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MATHEMATICAL MODELING IN DETERMINING THE PARAMETERS AFFECTING COTTON QUALITY INDICATORS

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ANNOTATION: Due to the fact that the heat and moisture exchange characteristics of cotton components are different, the process of heating and dehydration of these components takes place unevenly in cotton garams. Therefore, it is necessary to know the heat and moisture transfer parameters of cotton components. They include heat capacity, temperature conductivity, thermal conductivity, moisture conductivity.

The physical side of the problem is that the cotton raw material in the garam is self-heating as a biological system. This situation is called self-reorganization

The seeds in cotton raw materials form an inversion biological system and have the property of generating heat and moisture. The cotton picked from the fields is rarely fully ripe. This causes the generation intensity to vary.

KEY WORDS: Cotton, moisture, capacity, temperature, physical-mechanical, process, density, bund, biological, heat, chemical.

INTRODUCTION: Cotton belongs to the type of materials that do not transmit heat and moisture. The heat capacity C (kJ/°C) of cotton per 1 kg of absolute dry material can be determined by the following formula.

$$C = C_{mq} + 4.2V/100.$$

Here: C_{mq}-is the heat capacity of absolute dry cotton equal to 1.6-1.7 kJ/°C; V-cotton moisture, in percent. Heat transfer - transfer of thermal energy of cotton components. It depends on the humidity, temperature and volumetric weight of the cotton. Heat transfer of cotton is characterized by heat transfer λ- coefficient.

For absolutely dry cotton, temperature transfer λ=0.33 W/(m°C) is the ability of cotton components to expand the temperature field. It is characterized by the heat transfer coefficient a-. For cotton:

$$\alpha = \lambda/(C\gamma).$$

Here: specific gravity of γ −cotton.

Moisture transfer is the ability of cotton to transfer moisture.

For cotton: $\lambda^1 = 0.75 * 10^{-4} m^2/c$.

The physical and mechanical properties of cotton raw materials stored in the warehouses of cotton palaces differ sharply from their properties in the field.

Table 1

Thermal and physical parameters of cotton.

Indicators	Fiber	Shell	Magiz

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Relative weight, $\gamma, \frac{kN}{m^3}$ heat capacity, $C(kJ/kg * °C)$ Coefficients: temperature transfer α, $10^{-3}\frac{m^2}{c}$ heat transfer λ, $Vt/(m°C)$. wet transfer, $\lambda^1, 10^{-4}m^2/c$	15.2 1.8 0.08 0.06 0.9	3.8 1.67 0.47 0.24 0.3	16.2 1.55 0.5 0.35 0.075

Including:

a) high concentration in limited areas;

b) high density of cotton raw material in garam;

c) the size of the goods is large;

g) different humidity levels.

Such conditions do not change the physical state of the cotton pieces, but change their interaction with the external environment.

It is known that in the initial processing of cotton, how it is stored is of great importance. Because during the storage of cotton raw material in garam, some properties deteriorate, and some improve.

Therefore, mathematical modeling of cotton raw material storage conditions and physical-mechanical conditions occurring in it is of great importance.

Putting the problem.

The advantage of mathematical modeling is that with its help, it is possible to observe the technological properties of cotton raw materials, their changes during the storage period.

When creating the model, it is necessary to take into account the change of the following factors:

- changes in the density of cotton in the pile;
- change in heat transfer characteristics due to temperature change;
- compressive strength and relative weight of raw cotton according to the height of the pile.

The size of the garams made in the cotton warehouses is usually

It is 22×11×10 m and has the shape of a parallelepiped. It has been determined in experiments that the moisture content of raw materials is 9-10%, and the degree of contamination is around 5÷5.5%. The density of cotton raw material is 80-110 kg/m^3 in the upper layer of the pile, and 300-350 kg/m^3 in the lower layer.

In the mathematical model, in order for the thermal conductivity of the raw cotton in the garment to be at a certain level, it is necessary to maintain the necessary thermal insulation and air permeability at a certain level.

In the lower layer of cotton garam, the increase in density usually weakens the strength of cotton fibers. This situation, in turn, cannot be explained by the deterioration of the mechanical properties of the fibers. Because even when the fibers have a density of up to 300 kg/m^3, their mechanical properties do not decrease.

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The raw material stored in cotton wool can form a system that changes its physical and mechanical properties by changing its influence on the external environment, that is, through biological, thermal, chemical and other processes.

After the cotton is picked from the fields, it can be explained by the high heat storage-insulating properties of the fibers in it, the biological activity of the seed, the heat release, and the change in the humidity in the state of pressing.

Therefore, it is important to study the physico-mechanical process during the initial processing of cotton, the self-heating of cotton raw materials in the garam.

Creating a mathematical model that determines the change of non-stationary heat flow in cotton raw materials

The physical side of the problem is that the cotton raw material in the garam is self-heating as a biological system. This situation is called self-reorganization. Self-reorganization:

- sufficient humidity;
- unripe seed;
- occurs due to high temperature storage of cotton.

In the mathematical modeling of the problem, we accept the parameter of heat release in the biological (seed) system as the cause of the self-development process in raw cotton.

