TEMPERATURE CHANGE OVER TIME IN A LAYER OF RAW COTTON DURING THE DRYING PROCESS

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ABSTRACT Scientific research is being carried out around the world aimed at improving the accuracy and speed of cotton moisture control devices and expanding their functionality. Research into the development and improvement of instruments that provide high accuracy, sensitivity, speed and improved metrological characteristics in monitoring the moisture content of cotton is becoming increasingly important.

Keywords: cotton, moisture, device, mass ratio of moisture, devices, error, automated device

Introduction Depending on the state of moisture in the material and the possibility of its removal, free moisture, capillary-bound moisture (physical-chemical bonds), and hygroscopic moisture, as well as excess and equilibrium moisture, are distinguished.

Free moisture is moisture that is less than other bound to the material. It is expressed by the formula

$$U_{с.в}=U - U_{г}$$

where $U_{г}$ is the maximum hygroscopic moisture content of the material;

U is the total moisture content of the material.

Free moisture includes the main amount of osmotic moisture, microcapillary moisture and moisture in non-capillary pores, as well as wetting moisture [1].

Hygroscopic moisture is more firmly bound to the material. Materials in which there is still free moisture are called wet, in contrast to those in which there is only hygroscopic moisture. A material is considered wet when the partial vapor pressure at its surface at an infinitesimal drying rate is equal to the saturated vapor pressure at the surface of pure water. Hygroscopic moisture ($U_{г}$) is the moisture content of the material corresponding to its value at relative air humidity φ = 100%.

It characterizes the ability of the material to absorb moisture from the air, i.e., its hygroscopicity.

Excess moisture (U_n) is understood as such that can be removed from the material under certain drying conditions and given parameters of the ambient air. It consists of free moisture and that part of the hygroscopic which can be removed under these drying conditions.

$$U_n = U - U_p$$

where U_p is the equilibrium moisture content of the material.

Equilibrium moisture content of the material - a wet material can give off moisture, evaporating it under certain conditions into the environment, but can also absorb moisture from the environment. The absorption of water vapor from the atmosphere by raw cotton or fiber is called sorption, the process of transferring moisture from the material to the atmosphere is called desorption.

Development: When moisture is removed from the layer of raw cotton, located between the heated plates, the heat exchange processes of the raw cotton with the walls of the plate take place according to Newton's law, which is described by the equation

$$c\rho \frac{dT}{dt} = \alpha (T_0 - T)$$

where is the raw cotton temperature averaged over the layer thickness, deg; is the temperature of the plate, deg; is the reduced specific heat capacity of the raw cotton, The specific heat capacity according to the work [2] depends on the humidity according to the formula

$$c = \frac{c_0 + 0.01 c_в W}{1 + 0.01 W}$$

where is the specific heat capacity of absolutely dry raw cotton, is the specific heat capacity of water, is the time-variable moisture content of the raw cotton layer. In the case under consideration, according to, we accept

$$W = W_p - (W_p - W_0)\exp(-Kt)$$

$$\frac{dT}{T_0 - T} = \frac{\alpha}{c_9 \rho} \frac{a_1 + b_1 \exp(-Kt)}{a_2 + b_2 \exp(-Kt)}$$

$$a_1 = 1 + 0.01W_p\,,\; a_2 = 1 + 0.01W_p c_в./c_0 \quad b_1 = 0.01(W_0 - W_p)\,,\quad b_2 = 0.01(W_0 - W_p)\; c_в / c_0$$

The solution of equation, which satisfies the initial condition, has the form

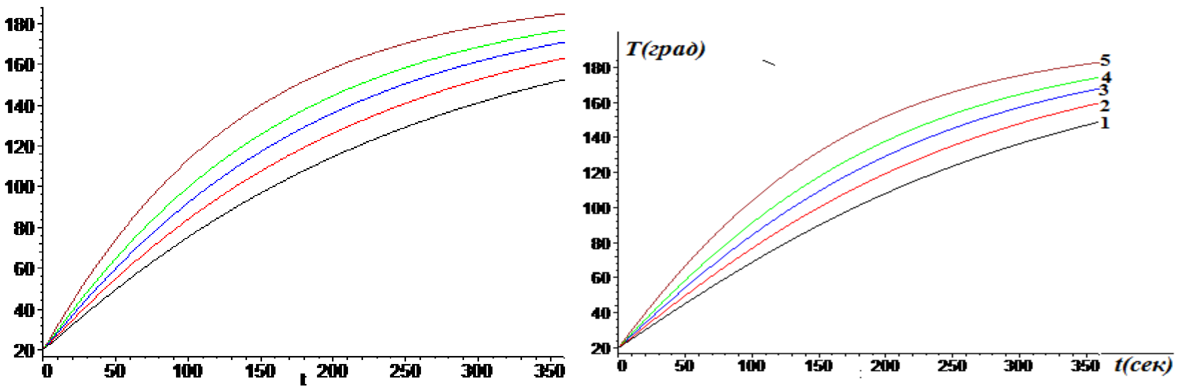
$$-\ln\frac{T_0 - T}{T_0 - T_n} = -\frac{\alpha}{c_0\rho}\frac{(a_2b_1 - a_1b_2)\{\ln[a_2 + b_2\exp(-Kt)] - \ln(a_2 + b_2)\} - a_1b_2Kt}{Kb_2a_2}$$

Solving the last equation for temperature, we obtain

Shows the time dependence curves of the raw material temperature for two cases of initial humidity and different values of the heat transfer coefficient between the plate and the raw material. In the calculations, it is assumed

$$T = T_0 - (T_0 - T_n)\exp\{\frac{\alpha}{c_0\rho}\frac{(a_2b_1 - a_1b_2)\{\ln[a_2 + b_2\exp(-Kt)] - \ln(a_2 + b_2)\} - a_1b_2Kt}{Kb_2a_2}\}$$

$Wn := 28.23 \quad Wp := .06 \quad k := .012$ $\qquad\qquad$ $Wn := 9.32 \quad Wp := .7 \quad k := .023$



Picture 1

Picture 1. Change in the temperature of the layer of raw cotton from time to time at different values of the heat transfer coefficient between the raw plate

$1-\alpha = 0.5,\; 2-\alpha = 0.6,\, 3-\alpha = 0.7,\, 4-\alpha = 0.8,\, 5-\alpha = 0.9$

Conclusion Based on the results of theoretical and experimental studies, software was developed and implemented, consisting of a leveling function and an algorithm for automatically adjusting the effect of temperature, which ensures the operation of the electronic unit of the device.

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