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Research of Electromagnetic Field Distribution when UHF-drying Wool in the Device

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GOAL OF THE STUDY

In the work it is necessary to carry out the calculation of the antenna device, to investigate the electromagnetic field distribution in the wool drying chamber at different number of switched on magnetrons, and determine: duration of wool drying at UHF power volume density of 0,01 W/cm^3; duration of wool drying when changing the volumetric density of UHF power; duration of wool heating for volumetric UHF energy density 0,01 W/cm^3; duration of wool drying during cyclic heating for a volumetric UHF energy density of 0,01 W/cm^3. To analyze the spectral dependencies (IR spectrum) of dirty and washed wool irradiated with microwave field and non-irradiated with microwave field. To analyze the dependence of breaking load of wool irradiated with microwave energy and non-irradiated on the value of wool bulk density

METHODOLOGY OF THE INVESTIGATION

As a result of numerous measurements of the characteristics of helical antennas in the axial radiation mode, the approximate dependencies for helices with a pitch angle were established $a = 12…15^\circ$

Table 1. Design parameters of a helical antenna

Options	Unit of measurement
1. Number of turns	3
2. Winding diameter, mm	30
3. Step	20 ± 2
4. Total wire length, mm	335 + 5
5. Distance between reflector and spiral, mm	21
6. Wire thickness, mm	2,8...3,5

MAIN RESULTS FROM THE STUDY

The actual wool moisture content (W_0) as a percentage was calculated using the formula:

$$W_0 = \frac{m_1 - m_2}{m_2} \cdot 100,$$

m_1 – is the initial mass of the wool sample, g; m_2 – permanent dry weight of wool sample, g.

The amount of energy that is absorbed per unit time in a unit volume of the irradiated medium is determined by the Joule-Lenz law and is equal to:

$$Q = 0,278 \cdot 10^{-10}\, \varepsilon \,\mathrm{tg}\, \delta\, f E^2,$$

ε – is the relative dielectric constant of the medium; tg δ – is its dielectric loss tangent: f – electromagnetic field frequency, Hz; E – electric field strength inside wet wool, V/m.

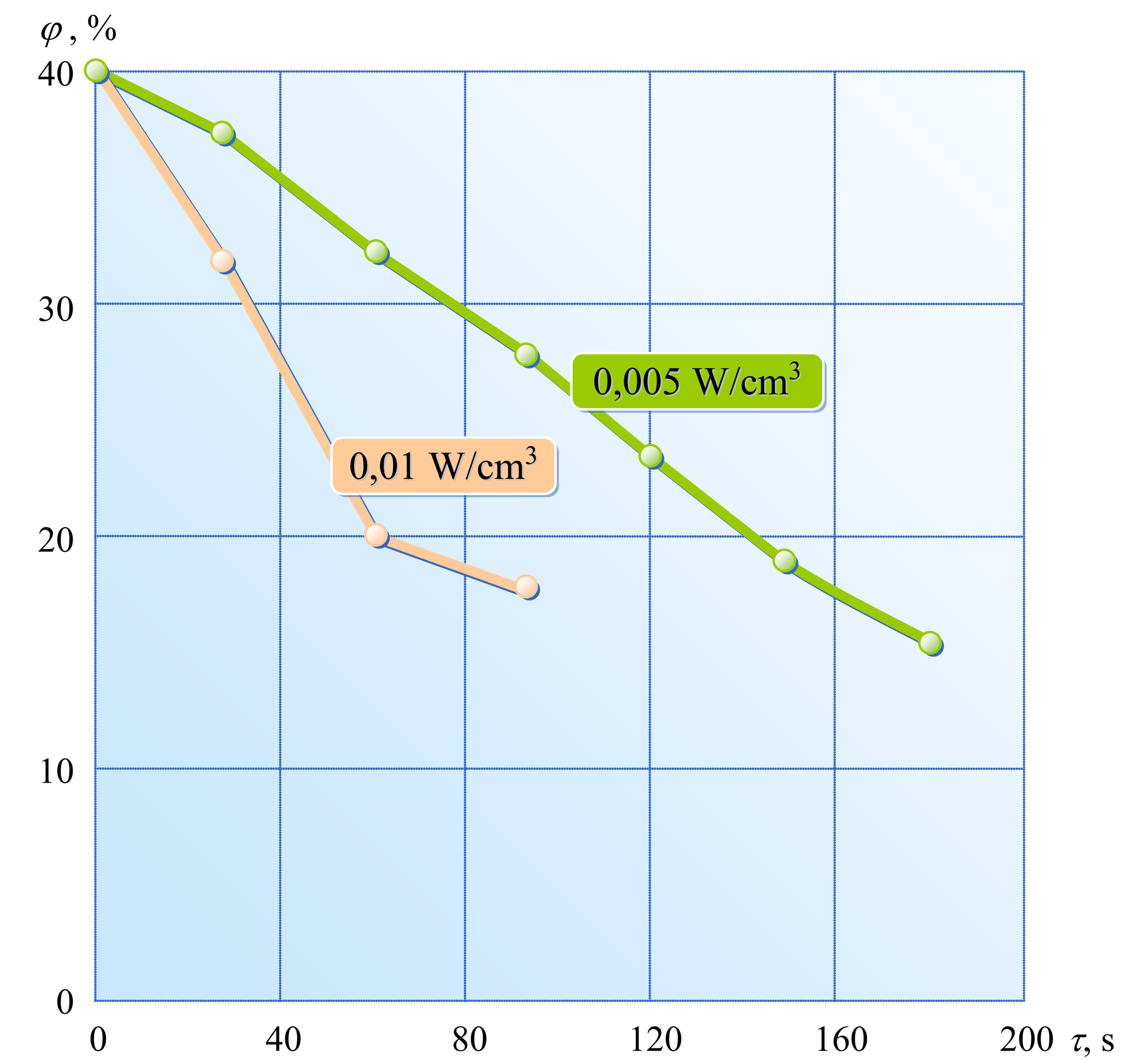

Fig. 1. Duration of wool drying when changing the volumetric density of UHF power

