibers depending on the frequency of sound and the propagation speed as follows:

$$\vartheta_p = \frac{\omega}{k} \quad (3)$$

Here: ω -angular frequency (rad/s), k -wave number (1/m) Angular frequency

$$\omega = 2\pi\nu \quad (4)$$

using the fact that we put equation (4) into equation (3) and calculate:

$$\vartheta_p = \frac{2\pi\nu}{k}$$

(5)

In most cases, the wave number in fibrous porous media is expressed as follows.

$$k^2 = \frac{\rho}{\mu} \omega^2 \quad (6)$$

Where: ρ -fiber density μ - fiber compression coefficient. Therefore, the phase velocity

$$\vartheta_p = \sqrt{\frac{\mu}{\rho}} \quad (7)$$

Dependence of phase speed on frequency. We express through the space velocity related to the frequency transmitted to the device as:

$$\vartheta_p(\nu) = \vartheta_0(1 + \alpha\nu) \quad (8)$$

Here: ϑ_0 - low frequency spatial velocity, ν -frequency, α -coefficient depending on the location of the fibers. Using equation (8), it is possible to determine the microneural index of the fibers by using the frequencies applied to the fibers in the universal device, since the sound speed $\vartheta_p = 343$ m/s is required, which allows us to determine how much frequency ν should be applied and thereby determine the microneural index of the fibers.

When determining the microneural index of fibers using a universal device, we should pay attention not only to the frequency of impact, but also to the humidity and temperature of cotton fibers.

In this case, the moisture content of cotton fibers should be in the range $W=6,5-8,5\%$. If the humidity is high, acoustic waves will not be reflected from the fiber walls, but from water molecules, indicating that unripe cotton fibers are ripe.

The temperature should be $T=20^\circ$. This keeps the air density ρ_0 constant, as a result of which the phase velocity of sound does not change.

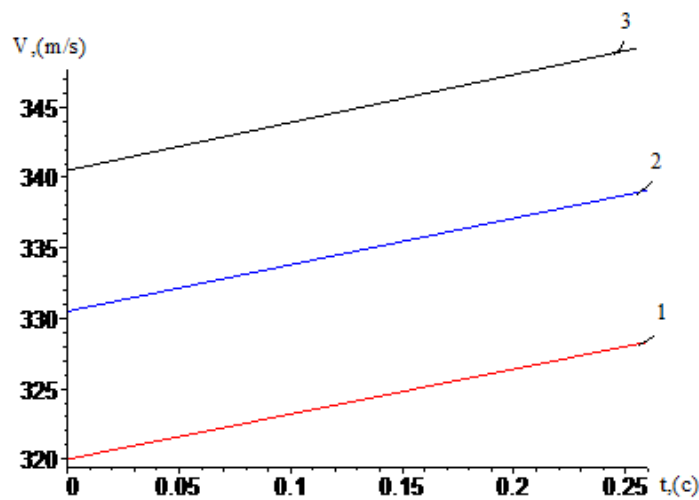


Figure 1. Graph of the low-frequency phase velocity as a function of frequency in determining the microneural index $\vartheta_{01} = 330 \frac{m}{s}$; $\vartheta_{02} = 340 \frac{m}{s}$; $\vartheta_{03} = 350 \frac{m}{s}$ of fibers at different values

Therefore, when determining the microneural index of cotton fibers using a universal device, it is important to correctly select its humidity and temperature. The frequency of impact on fibers can be determined using the following ripening coefficient [2].

$$k_p = \frac{4\pi A}{\rho^2} \quad (9)$$

Here, it is sufficient that the cross-sectional area of A-fibers, the density of, ρ -fibers (g/cm³), and the degree of cotton fiber ripening $k_p > 0.8$.

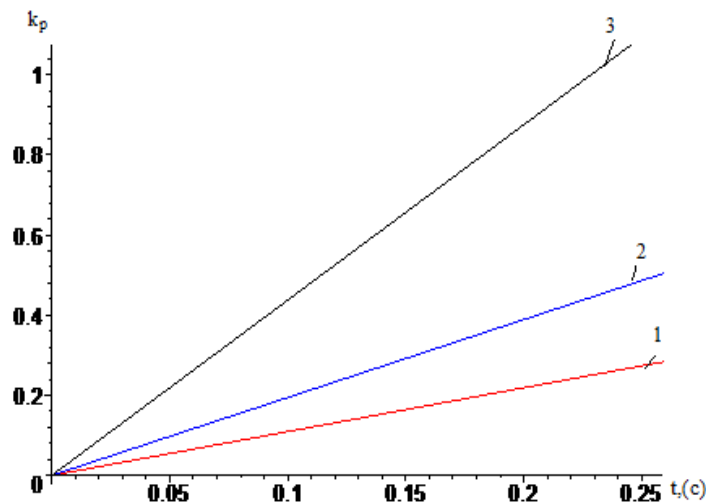


Figure 2. Graph of the change in the fiber ripening coefficient over time at different values $\rho_1 = 0.2 \frac{\text{gr}}{\text{sm}^3}$; $\rho_2 = 0.3 \frac{\text{gr}}{\text{sm}^3}$; $\rho_3 = 0.4 \frac{\text{gr}}{\text{sm}^3}$ of fiber density and speed

Conclusion: Considering that the fiber ripening coefficient $k_p = 0.6 - 1.0$ changes from the above graphs, it allows us to determine that the fiber is ripened at a density of $1.6 \frac{\text{gr}}{\text{sm}^3}$ and a frequency phase velocity of $\vartheta_{02} = 340 \frac{\text{m}}{\text{c}}$.

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