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MODELING OF THE INITIAL PROCESSING PROCESSES OF MULBERRY SILKWORM COLONS

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ABSTRACT

In this article, it is based on the use of sunlight energy as one of the main ways to reduce the consumption of energy resources in the initial processing of mulberry silkworm cocoons.
Development and creation of a pilot sample of an improved device specially designed for devitrification of cocoons with the help of solar energy, and the technology of complete drying of devitalized cocoons was developed. At the same time, a mathematical model of the preliminary processing of mulberry silkworm cocoons was developed.

Keywords: Cocoon, silk content, cocoon moisture, cocoon mass, cocoon shell mass, cocoon length, correlation coefficient, cocoon absolute error.

The Republic of Uzbekistan is a country that grows mulberry silkworm cocoons, which is an important strategic product. Coir is a raw material with great export potential, and it is possible to produce various products from it. In order to further increase the volume of cocoon cultivation, improve its quality, reduce the consumption of energy resources during preliminary processing of cocoons - devitalization and drying of cocoons, among other measures, it is required to develop and introduce modern technologies.

The cocooning season in Uzbekistan coincides with the sunniest months of the year, i.e. May and June. During these months, cocoon pre-processing bases of the Republic use SK-150K conveyor cocoon drying units, which process with the help of physically and mentally old hot air. In these units, 85-90 kg of diesel fuel and 70-75 kW of electricity are used to process 1 ton of cocoons.

In the conditions of our republic, one of the main ways of reducing the consumption of energy resources in the preliminary processing of cocoons is the use of solar energy.

In this regard, one of the urgent tasks is to develop and create an experimental model of an improved device, specially designed for devitrification of cocoons with the help of solar energy, and to develop a technology for complete drying of devitalized cocoons. As a result of this implementation, it is possible to save fuel and electricity during the preliminary processing of cocoons, it is possible to kill cocoons even on cloudy days, and 4-7 times faster and better complete drying of cocoons with dead cocoons compared to shaded cocoon dryers.

After the cocooning season, the devices can be used for drying other agricultural products.

The improved device designed for devitrification of cocoons with the help of solar energy is aimed at solving practical issues of saving energy resources spent in devitrification of cocoons and speeding up the complete drying process for long-term storage of treated cocoons. About 1,700-1,800 tons of diesel fuel and 1,400-1,500 mln. kW of electricity is saved.

The scientific value of the project consists in the development of an improved pilot model of a special, energy-saving device for devitrification of cocoons using solar energy, as well as a new technology for complete drying of devitalized cocoons.

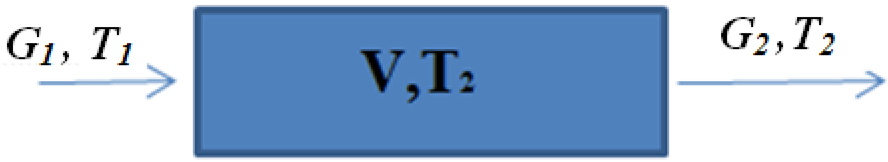
The planned results are in line with the results of world-class research. From the world experience, it was known that the devices created for the initial processing of cocoons with the help of sunlight were designed for processing only on sunny days, and the performance was low. As a result of the implementation of the results of this project, due to the direct and indirect use of solar energy in the device, even on cloudy days, it will be possible to completely kill the cocoon without lowering the temperature inside the device's chamber.

Mathematical models allow studying the static and dynamic states of the technological process. On the basis of the results obtained in the static models, the constructions of the optimal size of the devices are designed. The research conducted in the dynamic models of the process is the basis for the design of control (correction) systems of this process.

Technological processes are usually carried out with heating. For this, devices of various constructions are used.

In the modeling of the processes carried out in the mulberry silkworm cocoon pre-treatment device with the help of solar energy, its elementary processes are determined using the systematic analysis method. After studying them in depth, mathematical expressions of elementary processes are created, then they are combined into a system of equations and a model of the entire technological process is created.

The cocoons are supplied to the device with input G1 and temperature T1, and exit with input G2 and temperature T2.



The temperature inside the device, T2, is the same as the temperature in the whole volume, because the temperature of the cocoon inside the device and the temperature at every point of the device are the same.

When modeling the processes taking place in the working environment of the device, they can be divided into several elementary processes.

The following equation can be written for the amount of heat input to an improved solar device:

$$Q_{coming.} = Q_1 + Q_2 \qquad (1)$$

where, Q_{coming} is the amount of heat coming the device; Q_1 – the amount of heat passing through the glass of the device; Q_2 is the amount of heat coming to the device from electric heaters.