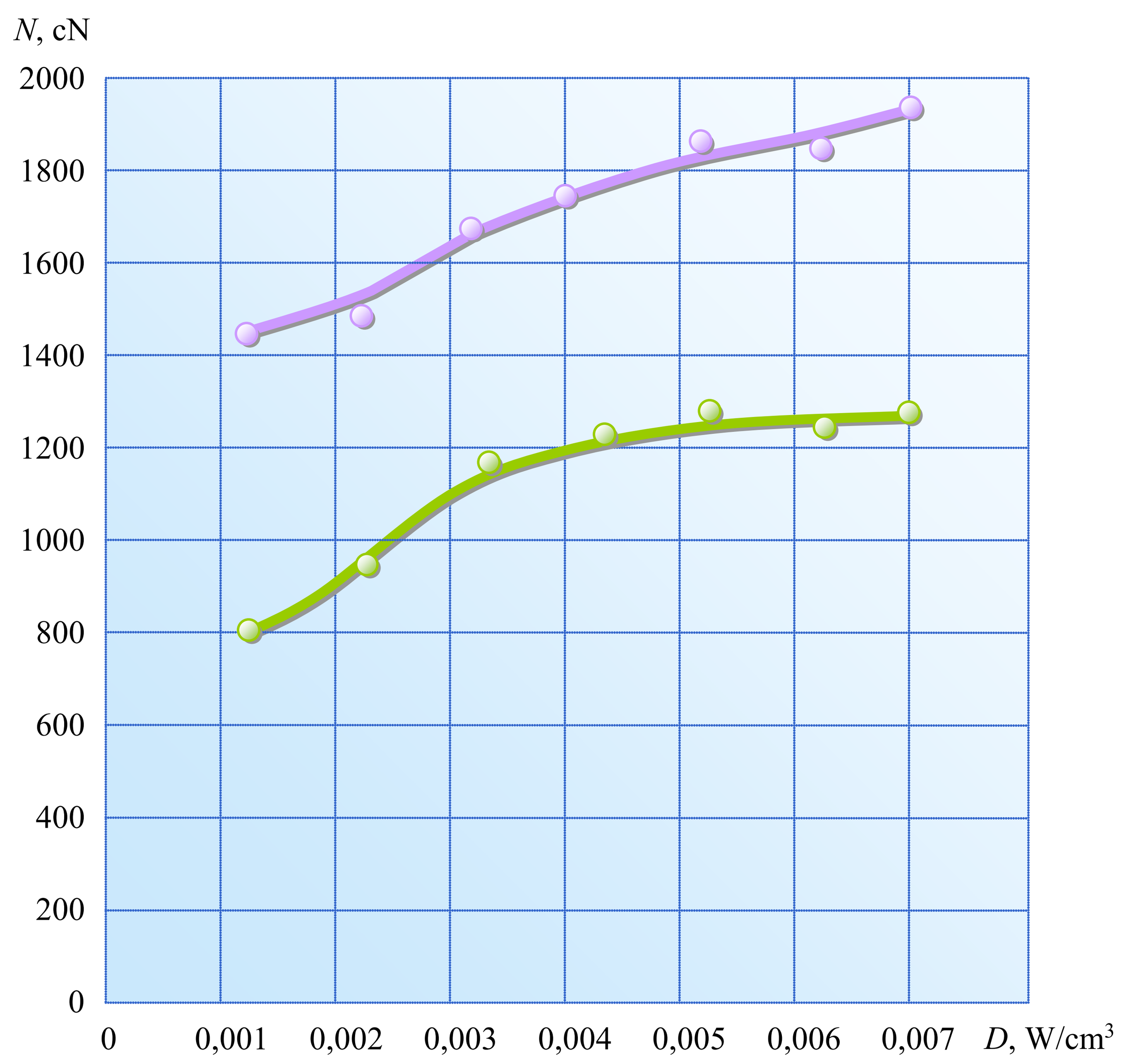

Fig. 2. Dependence of the breaking load (N) of wool when irradiated with UHF energy on the value of bulk density: ● – semi-fine; ● – semi-coarse

CONCLUSIONS

An increase in the number of input devices (magnetrons) leads to equalization of the electromagnetic field in the working chamber and, as a result, a more uniform temperature field is obtained, which improves the quality of the dried fiber. The drying intensity process depends both on the moisture content and on the volumetric density of UHF energy.

To reduce drying time and energy consumption, it is necessary to strive to bring the moisture content of wool to 30...40% using mechanical spinning methods. In the wool-water system, at a humidity of 40%, the temperature rises to 100° C in just 9 s at a volumetric UHF energy density of 0,01 W/cm^2. The use of cyclic drying will reduce energy costs by three times. When wool is treated with UHF energy, its relative strength increases by 4...5 cN/tex, and the breaking load by 400...500 cN.