In solving the technological issues of cotton storage and initial processing, the study of the nature of heat distribution in raw materials and its analysis is the main issue. Because any change in its temperature causes the main properties of cotton raw material to change. For example, due to kinetic and biological processes, the accumulated temperature in the tank can be spread over a large surface with a nonlinear law over time in a small-local state. As a result, a small change in temperature causes a qualitative change in the physical properties of raw cotton. The physical processes that take place in raw cotton in Garam are not homogeneous, but are subject to non-stationary nonlinear laws. In this case, in addition to the above-mentioned features, it is necessary to determine some parameters experimentally when constructing a mathematical model of the problem. One of them, the coefficient of heat transfer of raw cotton - л, based on experiments [9], we can express it with the following empirical formula:

$$\lambda = \propto_1 + \propto_2 T + \propto_3 \rho + \propto_4 w \,. \qquad (1.1)$$

Here: T-temperature, ρ -volumetric density, w-humidity, $\propto_1, \propto_2, \propto_3, \propto_4 -$ coefficients determined by experience. ρ-volume density for cotton raw material is expressed as follows:

$$\rho = \rho_0\left(1 + \frac{\rho'}{\rho_0}\right) . \qquad (1.2)$$

Here: ρ - volume density at the examined point. ρ_0 - is the average volume density at the checked point. ρ' - deviation from the average volume density at the checked point.

We model the temperature distribution in Garam as follows:

a) let it be in the form of a right quadrangular parallelepiped with dimensions a, b, H, and place the 0xyz-coordinate axes as shown in Fig. 1.

b) we consider that the heat distribution in raw cotton - (yz) is the same on the surface and changes only on the vertical - 0xy plane.

c) the temperature at an arbitrary point of the gas is three variables: t-time and

Let x, y be the function of the coordinate, i.e. - T(t, x,y).

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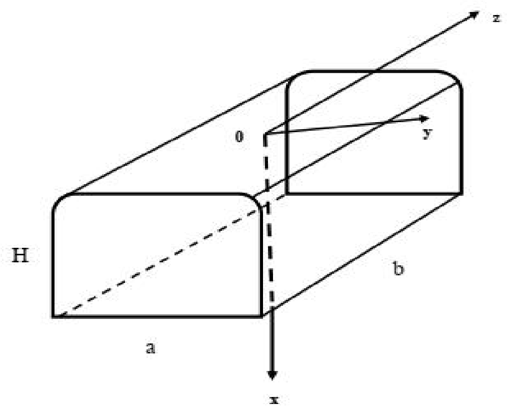

Figure 1. Geometrical scheme of the warehouse where cotton raw materials are stored.
a- the width of the groove; b- the height of the girdle; H- the height of the hill; oxy-Cartesian coordinate system.

According to experimental studies, the temperature can rise to 30-40°C in the hottest part of the gharam, and it is around 16°C in the points far from the heating center. Humidity is 12÷14%. Therefore, we can take $T_{min} = 16°C$, $T_{max} = 28°C$. In this case, if $17°C \leq T \leq 40°C$ changes, we enter the following dimensionless temperature value.

$$T = T_0(1 + V). \qquad (1.3)$$

$V = 0$ at $T = T_0$, V= 1 at $T = 2T_0$ be appropriate.

We use Laplace's heat transfer differential equation to determine the law of temperature distribution in cotton raw material located in the tank:

$$\rho c \frac{\partial T}{\partial t} = \Delta(\lambda T) + f(T) - v_0 \rho c \frac{\partial T}{\partial x}. \qquad (1.4)$$

Here: c-heat capacity; Δ - Laplace operator; v_0 -dispersion speed of the activity of the biological environment in the case of self-heating; $f(T)$ -is a given function, in particular we get $f(T) = -h_1(T - T_0)$. h_1-first linear approximation coefficient.

In order to keep the energy in balance in the distribution of the temperature of the cotton raw material in the furnace, we add a non-linear additional term to the equation (4).

That is:

$$f(T) = -h_1(T - T_0) + h_2(T - T_0)^2; \qquad (1.5)$$

h_2 -quadratic linear approximation coefficient. The solution of the differential equation (4) must satisfy the following initial and boundary conditions in terms of t and x-coordinates:

$$T(0, x) = T(x), \qquad (1.6)$$

$$T(t, 0) = \varphi_1(t), \qquad (1.7)$$

$$T(t, H) = \varphi_2(t). \qquad (1.8)$$

Before solving the differential equation (1.5), we pass to the following dimensionless quantities: $\bar{x} = \frac{x}{H}$, $\tau = \frac{t}{t_0}$, $V = V(\tau, \bar{x})$.

Here H- is the height of the pile, , t_0-is the storage time of the cotton in the pile, $V(\tau, \bar{x})$ - is a dimensionless temperature function. We express the relative density of cotton raw material in the pile by means of $\bar{x}$-coordinate in linear laws:

$$\rho(\bar{x}) = \rho_0(1 + k * \bar{x}) \qquad (1.9)$$

In this case, we write the differential equation (1.5) in dimensionless quantities, taking into account (1.4), (1.5) and (1.6).

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$$\frac{dV}{d\tau}=f(\overline{x})\ \frac{d^2V}{d\overline{x}^2}-v_0\frac{\partial T}{\partial \overline{x}} \qquad (2.10)$$

Here: $f(\overline{x}) = \frac{T_0(1+4.7k_0+3k_0t_0(1+k_0)\overline{x}+1.7k_0x_0\overline{x})}{3t_0\rho_0c(1+k_1x_0\overline{x})}$

Therefore, the equation (2.10) is the Laplace equation of the temperature distribution of the raw cotton in the cotton bale.

CONCLUSIONS: Appropriate models representing the pattern of changes in the density and pressure of raw cotton in the layers separated by the height of the cotton pile have been obtained. Using Laplace's differential equation of heat transfer, a mathematical model was created that determines the temperature changes that negatively affect the quality indicators of raw cotton stored in the warehouse.

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