The equation $Q_{coming} = Q_3 + Q_4$ (2) can be written for the amount of heat input to the solar device. Here, Q_3 is the amount of heat supplied to the inner walls of the device and the container from which the cocoon is removed; Q_3 is the amount of heat used to heat the cocoons in the device. Equating equations (1) and (2), we create the heat balance equation:

$$Q_1+Q_2 = Q_3+Q_4 \qquad (3)$$

From this equation, the amount of heat used to heat the cocoons in the working chamber of the device can be determined.

$$Q_4= Q_1+Q_2 - Q_3 \qquad (4)$$

The process of accumulation of matter inside the device depends on the consumption of incoming and outgoing cocoons (material balance), i.e.

$$\frac{dV}{d\tau} = G_1 - G_2 \text{ or, } V=S\cdot H \quad \text{if} \quad \frac{dH}{d\tau} = \frac{G_1-G_2}{S} \quad .$$

The process of heat accumulation of the internal wall of the device (ie, the change in wall heat) depends on the difference of heat coming and going to the wall (heat balance equation), i.e.

$$\frac{dQ_{wall}}{d\tau} = Q_{\text{come}} - Q_{going}$$

where, Q_{wall} is wall heat,

$$Q_{wall}=\rho_{wall}\cdot V_{wall}\cdot C_{wall}\cdot T_{wall}\,,$$

ρ_{wall} is the density of the wall material;
V_{wall} is the size of the wall;
C_{wall} –wall heat capacity;
T_{wall} –wall temperature.

Q_{come} – amount of heat coming to the wall $Q_{\text{come}}=\lambda_1\cdot S_1\cdot(T_k-T_{wall})$
where, λ_1– coefficient of heat transfer to the wall of the device; S1–heat transfer surface.

Q_{going} – amount of heat leaving the wall $Q_{going}=\lambda_2\cdot S_2\cdot(T_{wall} -T_2)$,
where, λ_2 is the coefficient of heat transfer to the wall of the device; S_2–heat transfer surface; T_2 is the temperature of the cocoon inside the device.

Taking into account the above, we form the following equation:

$$\rho_{wall}\cdot V_{wall}\cdot C_{wall}\frac{dT_{wall}}{d\tau} =\lambda_1\cdot S_1\cdot(T_k-T_{wall}) - \lambda_2\cdot S_2\cdot(T_{wall}-T_2).$$

The heat of the cocoon inside the device varies depending on the amount of heat entering and leaving it (heat balance equation).

$$\frac{dQ}{d\tau} = Q_{\text{come}} - Q_{going}$$

The amount of heat given to the cocoon is equal to $Q=\rho\cdot V\cdot C\cdot T_2$. Bunla ρ is the density of cocoons inside the device; V – size of cocoons; C – specific heat capacity of the cocoon; T_2 is the temperature of the cocoons.

Q_{come} is the amount of heat coming to the cocoon, $Q_{\text{come}}=\rho\cdot G_1 \cdot C\cdot T_1+\lambda_2\cdot S_2\cdot(T_{wall}-T_2)$ where the amount of heat coming to the container with the cocoon; $\lambda_2\cdot S_2\cdot(T_{wall}-T_2)$ is the amount of heat supplied to the cocoon from the device wall.

Q_{going} is the amount of heat leaving the device container, equal to $Q_{going}=G_2\cdot C\cdot T_2$.

Putting the amounts of heat coming and going to the cocoons inside the device into the heat balance equation, we get:

$$\frac{d(\rho\cdot V\cdot C\cdot T_2)}{d\tau} = \rho\cdot G_1\cdot C\cdot T_1+\lambda_2\cdot S_2\cdot(T_{wall}-T_2) - G_2\cdot C\cdot T_2 \,.$$

When solving this equation, it is necessary to take into account that the size and temperature of the cocoons inside the device vary with time, i.e.

$$\rho \cdot C \cdot T_2 \frac{dV}{d\tau} + \rho \cdot V \cdot C \frac{dT_2}{d\tau} = \rho \cdot G_1 \cdot C \cdot T_1 + \lambda_2 \cdot S_2 \cdot (T_{wall} - T_2) - \rho \cdot G_2 \cdot C \cdot T_2.$$

Solving this equation with respect to the cocoon temperature T_2, we form a mathematical expression of the heating process of the cocoon inside the device:

$$\frac{dT_2}{d\tau} = \frac{G_1 \cdot T_1}{V} + \frac{\lambda_2 \cdot S_2 \cdot (T_{wall} - T_2)}{\rho \cdot C \cdot V} - \frac{G_2 \cdot T_2}{V} - \frac{T_2 \cdot (G_1 - G_2)}{V}$$

Thus, a mathematical model has been developed for the rate of change in the temperature of cocoons inside a solar device, taking into account the thermal characteristics of its enclosing elements, the arrival of solar radiation and changes in ambient temperature. As a result of comparing the calculated and experimental data on the rate temperature changes of cocoons in a solar device.

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